NL8902

High Quality Sound, JFET Input, Dual Audio Operational Amplifier

FEATURES

- High Quality Sound
- Low Noise 10nV/√Hz at f=1kHz
- Low Distortion 0.0004% at f=1kHz
- High Slew Rate 20V/μs
- Gain Bandwidth Product 9MHz
- Low Input Bias Current 10pA
- High EMI Immunity EMIRR = 82dB (f = 1.8GHz)
- No Phase Reversal over Input Voltage Range
- Unity-Gain Stable
- Operating Voltage Range ±4.0V to ±16V
- Quiescent Current 2.6mA (Dual)
- JFET Input
- Bipolar Technology
- Package Outline EMP-8-AN, DFN4035-8-GR

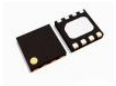
APPLICATIONS

- Home Audio
- Professional Audio
- Car Audio
- Portable Audio

DESCRIPTION

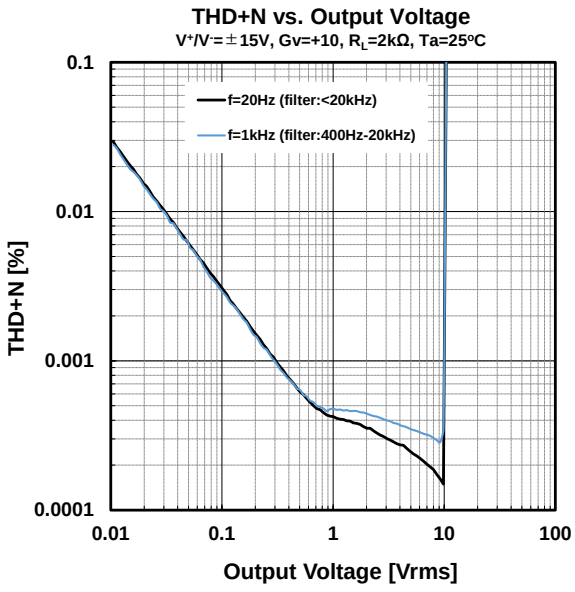
The NL8902 is a high quality sound dual audio operational amplifier that applies the high quality sound technology of "MUSES" to a more productive technology.
The NL8902 features high quality sound, low noise, low distortion, high slew rate, and high EMI Immunity. The NL8902 is suitable for preamplifiers, active filters, line amplifiers, and other applications, especially for I/V conversion amplifiers that take advantage of the low input bias current characteristics of JFET inputs.

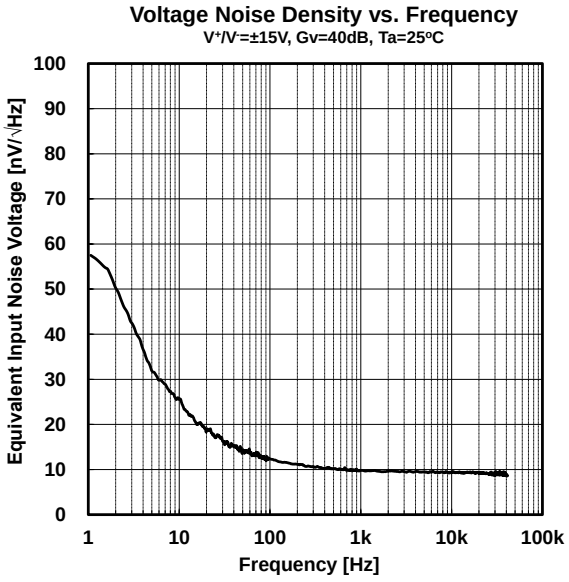
NL8902AN
(EMP-8-AN)



NL8902GR
(DFN4035-8-GR)

THD+N and Noise





■ PRODUCT NAME INFORMATION

NL8902 aa A bb S

Description of configuration

Suffix	Item	Description
aa	Package code	Indicates the package. Refer to the order information. AN: EMP-8-AN GR: DFN4035-8-GR
A	Version	Indicates the product version. “A” is initial version.
bb	Packing	Refer to the packing specifications.
S	Grade	Indicates the quality grade. S: Standard

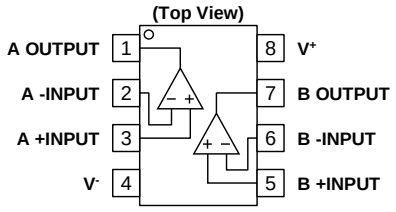
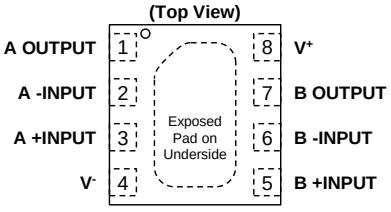
Grade

	Applications	Operating Temperature Range	Test Temperature
S	General−purpose and Consumer application	-40°C to 125°C	25°C

■ ORDER INFORMATION

Product Name	Package	RoHS	Halogen-Free	Terminal Finish	Weight (mg)	QUANTITY (pcs/reel)
NL8902ANAE2S	EMP-8-AN	✓	✓	Sn2Bi	76	2000
NL8902GRAE4S	DFN4035-8-GR	✓	✓	Sn2Bi	18	1500

■ PIN DESCRIPTIONS

Product Name	NL8902AN	NL8902GR
Package	EMP-8-AN	DFN4035-8-GR
Pin Functions		 *About Exposed Pad Floating (Electrical open) or connecting to V-. Floating (Electrical open) state is recommended when sound quality is important.

Pin No.	Pin Name	I/O	Description
1	A OUTPUT	O	Output channel A
2	A -INPUT	I	Inverting input channel A
3	A +INPUT	I	Non-inverting input channel A
4	V^-	-	Negative supply or Ground (single supply)
5	B +INPUT	I	Non-inverting input channel B
6	B -INPUT	I	Inverting input channel B
7	B OUTPUT	O	Output channel B
8	V^+	-	Positive supply

■ ABSOLUTE MAXIMUM RATINGS

	Symbol	Rating	Unit
Supply Voltage (Vs = V^+ - V^-)	V^+/ V^-	±18 (36)	V
Input Voltage *1	V_{IN}	V^- -0.3 to V^+ +0.3	V
Input Current *1	I_{IN}	±10	mA
Differential Input Voltage *2	V_{ID}	±36	V
Storage Temperature	T_{stg}	-65 to 150	°C
Junction Temperature *3	T_j	150	°C

*1 Input voltages outside the supply voltage will be clamped by ESD protection diodes. If the input voltage exceeds the supply voltage,
The current must be limited 10mA or less by using a restriction resistance.
*2 The normal operation will establish when any input is within the "Common-Mode Input Voltage Range" of electrical characteristics. Differential voltage is the voltage difference between +INPUT and −INPUT.
*3 Calculate the power consumption of the IC from the operating conditions, and calculate the junction temperature with the thermal resistance. Please refer to "Thermal characteristics" for the thermal resistance under our measurement board conditions.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

■ THERMAL CHARACTERISTICS

Package	Measurement Result		Unit
	Thermal Resistance (Θja)	Thermal Characterization Parameter (ψjt)	
EMP-8-AN	157 *1 / 103 *2	16 *1 / 12 *2	°C/W
DFN4035-8-GR	182 *3 / 44 *4	TBD	

Θja: Junction-to-Ambient Thermal Resistance
ψjt: Junction-to-Top Thermal Characterization Parameter
*1 2-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 2-layer FR-4).
*2 4-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 4-layer FR-4).
*3 2-Layer: Mounted on glass epoxy board (101.5 mm × 114.5 mm × 1.6 mm: based on EIA/JEDEC standard, 2-layer FR-4, with exposed pad.)
*4 4-Layer: Mounted on glass epoxy board (101.5 mm × 114.5 mm × 1.6 mm: based on EIA/JEDEC standard, 4-layer FR-4, with exposed pad.)
(For 4-layer: Applying 99.5 mm × 99.5 mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5.)

■ ELECTROSTATIC DISCHARGE (ESD) PROTECTION VOLTAGE

	Conditions	Protection Voltage
HBM	C = 100 pF, R = 1.5 kΩ	±1000 V
CDM	FI-CDM	±1000 V

ELECTROSTATIC DISCHARGE RATINGS

The electrostatic discharge tests are done based on JEDEC JS-001 and JS-002.
In the HBM method, ESD is applied using the power supply pin and GND pin as reference pins.

■ RECOMMENDED OPERATING CONDITIONS

	Symbol	Conditions	Rating	Unit
Supply Voltage	V^+/ V^-		±4.0 to ±16	V
Operating Temperature	T_a		-40 to 125	°C

RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

■ ELECTRICAL CHARACTERISTICS

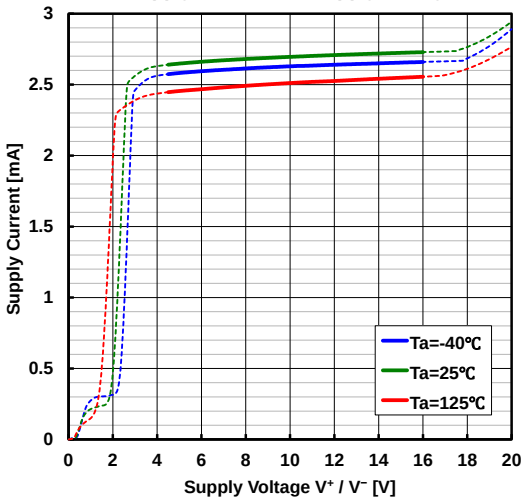
V^+/V^-=±15V, V_{COM} = 0V, R_L=2kΩ to GND, Ta=25°C, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
DC CHARACTERISTICS						
Supply Current	Icc	No Signal, R_L=∞	-	2.6	4.0	mA
Input Offset Voltage	V_{IO}		-	0.8	3.0	mV
Input Bias Current	I_B		-	10	80	pA
Input Offset Current	I_{IO}		-	5	75	pA
Voltage Gain	A_V	R_L=2kΩ, V_O=±13.5V	90	100	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=±12.5V	86	115	-	dB
Supply Voltage Rejection Ratio	SVR	V^+/V^-=±4.0 to ±16V	86	123	-	dB
Maximum Output Voltage 1	V_{OM1}	R_L=2kΩ	±13.8	±14.1	-	V
Maximum Output Voltage 2	V_{OM2}	R_L =600Ω	±13.5	±13.9	-	V
Common Mode Input Voltage Range	V_{ICM}	CMR≥86dB	±12.5	±13.0	-	V
Short-circuit Output Current	I_O		-	50	-	mA
AC CHARACTERISTICS						
Gain Bandwidth Product	GBW	f=1MHz	-	9	-	MHz
Unity Gain Frequency	f_T	C_L=10pF	-	7	-	MHz
Phase Margin	Φ_M	C_L=10pF	-	70	-	Deg
Slew Rate	SR	A_V=+1, V_{IN}=2Vp-p, C_L=10pF	-	20	-	V/μs
Channel Separation	CS	f=1kHz	-	148	-	dB
Total Harmonic Distortion	THD+N	f=1kHz, A_V=+1, Vo=5Vrms,	-	0.0004	-	%
Input Noise Voltage1	e_n	f=1kHz	-	10	-	nV/√Hz
Input Noise Voltage2	V_{NI}	f=20Hz to 20kHz	-	1.4	-	μVrms

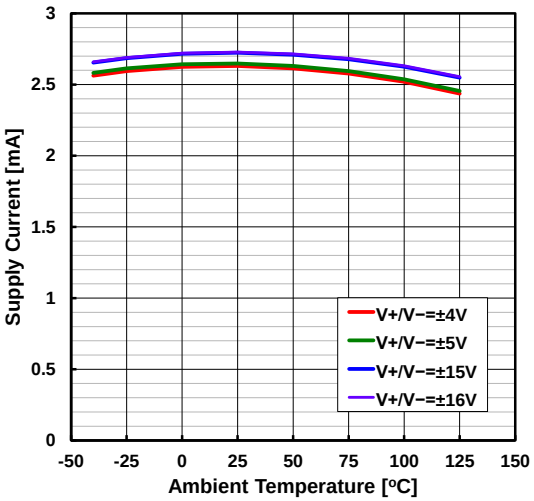
■ TYPICAL CHARACTERISTICS

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

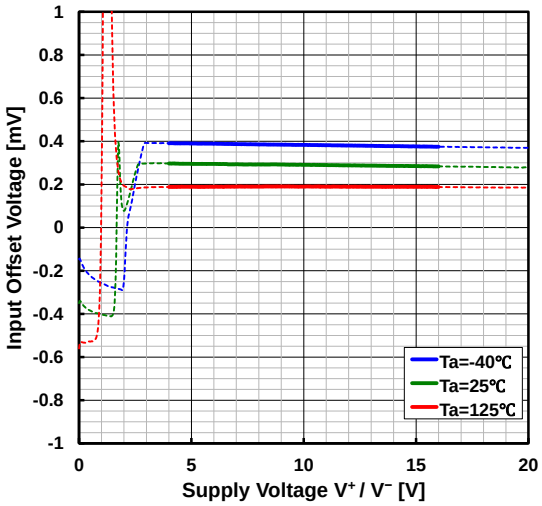
Supply Current vs. Supply Voltage



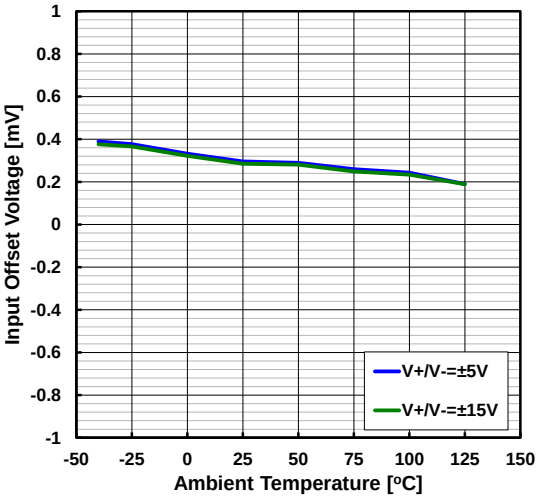
Supply Current vs. Temperature



Input Offset Voltage vs. Supply Voltage

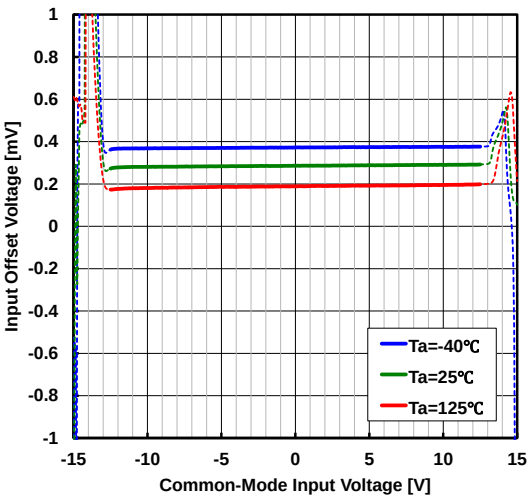


Input Offset Voltage vs. Temperature



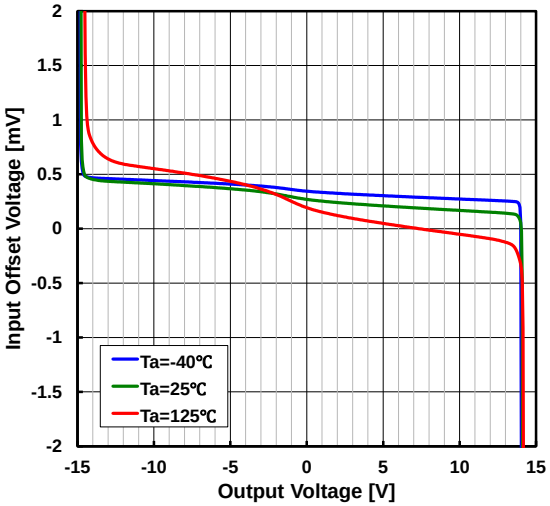
Input Offset Voltage vs. Common-Mode Input Voltage

V+/V−=±15V



Input Offset Voltage vs. Output Voltage

V+/V-=±15V, V_{ICM}=0V, R_L=2kΩ to GND



■ TYPICAL CHARACTERISTICS

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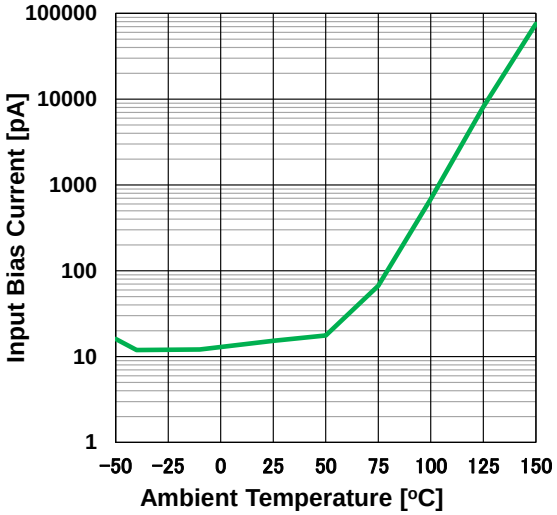
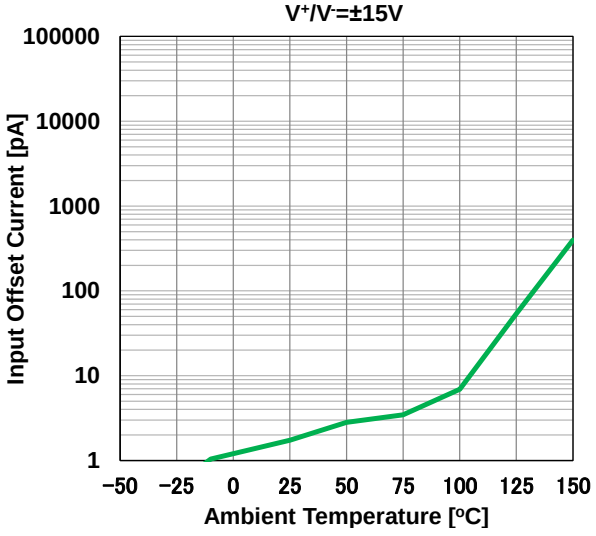
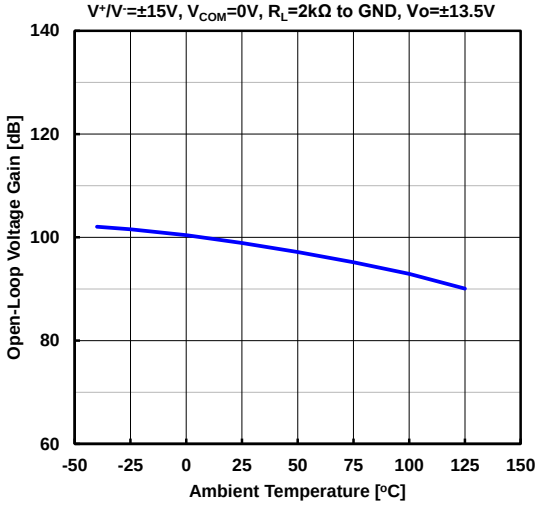
Input Bias Current vs. Temperature
V+/V-=±15V



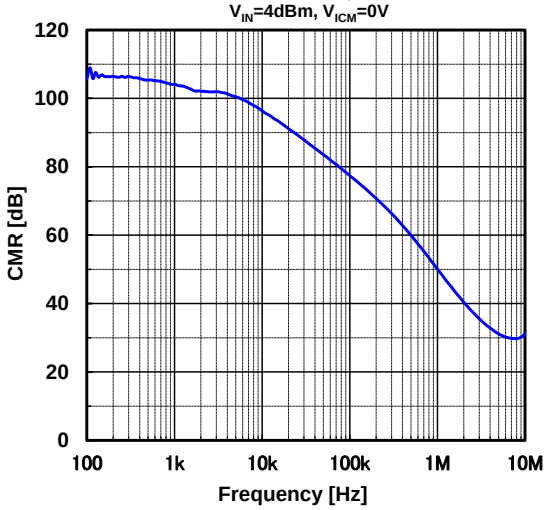
Input Offset Current vs. Temperature
V+/V-=±15V



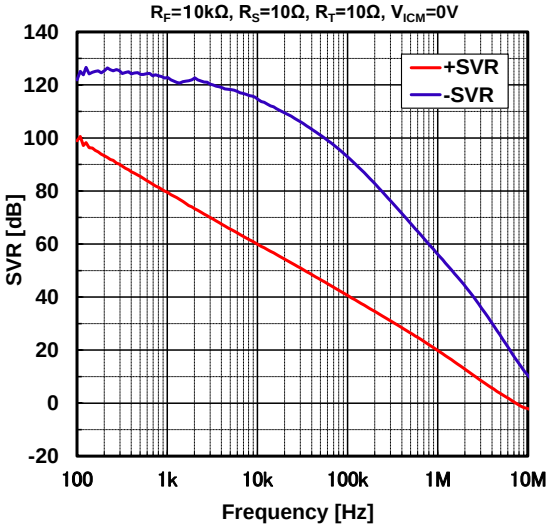
Open-Loop Voltage Gain vs. Temperture
V+/V-=±15V, VCOM=0V, RL=2kΩ to GND, Vo=±13.5V



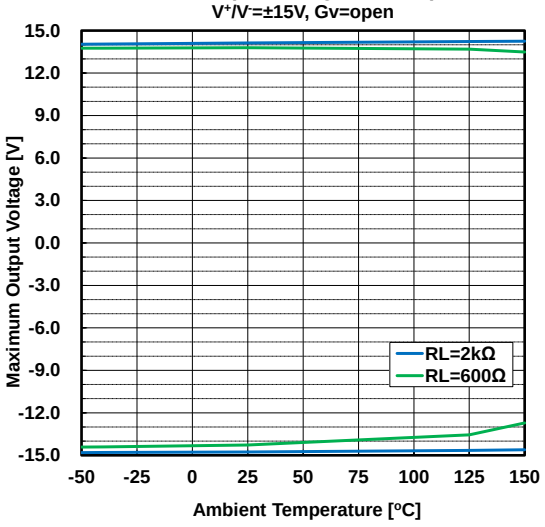
CMR vs Frequency
V+/V-=±15V, RF=10kΩ, RS=10Ω, RT=50Ω,
VIN=4dBm, VICM=0V



SVR vs Frequency
V+/V-=±15V, Gv=40dB
RF=10kΩ, RS=10Ω, RT=10Ω, VICM=0V



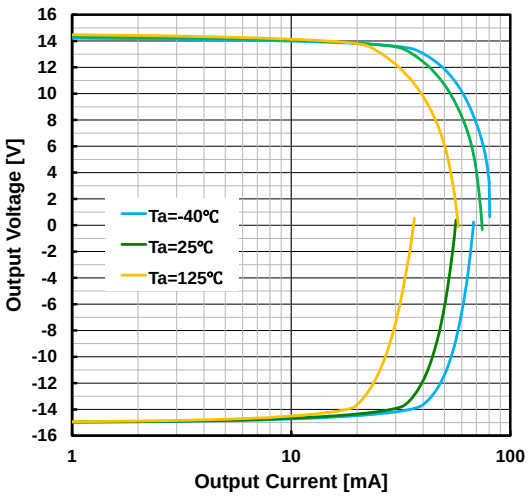
Maximum Output Voltage vs. Temperature
V+/V-=±15V, Gv=open



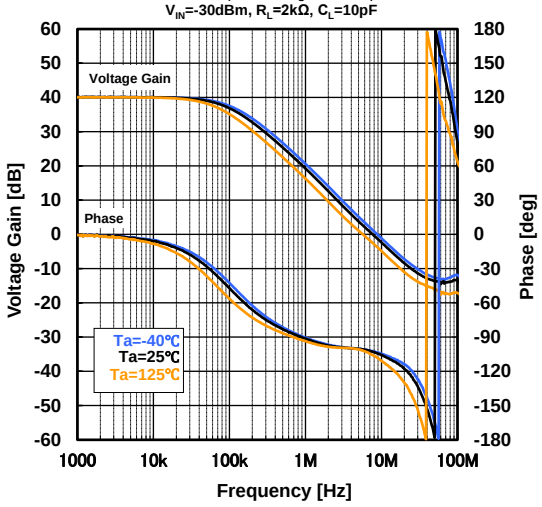
■ TYPICAL CHARACTERISTICS

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

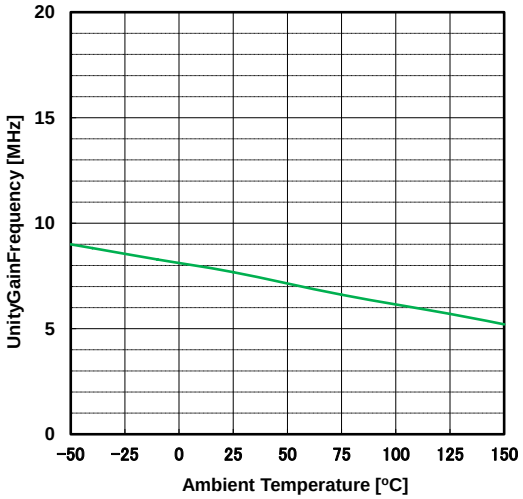
Output Voltage vs. Output Current
V+/V-=±15V



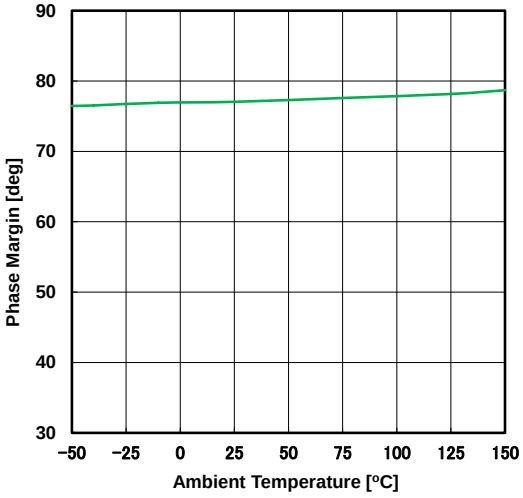
Voltage Gain/Phase vs. Frequency
V+/V-=±15V, RF=10kΩ, RS=100Ω, RT=50Ω,
VIN=-30dBm, RL=2kΩ, CL=10pF



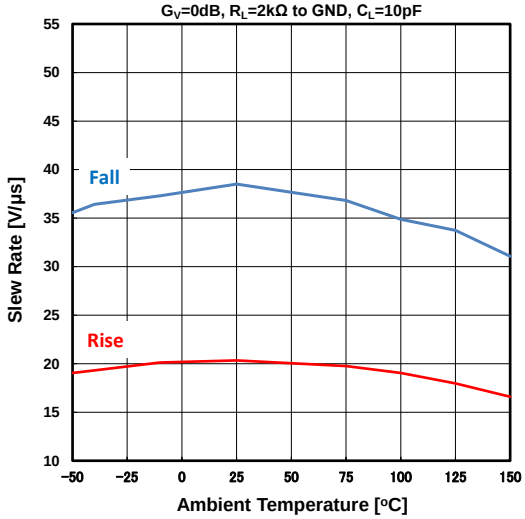
UnityGainFrequency vs. Temperature
V+/V-=±15V, RF=10kΩ, RS=100Ω, RT=50Ω,
VIN=-30dBm, RL=2kΩ, CL=10pF



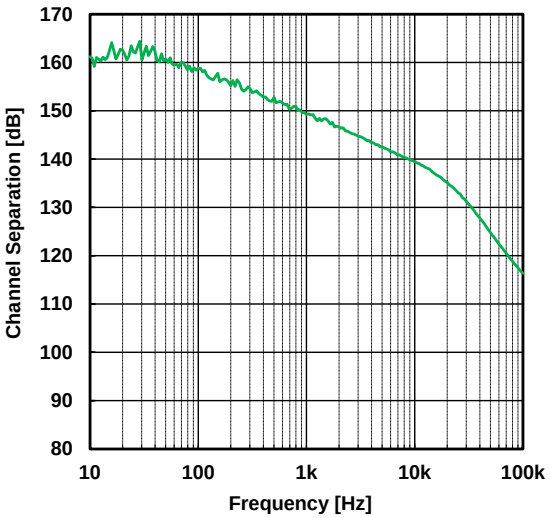
Phase Margin vs. Temperature
V+/V-=±15V, RF=10kΩ, RS=100Ω, RT=50Ω,
VIN=-30dBm, RL=2kΩ, CL=10pF



Slew Rate vs. Temperature
V+/V-=±15V, VIN=2VPP, f=200kHz,
GV=0dB, RL=2kΩ to GND, CL=10pF

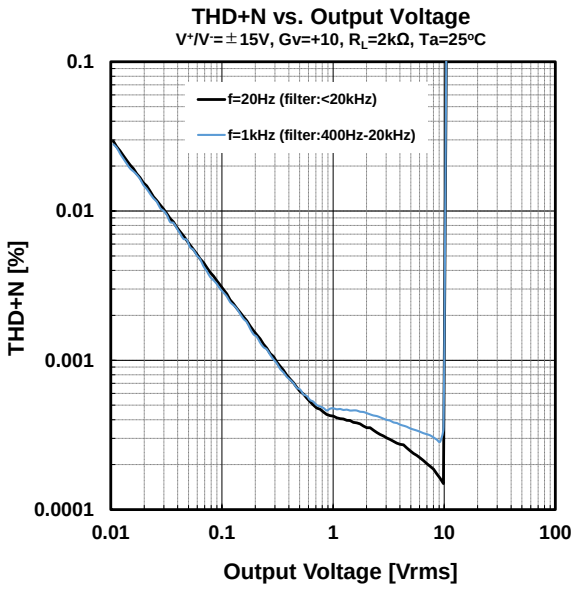


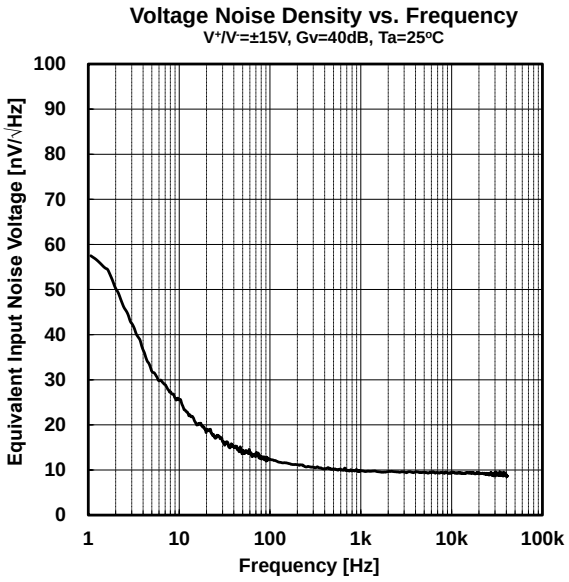
Channel Separation vs. Frequency
V+/V-=±15V, RF=100kΩ, RS=1kΩ, RL=2kΩ, Vo=5Vrms,



■ TYPICAL CHARACTERISTICS

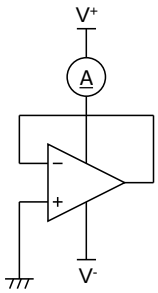
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.





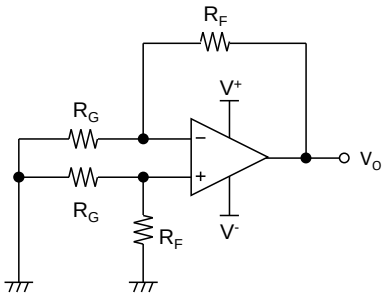
■ TEST CIRCUITS

● Icc



● V_{IO}, CMR, SVR

R_G=50Ω, R_F=50kΩ



$$V_{IO}=\frac{R_G}{(R_G+R_F)}\times V_O$$

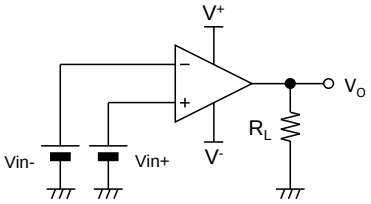
$$CMR=20\log\frac{\Delta V_{COM}\left(1+\frac{R_F}{R_G}\right)}{\Delta V_O}$$

$$SVR=20\log\frac{\Delta V_S\left(1+\frac{R_F}{R_G}\right)}{\Delta V_O}$$

$V_S=V^+-V^-$

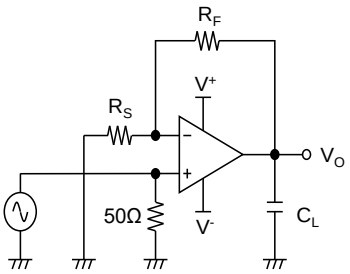
● V_{OH}, V_{OL}

V_{OH}; Vin+ = 1V, Vin- =0V
V_{OL}; Vin+ = -1V, Vin- =0V



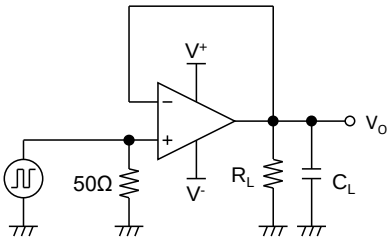
● GBW

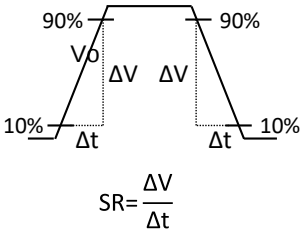
R_S=100Ω, R_F=10kΩ, C_L=open



● SR

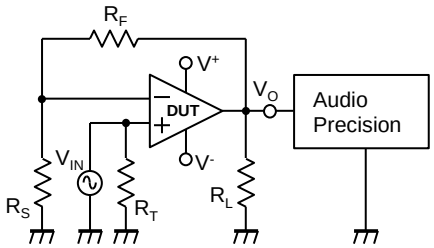
R_L=2kΩ, C_L=10pF



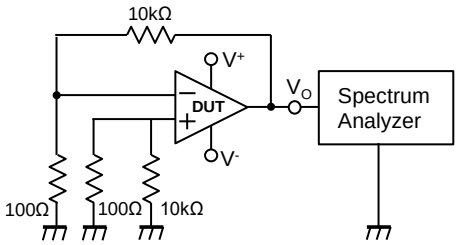


$$SR=\frac{\Delta V}{\Delta t}$$

● THD+N



● V_{NI}



■ APPLICATION NOTE

Single and Dual Supply Voltage Operation

The NL8902 works with both single supply and dual supply when the voltage supplied is between V+ and V−. These amplifiers operate from single 8V to 32V supply and dual ±4V to ±16V supply.

Common-Mode Input Voltage Range

When the supply voltage does not meet the condition of electrical characteristics, the range of common-mode input voltage is as follows:
V_{ICM} (typ.) = V^-+2.5V to V^+-2.5V (Ta = 25°C)
Difference of V_{ICM} when Temperature change, refer to typical characteristic graph.
During designing, consider variations in characteristics for use with allowance.

Maximum Output Voltage Range

When the supply voltage does not meet the condition of electrical characteristics, the range of the typ. value of the maximum output voltage is as follows:
V_{OM} (typ.) = V^-+0.9V to V^+-0.9V (R_L=2kΩ to GND, Ta=25°C)
During designing, consider variations in characteristics and temperature characteristics for use with allowance. In addition, also note that the output voltage range becomes narrow as shown in typical characteristics graph when an output current increases.

No Phase Reversal

The NL8902 is designed to prevent phase reversal at the input voltage above the common mode input voltage range. Figure1 shows no phase reversal characteristics with the input voltage exceeding the supply voltage. It is designed to prevent phase reversal at the input voltage above the supply voltage, but the input voltage should not exceed the absolute maximum rating of V^--0.3V or V^++0.3V. The range of normal operation is the common mode input voltage range shown in the electrical characteristics table.

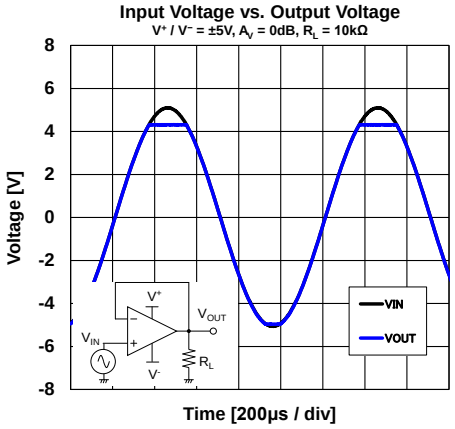


Figure1. No phase reversal

Capacitive load

The NL8902 can use at unity gain follower, but the unity gain follower is the most sensitive configuration to capacitive loading. The combination of capacitive load placed directly on the output of an amplifier along with the output impedance of the amplifier creates a phase lag which in turn reduces the phase margin of the amplifier. If phase margin is significantly reduced, the response will cause overshoot and ringing in the step response.
The NL8902 is unity gain stable for capacitive loads of 1000pF. To drive heavier capacitive loads, an isolation resistor, R_{ISO} as shown Figure2, should be used. R_{ISO} improves the feedback loop's phase margin by making the output load resistive at higher frequencies. The larger the value of R_{ISO}, the more stable the output voltage will be. However, larger values of R_{ISO} result in reduced output swing, reduced output current drive and reduced frequency bandwidth.

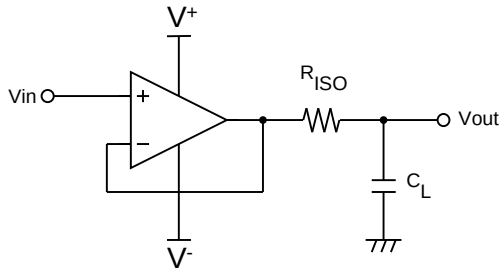


Figure2. Isolating capacitive load

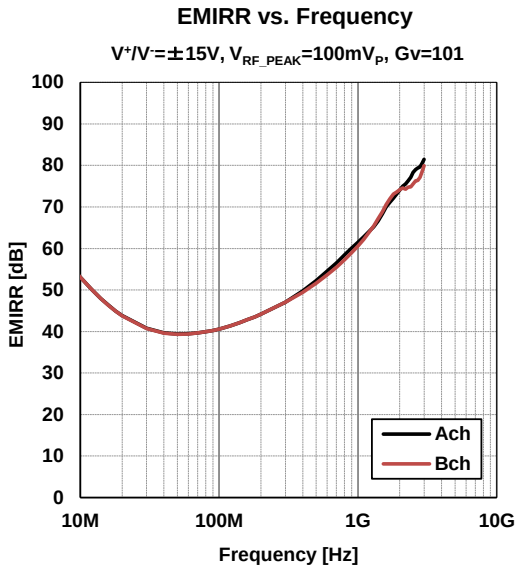
EMIRR (EMI Rejection Ratio) Definition

EMIRR is a parameter indicating the EMI robustness of an OpAmp. The definition of EMIRR is given by the following equation1.

$$EMIRR = 20 \cdot \log_{10}\left(\frac{V_{RF\_PEAK}}{|\Delta V_{IO}|}\right) \quad \text{--- eq.1}$$

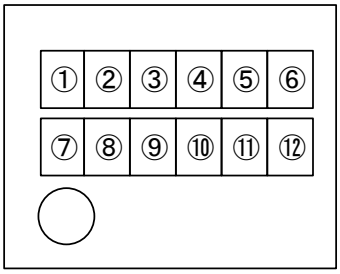
V_{RF_PEAK}: RF Signal Amplitude [V_P]
ΔV_{IO}: Input offset voltage shift quantity [V]

The tolerance of the RF signal can be grasped by measuring an RF signal and offset voltage shift quantity. Offset voltage shift is small so that a value of EMIRR is big. And it understands that the tolerance for the RF signal is high. In addition, about the input offset voltage shift with the RF signal, there is the thinking that influence applied to the input terminal is dominant. Therefore, generally the EMIRR becomes value that applied an RF signal to +INPUT terminal.



■ MARKING SPECIFICATION (EMP-8-AN)

①②③④⑤⑥⑦⑧: Product Cord Refer to Part Marking List
⑨⑩⑪⑫: Control Number



EMP-8-AN Part Markings

NOTICE

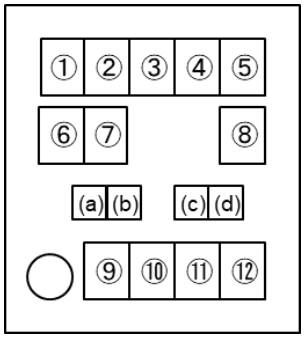
There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or distributor before attempting to use AOI.

Part Marking List (EMP-8-AN)

Product Name	①	②	③	④	⑤	⑥	⑦	⑧
NL8902ANAE2S	L	8	9	0	2	A	S	A

■ MARKING SPECIFICATION (DFN4035-8-GR)

①②③④⑤⑥⑦⑧: Product Cord Refer to Part Marking List
⑨⑩⑪⑫: Control Number
(a)(b)(c)(d): Control Number



DFN4035-8-GR Part Markings

NOTICE

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Part Marking List (DFN4035-8-GR)

Product Name	①	②	③	④	⑤	⑥	⑦	⑧
NL8902GRAE4S	L	8	9	0	2	A	S	A

■ REVISION HISTORY

Date	Revision	Contents of Changes
April 11, 2025	Ver. 1.0	Initial release

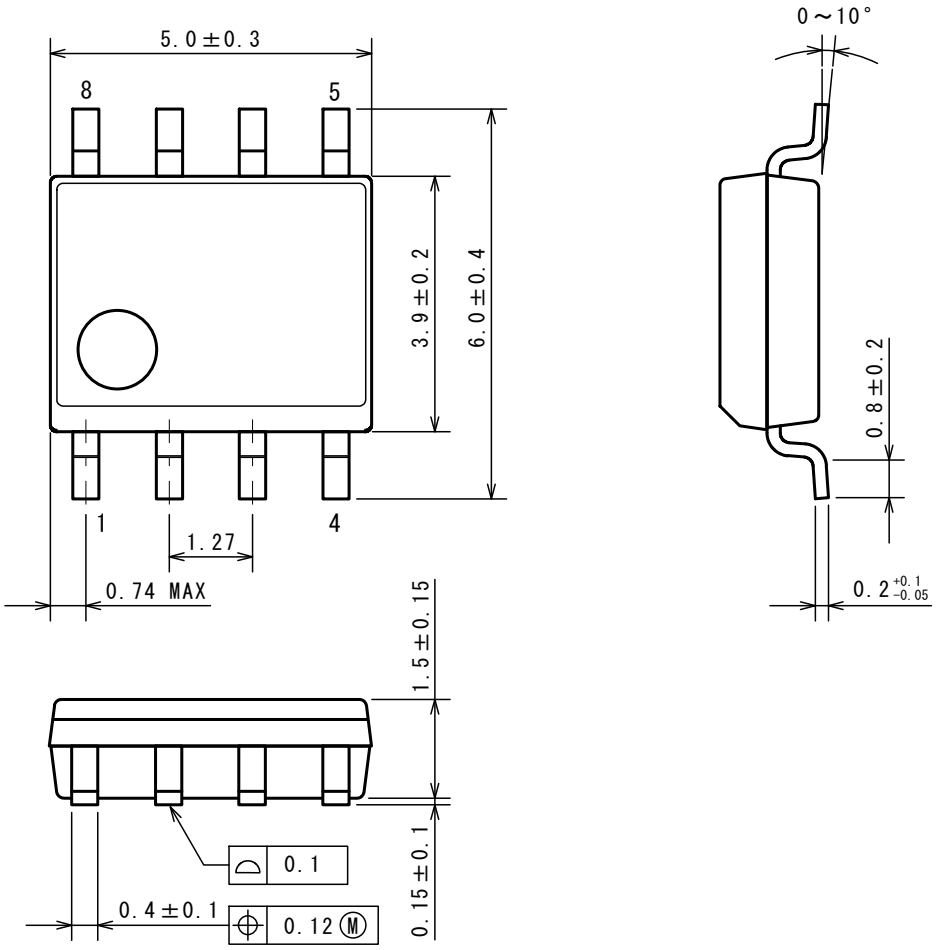
Nisshinbo Micro Devices Inc.

EMP-8-AN

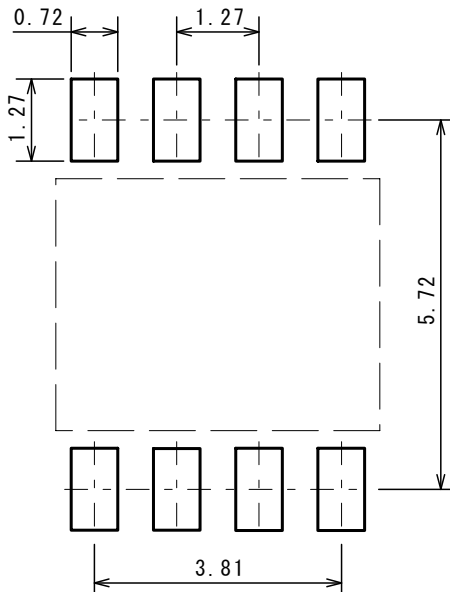
PI-EMP-8-AN-E-B

■ PACKAGE DIMENSIONS

UNIT: mm



■ EXAMPLE OF SOLDER PADS DIMENSIONS



Nisshinbo Micro Devices Inc.

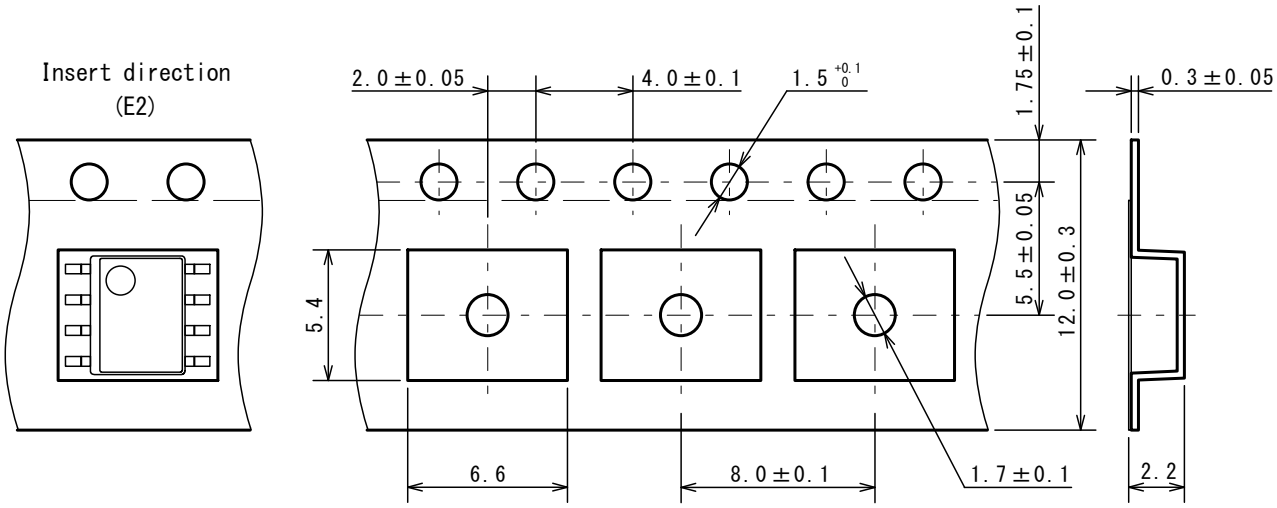
EMP-8-AN

PI-EMP-8-AN-E-B

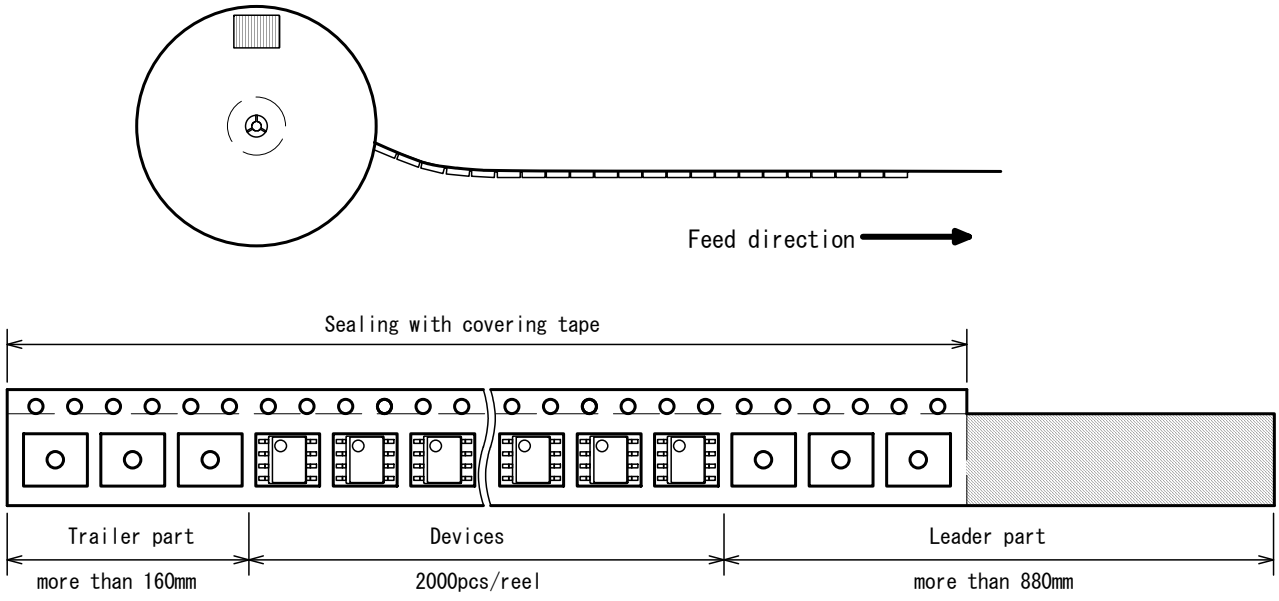
■ PACKING SPEC

UNIT: mm

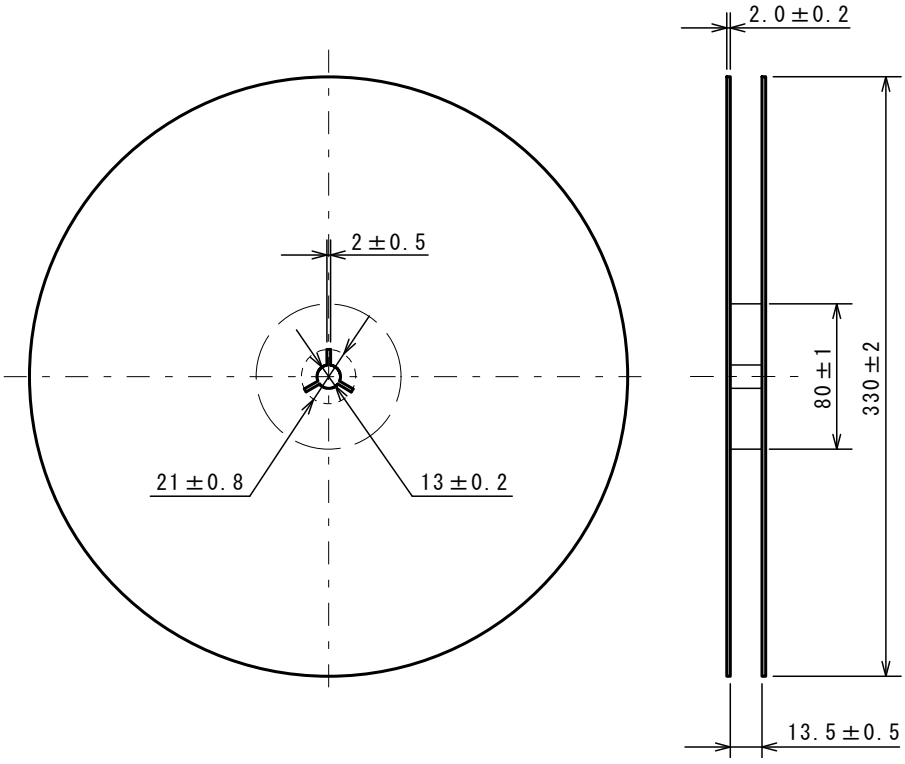
(1) Taping dimensions / Insert direction



(2) Taping state



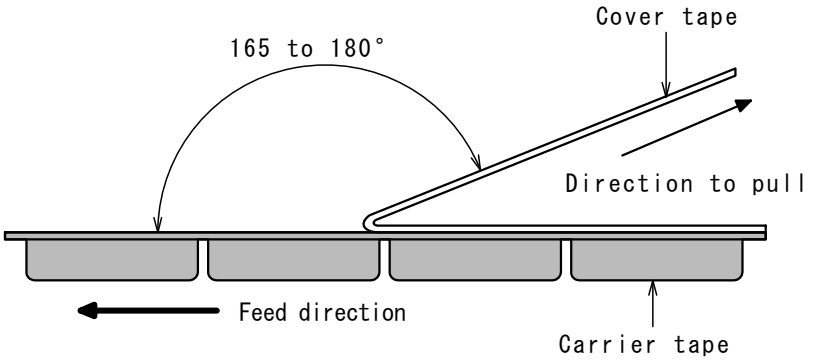
(3) Reel dimensions



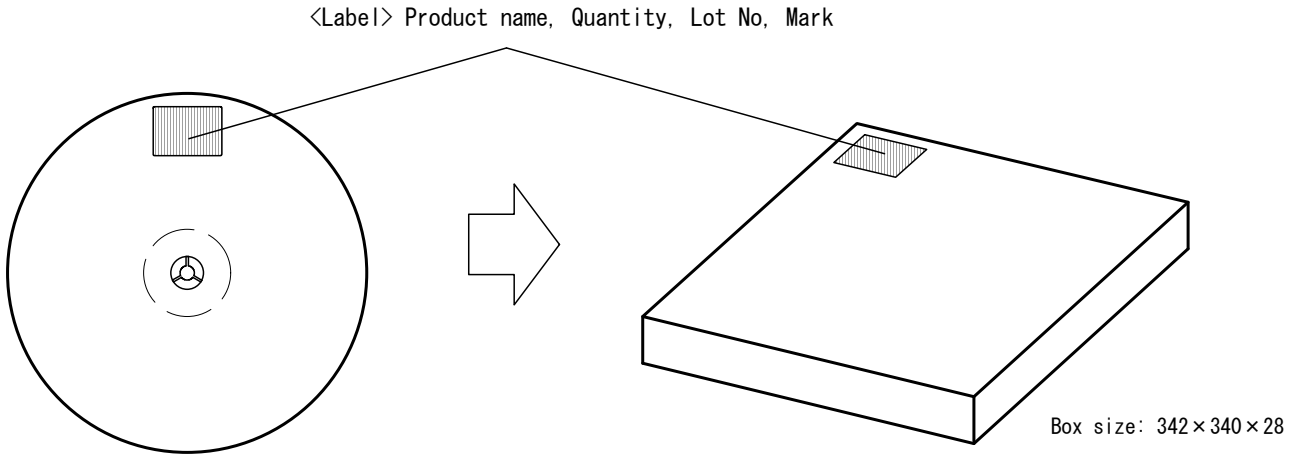
(4) Peeling strength

Peeling strength of cover tape

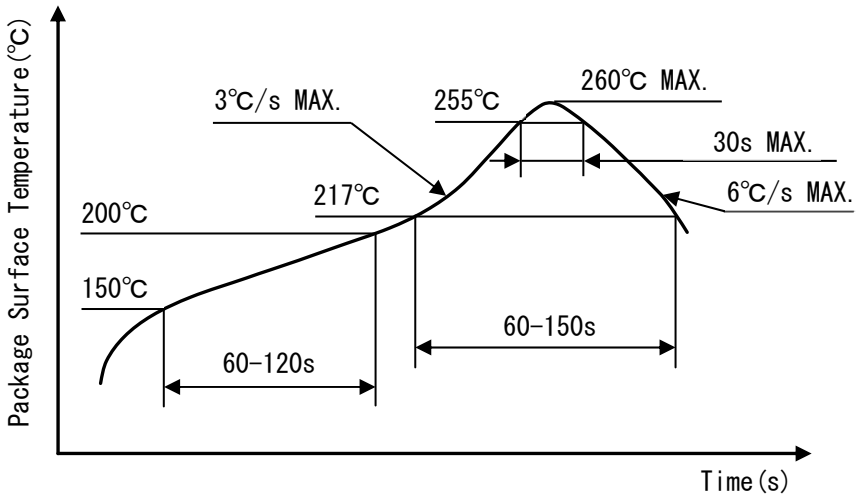
・Peeling angle	165 to 180° degrees to the taped surface.
・Peeling speed	300mm/min
・Peeling strength	0.1 to 1.3N



(5) Packing state



■ **HEAT-RESISTANCE PROFILES**



Reflow profile

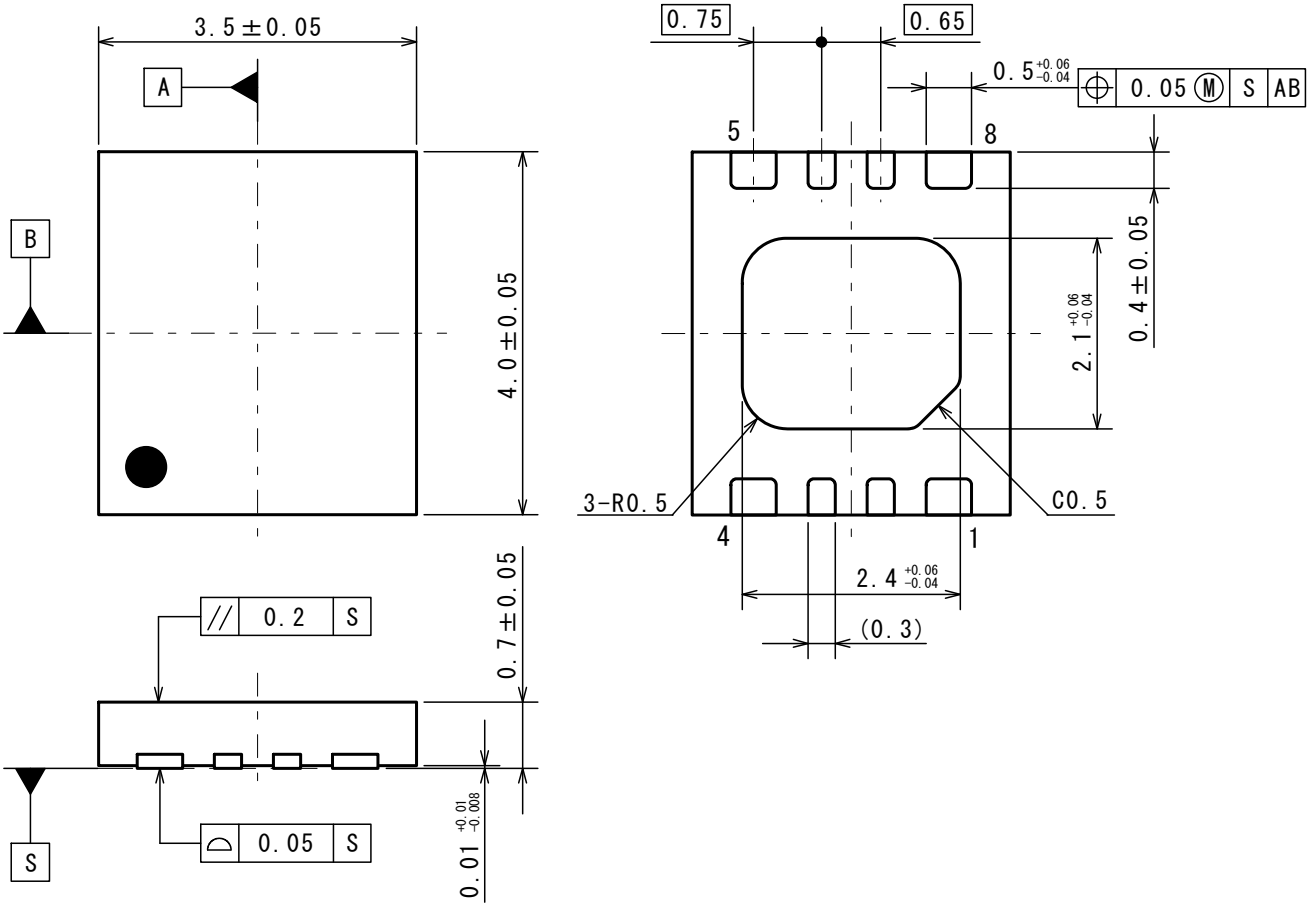
Nisshinbo Micro Devices Inc.

DFN4035-8-GR

PI-DFN4035-8-GR-E-A

■ PACKAGE DIMENSIONS

UNIT: mm



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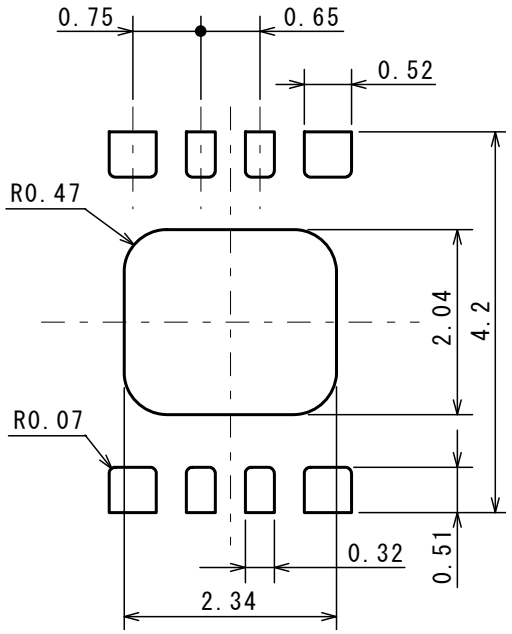


Nisshinbo Micro Devices Inc.

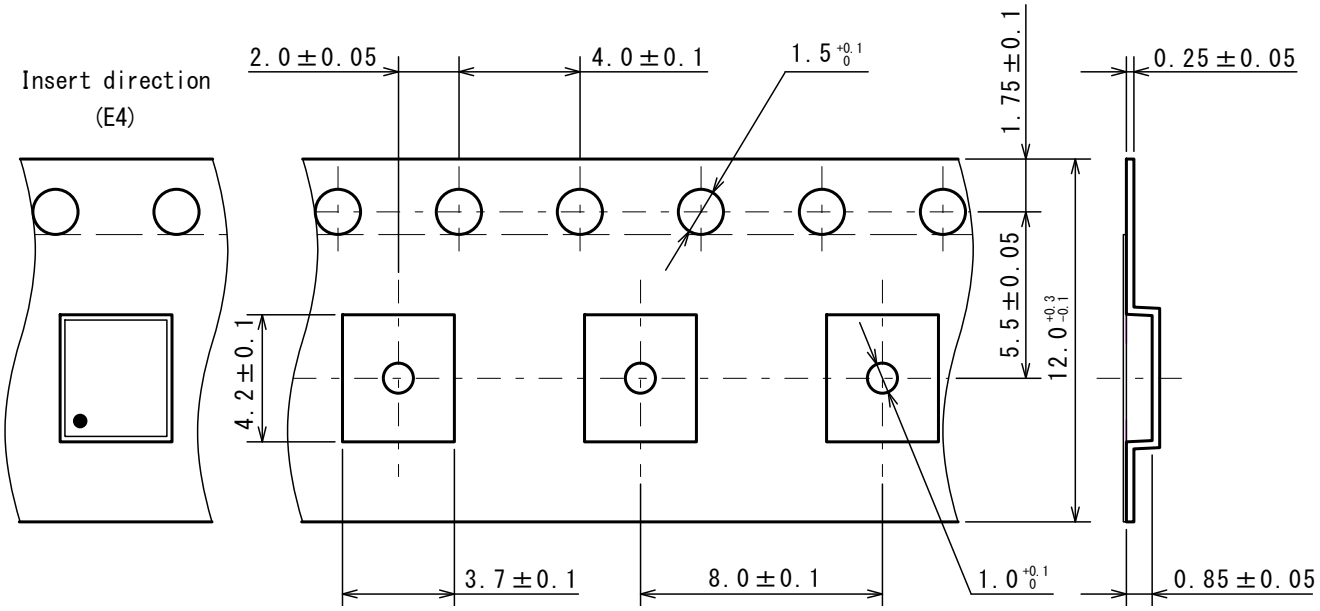
DFN4035-8-GR

PI-DFN4035-8-GR-E-A

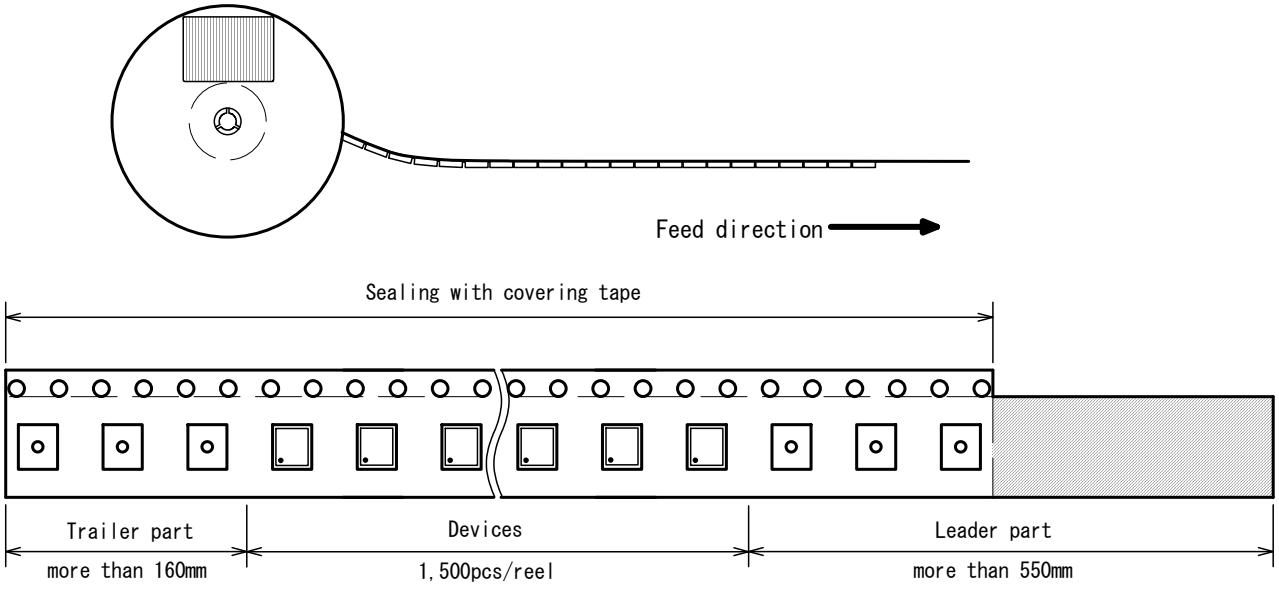
■ PACKING SPEC

UNIT: mm

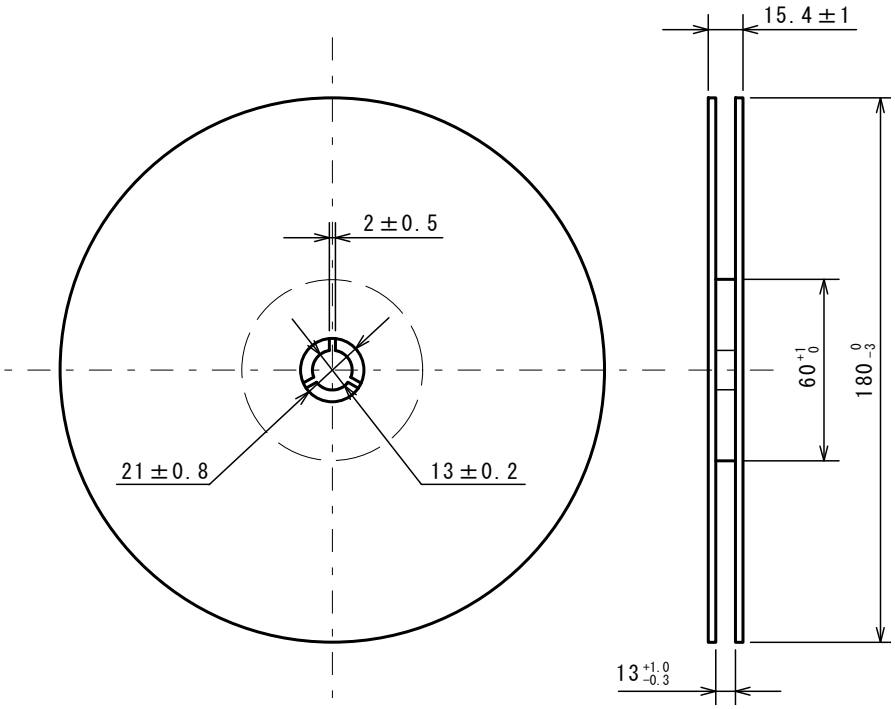
(1) Taping dimensions / Insert direction



(2) Taping state



(3) Reel dimensions



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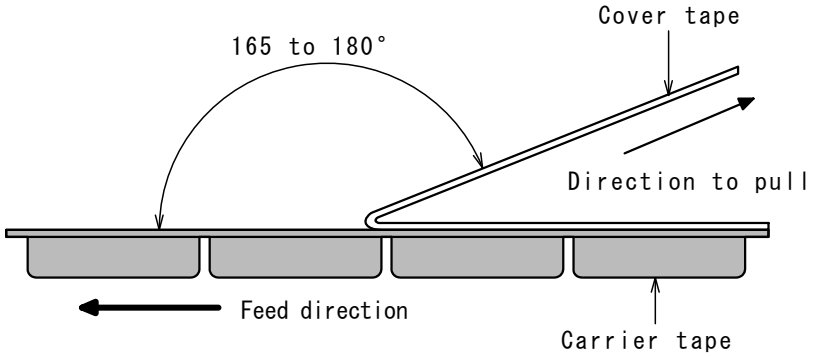
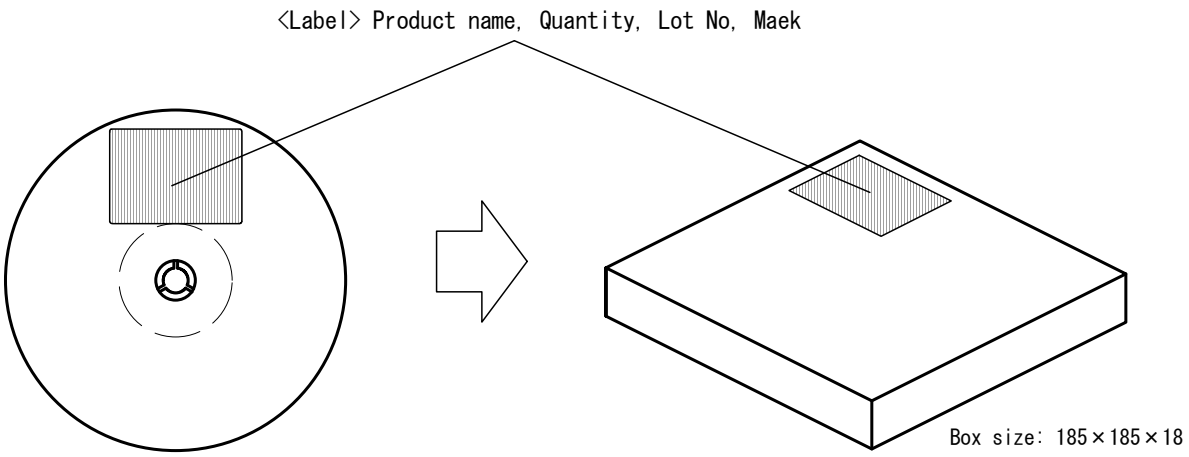


(5) Packing state



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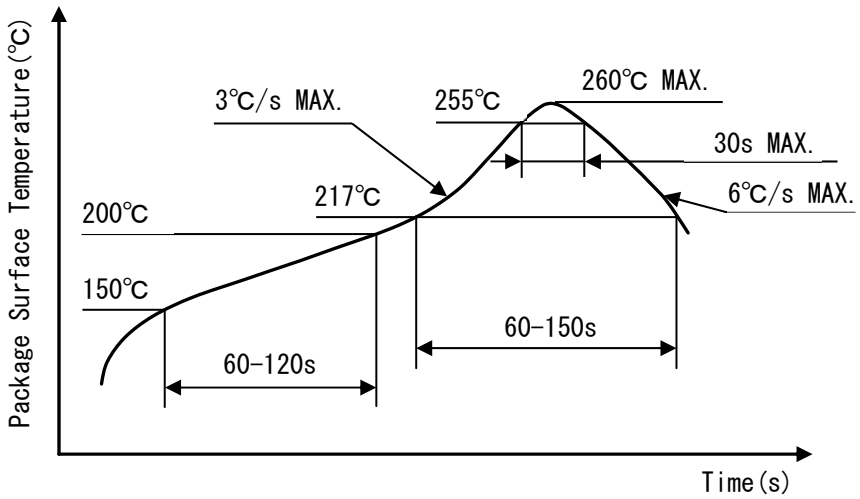

Reflow profile

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    8-2. Quality Warranty Remedies
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    Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
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