NJM8208

Precision, Single Supply, Rail-to-Rail Output Dual Operational Amplifier

FEATURES

Operation voltage	3V to 35V (±1.5V to ±17.5V)
Input offset voltage	150μV typ.
Input offset voltage drift	1μV/°C typ.
Supply current	1.2mA max.
Output current	±2mA min.
Slew rate	0.2V/μs typ.
Unity gain frequency	350 kHz typ.
Input voltage protection	V_{IN} = 36V max.
Integrated EMI filter	
	EMIRR = 110dB typ. @f = 900 MHz
Rail-to-Rail output	
Bipolar Technology	
Package	MSOP8(VSP8)

APPLICATIONS

Load Cell / Bridge Sensor
Current sensor amplifier
ADC peripheral
Powe Line Monitor

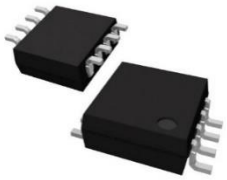
GENERAL DESCRIPTION

The NJM8208 is a dual operational amplifier featuring single power supply and high precision. Device is of bipolar technology.

The output full swing characteristic in single power supply operation allows input signals to be handled from the ground level, and output signals to be handled from ground to near the power supply voltage.

Also, this Op-Amp has the high EMI noise immunity and the over input voltage protection so that it can minimize the malfunction or the characteristics deterioration caused by EMI noise and over input signal.

Furthermore, its low offset drift over the entire temperature range makes it ideal for amplifying a wide variety of sensors.



MSOP8 (VSP8)

■ PRODUCT NAME INFORMATION

NJM8208 R (TE2)

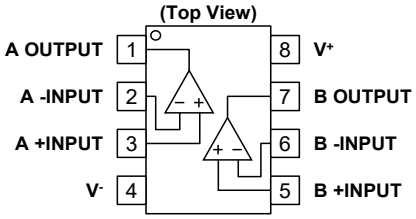
Description of configuration

Composition	Item	Description
R	Package code	Indicates the package. R: MSOP8(VSP8)
TE2	Packing	Insert Direction. Refer to the packing specifications.

■ ORDER INFORMATION

Product Name	Package	RoHS	Halogen-Free	Plating Composition	Weight (mg)	Quantity (pcs/reel)
NJM8208R (TE2)	MSOP8(VSP8)	✓	✓	Sn2Bi	21	2000

■ PIN DESCRIPTIONS (NJM8208R)



MSOP8 (VSP8)

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 GND (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	Ratings	Unit
Supply Voltage $V_S = V^+ - V^-$	$V^+ - V^-$	36 (±18)	V
Differential Input Voltage*1	V_{ID}	±36	V
Input Voltage*2	V_{IN}	V^- - 0.3 to V^- + 36	V
Storage Temperature Range	T_{stg}	-50 to 150	°C
Junction Temperature *3	T_j	150	°C

*1 Differential voltage is the voltage difference between +INPUT and −INPUT.

*2 Input voltage is the voltage should be allowed to apply to the input terminal independent of the magnitude of V^+.
The normal operation will establish when any input is within the "Common-Mode Input Voltage Range" of electrical characteristics.

*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 *1		Unit
	θja	ψjt	
MSOP8(VSP8)	152	24	°C/W

θja: Junction-to-Ambient Thermal Resistance
ψjt: Junction-to-Top Thermal Characterization Parameter

*1 Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 4-layer FR-4), internal Cu area: 74.2 mm × 74.2 mm.

■ ELECTROSTATIC DISCHARGE (ESD) PROTECTION VOLTAGE

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

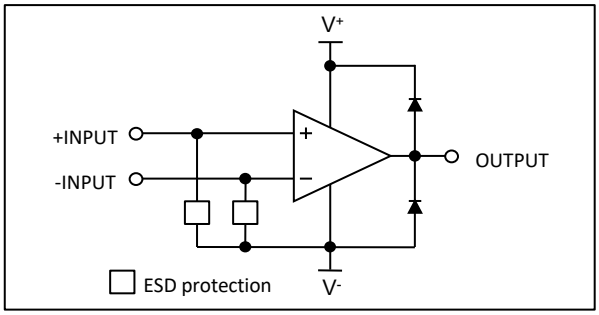
ELECTROSTATIC DISCHARGE RATINGS
The electrostatic discharge test is done based on JEITA ED-4701.

■ RECOMMENDED OPERATING CONDITIONS

	Symbol	Ratings	Unit
Supply Voltage	$V^+ - V^-$	3 to 35	V
	V^+ / V^-	±1.5V to ±17.5V	V
Operating Temperature Range	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 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.

■ BLOCK DIAGRAM



■ ELECTRICAL CHARACTERISTICS

V^+ = 5V, V^- = 0V, T_a = 25°C, unless otherwise specified.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
DC CHARACTERISTICS *1						
Input Offset Voltage	V_{IO}	R_S = 50Ω, R_F = 50kΩ	-	150	800	μV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	T_a = -40°C to 125°C	-	1	-	μV/°C
Input Bias Current	I_B		-	55	250	nA
Input Offset Current	I_{IO}		-	5	20	nA
Supply Current (All Amplifiers)	I_{SUPPLY}	No Signal	-	0.9	1.2	mA
High-level Output Voltage1	V_{OH1}	R_L ≥ 2kΩ to 2.5V	4.85	4.95	-	V
Low-level Output Voltage1	V_{OL1}	R_L ≥ 2kΩ to 2.5V	-	0.05	0.15	V
High-level Output Voltage2	V_{OH2}	R_L ≥ 2kΩ to 0V	4.85	4.95	-	V
Low-level Output Voltage2	V_{OL2}	R_L ≥ 2kΩ to 0V	-	0.05	0.15	V
Output Source Current	I_{SOURCE}	V_{OH} ≥ 4.75V	2	10	-	mA
Output Sink Current	I_{SINK}	V_{OL} ≤ 0.25V	2	6	-	mA
Common-Mode Input Voltage Range	V_{ICM}	CMR ≥ 70dB	0	-	4	V
Common-Mode Rejection Ratio	CMR	V_{ICM} = 0V to 4.0V	70	100	-	dB
Supply Voltage Rejection Ratio	SVR	V^+ / V^- = ±1.5V to ±17.5V	70	110	-	dB
Open-Loop Voltage Gain	Av	R_L ≥ 10kΩ to 2.5V, V_O = 2.5V±2V	70	96	-	dB
AC CHARACTERISTICS						
Unity Gain Frequency	f_T	G_V = 40dB, R_L = 10kΩ to 2.5V, C_L = 10pF	-	350	-	kHz
Phase Margin	Φ_M	G_V = 40dB, R_L = 10kΩ to 2.5V, C_L = 10pF	-	50	-	deg
Gain Margin	G_M	G_V = 40dB, R_L = 10kΩ to 2.5V, C_L = 10pF	-	12	-	dB
Channel Separation	CS	f = 1kHz, G_V = 40dB, R_L = 10kΩ to 2.5V	-	120	-	dB
Transient Response						
Slew Rate *2	SR	G_V = 1, V_{IN} = $2V_{PP}$, R_L = 10kΩ to 2.5V, C_L = 10pF	-	0.2	-	V/μs

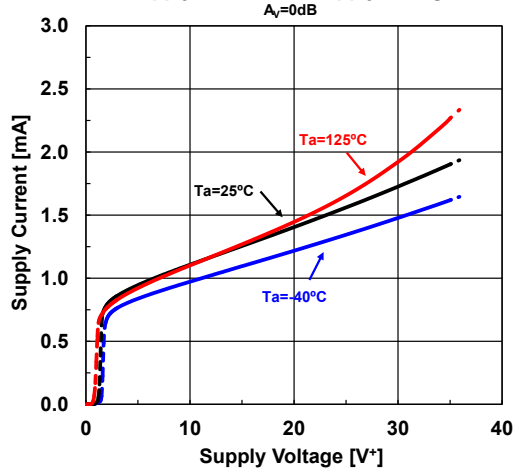
*1 Input offset voltage and drift are positive or negative, its absolute values are listed in electrical characteristics.

*2 Slew rate is defined by the lower value of the rise or fall.

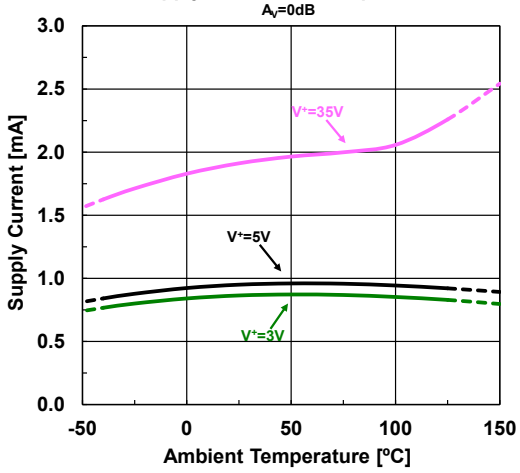
■ TYPICAL CHARACTERISTICS

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

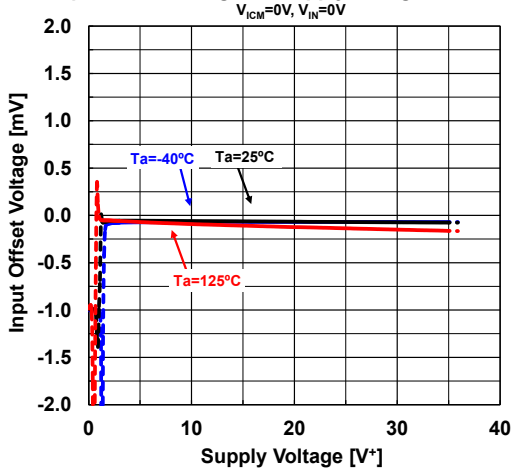
Supply Current vs. Supply Voltage
A_V=0dB



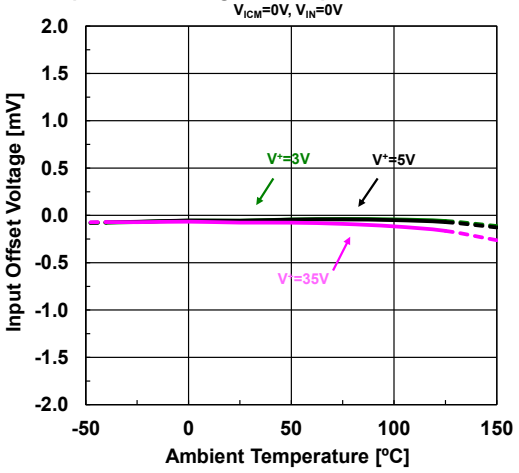
Supply Current vs. Temperature
A_V=0dB



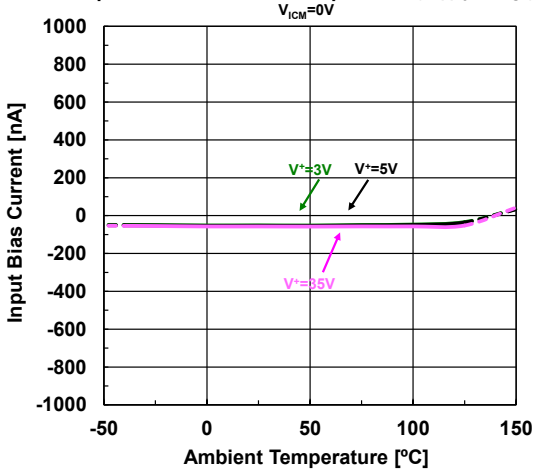
Input Offset Voltage vs. Supply Voltage (Temperature)
V_{ICM}=0V, V_{IN}=0V



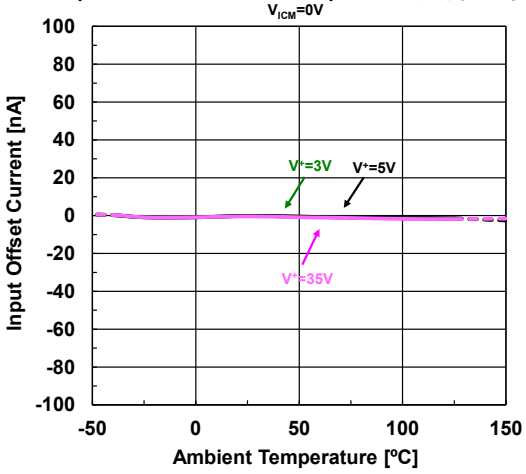
Input Offset Voltage vs. Temperature (Supply Voltage)
V_{ICM}=0V, V_{IN}=0V



Input Bias Current vs. Temperature (Supply Voltage)
V_{ICM}=0V



Input Offset Current vs. Temperature (Supply Voltage)
V_{ICM}=0V



■ TYPICAL CHARACTERISTICS

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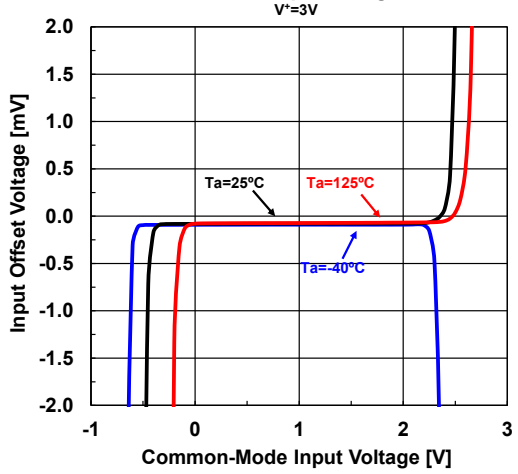
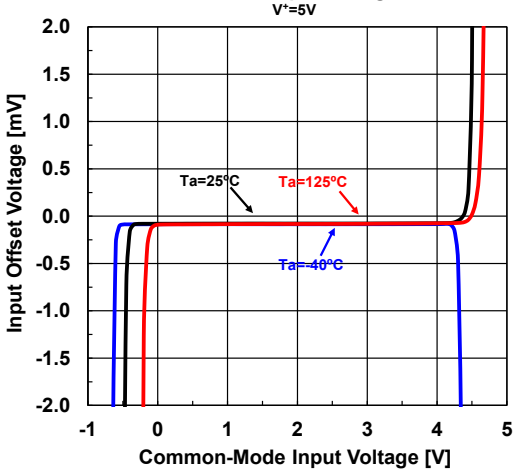
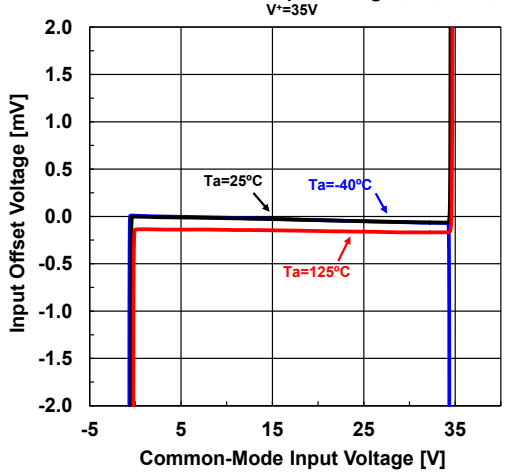
Input Offset Voltage vs. Common-Mode Input Voltage (Temperature)
V⁺=3V



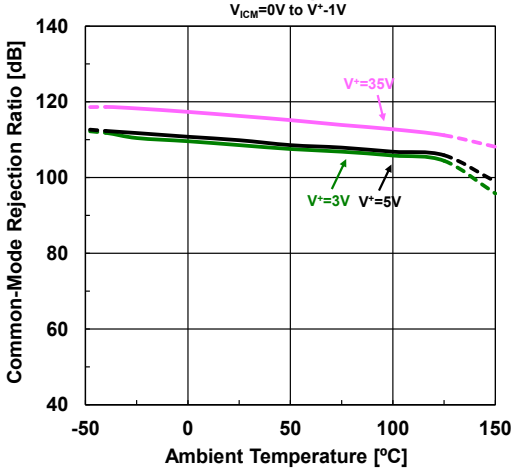
Input Offset Voltage vs. Common-Mode Input Voltage (Temperature)
V⁺=5V



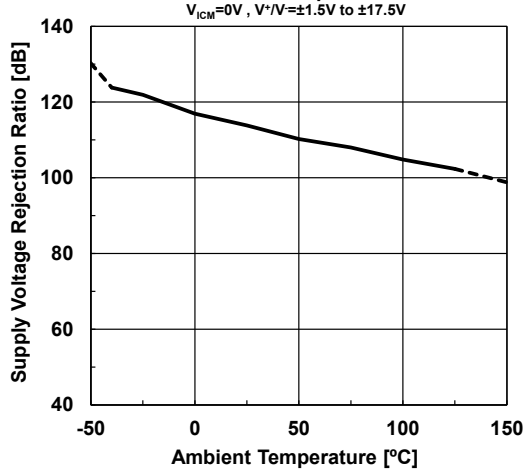
Input Offset Voltage vs. Common-Mode Input Voltage (Temperature)
V⁺=35V



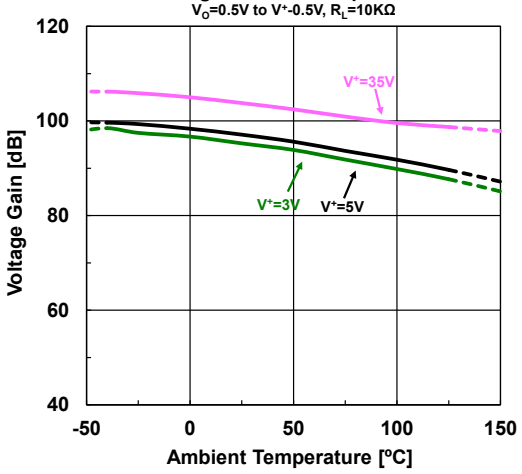
CMR vs. Temperature
V_{ICM}=0V to V⁺-1V



SVR vs. Temperature
V_{ICM}=0V , V⁺/V=±1.5V to ±17.5V



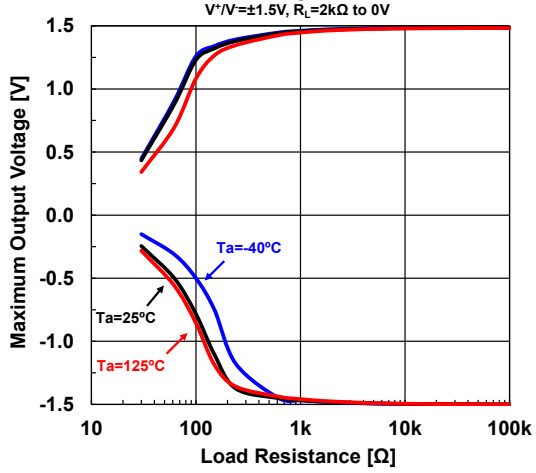
Voltage Gain vs. Temperature
V_O=0.5V to V⁺-0.5V, R_L=10KΩ



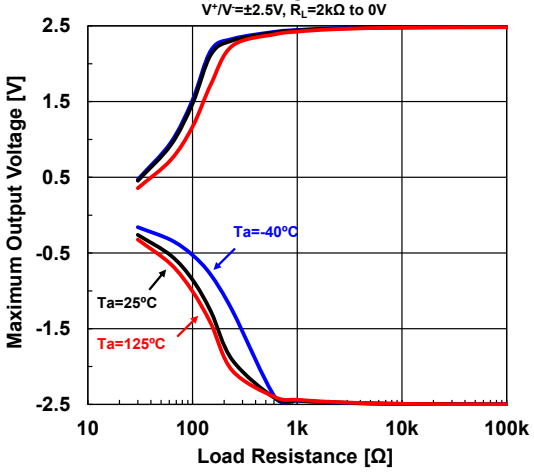
■ TYPICAL CHARACTERISTICS

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

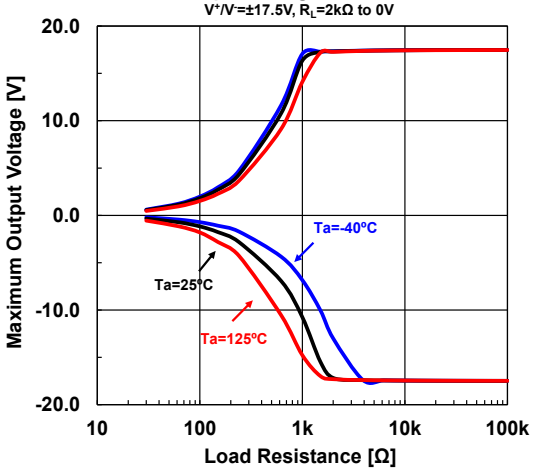
Maximum Output Voltage vs. Load Resistance
V⁺/V⁻=±1.5V, R_L=2kΩ to 0V



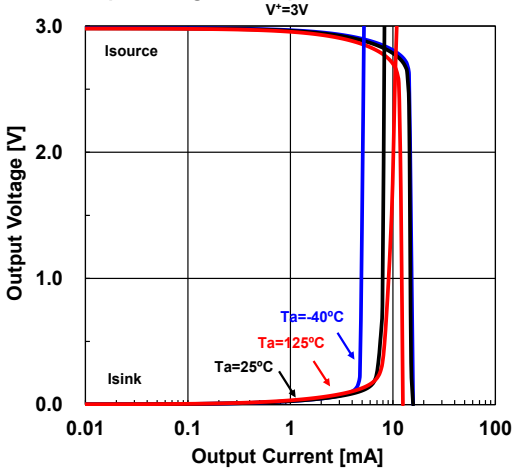
Maximum Output Voltage vs. Load Resistance
V⁺/V⁻=±2.5V, R_L=2kΩ to 0V



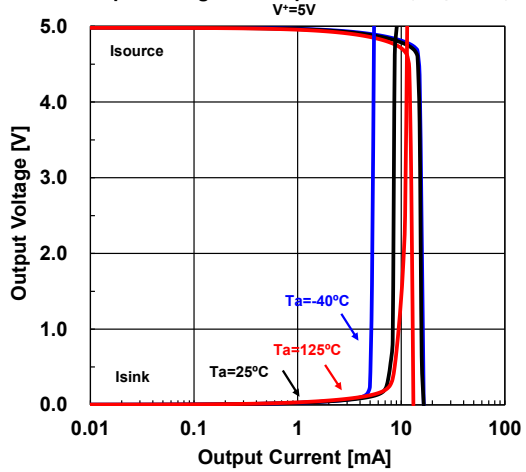
Maximum Output Voltage vs. Load Resistance
V⁺/V⁻=±17.5V, R_L=2kΩ to 0V



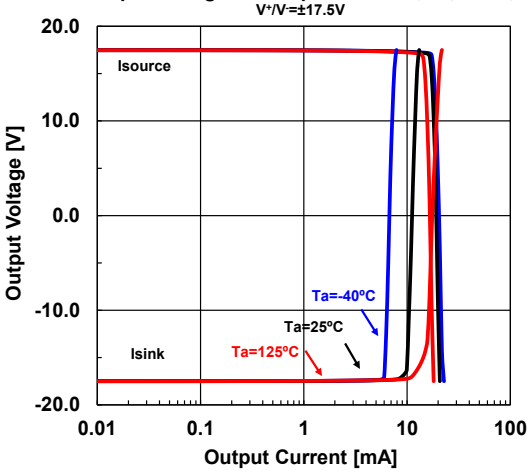
Output Voltage vs. Output Current (Temperature)
V⁺=3V



Output Voltage vs. Output Current (Temperature)
V⁺=5V



Output Voltage vs. Output Current (Temperature)
V⁺/V⁻=±17.5V



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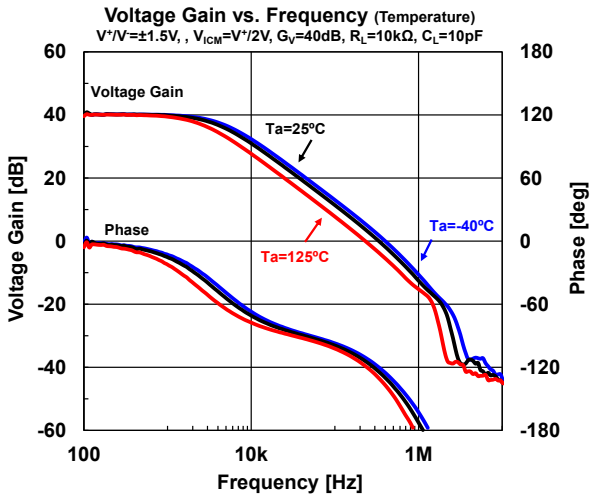

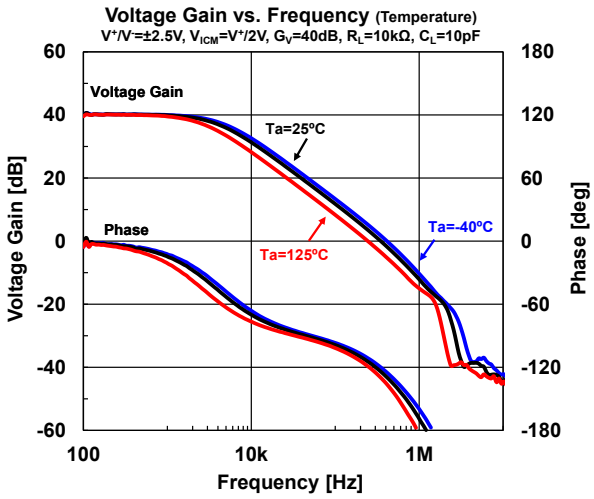

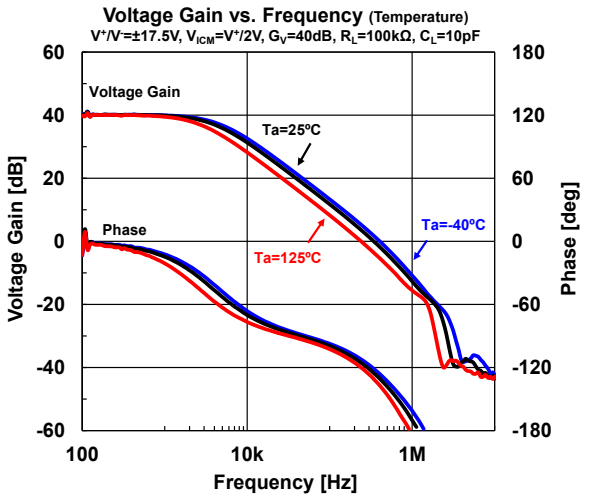

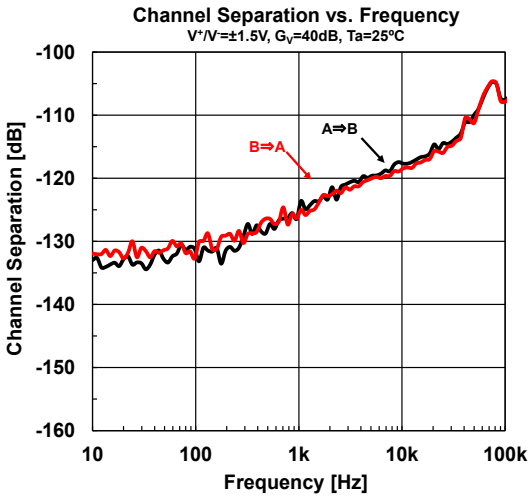

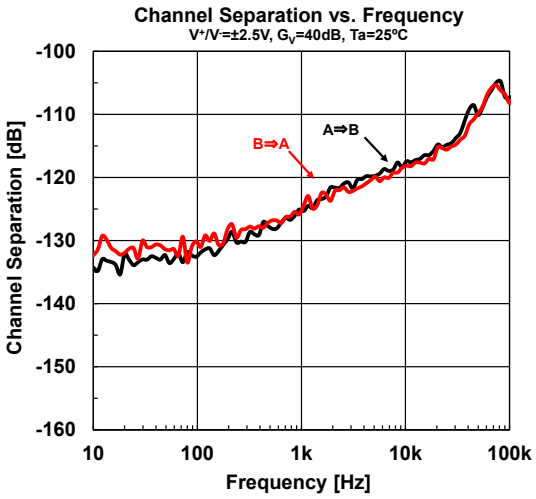

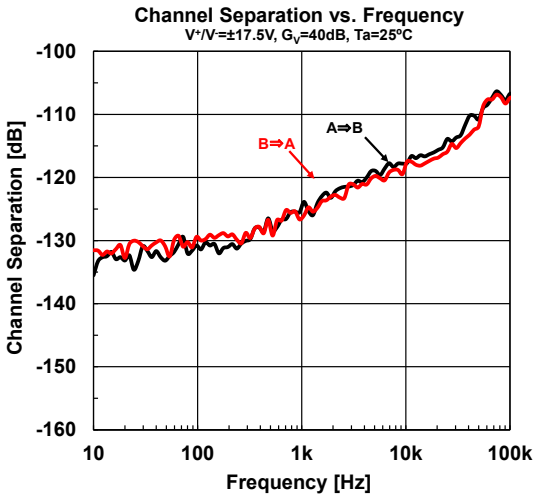

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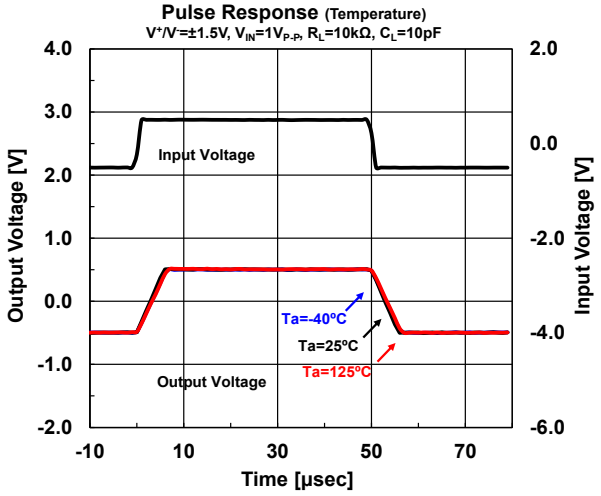
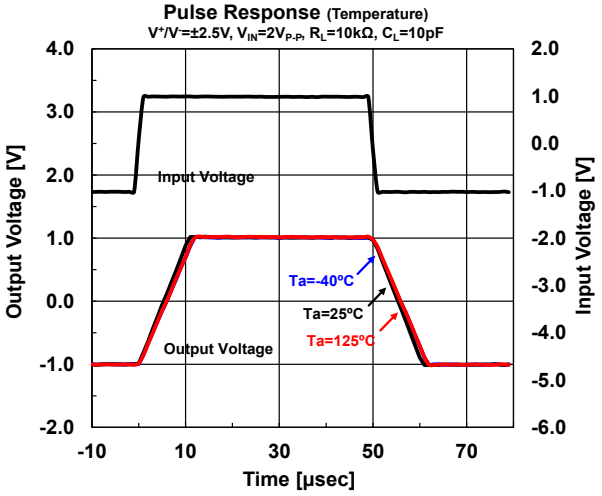
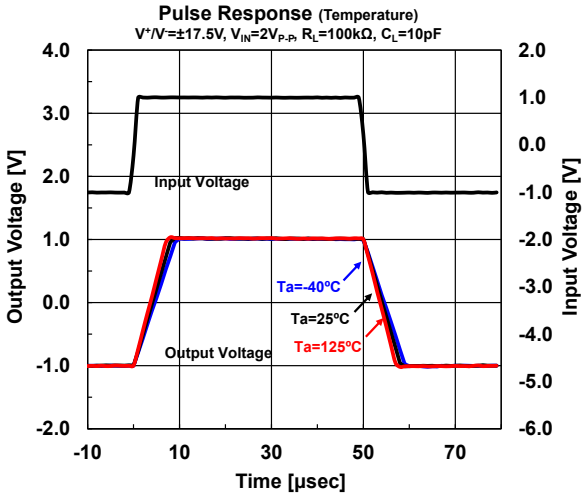
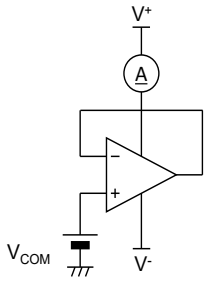






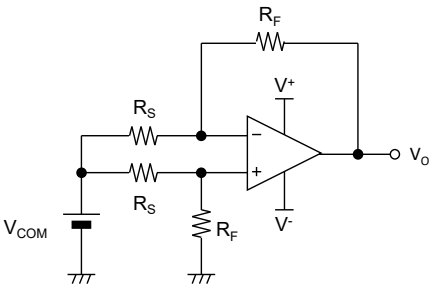
■ TEST CIRCUITS

● I_{SUPPLY}



● V_{IO}, CMR, SVR

R_S = 50Ω, R_F = 50kΩ



$$V_{IO}=\frac{R_S}{(R_S+R_F)}\times(V_O-V_{COM})$$

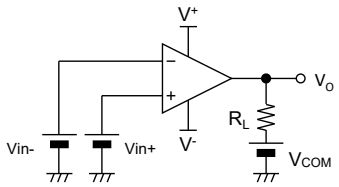
$$CMR=20\log\frac{\Delta V_{COM}\left(1+\frac{R_F}{R_S}\right)}{\Delta V_O}$$

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

$V_S=V^+-V^-$

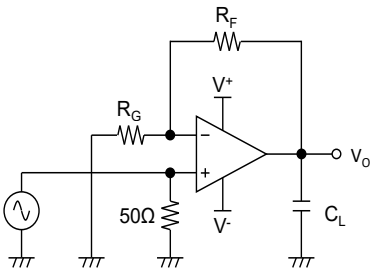
● V_{OH}, V_{OL}

V_{OH}; Vin+ = 1V, Vin- = 0V, $V_{COM}=V^+/2$, V^-
V_{OL}; Vin+ = 0V, Vin- = 1V, $V_{COM}=V^+/2$, V^-



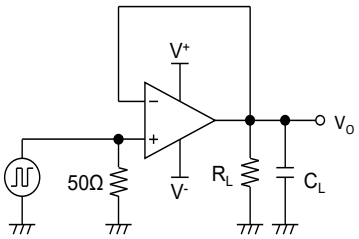
● GBW

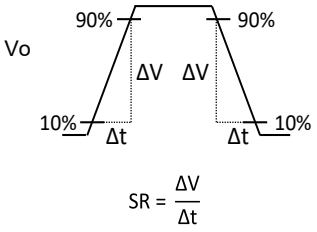
R_G = 100Ω, R_F = 10kΩ



● SR

R_L = 100kΩ





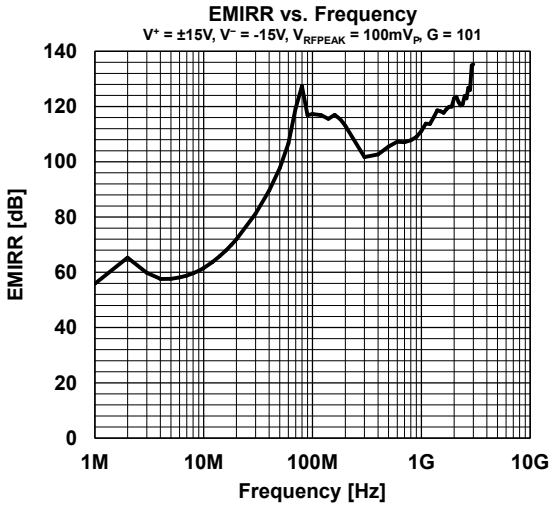
$$SR=\frac{\Delta V}{\Delta t}$$

■ APPLICATION NOTES

EMIRR(EMI Rejection Ratio)
EMIRR is a parameter indicating the EMI robustness of an Op-Amp. The definition of EMIRR is given by the following eq.1.
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.

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

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



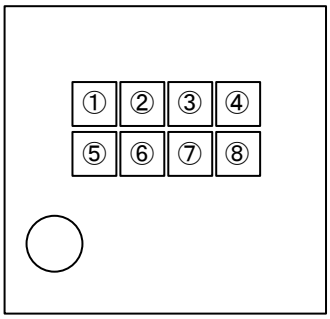
*For details, refer to “Application Note for EMI Immunity" in our HP.

Single and Dual Supply Voltage Operation
The NJM8208 works with both single supply and dual supply when the voltage supplied is between V^+ and V^-. These amplifiers operate from single 3V to 35V supply and dual ±1.5V to ±17.5V 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^- to V^+ - 1V (T_a = 25°C)
Difference of V_{ICM} when Temperature change, refer to typical characteristic graph.
During designing, consider variations in characteristics for use with allowance.

■ MARKING SPECIFICATION (MSOP8 (VSP8))

① to ④	Product Code	Refer to *Part Marking List*
⑤ to ⑧	Lot Number	Alphanumeric Serial Number



1Pin

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

Product Name	①	②	③	④
NJM8208R (TE2)	8	2	0	8

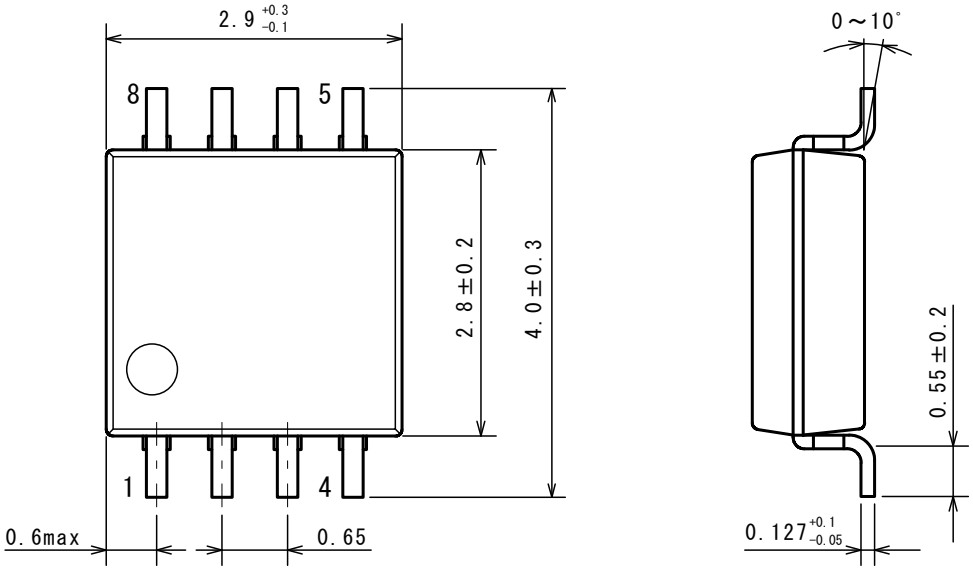
Nisshinbo Micro Devices Inc.

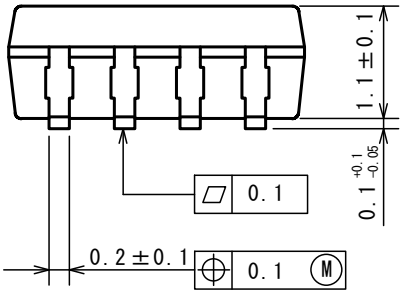
MSOP8 (VSP8)

PI-VSP8-E-C

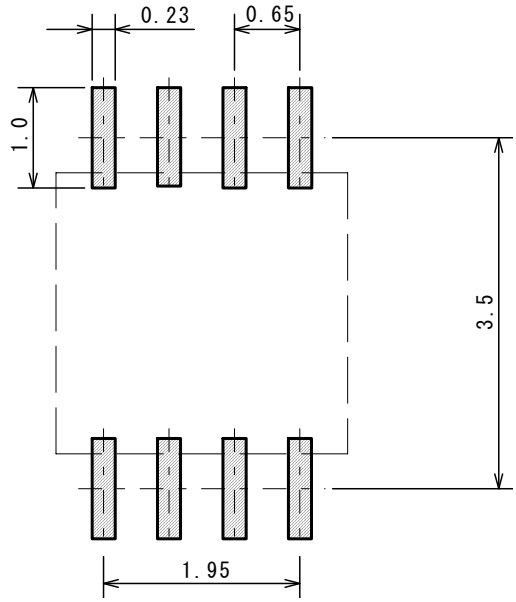
■ PACKAGE DIMENSIONS

UNIT: mm





■ EXAMPLE OF SOLDER PADS DIMENSIONS



Nisshinbo Micro Devices Inc.

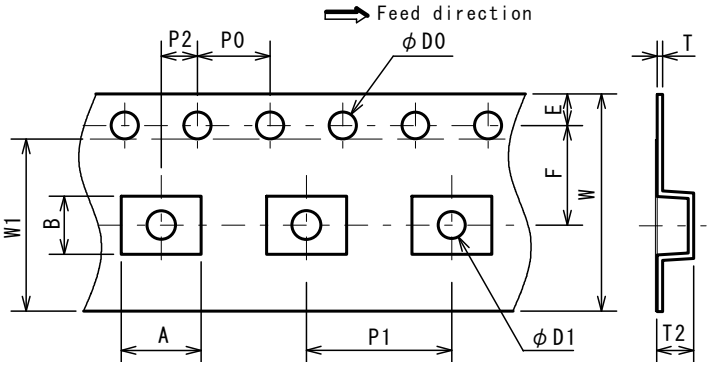
MSOP8 (VSP8)

PI-VSP8-E-C

■ PACKING SPEC

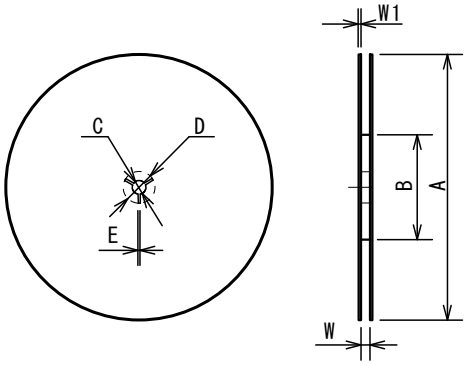
UNIT: mm

TAPING DIMENSIONS



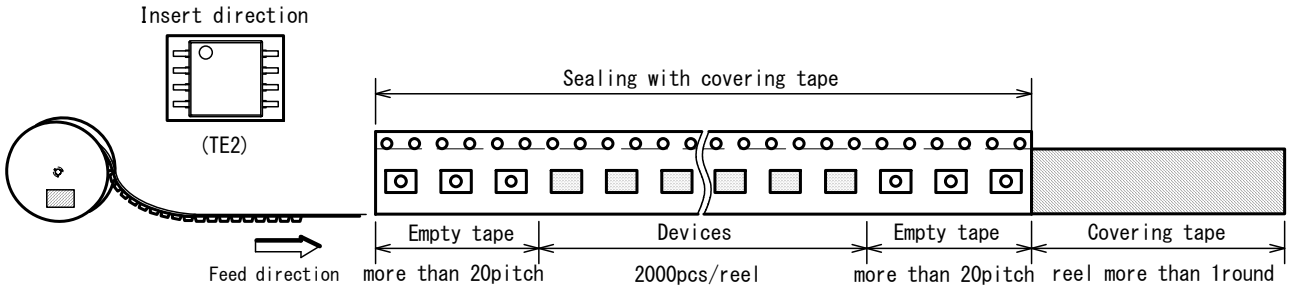
SYMBOL	DIMENSION	REMARKS
A	4.4	BOTTOM DIMENSION
B	3.2	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	$1.5^{+0.1}_{0}$	
E	1.75±0.1	
F	5.5±0.05	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.05	
T	0.30±0.05	
T2	2.0 (MAX.)	
W	12.0±0.3	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

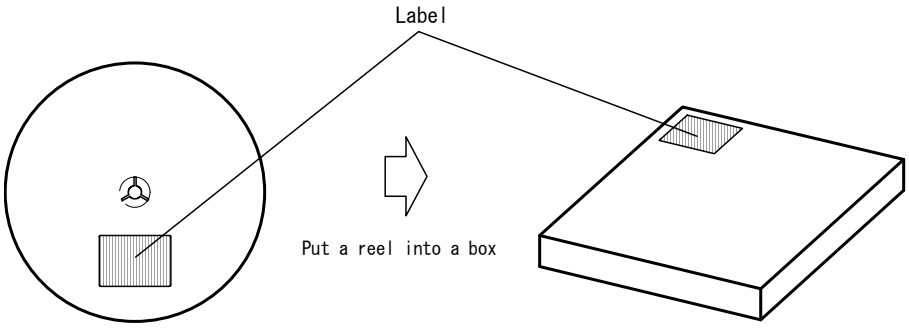


SYMBOL	DIMENSION
A	φ254±2
B	φ100±1
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	13.5±0.5
W1	2.0±0.2

TAPING STATE



PACKING STATE



■ REVISION HISTORY

Date	Revision	Contents of Changes
June 9, 2025	Ver.1.0	Initial Release

1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to our sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without the prior written consent of us.
3. This product and any technical information relating thereto are subject to complementary export controls (so-called KNOW controls) under the Foreign Exchange and Foreign Trade Law, and related politics ministerial ordinance of the law. (Note that the complementary export controls are inapplicable to any application-specific products, except rockets and pilotless aircraft, that are insusceptible to design or program changes.) Accordingly, when exporting or carrying abroad this product, follow the Foreign Exchange and Foreign Trade Control Law and its related regulations with respect to the complementary export controls.
4. The technical information described in this document shows typical characteristics and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under our or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death should first contact us.
    - Aerospace Equipment
    - Equipment Used in the Deep Sea
    - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
    - Life Maintenance Medical Equipment
    - Fire Alarms / Intruder Detectors
    - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

    In case your company desires to use this product for any applications other than general electronic equipment mentioned above, make sure to contact our company in advance. Note that the important requirements mentioned in this section are not applicable to cases where operation requirements such as application conditions are confirmed by our company in writing after consultation with your company.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. The products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. Quality Warranty
    8-1. Quality Warranty Period
    In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
    8-2. Quality Warranty Remedies
    When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.
    Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
    8-3. Remedies after Quality Warranty Period
    With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.

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Nisshinbo Micro Devices Inc.

Official website
https://www.nisshinbo-microdevices.co.jp/en/

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