Nisshinbo Micro Devices Inc.

Automotive NJM2904BR-Z2
High EMC performance, Single Supply, Operational Amplifier

FEATURES

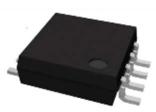
- AEC-Q100 grade 1 in progress
- Internal EMI filter
- Operating voltage range +3V to +36V
- Input offset voltage 0.5mV typ.
- Consumption current 0.7mA typ.
- Slew rate 0.4V/µs typ.
- Unity-gain stability
- Bipolar process
- Package MSOP8 (VSP8)

DESCRIPTION

The NJM2904BR-Z2 is a versatile operational amplifier for automotive use.

The features took over from original NJM2904 such as wide operating voltage range, common-mode input range to ground level or unity-gain stability, also improved EMC performance, ESD breakdown voltage and electric characteristics minimize the risks in parts replacement.

This basic product provides wide solutions for various automotive applications.



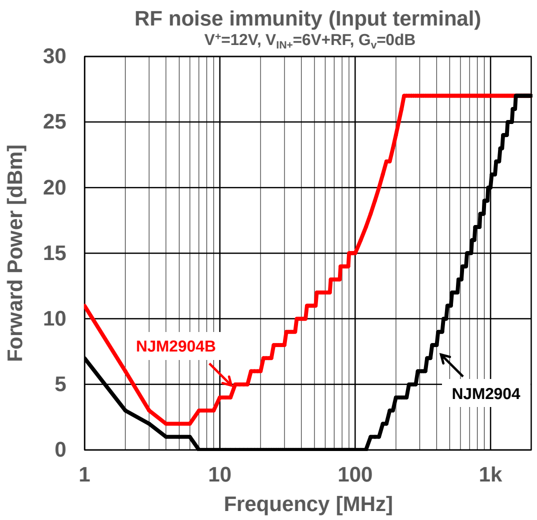
NJM2904BR-Z2
MSOP8 (VSP8)
2.9 × 4.0 × 1.1 (mm)

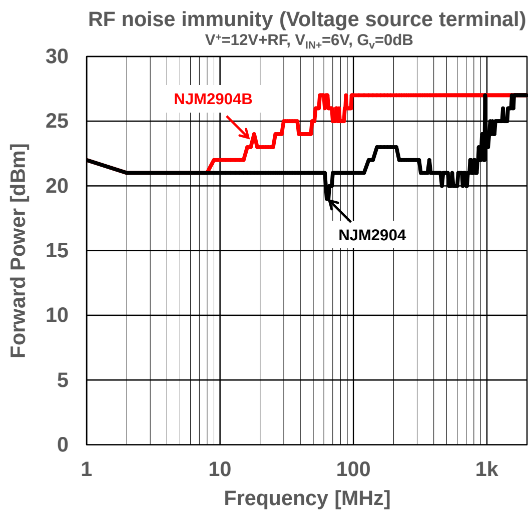
APPLICATIONS

- General use for automotive

■ TYPICAL CHARACTERISTICS of EMC performance (Immunity)

The NJM2904B achieved high immunity with IEC 62132-4 (DPI method) and ED-5008 benchmark with not only input terminals but also voltage supply terminals.





■ PRODUCT NAME INFORMATION

NJM2904B R - Z2 (TE1)

Description of configuration

Suffix	Parameter	Description
R	Package code	Indicates the package. Refer to the order information. MSOP8(VSP8)
Z2	Grade	Automotive Grade.
TE1	Packing	Refer to the packing specifications.

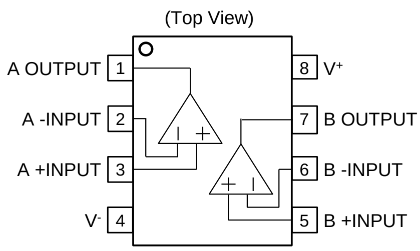
Grade

Grade	Applications	Operating Temperature Range	Test Temperature
Z2	Powertrain and Safety driving related	−40°C to 125°C	−40°C, 25°C, 125°C

■ ORDER INFORMATION

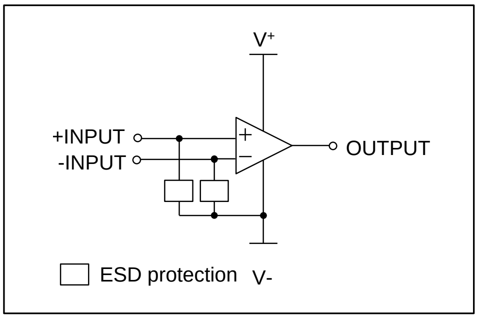
Product Name	Package	RoHS	Halogen-Free	Terminal Finish	Weight (mg)	QUANTITY PER REEL (pcs/reel)
NJM2904BR-Z2(TE1)	MSOP8 (VSP8)	✓	✓	Sn2Bi	21	2000

■ PIN DESCRIPTIONS



Pin No.	SYMBOL	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	Inverting input channel B
6	B +INPUT	I	Non-inverting input channel B
7	B OUTPUT	O	Output channel B
8	V^+	-	Positive supply

■ BLOCK DIAGRAM (Single Circuit)



■ ABSOLUTE MAXIMUM RATINGS

	Symbol	Rating	Unit
Supply Voltage	$V^+ - V^-$	36	V
Input Voltage *1	V_{IN}	V^- -0.3 to V^-+36	V
Input Current *1	I_{IN}	-10	mA
Differential Input Voltage *2	V_{ID}	±36	V
Applicable Voltage to Output terminals *3	V_O	V^- -0.3 to V^+ +0.3	V
Output Short-Circuit Duration *4	-	Continuous	-
Package Dissipation (T_a=25°C)	P_D	2-Layer / 4-Layer *5	mW
MSOP8 (VSP8)		570 / 770	
Storage Temperature	Tstg	-55 to 150	°C
Junction Temperature *6	T_j	150	°C

*1 "Input Voltage" is independent of supply voltage. Normal operating range as operational amplifier is shown in "Common-Mode Input Voltage Range" of "ELECTRICAL CHARACTERISTICS".
Limit input current under 10mA by using limit resistor if input voltage is below V^--0.3V.
Plus value of "Input Current" means sink direction, and minus value means source direction.
*2 " Differential Input Voltage " means potential difference between "+INPUT" and "-INPUT" terminals.
*3 Applicable voltage range to output pins from the outside without characteristic degradation or destruction.
*4 Short circuit from outputs to ground is allowed only when supply voltage is under 15V.
*5 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).
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), internal Cu area: 74.2 mm × 74.2 mm.
*6 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

Parameter	Measurement Result
Thermal Resistance (Θja)	2-Layer / 4-Layer *5
	Θja =220 / 163 °C/W
Thermal Characterization Parameter (ψjt)	2-Layer / 4-Layer *5
	ψjt = 41 / 32 °C/W

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

■ ELECTROSTATIC DISCHARGE RATINGS

	Conditions	Protection Voltage
HBM	C = 100 pF, R = 1.5 kΩ	±2000 V
CDM		±1000 V

ELECTROSTATIC DISCHARGE RATINGS
The electrostatic discharge test is done based on JEITA ED-4701. In the HBM method, ESD is applied using the power supply pin and GND pin as reference pins.

■ RECOMMENDED OPERATING CONDITIONS

	Symbol	Rating	Unit
Supply Voltage	$V^+ - V^-$	3 to 36	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^+=5V, V^-=0V, unless otherwise specified.
For parameter that do not describe the temperature condition, the MIN / MAX value under the condition of -40°C ≤ Ta ≤ 125°C is described.

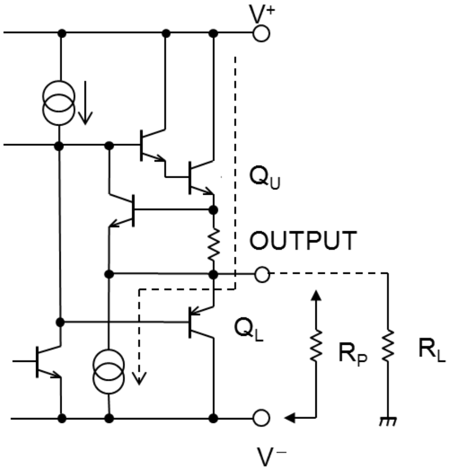
Parameter	Symbol	Test Conditions	MIN	TYP	MAX	Unit
Input Offset Voltage*1	V_{IO}	R_S = 50Ω, T_a=25°C	-	0.5	2.5	mV
		R_S = 50Ω	-	-	3.0	
Input Offset Voltage Drift*1	$\Delta V_{IO}/\Delta T$	R_S = 50Ω	-	3	-	µV/°C
Input Offset Current*1	I_{IO}	Ta=25°C	-	1	20	nA
			-	-	20	
Input Bias Current*1	I_B	Ta=25°C	-	10	30	nA
			-	-	30	
Open-Loop Voltage Gain	A_V	R_L ≥ 2kΩ to V^+ / 2, T_a=25°C	80	100	-	dB
		R_L ≥ 2kΩ to V^+ / 2	80	-	-	
		V^+ = 15V, R_L ≥ 2kΩ to V^+ / 2, T_a=25°C	96	106	-	
		V^+ = 15V, R_L ≥ 2kΩ to V^+ / 2	90	-	-	
High-level Output Voltage	V_{OH}	R_L ≥ 2kΩ to 0V, T_a = 25°C	3.5	-	-	V
		R_L ≥ 2kΩ to 0V	3.2	-	-	
		V^+ = 30V, V^-=0V, R_L ≥ 10kΩ to 0V, T_a=25°C	27.5	-	-	
		V^+ = 30V, V^-=0V, R_L ≥ 10kΩ to 0V	27.0	-	-	
Low-level Output Voltage	V_{OL}	R_L ≥ 2kΩ to 0V, T_a=25°C	-	-	0.02	V
		R_L ≥ 2kΩ to 0V	-	-	0.02	
		V^+ = 30V, V^-=0V, R_L ≥ 10kΩ to 0V, T_a=25°C	-	-	0.02	
		V^+ = 30V, V^-=0V, R_L ≥ 10kΩ to 0V	-	-	0.02	
Common Mode Input Voltage Range	V_{ICM}	CMR ≥ 74dB, T_a = 25°C	0	-	V^+ -1.5	V
		CMR ≥ 66dB	0	-	V^+ -2.0	
Common Mode Rejection Ratio	CMR	V_{ICM} = 0V to 3.5V, T_a = 25°C	74	90	-	dB
		V_{ICM} = 0V to 3.0V	66	-	-	
Supply Voltage Rejection Ratio	SVR	V^+ = 3.0V to 32V, T_a = 25°C	88	112	-	dB
		V^+ = 3.0V to 32V	76	-	-	
Output source current	I_{SOURCE}	V_{IN+} = 1V, V_{IN-} = 0V, T_a = 25°C	20	40	-	mA
		V_{IN+} = 1V, V_{IN-} = 0V	10	-	-	
Output sink current	I_{SINK}	V_{IN+} = 0V, V_{IN-} = 1V, T_a = 25°C	10	20	-	mA
		V_{IN+} = 0V, V_{IN-} = 1V	5	-	-	
Supply current (2 circuits)	I_{SUPPLY}	No signal, T_a = 25°C	-	0.7	1.2	mA
		No signal	-	-	1.2	
Channel Separation	CS	f = 1kHz to 20kHz, as input value, T_a = 25°C	-	120	-	dB
Slew Rate	SR	V^+ / V^- = ±15V, T_a = 25°C	-	0.4	-	V/µs
Gain Bandwidth Product	GBW	V^+ / V^- = ±15V, T_a= 25°C	-	0.9	-	MHz
Total Harmonic Distortion + Noise	THD+N	f = 1kHz, Gain = 20dB, V_O = 2V_{PP}, R_L = 2kΩ to V^-, C_L=100pF, T_a = 25°C	-	0.02	-	%
Equivalent Input Noise Voltage	e_n	V^+= 30V, f = 1kHz, R_S = 100Ω, T_a = 25°C	-	30	-	nV/√Hz

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

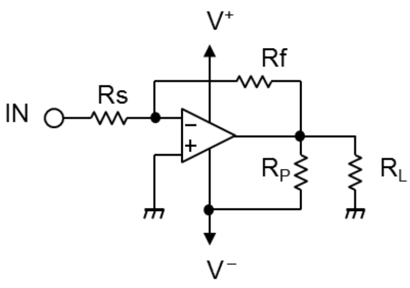
■ APPLICATION NOTE

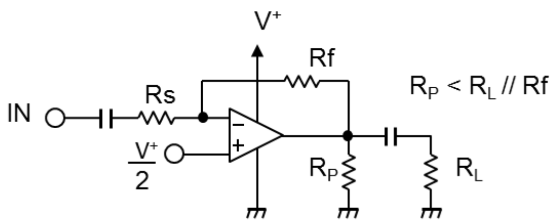
Improvement of Cross-over Distortion

Equivalent circuit at the output stage



NJM2904B, in its static state (No in and output condition) when design, Q_U being biased by constant current (break down beam) yet, Q_L stays OFF.
While using with both power source mode, the cross-over distortion might occur instantly when Q_L ON.
There might be cases when application for amplifier of audio signals, not only distortion but also the apparent frequency bandwidth being narrowed remarkably.
It is adjustable especially when using both power source mode, constantly to use with higher current on Q_U than the load current (including feedback current),and then connect the pull-down resister RP at the part between output and V- pins.



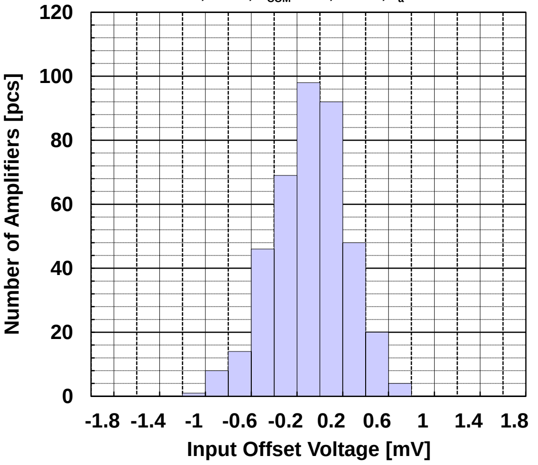


■ TYPICAL CHARACTERISTICS

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

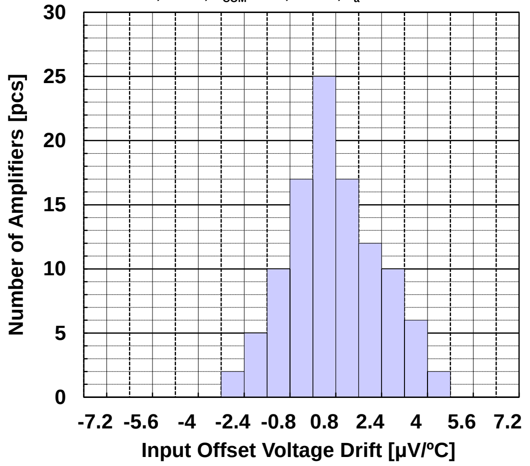
Input Offset Voltage histogram

V^{+}=5V, V^{-}=0V, V_{COM}=V^{+}/2, n=400, T_a=25ºC



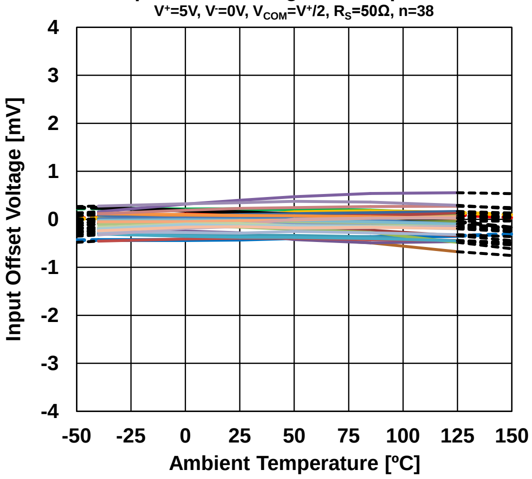
Input Offset Voltage Drift histogram

V^{+}=5V, V^{-}=0V, V_{COM}=V^{+}/2, n=106, T_a=-40ºC to 125ºC



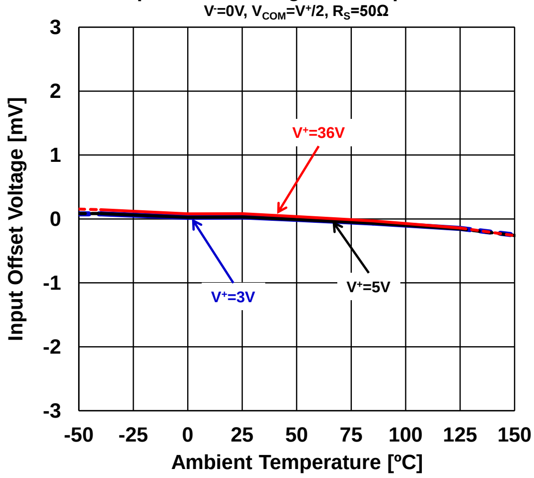
Input Offset Voltage vs. Temperature

V^{+}=5V, V^{-}=0V, V_{COM}=V^{+}/2, R_S=50Ω, n=38



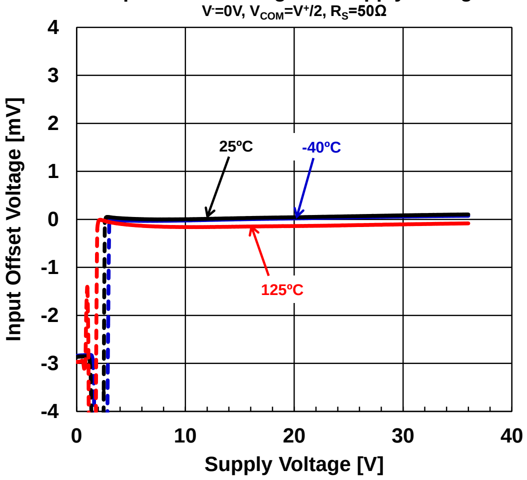
Input Offset Voltage vs. Temperature

V^{-}=0V, V_{COM}=V^{+}/2, R_S=50Ω



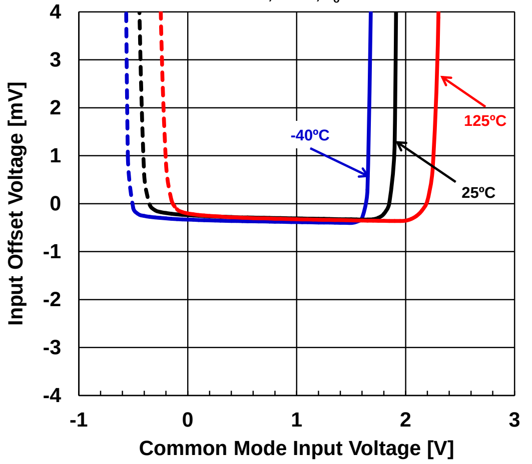
Input Offset Voltage vs. Supply Voltage

V^{-}=0V, V_{COM}=V^{+}/2, R_S=50Ω



Input Offset Voltage vs. Common Mode Input Voltage

V^{+}=3V, V^{-}=0V, V_o=1.2V



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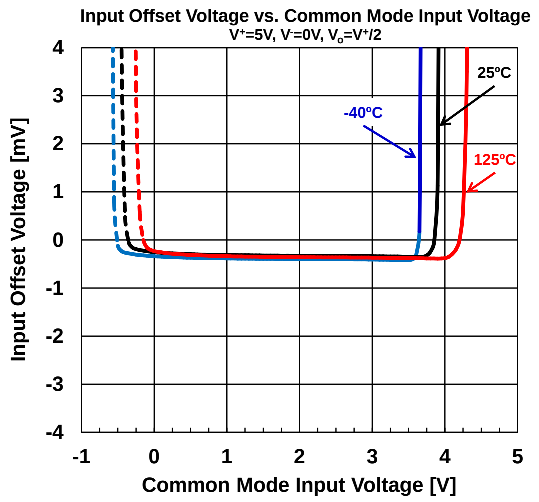

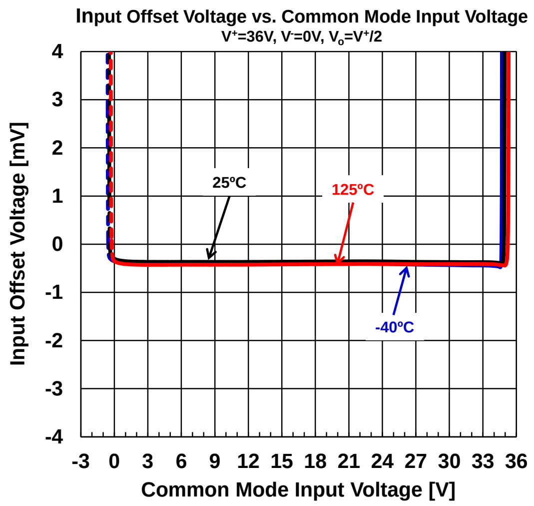

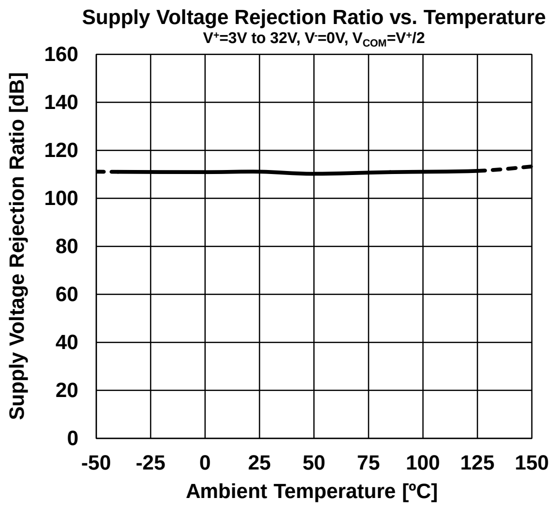

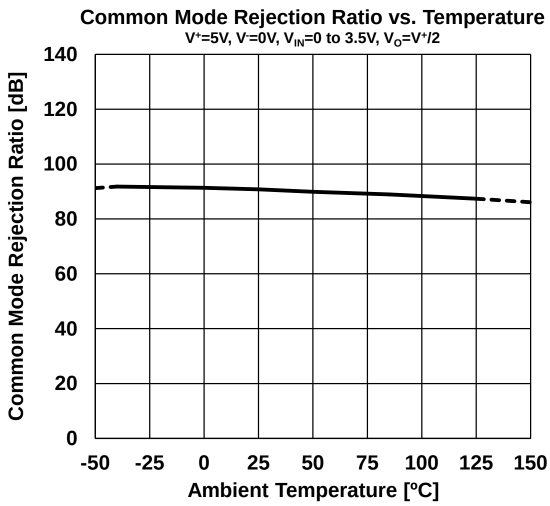

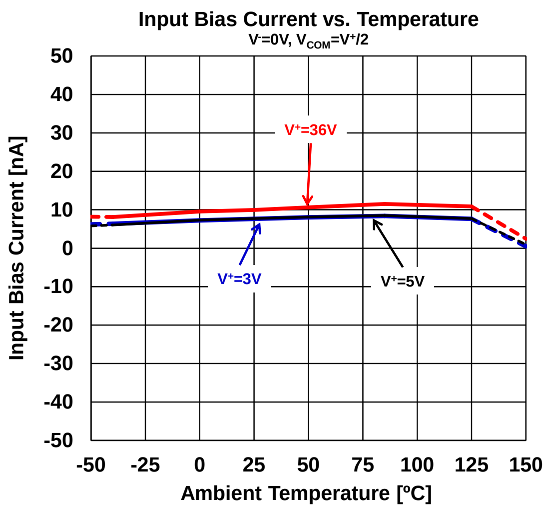

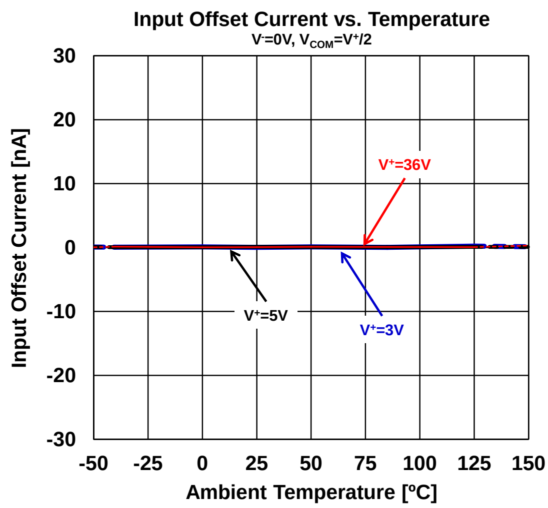

■ TYPICAL CHARACTERISTICS

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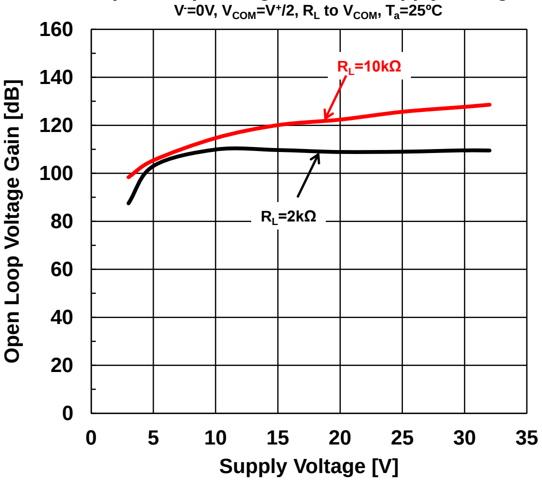
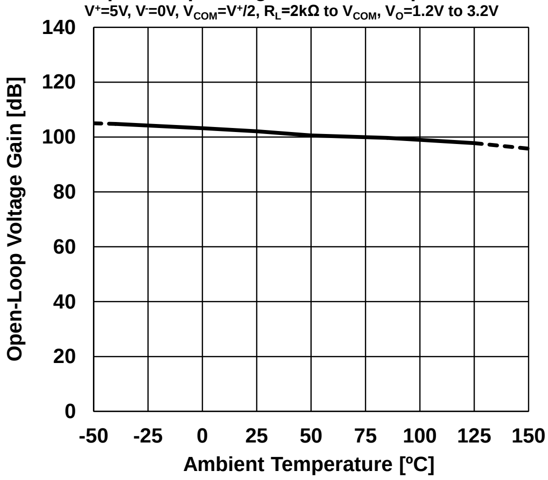
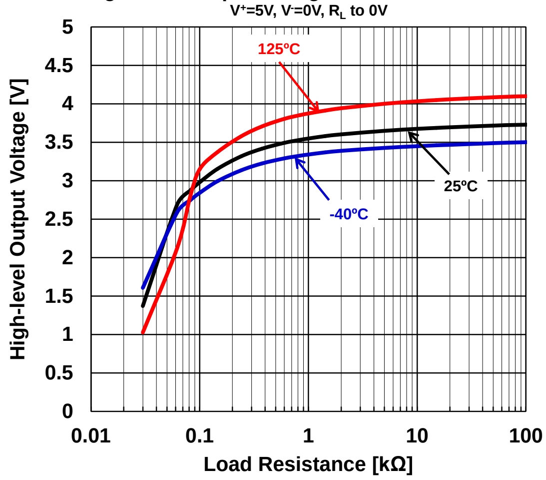
Open Loop Voltage Gain vs. Supply Voltage
V^-=0V, V_{COM}=V^+/2, R_L to V_{COM}, T_a=25ºC



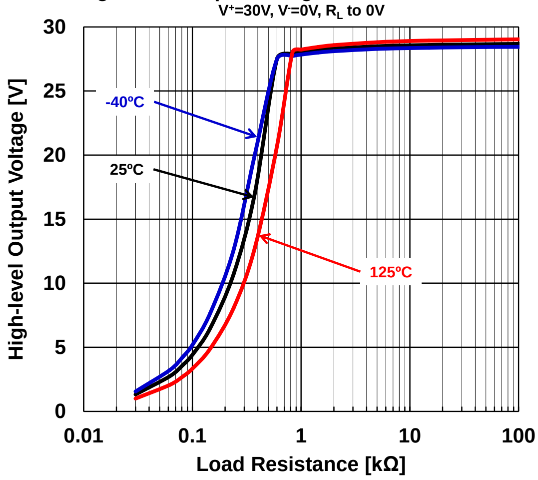
Open-Loop Voltage Gain vs. Temperature
V^+=5V, V^-=0V, V_{COM}=V^+/2, R_L=2kΩ to V_{COM}, V_O=1.2V to 3.2V



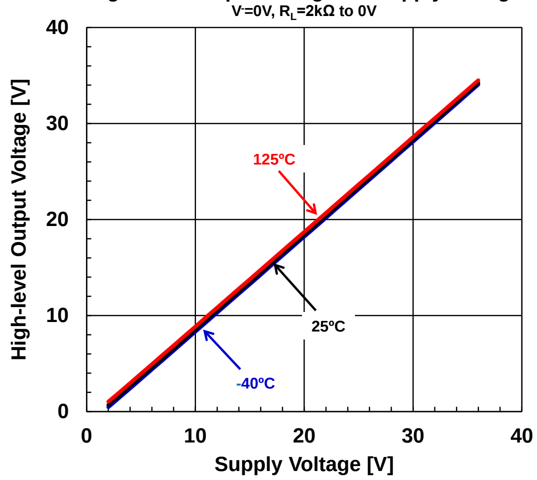
High-level Output Voltage vs. Load Resistance
V^+=5V, V^-=0V, R_L to 0V



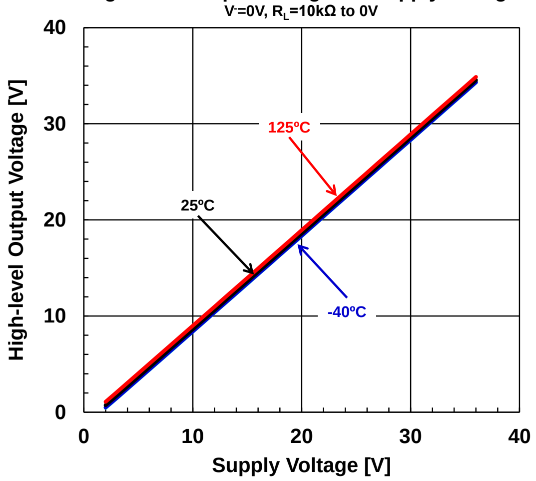
High-level Output Voltage vs. Load Resistance
V^+=30V, V^-=0V, R_L to 0V



High-level Output Voltage vs. Supply Voltage
V^-=0V, R_L=2kΩ to 0V



High-level Output Voltage vs. Supply Voltage
V^-=0V, R_L=10kΩ to 0V



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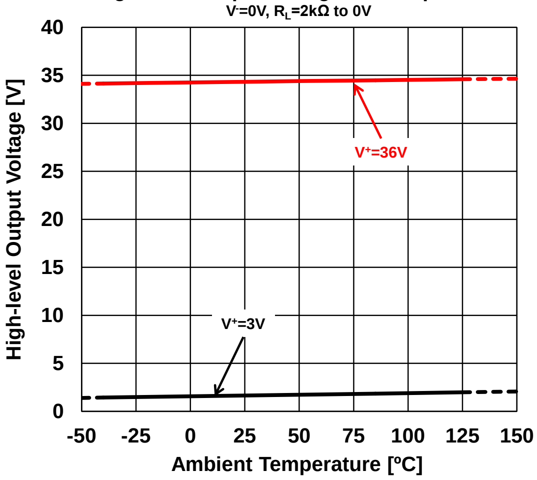
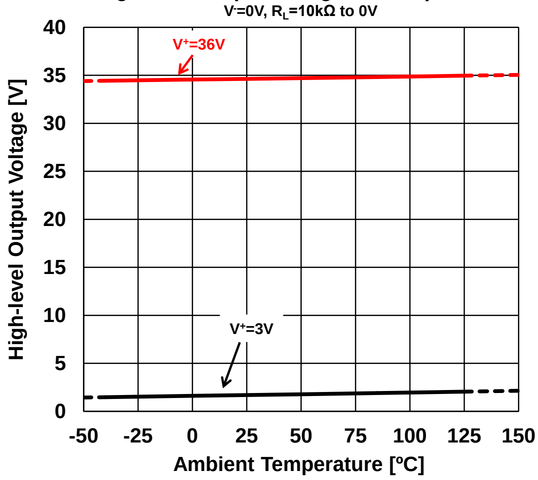
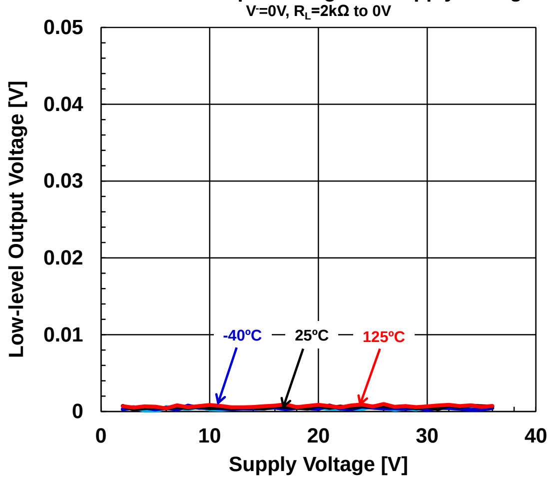
High-level Output Voltage vs. Temperature
V^-=0V, R_L=2kΩ to 0V



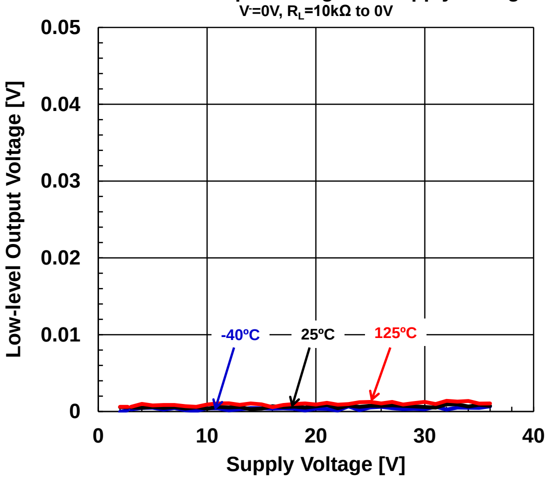
High-level Output Voltage vs. Temperature
V^-=0V, R_L=10kΩ to 0V



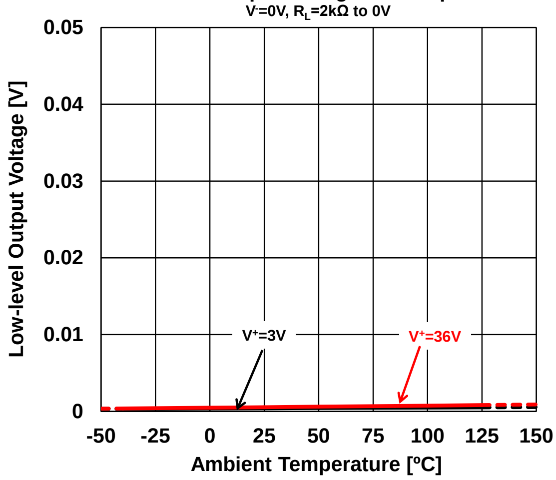
Low-level Output Voltage vs. Supply Voltage
V^-=0V, R_L=2kΩ to 0V



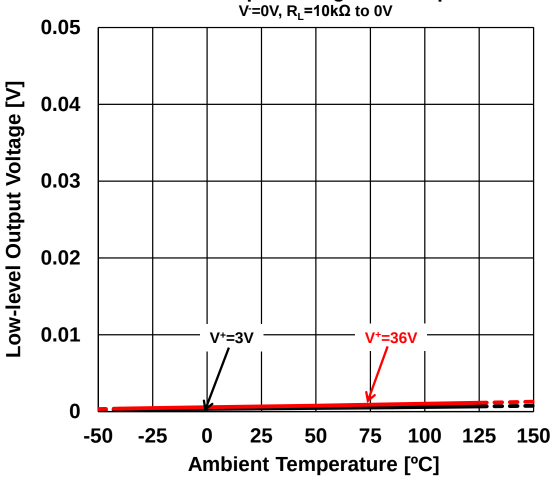
Low-level Output Voltage vs. Supply Voltage
V^-=0V, R_L=10kΩ to 0V



Low-level Output Voltage vs. Temperature
V^-=0V, R_L=2kΩ to 0V



Low-level Output Voltage vs. Temperature
V^-=0V, R_L=10kΩ to 0V



■ TYPICAL CHARACTERISTICS

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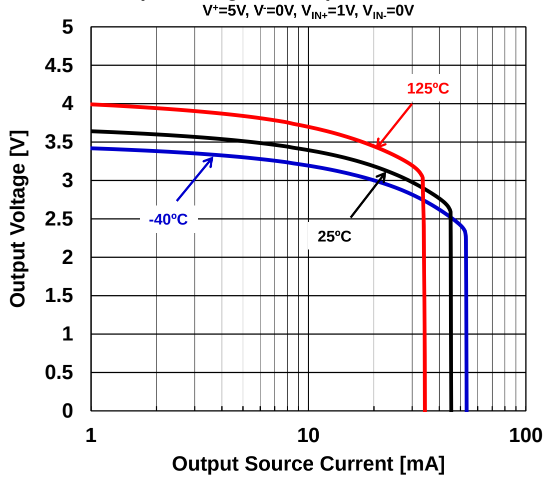
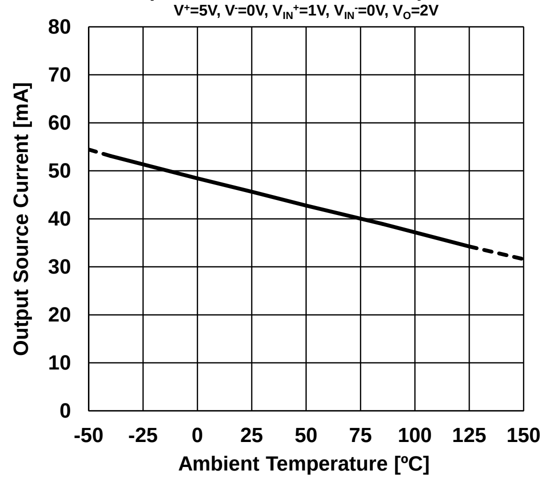
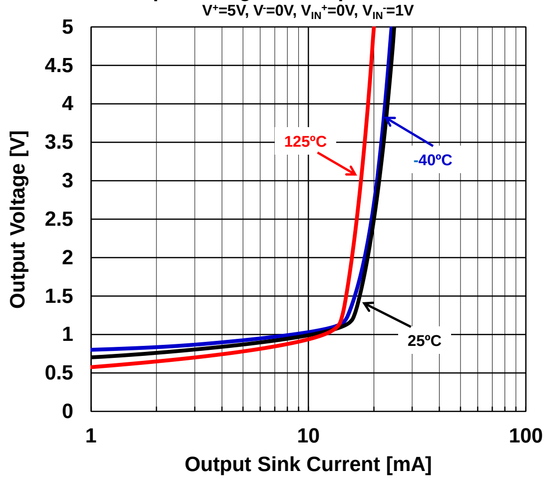
Output Voltage vs. Output Source Current
V^+=5V, V^-=0V, V_{IN+}=1V, V_{IN-}=0V



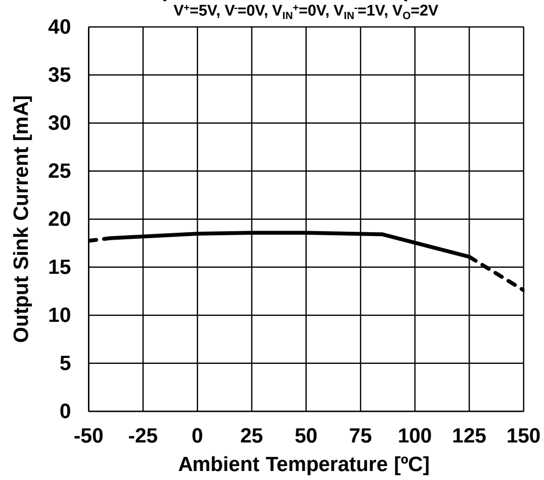
Output Source Current vs. Temperature
V^+=5V, V^-=0V, V_{IN}^+=1V, V_{IN}^-=0V, V_O=2V



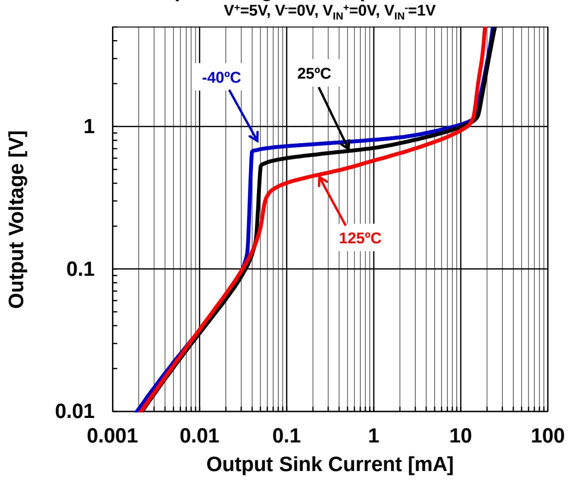
Output Voltage vs. Output Sink Current
V^+=5V, V^-=0V, V_{IN}^+=0V, V_{IN}^-=1V



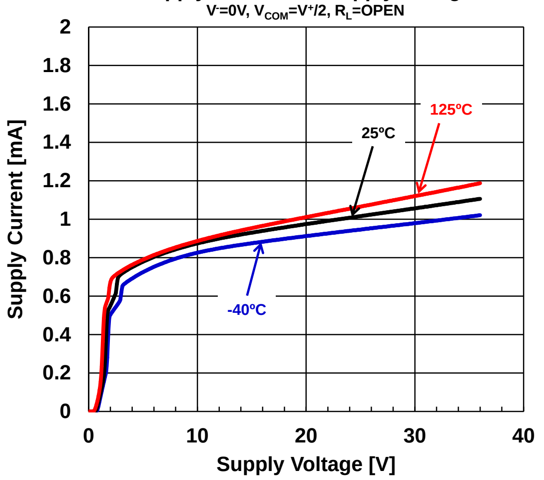
Output Sink Current vs. Temperature
V^+=5V, V^-=0V, V_{IN}^+=0V, V_{IN}^-=1V, V_O=2V



Output Voltage vs. Output Sink Current
V^+=5V, V^-=0V, V_{IN}^+=0V, V_{IN}^-=1V



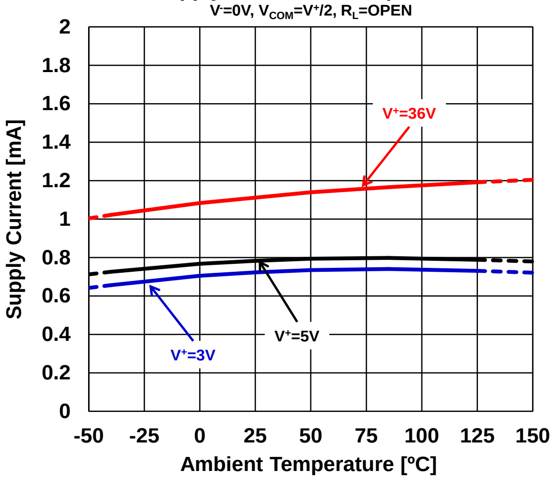
Supply Current vs. Supply Voltage
V^-=0V, V_{COM}=V^+/2, R_L=OPEN



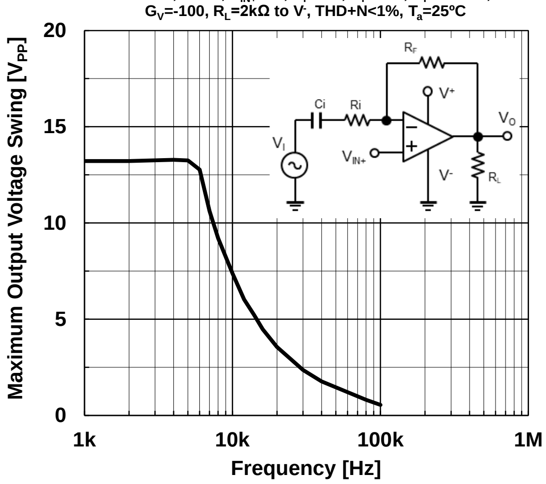
■ TYPICAL CHARACTERISTICS

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

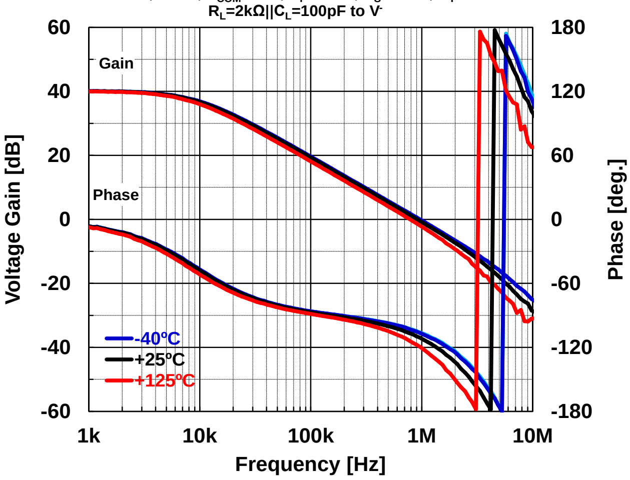
Supply Current vs. Temperature
V^-=0V, V_{COM}=V^+/2, R_L=OPEN



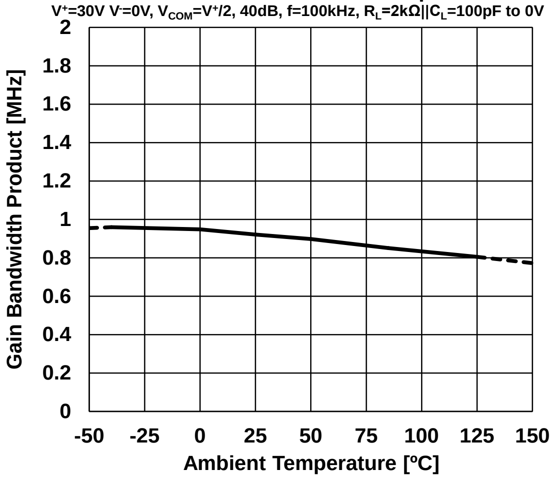
Maximum Output Voltage Swing vs. Frequency
V^+=15V, V^-=0V, V_{IN+}=7V, C_i=1uF, R_i=1kΩ, R_F=100kΩ, G_V=-100, R_L=2kΩ to V^-, THD+N<1%, T_a=25ºC



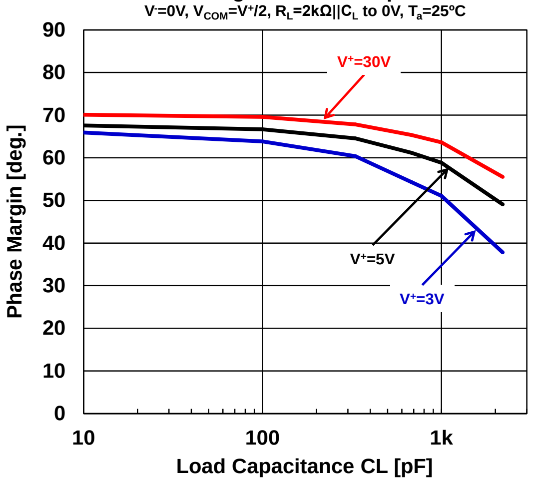
Gain/Phase vs. Frequency
V^+=30V, V^-=0V, V_{COM}=V^+/2, R_F=10kΩ, R_S=100Ω, R_T=50Ω, R_L=2kΩ||C_L=100pF to V^-



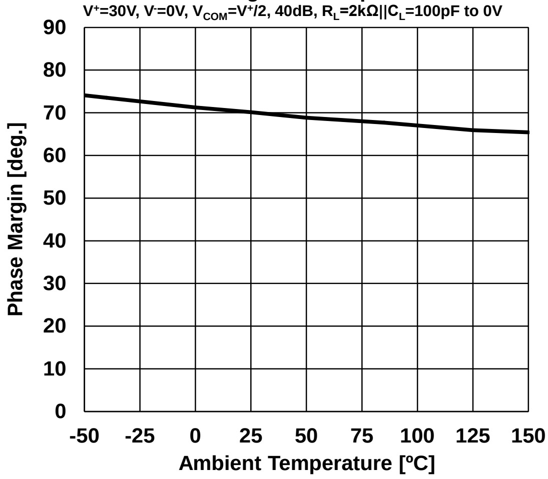
Gain Bandwidth Product vs. Temperature
V^+=30V V^-=0V, V_{COM}=V^+/2, 40dB, f=100kHz, R_L=2kΩ||C_L=100pF to 0V



Phase Margin vs. Load Capacitance
V^-=0V, V_{COM}=V^+/2, R_L=2kΩ||C_L to 0V, T_a=25ºC



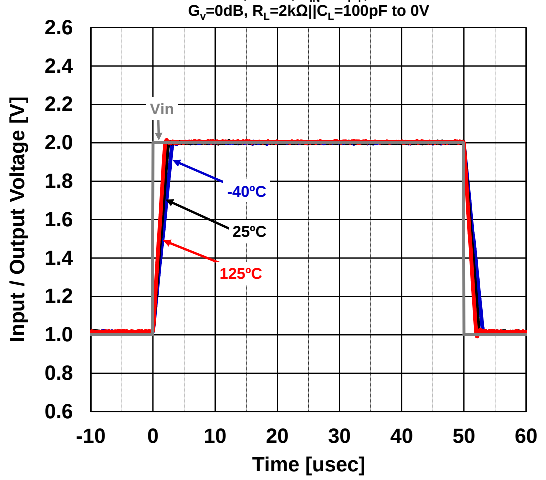
Phase Margin vs. Temperature
V^+=30V, V^-=0V, V_{COM}=V^+/2, 40dB, R_L=2kΩ||C_L=100pF to 0V



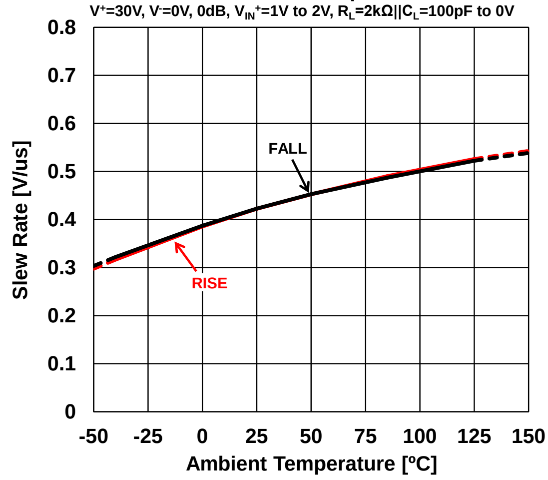
■ TYPICAL CHARACTERISTICS

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

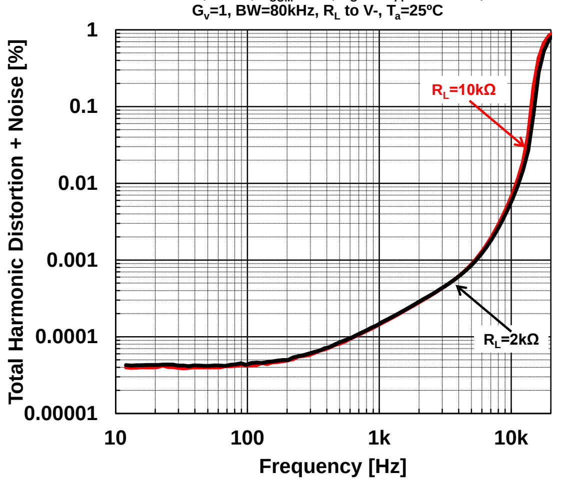
Pulse Response (Temperature)
V^+-=30V, V^-=0V, V_{IN}=1V_{P-P}, f=10kHz
G_v=0dB, R_L=2kΩ||C_L=100pF to 0V



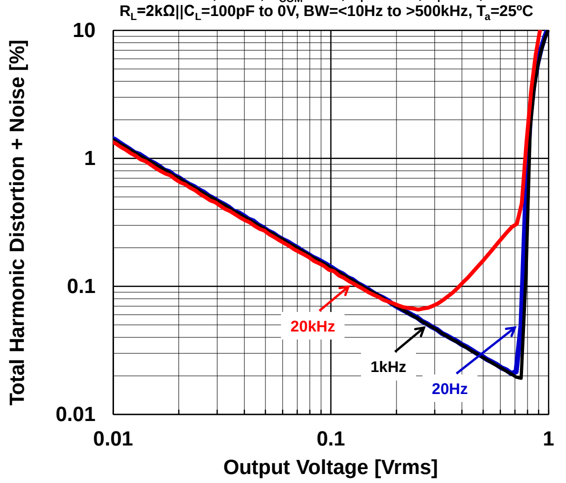
Slew Rate vs. Temperature
V^+=30V, V^-=0V, 0dB, V_{IN}^+=1V to 2V, R_L=2kΩ||C_L=100pF to 0V



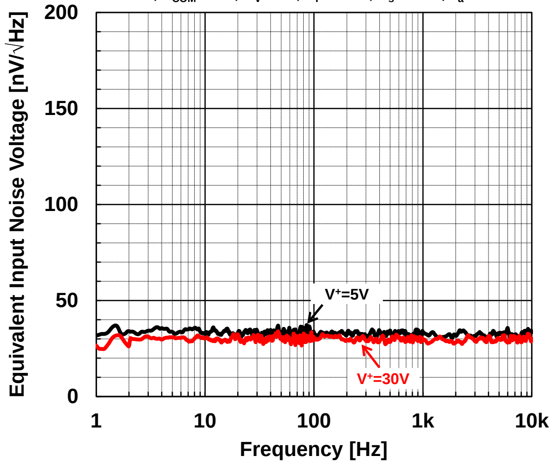
THD+N vs. Frequency
V^+=30V, V^-=0V, V_{COM}=V^+/2, V_O=10V_{PP} at f=1kHz,
G_v=1, BW=80kHz, R_L to V-, T_a=25ºC



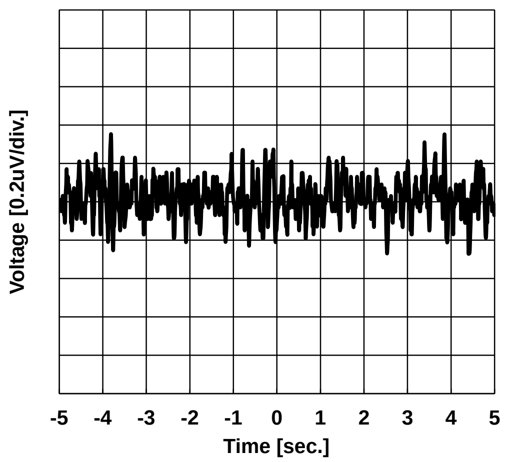
THD+N vs. Output Voltage
V^+=5V, V^-=0V, V_{COM}=V^+/2, R_F=9.1kΩ, R_I=1kΩ,
R_L=2kΩ||C_L=100pF to 0V, BW=<10Hz to >500kHz, T_a=25ºC



Voltage Noise Density vs. Frequency
V^-=0V, V_{COM}=V^+/2, G_V=100, R_F=10kΩ, R_S=100Ω, T_a=25ºC



0.1Hz to 10Hz Voltage Noise vs. Time
V^+=5V, V^-=0V, V_{COM}=V^+/2, T_a=25ºC

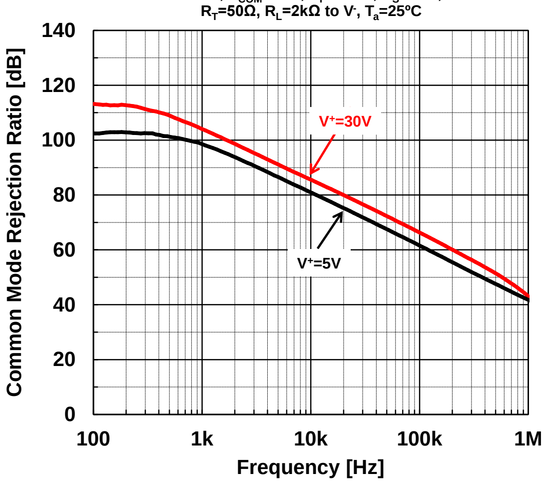


■ TYPICAL CHARACTERISTICS

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

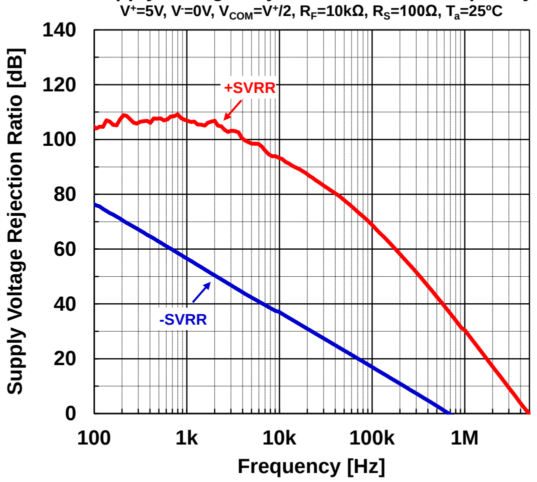
Common Mode Rejection Ratio vs. Frequency

V^-=0V, V_{COM}=V^+/2, R_F=10kΩ, R_S=10Ω,
R_T=50Ω, R_L=2kΩ to V^-, T_a=25ºC



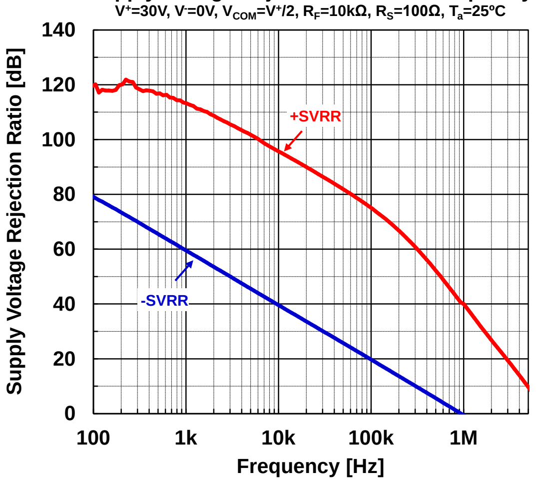
Supply Voltage Rejection Ratio vs. Frequency

V^+=5V, V^-=0V, V_{COM}=V^+/2, R_F=10kΩ, R_S=100Ω, T_a=25ºC



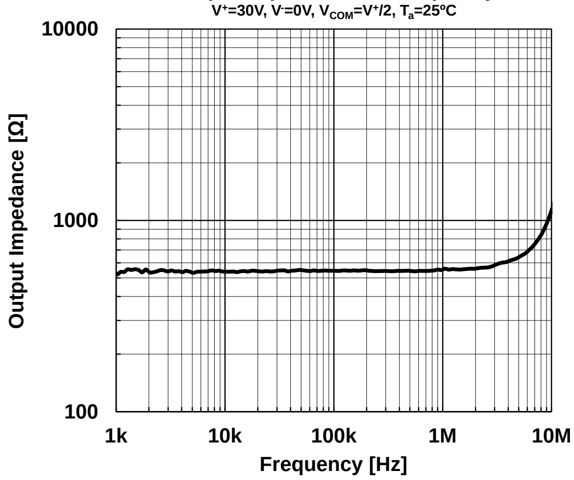
Supply Voltage Rejection Ratio vs. Frequency

V^+=30V, V^-=0V, V_{COM}=V^+/2, R_F=10kΩ, R_S=100Ω, T_a=25ºC



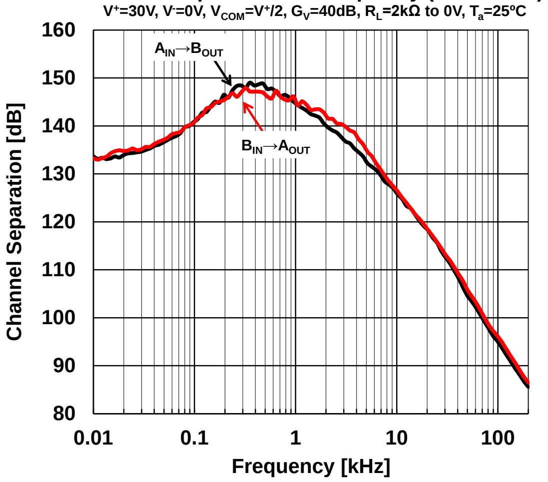
Output Impedance vs. Frequency

V^+=30V, V^-=0V, V_{COM}=V^+/2, T_a=25ºC



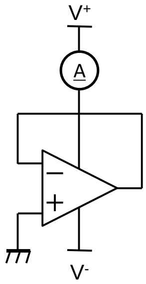
Channel Separation vs. Frequency (NJM2904B)

V^+=30V, V^-=0V, V_{COM}=V^+/2, G_V=40dB, R_L=2kΩ to 0V, T_a=25ºC

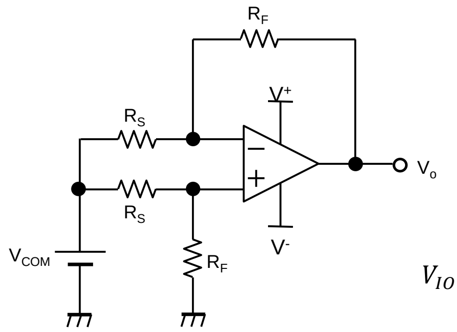


■ TYPICAL TEST CIRCUIT

● I_{SUPPLY}



● V_{IO}, CMR, SVR



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

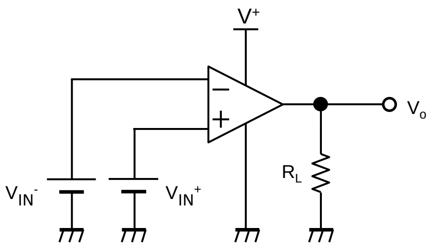
$$\mathrm{CMR} = 20log\frac{\Delta V_{COM}\left(1 + \frac{R_F}{R_S}\right)}{\Delta V_O}$$

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

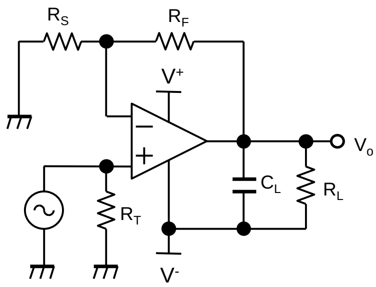
$$V_S = V^+ - V^-$$

● V_{OH}, V_{OL}

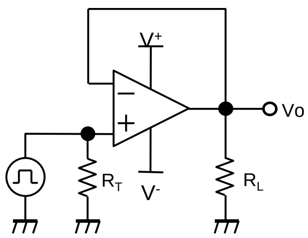
V_{OH}; V_{IN+} = 1V, V_{IN-} =0V
V_{OL}; V_{IN+} = 0V, V_{IN-} =1V

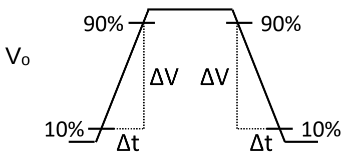


● GBW



● SR





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

■ REVISION HISTORY

Date	Revision	Changes
July 1, 2023	Ver.1.0	Initial Release

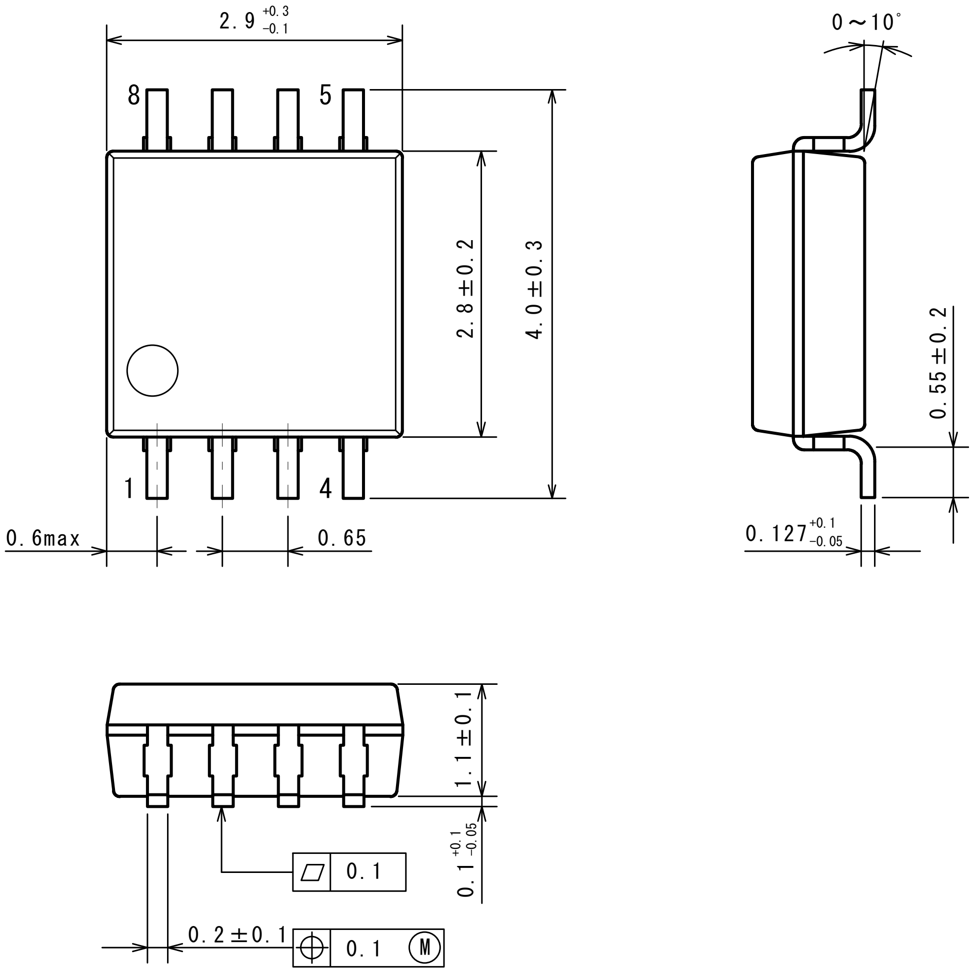
Nisshinbo Micro Devices Inc.

MSOP8 (VSP8)

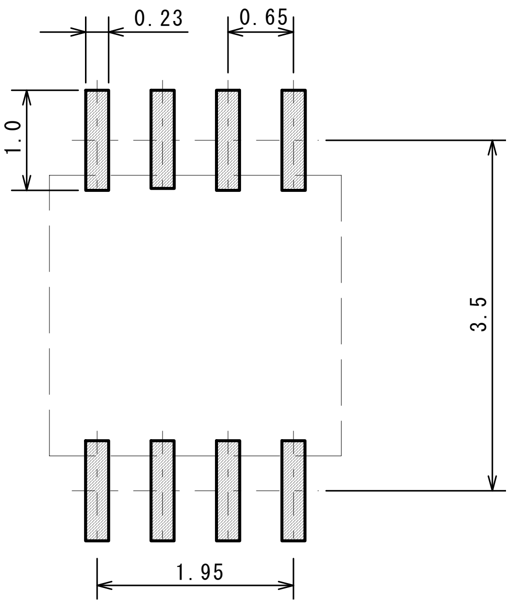
PI-VSP8-E-B

■ **PACKAGE DIMENSIONS**

UNIT: mm



■ **EXAMPLE OF SOLDER PADS DIMENSIONS**



Nisshinbo Micro Devices Inc.

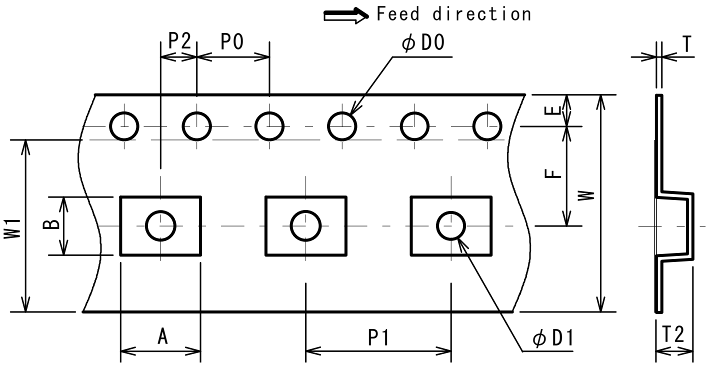
MSOP8 (VSP8)

PI-VSP8-E-B

■ **PACKING SPEC**

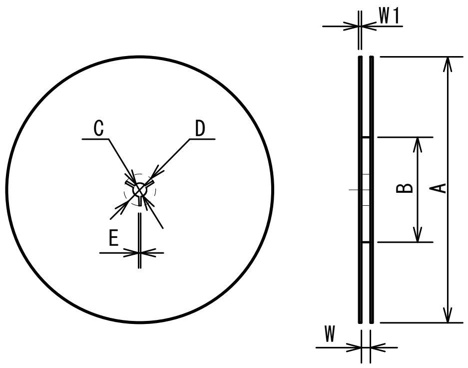
UNIT: mm

TAPING DIMENSIONS



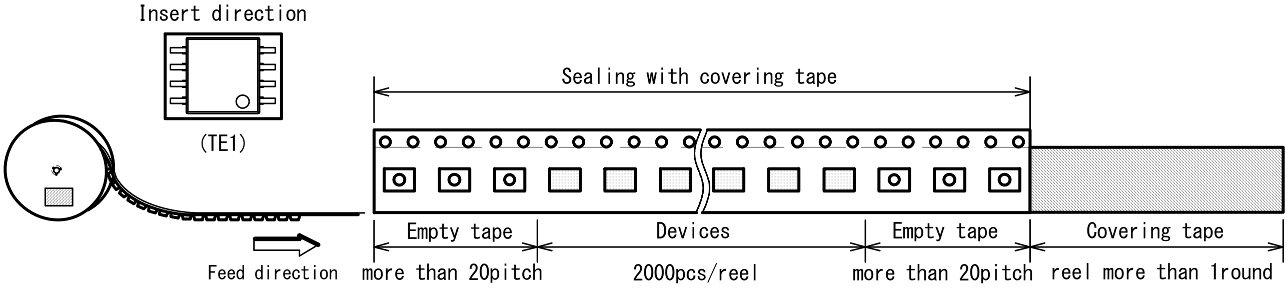
SYMBOL	DIMENSION	REMARKS
A	4.4	BOTTOM DIMENSION
B	3.2	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	$1.5^{+0.1}_{0}$	
E	1.75±0.1	
F	5.5±0.05	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.05	
T	0.30±0.05	
T2	2.0 (MAX.)	
W	12.0±0.3	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

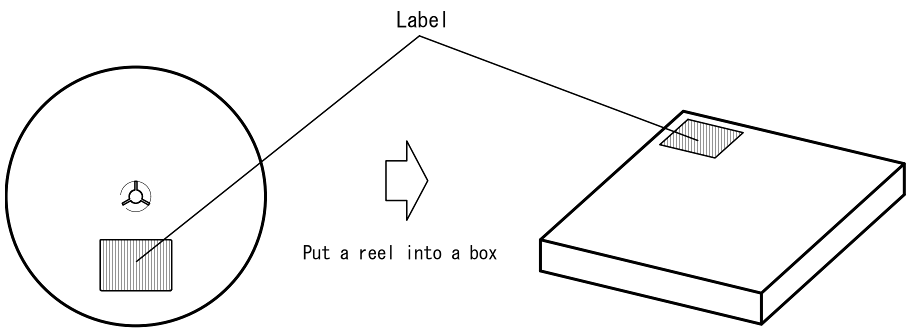


SYMBOL	DIMENSION
A	φ254±2
B	φ100±1
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	13.5±0.5
W1	2.0±0.2

TAPING STATE



PACKING STATE



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    - Life Maintenance Medical Equipment
    - Fire Alarms / Intruder Detectors
    - Vehicle Control Equipment (airplane, railroad, ship, etc.)
    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

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   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.
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