Nisshinbo Micro Devices Inc.

NJM2725

160MHz, 1.4nV/√Hz, Operational Amplifier

FEATURES

(V^+ = 5V, V^- = 0V, Typical value)

- GBW 160MHz
- Low Noise (f = 100kHz) 1.4nV/√Hz
- Input Offset Voltage 1mV max
- Supply Voltage 4V to 10V
- Common-Mode Input Voltage Range 1.5V to 3.8V
- Output Voltage (R_L = 1kΩ) 1.3V to 3.5V
- Supply Current 4mA/ch
- Operating Temperature -40°C to 125°C
- Slew Rate 15V/µs
- Stable Gain ≥ 2
- Package MSOP8 (VSP8) (U.D.) SOP8

APPLICATIONS

- Low Noise Instrumentation Front End
- Ultrasound Preamp
- High Speed Low Noise Active Filter
- ADC Input Buffer Amplifier
- Sensor Interface

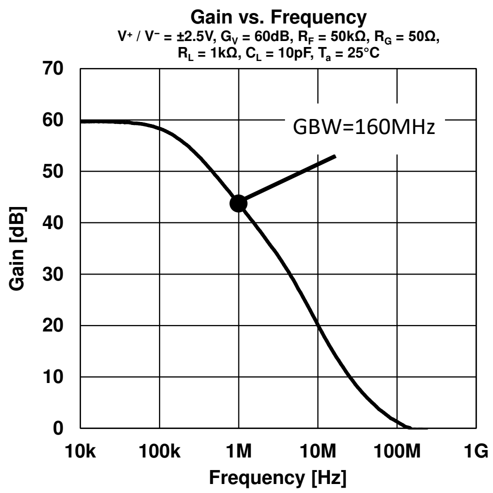
DESCRIPTION

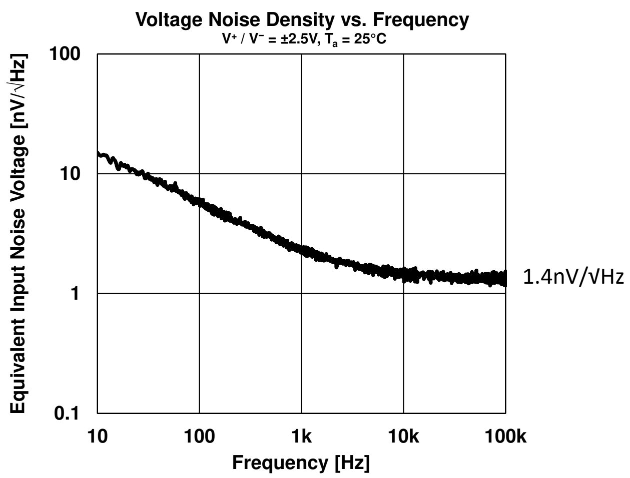
The NJM2725 is a dual high speed voltage feedback operational amplifier designed for ease of use in a high speed and low noise applications.

The combination of 1.4nV/√Hz voltage noise and 160MHz bandwidth makes the NJM2725 suitable for ultra-small signal and high frequency applications such as high speed photosensors, ultrasound sensors, active filters and other wideband applications. NJM2725 can be easily configured as a low noise amplifier, and it can also be used as a high performance ADC front end in combination with rail-to-rail op amps.

NJM2725 is stable for Gain ≥ 2 or Gain ≤ -1. Packages for this device is the 8pin SOP and the 8pin MSOP8 (VSP8) and is offered in the extended industrial temperature grade of -40°C to 125°C.

■ GBW and Noise





■ PRODUCT NAME INFORMATION

NJM2725 a (bbb)

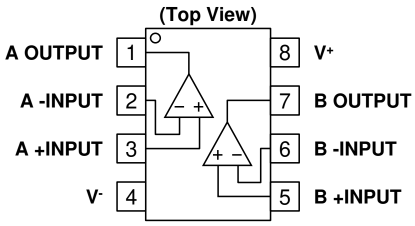
Description of configuration

Suffix	Parameter	Description
a	Package code	Indicates the package. Refer to the order information.
bbb	Packing	Refer to the packing specifications.

■ ORDER INFORMATION

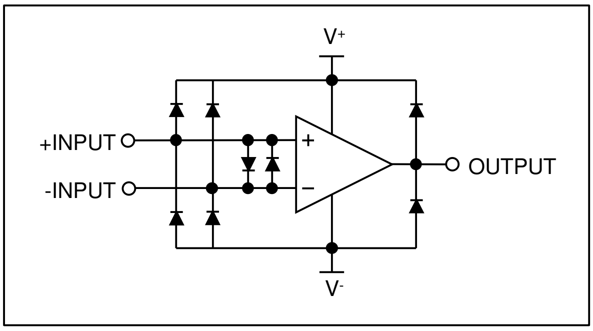
Product Name	Package	RoHS	Halogen-Free	Terminal Finish	Marking	Weight (mg)	MOQ (pcs)
NJM2725G (TE1)	SOP8 Under Development	Yes	Yes	Pure Sn	2725	88	2500
NJM2725R (TE1)	MSOP8 (VSP8)	Yes	-	Sn2Bi	2725	21	2000

■ PIN DESCRIPTIONS (8 Pin)



Pin No.		Symbol	I/O	Description
SOP8	VSP8			
1	1	A OUTPUT	O	Output channel A
2	2	A -NPUT	I	Inverting input channel A
3	3	A +NPUT	I	Non-inverting input channel A
7	7	BOUTPUT	O	Output channel B
6	6	B -INPUT	I	Inverting input channel B
5	5	B +INPUT	I	Non-inverting input channel B
8	8	V+	-	Positive supply
4	4	V−	-	Negative supply or Ground (single supply)

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Supply Voltage	$V^+ - V^-$	11	V
Input Voltage [*1]	V_{IN}	$V^- - 0.3$ to $V^+ + 0.3$	V
Input Current [*1]	I_{IN}	±1	mA
Differential Input Voltage [*2]	V_{ID}	±1.2	V
Output Short-Circuit Duration [*3]		Continuous	
Storage Temperature	T_{stg}	−65 to 150	°C
Junction Temperature [*4]	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 1 mA or less by µsing a restriction resistance. Input current inflow is positive and Input current outflow is negative.

[*2] Differential voltage is the voltage difference between +INPUT and −INPUT.

[*3] Short-circuit can cause excessive heating and destructive dissipation.

[*4] 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)	
SOP8 MSOP8 (VSP8)	125 189	43 53	°C/W

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

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

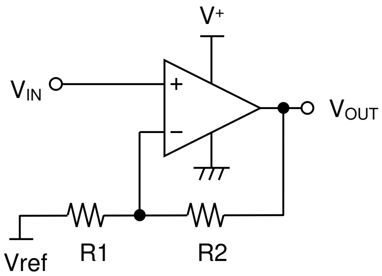
ELECTROSTATIC DISCHARGE RATINGS
The electrostatic discharge test is done based on JEITA ED-4701. In the HBM method, ESD is applied using the power supply pin and GND pin as reference pins.

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	Rating	Unit
Supply Voltage	$V^+ - V^-$		4 to 10	V
Operating Temperature	T_a		−40 to 125	°C

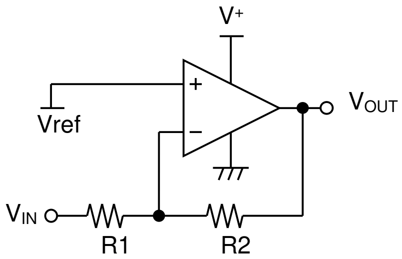
RECOMMENDED OPERATING CONDITIONS
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such 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.

■ TYPICAL APPLICATION CIRCUIT



Non-inverting amplifier

Stable Gain ≥ 2



Inverting amplifier

Stable Gain ≤ -1

■ ELECTRICAL CHARACTERISTICS

$V^+ = 5V$, $V^- = 0V$, $V_{COM} = V^+/2$, $R_L = 5k\Omega$ to V_{COM}, $T_a = 25°C$, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS [*1]						
Input Offset Voltage	V_{IO}		-	0.5	1	mV
Input Bias Current	I_B		-	4.6	10	μA
Input Offset Current	I_{IO}		-	0.5	5	μA
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$		-	1	-	μV/°C
Input Resistance	R_{IN}		-	12000	-	Ω
Input Capacitance	C_{IN}		-	2.8	-	pF
Open-Loop Voltage Gain	A_V	V_O = 1.5V to 3.5V	90	115	-	dB
Common-Mode Rejection Ratio	CMR	VCOM = V− + 1.5 to V+ − 1.2	70	100	-	dB
Common-Mode Input Voltage Range	V_{ICM}	Guaranteed by CMR	V^- + 1.5	-	V^+ − 1.2	V
OUTPUT CHARACTERISTICS						
High-level Output Voltage	V_{OH}	R_L = 1kΩ to $V^+/2$	V^+ − 1.5	V^+ − 1.0	-	V
Low-level Output Voltage	V_{OL}	R_L = 1kΩ to $V^+/2$	-	V^- + 0.2	V^- + 1.3	V
Output Current	I_O	Sourcing, V_O = 3.5V	-	25	-	mA
		Sinking, V_O = 1.5V	-	30	-	mA
POWER SUPPLY						
Supply Current per Amplifier	I_{SUPPLY}	No signal	-	4	5.8	mA
Supply Voltage Rejection Ratio	SVR	V^+ = 4 to 10V	80	110	-	dB
AC CHARACTERISTICS (Gain = 2)						
Slew Rate	SR	$V_O = 1V_{PP}$	-	15	-	V/μs
Gain Bandwidth Product	GBW	f = 1MHz	-	160	-	MHz
Settling Time 0.1%	t_s	$V_O = 1V_{PP}$	-	0.13	-	μs
Gain Margin	G_M	C_L = 50pF	-	10	-	dB
Phase Margin	Φ_M	C_L = 50pF	-	60	-	deg
Total Harmonic Distortion + Noise	THD+N	$V_O = 1V_{PP}$, f = 1MHz	-	0.1	-	%
Equivalent Input Noise Voltage	e_n	f = 100kHz	-	1.4	-	nV/√Hz
Equivalent Input Noise Current	In	f = 100kHz	-	1.5	-	pA/√Hz
Channel Separation	CS	f = 1MHz	-	80	-	dB

[*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

Single and Dual Supply Voltage Operation

The NJM2725 works with both single supply and dual supply when the voltage supplied is between V^+ and V^-. These amplifiers operate from single 4V to 10V supply and dual ±2V to ±5V supply. The power supply pin should have bypass capacitor (i.e. 0.1µF).

No Phase Reversal

NJM2725 are designed to prevent phase reversal at the input voltage above the supply voltage. Figure1 shows no phase reversal characteristics with the input voltage exceeding the supply voltage.

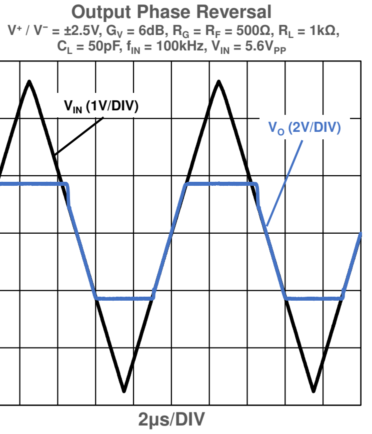


Figure1. No phase reversal

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^-+1.5V to V^+-1.2V (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^-+0.2V to V^+-1.0V (R_L=1kΩ to V^+/2, 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.

Terminating unused Op-Amps

Figure 2 shows examples of common method of terminating uncommitted operational amplifiers with using dual or quad. Improper termination can be result increase supply current, heating and noise in Op-Amps.

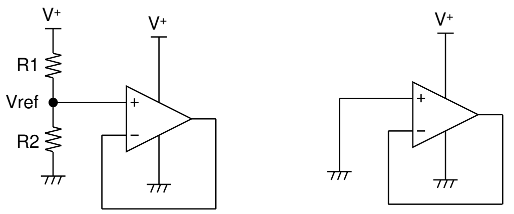
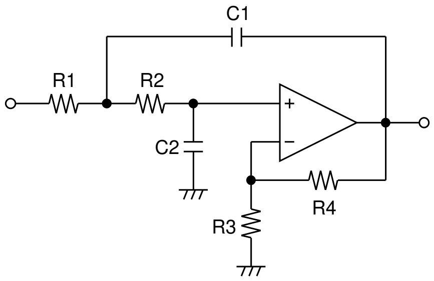


Figure 2. Terminating unused Op-Amps

Sallen-Key 2nd-Order Active Low-Pass Filter

The Sallen-Key 2nd-order active low-pass filter is shown in Figure 3. It can be used for a multiple pole filter required high attenuation.



R=R1=R2 , C=C1=C2
Q: Quality factor , G_{DC}: DC Gain

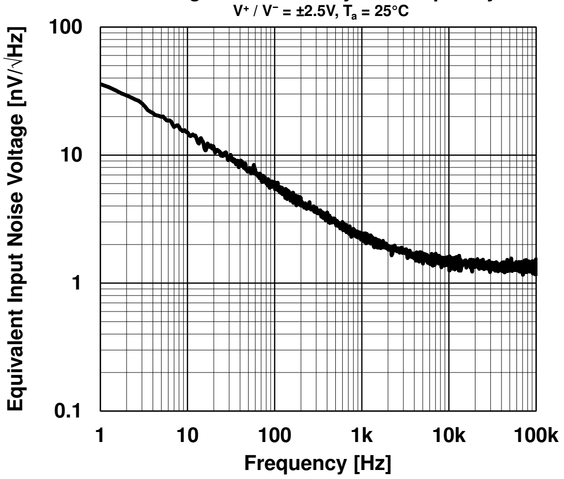
$$f_{-3dB}=\frac{1}{2\pi RC}\ ,\ Q=\frac{1}{3-G_{DC}}\ ,\ G_{DC}=1+\frac{R4}{R3}=3-\frac{1}{Q}$$

Figure 3. Sallen-Key 2nd-Order Low-Pass Filter

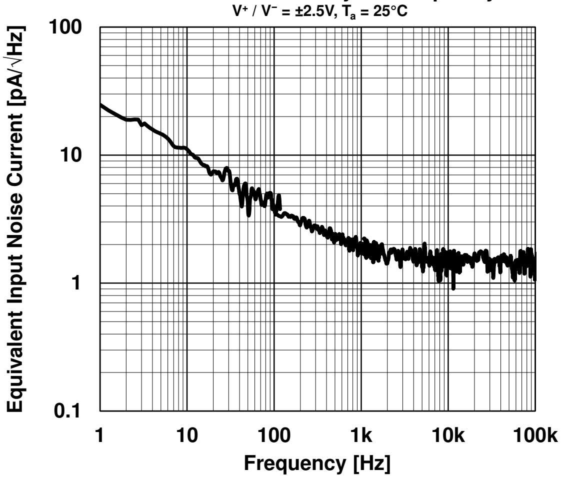
■ TYPICAL CHARACTERISTICS

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

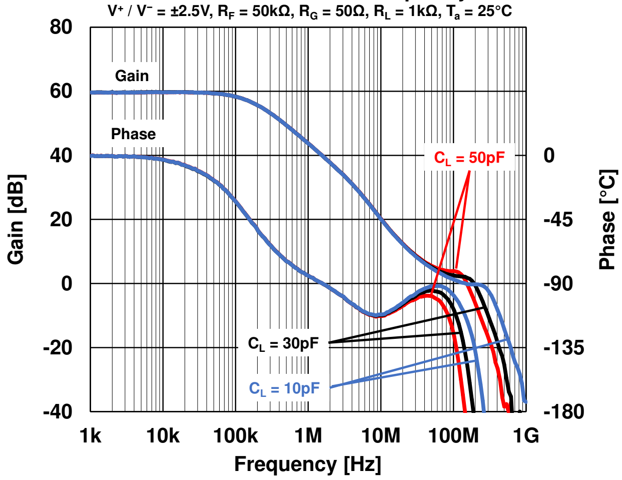
Voltage Noise Density vs. Frequency
$V^+ / V^- = \pm 2.5V$, $T_a = 25°C$



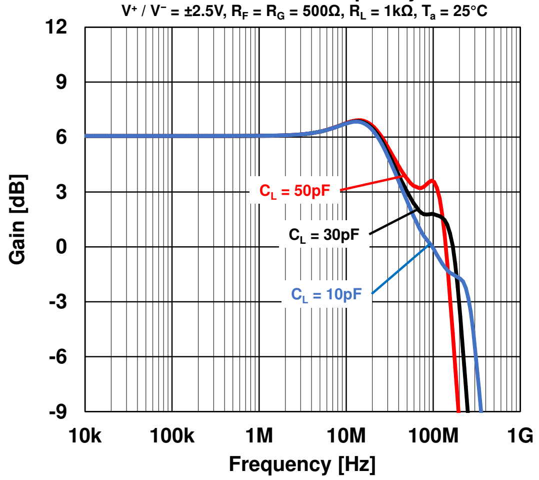
Current Noise Density vs. Frequency
$V^+ / V^- = \pm 2.5V$, $T_a = 25°C$



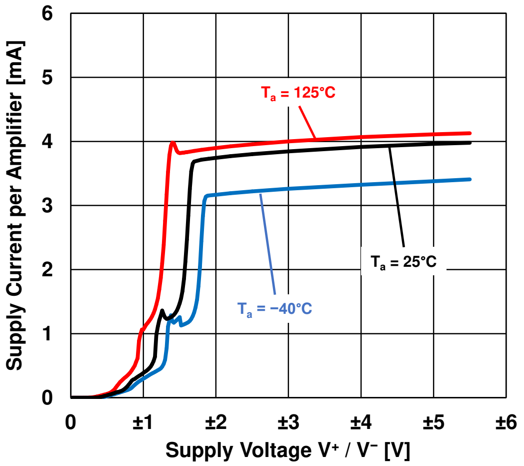
60dB Gain / Phase vs. Frequency
$V^+ / V^- = \pm 2.5V$, $R_F = 50k\Omega$, $R_G = 50\Omega$, $R_L = 1k\Omega$, $T_a = 25°C$



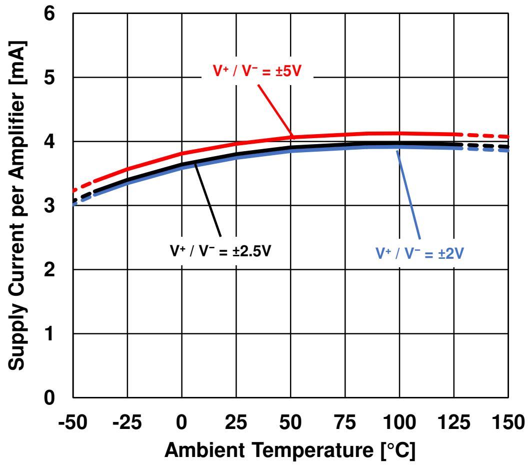
6dB Gain vs. Frequency
$V^+ / V^- = \pm 2.5V$, $R_F = R_G = 500\Omega$, $R_L = 1k\Omega$, $T_a = 25°C$



Supply Current per Amplifier vs. Supply Voltage

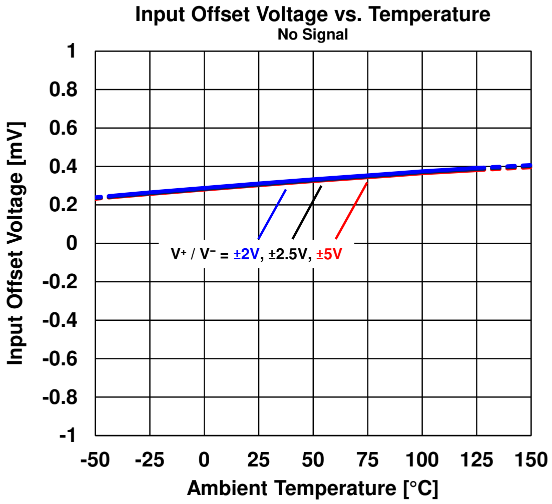


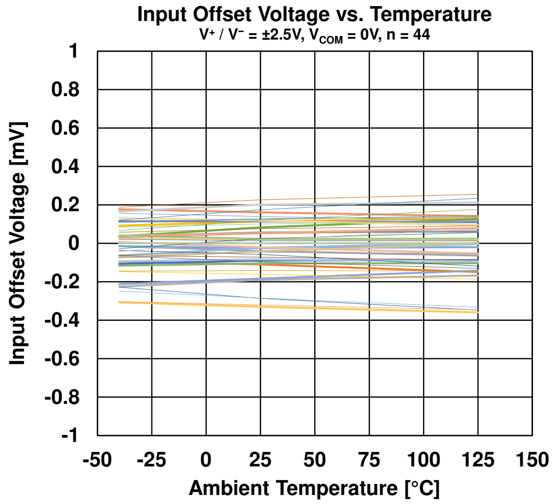
Supply Current per Amplifier vs. Temperature

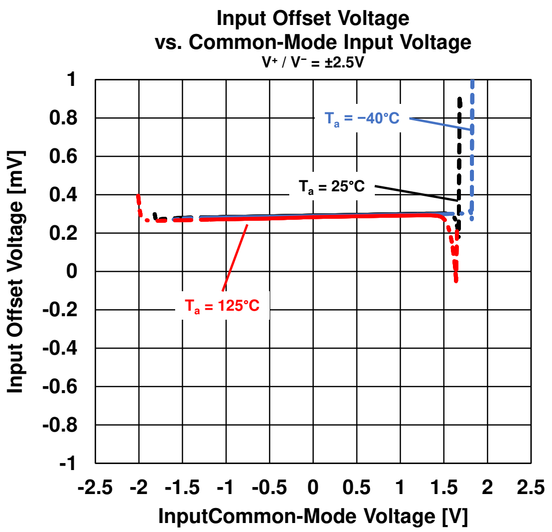


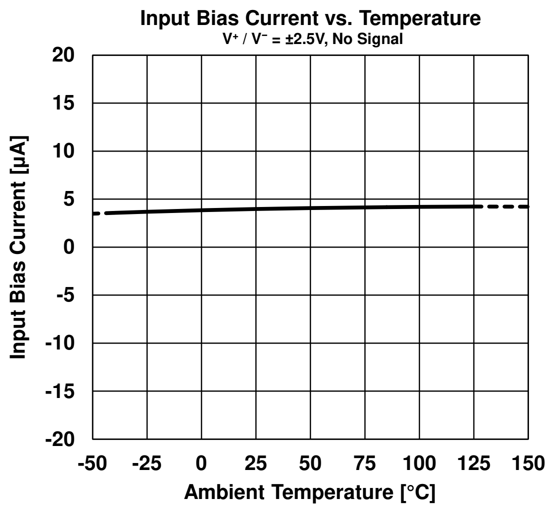
■ TYPICAL CHARACTERISTICS

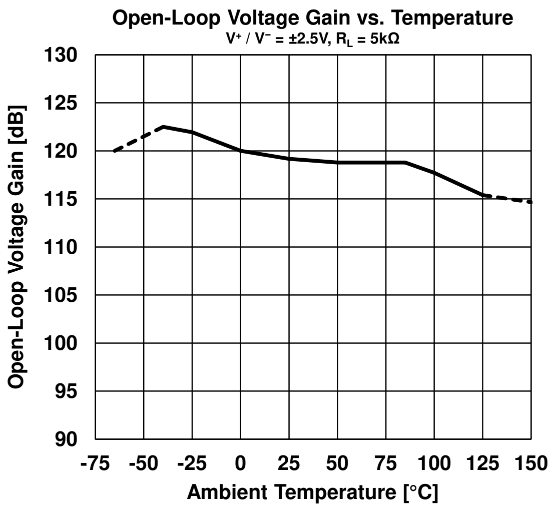
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

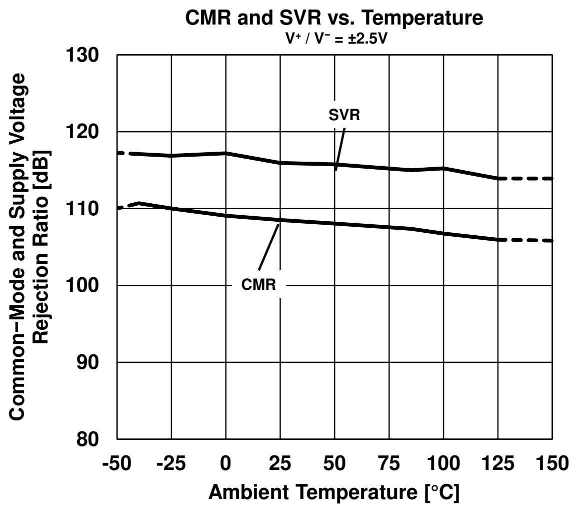








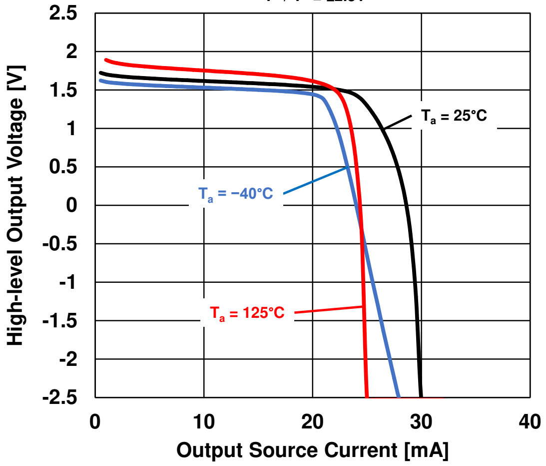




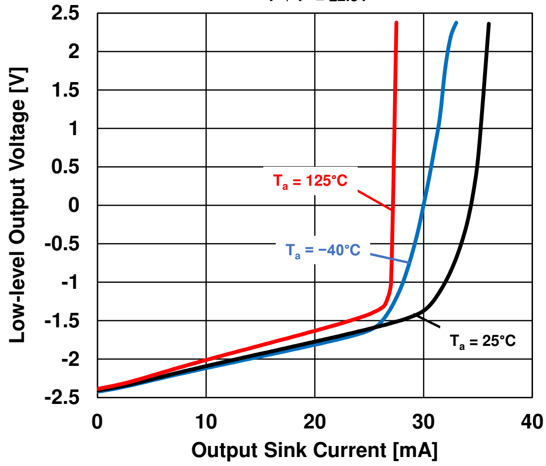
■ TYPICAL CHARACTERISTICS

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

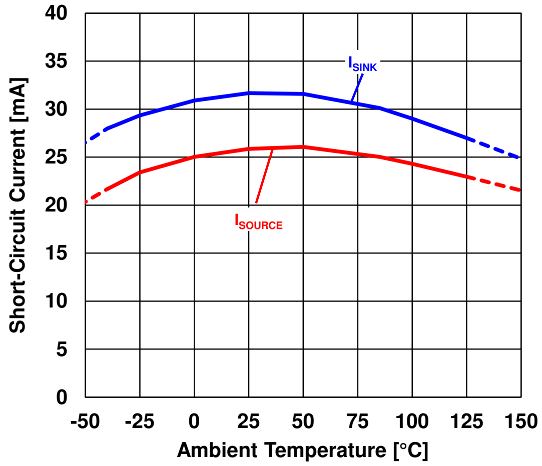
High-level Output Voltage vs. Output Source Current
V+ / V− = ±2.5V



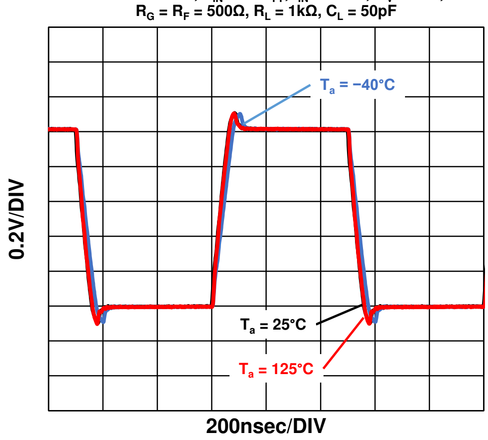
Low-level Output Voltage vs. Output Sink Current
V+ / V− = ±2.5V



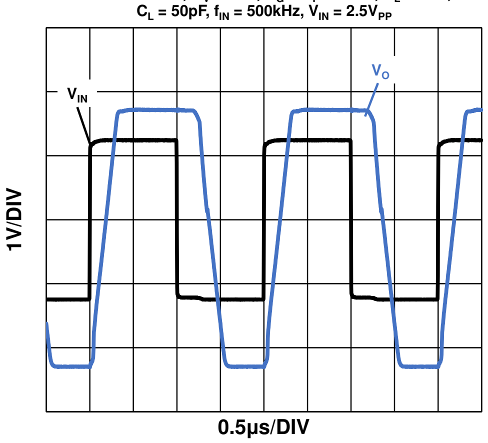
Short-Circuit Current vs. Temperature



Pulse Response
V+ / V− = ±2.5V, V_{IN} = 0.5V_{PP}, f_{IN} = 1MHz, G_V = 6dB,
R_G = R_F = 500Ω, R_L = 1kΩ, C_L = 50pF



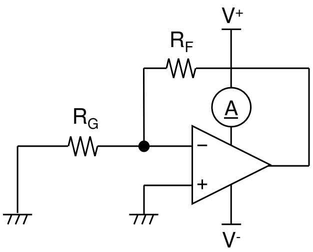
Overload Recovery Response
V+ / V− = ±2.5V, G_V = 6dB, R_G = R_F = 500Ω, R_L = 1kΩ,
C_L = 50pF, f_{IN} = 500kHz, V_{IN} = 2.5V_{PP}



■ TEST CIRCUITS

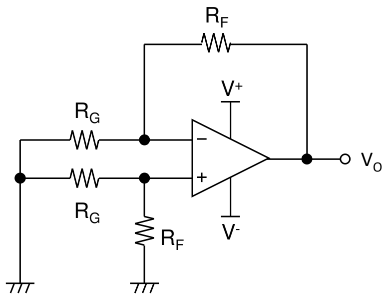
● I_{SUPPLY}

R_G=500Ω, R_F=500Ω



● V_{IO}, CMR, SVR

R_G=50Ω, R_F=50kΩ



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

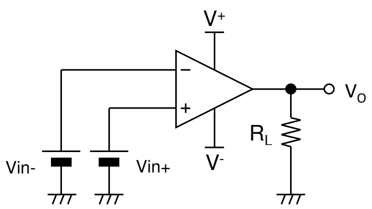
$$CMR=20\log\frac{\Delta V_{COM}\left(1+\frac{R_F}{R_G}\right)}{\Delta V_O}$$

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

$V_S=V^+-V^-$

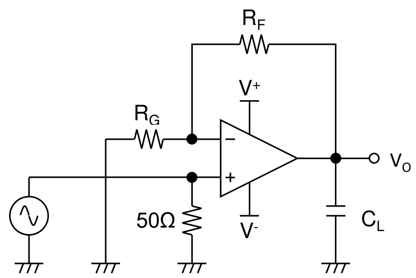
● V_{OH}, V_{OL}

V_{OH}; Vin+ = 0.1V, Vin- =0V
V_{OL}; Vin+ = -0.1V, Vin- =0V



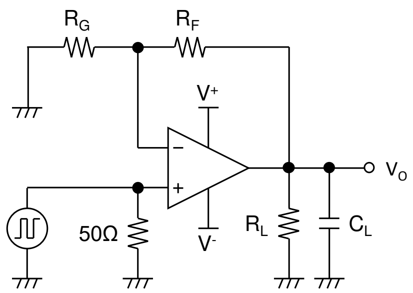
● GBW

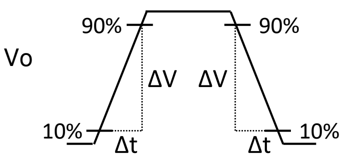
R_G=50Ω, R_F=50kΩ, C_L=50pF



● SR

R_G=50Ω, R_F=50kΩ, R_L=1kΩ, C_L=50pF





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

■ **REVISION HISTORY**

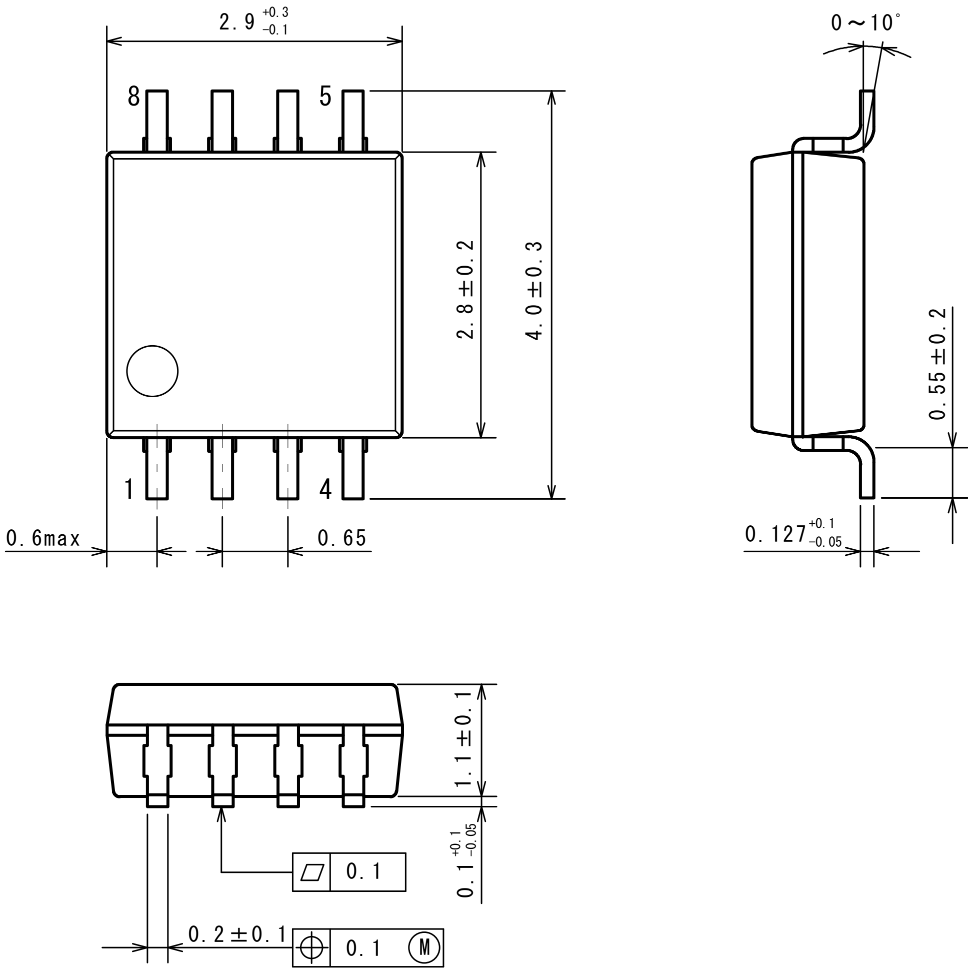
Date	Revision	Changes
May 10, 2022	Ver.1.0	Initial Release
August 25, 2022	Ver.1.1	Corrected unit of Input Offset Voltage vs. Temperature characteristics.

Nisshinbo Micro Devices Inc.

MSOP8 (VSP8)

■ PACKAGE DIMENSIONS

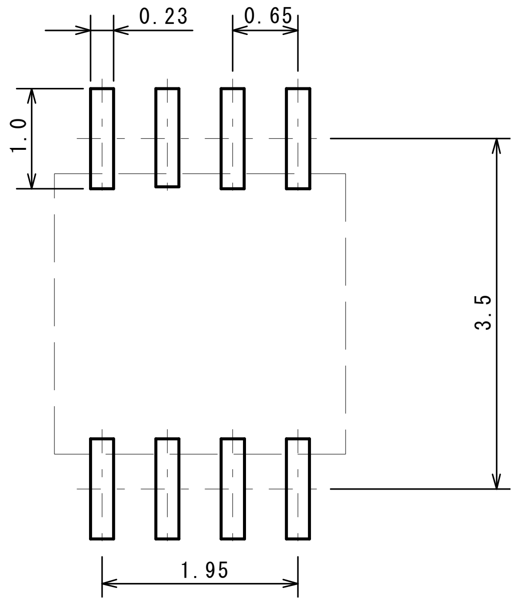
UNIT: mm



MSOP8 (VSP8) PI-VSP8-E-A

■ **EXAMPLE OF SOLDER PADS DIMENSIONS**

UNIT: mm



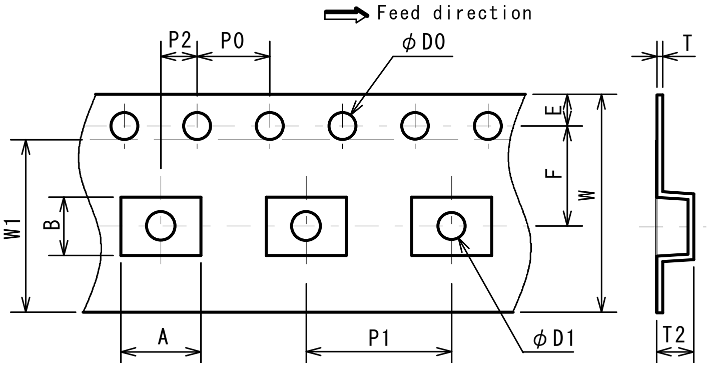
Nisshinbo Micro Devices Inc.

MSOP8 (VSP8)

■ PACKING SPEC

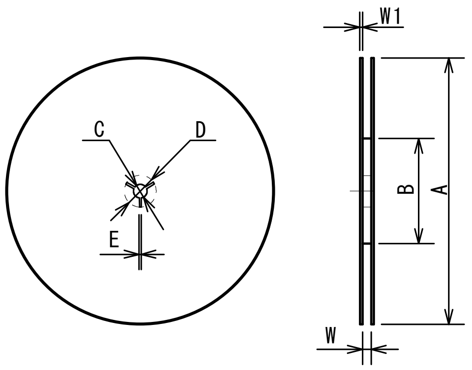
UNIT: mm

TAPING DIMENSIONS



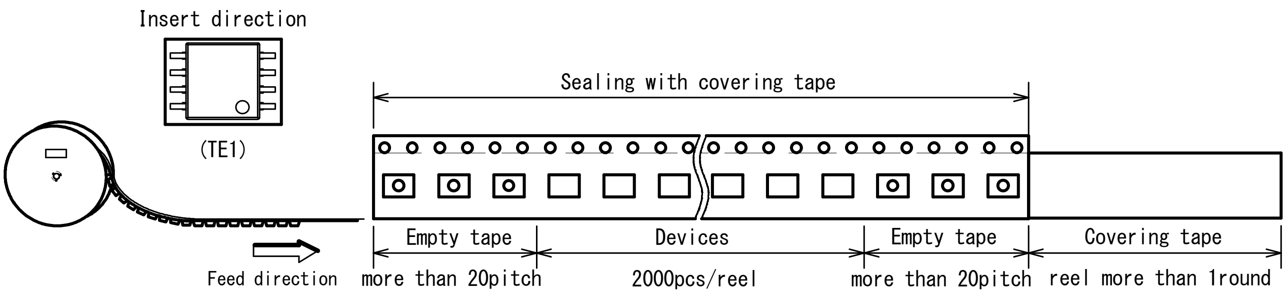
SYMBOL	DIMENSION	REMARKS
A	4.4	BOTTOM DIMENSION
B	3.2	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	$1.5^{+0.1}_{0}$	
E	1.75±0.1	
F	5.5±0.05	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.05	
T	0.30±0.05	
T2	2.0 (MAX.)	
W	12.0±0.3	
W1	9.5	THICKNESS 0.1max

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



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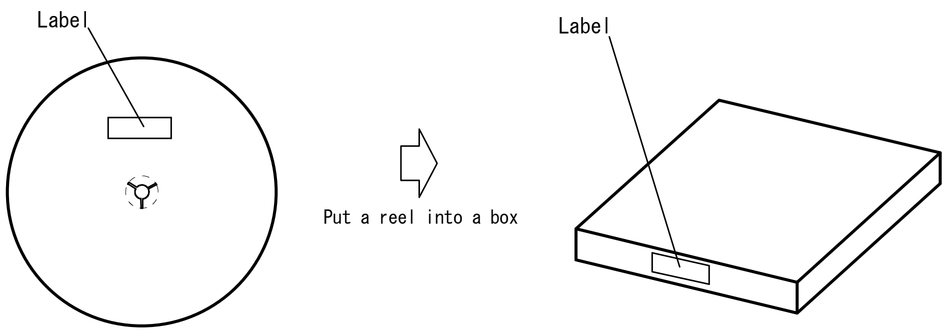

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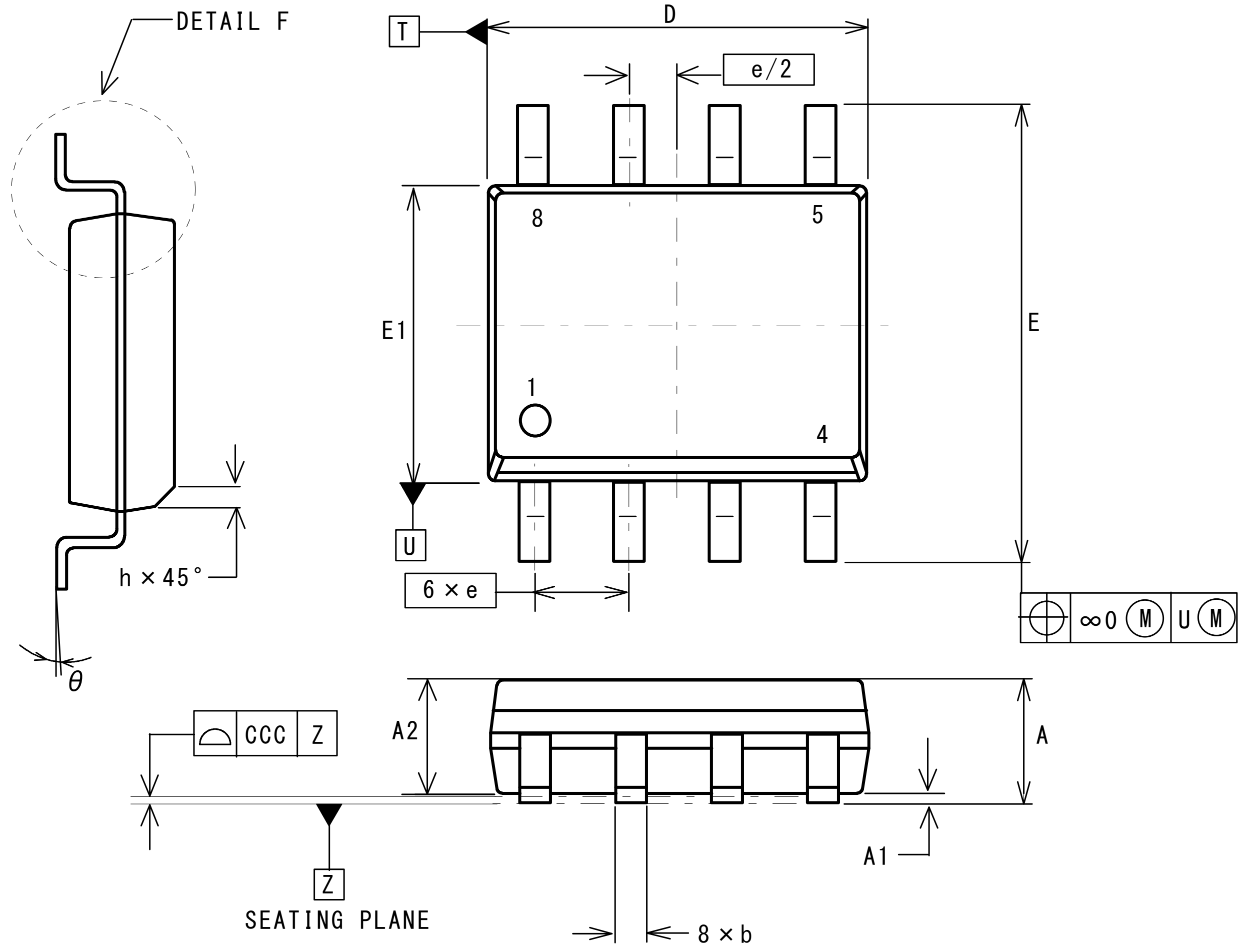
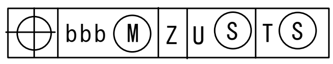
SOP8

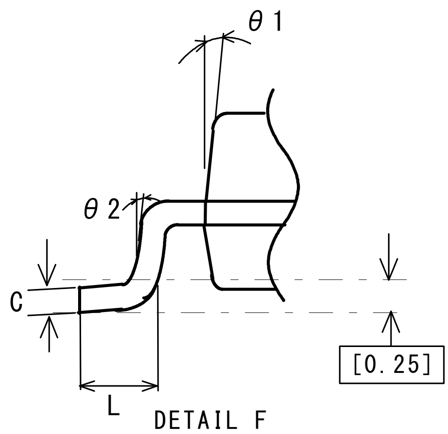
■ PACKAGE DIMENSIONS

UNIT: mm



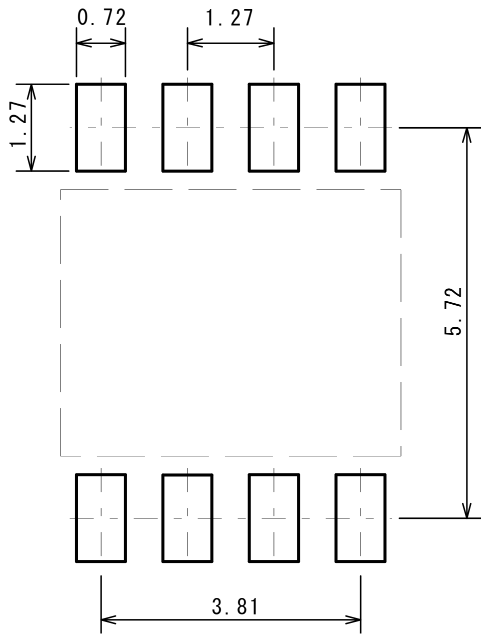


DESCRIPTION	SYMBOL	INCH			MILLIMETER		
		MIN	NCM	MAX	MIN	NCM	MAX
TOTAL THICKNESS	A	.053		.069	1.35		1.75
STAND OFF	A_1	.004		.010	0.10		0.25
MOLD THICKNESS	A_2	.049		–	1.25		–
LEAD WIDTH	b	.014		.019	0.35		0.49
L/F THICKNESS	C	.007		.010	0.19		0.25
BODY SIZE	D	.189		.197	4.80		5.00
	E_1	.150		.157	3.80		4.00
LEAD PITCH	E	.228		.244	5.80		6.20
	e		.050 BSC			1.27 BSC	
	L	.015		.049	0.40		1.25
	h	.010		.020	0.25		0.50
	θ	0°		8°	0°		7°
	θ_1	5°		15°	5°		15°
	θ_2	2°	7°	12°	2°	7°	12°
LEAD EDGE OFFSET	∞0		.010			0.25	
LEAD OFFSET	bbb		.010			0.25	
COPLANARITY	ccc		.004			0.10	



■ **EXAMPLE OF SOLDER PADS DIMENSIONS**

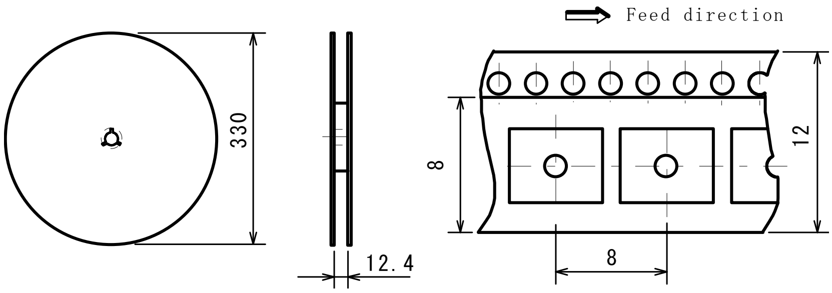
UNIT: mm



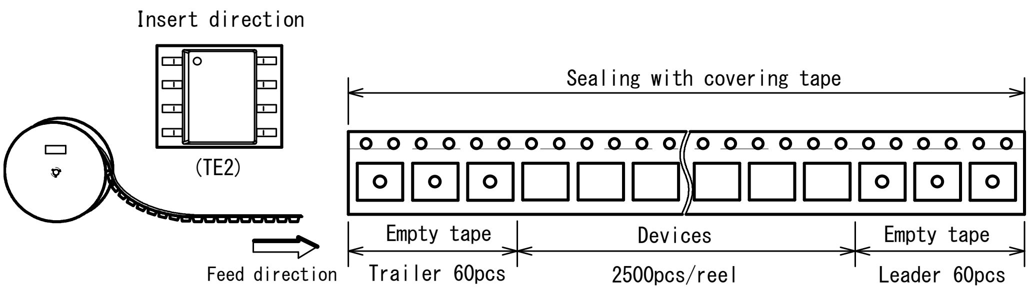
■ PACKING SPEC

UNIT: mm

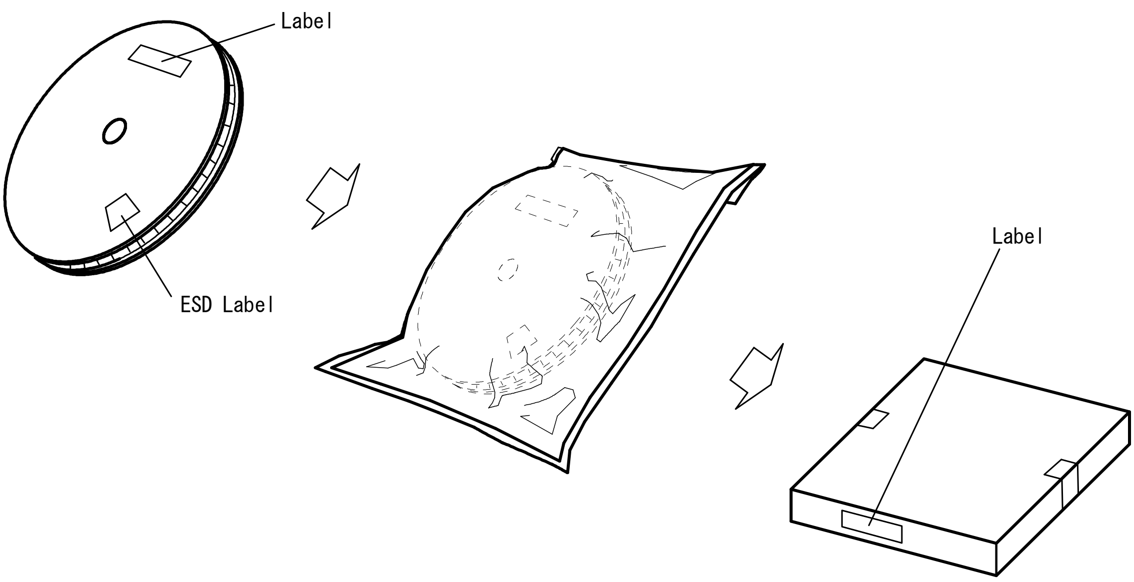
REEL DIMENSIONS / TAPING DIMENSIONS



TAPING STATE



PACKING STATE



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