

1.5V, 0.23μA/ch, Ultra-Low Power, Excellent EMI Immunity, Rail-to-Rail Input/Output, CMOS Operational Amplifiers

FEATURES ($V^+=5V$)

• Supply Voltage	1.5V to 5.5V
• Input Offset Voltage	
NJU77000 / NJU77001	1.0mV max.
NJU77002	1.3mV max.
NJU77004	1.5mV max.
• Input Offset Voltage Drift	0.65μV/°C typ.
• Input Bias Current	10pA max.
• Integrated EMI Filter	EMIRR=89dB typ. @f=900MHz
• Rail-to-Rail Input / Output	
• CMOS Technology	
• Slew Rate	0.7V/ms
• Unity Gain Frequency	1.0kHz
• Ultra-Low Power Supply Current	
NJU77000 / NJU77001	0.29μA typ.
NJU77002 / NJU77004	0.23μA/ch typ.
• Package	
NJU77000	SOT-23-5
NJU77001	SC-88A, SOT-23-5
NJU77002	SOP8 JEDEC 150mil
	MSOP8 (TVSP8)*
	*JEDEC MO-187-DA / thin type
	DFN8-U1 (ESON8-U1)
NJU77004	SSOP14

APPLICATIONS

- Battery-Powered Instruments
- Micro-Power Oxygen Sensors and Gas Sensors
- Power Line Monitoring
- Micro Power Current Sensing
- Healthcare Instruments

DESCRIPTION

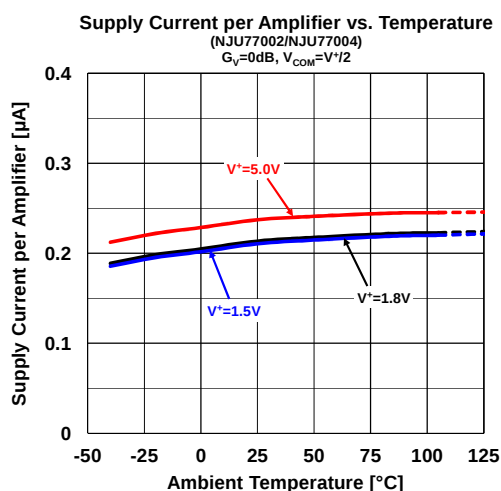
The NJU77000/NJU77001/NJU77002/NJU77004 are single/dual/quad ultra-low power CMOS operational amplifiers designed specifically to extend battery life and performance for portable applications. The supply voltage range is 1.5V to 5.5V and supply current is 0.29μA typ. (single), 0.23μA/ch typ. (dual/quad). The supply current is stable against ambient temperature and voltage change, making them suitable for micro power oxygen sensors, gas sensors, and remote sensor applications.

These devices also feature rail-to-rail I/O and input offset voltage of 1.0mV max. (single), 1.3mV max. (dual), 1.5mV max. (quad). Moreover, this series has excellent characteristics ideal for battery-powered applications, such as 0.65μV/°C typ. input offset voltage drift, input bias current of 10pA max. and ability of capacity load drive of 470pF.

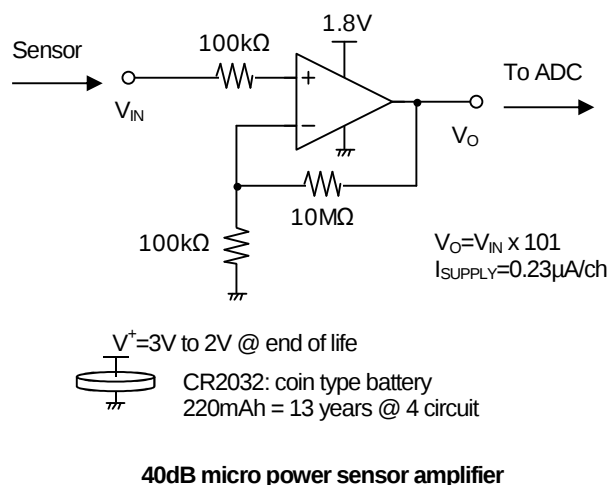
NJU77000 series has normal grade (NJU7700x) and A-Grade (NJU7700xA). A-Grade has improved offset voltage and supply voltage than normal grade, and other characteristics are also guaranteed from -40 to 105 °C.

The NJU77000 is available in a 5-pin SOT-23 package. NJU77001 is offered in 5-pin SOT-23 and SC-88A packages. NJU77000 and NJU77001 have different pin functions (see pin configurations). The NJU77002 is offered in 8-pin SOP JEDEC 150mil, MSOP (TVSP JEDEC MO-187-DA / thin type) and DFN (ESON) that is thin and 2mm square small package. The NJU77004 is a 14-pin SSOP package.

■ TYPICAL CHARACTERISTIC



■ TYPICAL APPLICATION



■ PRODUCT INFORMATION (Ta = 25°C)

V _O max.	I _{SUPPLY} max.	I _B max.	PACKAGE / PRODUCT NAME					
			SC-88A	SOT-23-5	SOP8 JEDEC 150 mil	MSOP8 (TVSP8)	DFN8-U1 (ESON8-U1)	SSOP14
1.8mV	0.49μA	-	NJU77001F3	NJU77000F NJU77001AF	-	-	-	-
1.0mV	0.39μA	10pA	NJU77001AF3	NJU77000AF NJU77001AF	-	-	-	-
2.0mV	0.66μA	-	-	-	NJU77002E	NJU77002RB1	NJU77002KU1	-
1.3mV	0.76μA	10pA	-	-	NJU77002AE	NJU77002ARB1	NJU77002AKU1	-
2.2mV	1.32μA	-	-	-	-	-	-	NJU77004V
1.5mV	1.22μA	10pA	-	-	-	-	-	NJU77004AV

■ PIN CONFIGURATIONS

PRODUCT NAME	NJU77000F NJU77000AF	NJU77001F NJU77001AF	NJU77001F3 NJU77001AF3	NJU77002E NJU77002AE	NJU77002RB1 NJU77002ARB1
Package	SOT-23-5	SOT-23-5	SC-88A	SOP8 JEDEC 150 mil	MSOP8 (TVSP8)
Pin Functions	(Top View)	(Top View)	(Top View)	(Top View)	(Top View)
PRODUCT NAME	NJU77002KU1 NJU77002AKU1	NJU77004V / NJU77004AV			
Package	DFN8-U1 (ESON8-U1)	SSOP14			
Pin Functions	(Top View)	(Top View)			

■ PRODUCT NAME INFORMATION

NJU77000 F (TE1)
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 Part Number Package Taping Form

■ ORDER INFORMATION

PRODUCT NAME	PACKAGE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJU77000F	SOT-23-5	Yes	Yes	Sn2Bi	17	15	3000
NJU77000AF	SOT-23-5	Yes	Yes	Sn2Bi	1A	15	3000
NJU77001F	SOT-23-5	Yes	Yes	Sn2Bi	16	15	3000
NJU77001AF	SOT-23-5	Yes	Yes	Sn2Bi	18	15	3000
NJU77001F3	SC-88A	Yes	Yes	Sn2Bi	AH	7.5	3000
NJU77001AF3	SC-88A	Yes	Yes	Sn2Bi	AK	7.5	3000
NJU77002E	SOP8 JEDEC 150 mil	Yes	Yes	Sn2Bi	77002	76	2000
NJU77002AE	SOP8 JEDEC 150 mil	Yes	Yes	Sn2Bi	77002A	76	2000
NJU77002RB1	MSOP8 (TVSP8)	Yes	Yes	Sn2Bi	77002	18	2000
NJU77002ARB1	MSOP8 (TVSP8)	Yes	Yes	Sn2Bi	77002A	18	2000
NJU77002KU1	DFN8-U1(ESON8-U1)	Yes	Yes	Sn2Bi	77002	5.3	3000
NJU77002AKU1	DFN8-U1(ESON8-U1)	Yes	Yes	Sn2Bi	77002A	5.3	3000
NJU77004V	SSOP14	Yes	Yes	Sn2Bi	77004	65	2000
NJU77004AV	SSOP14	Yes	Yes	Sn2Bi	77004A	65	2000

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V^+ - V^-$	7	V
Differential Input Voltage ⁽¹⁾	V_{ID}	$\pm 7^{(2)}$	V
Input Voltage	V_{IN}	$V^- - 0.3$ to $V^+ + 0.3^{(3)}$	V
Power Dissipation (Ta=25°C)	P_D	2-Layer / 4-Layer ⁽⁴⁾	mW
SOT-23-5		390 / 520	
SC-88A		280 / 390	
SOP8 JEDEC 150 mil		500 / 700	
MSOP8 (TVSP8)		410 / 540	
DFN8-U1 (ESON8-U1)		360 / 940	
SSOP14		400 / 500	
Storage Temperature Range	T_{stg}	-55 to 125	°C
Maximum Junction Temperature	T_{jmax}	125	°C

■ THERMAL CHARACTERISTICS

PACKAGE	SYMBOL	VALUE	UNIT
Junction-to-Ambient Thermal Resistance	Θ_{ja}	2-Layer / 4-Layer ⁽⁴⁾	°C/W
SOT-23-5		256 / 192	
SC-88A		357 / 256	
SOP8 JEDEC 150 mil		182 / 122	
MSOP8 (TVSP8)		244 / 185	
DFN8-U1 (ESON8-U1)		278 / 106	
SSOP14		250 / 200	
Junction-to-Top of Package Characterization Parameter	Ψ_{jt}	2-Layer / 4-Layer ⁽⁴⁾	°C/W
SOT-23-5		67 / 58	
SC-88A		91 / 73	
SOP8 JEDEC 150 mil		32 / 27	
MSOP8 (TVSP8)		51 / 45	
DFN8-U1 (ESON8-U1)		42 / 25	
SSOP14		53 / 52	

(1) Differential voltage is the voltage difference between +INPUT and -INPUT.

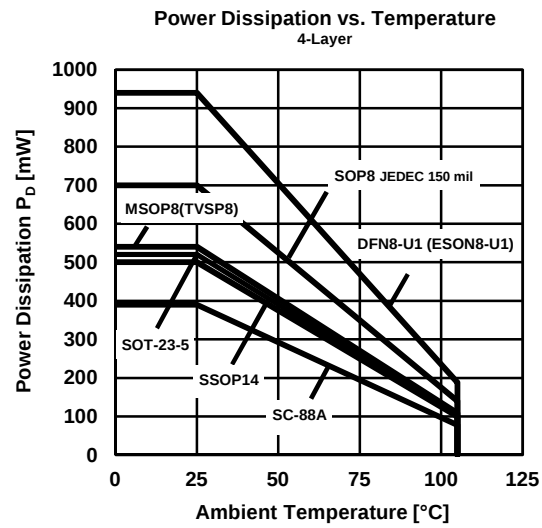
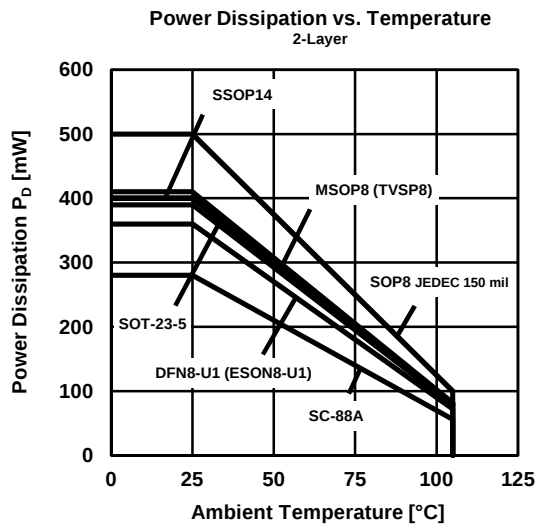
(2) For supply voltage less than 15V, the absolute maximum rating is equal to the supply voltage.

(3) The absolute maximum input voltage is limited at 7V.

(4) 2-Layer: Mounted on glass epoxy board. (76.2×114.3×1.6mm: based on EIA/JDEC standard, 2-layer FR-4)

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

■ POWER DISSIPATION vs. AMBIENT TEMPERATURE



■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	VALUE	UNIT
Supply Voltage	$V^+ - V^-$	$T_a = 25^\circ\text{C}$	1.5 to 5.5	V
Operating Temperature Range	T_{opr}		-40 to 105	$^\circ\text{C}$

■ ELECTRICAL CHARACTERISTICS

($V^+=5V$, $V=0V$, $V_{COM}=2.5V$, $R_L=100k\Omega$ to $2.5V$, $T_a=25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITIONS	NJU7700xA			NJU7700x			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
INPUT CHARACTERISTICS									
Input Offset Voltage NJU77000 / NJU77001	V _{IO}	V _{COM} =0V	-	0.35	1	-	0.35	1.8	mV
		T _a =-40°C to 105°C	-	-	1.2	-	-	-	
NJU77002		T _a =-40°C to 105°C	-	0.35	1.3	-	0.35	2.0	
		T _a =-40°C to 105°C	-	-	1.5	-	-	-	
NJU77004		T _a =-40°C to 105°C	-	0.35	1.5	-	0.35	2.2	
		T _a =-40°C to 105°C	-	-	1.7	-	-	-	
Input Offset Voltage Drift NJU77000 / NJU77001 NJU77002 NJU77004	ΔV _{IO} /ΔT	V _{COM} =0V, T _a =-40°C to 105°C	-	0.65	17	-	0.65	-	μV/deg
			-	0.65	21	-	0.65	-	
			-	0.65	24	-	0.65	-	
Input Bias Current	I _B	T _a =-40°C to 105°C	-10 -100	1 -	10 100	- -	1 -	- -	pA
Input Offset Current	I _{IO}	T _a =-40°C to 105°C	-10 -100	1 -	10 100	- -	1 -	- -	pA
Open-Loop Voltage Gain	A _V	V _O =0.5V to 4.5V T _a =-40°C to 105°C	70 70	100 -	- -	70 -	100 -	- -	dB
Common-Mode Rejection Ratio	CMR	V _{COM} =0V to 5V T _a =-40°C to 105°C	60 60	80 -	- -	60 -	80 -	- -	dB
Common-Mode Input Voltage Range	V _{ICM}	CMR≥60dB T _a =-40°C to 105°C	0 0	- -	5 5	0 -	- -	5 -	V
OUTPUT CHARACTERISTICS									
Maximum Output Voltage	V _{OH}	R _L =100kΩ to 2.5V T _a =-40°C to 105°C	4.9 4.9	4.95 -	- -	4.9 -	4.95 -	- -	V
	V _{OL}	R _L =100kΩ to 2.5V T _a =-40°C to 105°C	- -	0.05 -	0.1 0.1	- -	0.05 -	0.1 -	V
POWER SUPPLY									
Supply Current (All Amplifiers) NJU77000 / NJU77001	I _{SUPPLY}	No Signal	-	0.29	0.39	-	0.29	0.49	μA
		T _a =-40°C to 105°C	-	-	0.39	-	-	-	
NJU77002		T _a =-40°C to 105°C	-	0.46	0.66	-	0.46	0.76	
		T _a =-40°C to 105°C	-	-	0.66	-	-	-	
NJU77004		T _a =-40°C to 105°C	-	0.92	1.22	-	0.92	1.32	
		T _a =-40°C to 105°C	-	-	1.22	-	-	-	
Supply Voltage Rejection Ratio	SVR	V ⁺ =1.5V to 5.5V, V _{COM} =0V T _a =-40°C to 105°C	70 70	90 -	- -	70 -	90 -	- -	dB
AC CHARACTERISTICS									
Slew Rate NJU77000 / NJU77001 NJU77002 / NJU77004	SR	G _V =0dB, C _L =20pF, V _{IN} =1V _{PP}	- -	0.8 0.7	- -	- -	0.8 0.7	- -	V/ms
Unity-Gain Frequency NJU77000 / NJU77001 NJU77002 / NJU77004	f _T	G _V =20dB, C _L =20pF	- -	1.1 1.0	- -	- -	1.1 1.0	- -	kHz
Phase Margin	Φ _M	C _L =20pF	-	60	-	-	60	-	deg
Gain Margin	G _M	C _L =20pF	-	30	-	-	30	-	dB
Equivalent Input Noise Current NJU77000 / NJU77001 NJU77002 / NJU77004	V _{NI}	f=100Hz	- -	600 700	- -	- -	600 700	- -	nV/√Hz

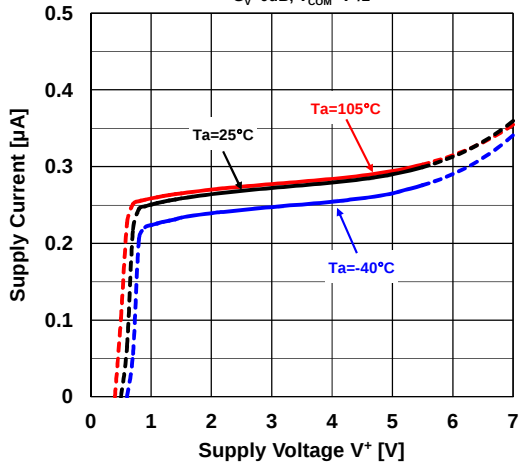
■ ELECTRICAL CHARACTERISTICS

($V^+=1.8V$, $V^-=0V$, $V_{COM}=0.9V$, $R_L=100k\Omega$ to $0.9V$, $T_a=25^\circ C$, unless otherwise noted.)

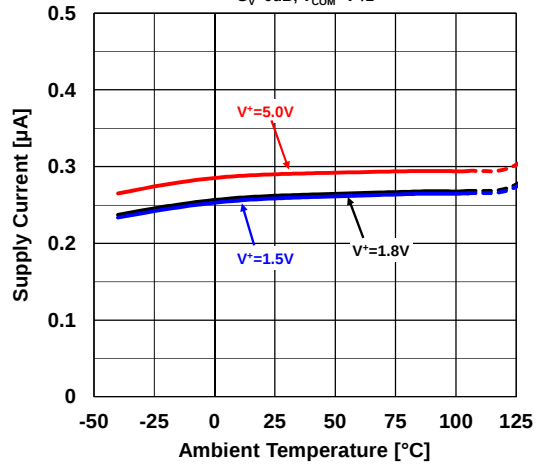
PARAMETER	SYMBOL	TEST CONDITIONS	NJU7700xA			NJU7700x			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
INPUT CHARACTERISTICS									
Input Offset Voltage NJU77000 / NJU77001	V _{IO}	V _{COM} =0V	-	0.35	1	-	0.35	1.8	mV
		Ta=-40°C to 105°C	-	-	1.2	-	-	-	
NJU77002		Ta=-40°C to 105°C	-	0.35	1.3	-	0.35	2.0	
		Ta=-40°C to 105°C	-	-	1.5	-	-	-	
NJU77004		Ta=-40°C to 105°C	-	0.35	1.5	-	0.35	2.2	
		Ta=-40°C to 105°C	-	-	1.7	-	-	-	
Input Offset Voltage Drift NJU77000 / NJU77001	ΔV _{IO} /ΔT	V _{COM} =0V, Ta=-40°C to 105°C	-	0.65	17	-	0.65	-	μV/deg
NJU77002			-	0.65	21	-	0.65	-	
NJU77004			-	0.65	24	-	0.65	-	
Input Bias Current	I _B	Ta=-40°C to 105°C	-10 -100	1 -	10 100	- -	1 -	- -	pA
Input Offset Current	I _{IO}	Ta=-40°C to 105°C	-10 -100	1 -	10 100	- -	1 -	- -	pA
Open-Loop Voltage Gain	A _V	V _O =0.5V to 1.3V Ta=-40°C to 105°C	70 70	100 -	- -	70 -	100 -	- -	dB
Common-Mode Rejection Ratio	CMR	V _{COM} =0V to 1.8V Ta=-40°C to 105°C	55 55	80 -	- -	55 -	80 -	- -	dB
Common-Mode Input Voltage Range	V _{ICM}	CMR≥55dB Ta=-40°C to 105°C	0 0	- -	1.8 1.8	0 -	- -	1.8 -	V
OUTPUT CHARACTERISTICS									
Maximum Output Voltage	V _{OH}	R _L =100kΩ to 0.9V Ta=-40°C to 105°C	1.7 1.7	1.75 -	- -	1.7 -	1.75 -	- -	V
	V _{OL}	R _L =100kΩ to 0.9V Ta=-40°C to 105°C	- -	0.05 -	0.1 0.1	- -	0.05 -	0.1 -	V
POWER SUPPLY									
Supply Current (All Amplifiers) NJU77000 / NJU77001	I _{SUPPLY}	No Signal	-	0.26	0.36	-	0.26	0.49	μA
		Ta=-40°C to 105°C	-	-	0.36	-	-	-	
NJU77002		Ta=-40°C to 105°C	-	0.42	0.62	-	0.42	0.76	
		Ta=-40°C to 105°C	-	-	0.62	-	-	-	
NJU77004		Ta=-40°C to 105°C	-	0.84	1.17	-	0.84	1.27	
		Ta=-40°C to 105°C	-	-	1.17	-	-	-	
Supply Voltage Rejection Ratio	SVR	V ⁺ =1.5V to 5.5V, V _{COM} =0V Ta=-40°C to 105°C	70 70	90 -	- -	70 -	90 -	- -	dB
AC CHARACTERISTICS									
Slew Rate NJU77000 / NJU77001 NJU77002 / NJU77004	SR	G _V =0dB, C _L =20pF, V _{IN} =1V _{PP}	- -	0.7 0.6	- -	- -	0.7 0.6	- -	V/ms
Unity-Gain Frequency NJU77000 / NJU77001 NJU77002 / NJU77004	f _T	G _V =20dB, C _L =20pF	- -	1.0 0.9	- -	- -	1.0 0.9	- -	kHz
Phase Margin	Φ _M	C _L =20pF	-	60	-	-	60	-	deg
Gain Margin	G _M	C _L =20pF	-	30	-	-	30	-	dB
Equivalent Input Noise Current NJU77000 / NJU77001 NJU77002 / NJU77004	V _{NI}	f=100Hz	- -	700 800	- -	- -	700 800	- -	nV/√Hz

■ TYPICAL CHARACTERISTICS

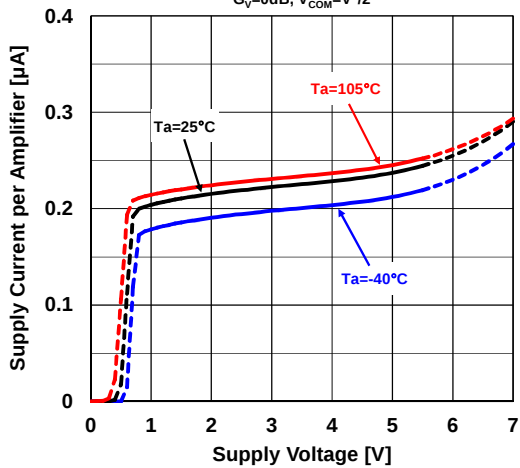
Supply Current vs. Supply Voltage
(NJU77000/NJU77001)
 $G_V=0\text{dB}$, $V_{\text{COM}}=V^*/2$



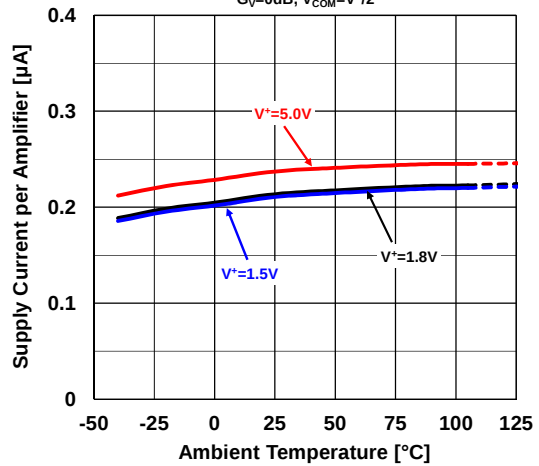
Supply Current vs. Temperature
(NJU77000/NJU77001)
 $G_V=0\text{dB}$, $V_{\text{COM}}=V^*/2$



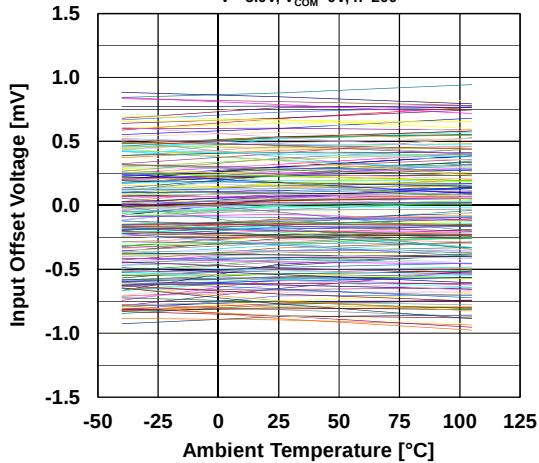
Supply Current per Amplifier vs. Supply Voltage
(NJU77002/NJU77004)
 $G_V=0\text{dB}$, $V_{\text{COM}}=V^*/2$



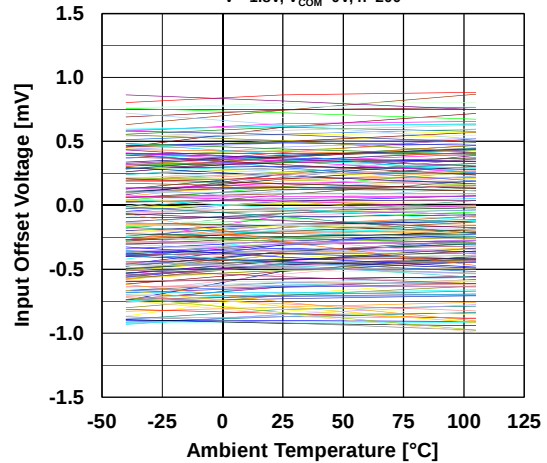
Supply Current per Amplifier vs. Temperature
(NJU77002/NJU77004)
 $G_V=0\text{dB}$, $V_{\text{COM}}=V^*/2$



Input Offset Voltage vs. Temperature
 $V^*=5.0\text{V}$, $V_{\text{COM}}=0\text{V}$, $n=200$

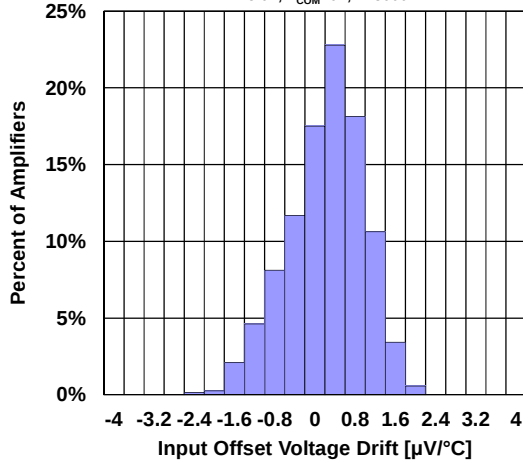


Input Offset Voltage vs. Temperature
 $V^*=1.8\text{V}$, $V_{\text{COM}}=0\text{V}$, $n=200$

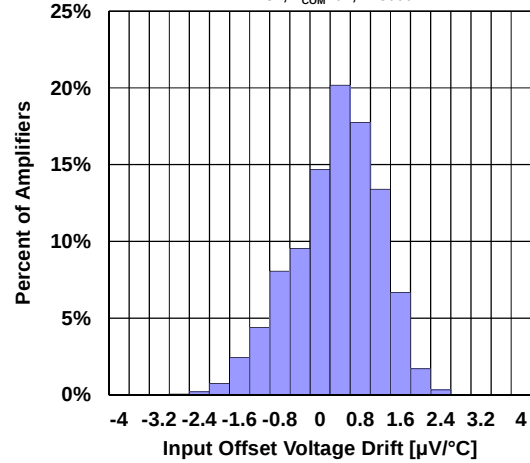


■ TYPICAL CHARACTERISTICS

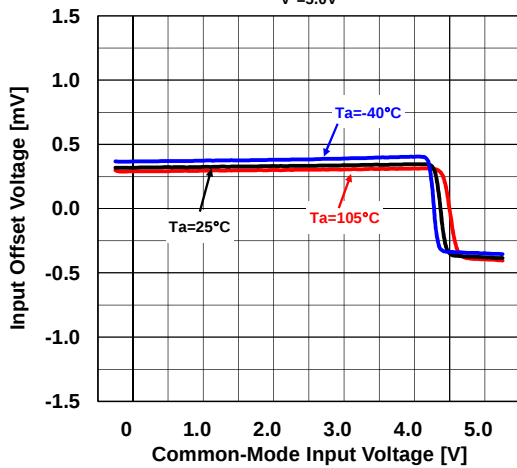
Input Offset Voltage Drift Distribution
 $V^+=5.0\text{V}$, $V_{\text{COM}}=0\text{V}$, $n=3000$



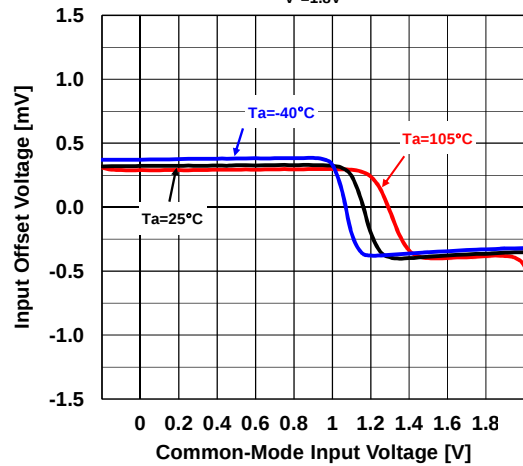
Input Offset Voltage Drift Distribution
 $V^+=1.8\text{V}$, $V_{\text{COM}}=0\text{V}$, $n=3000$



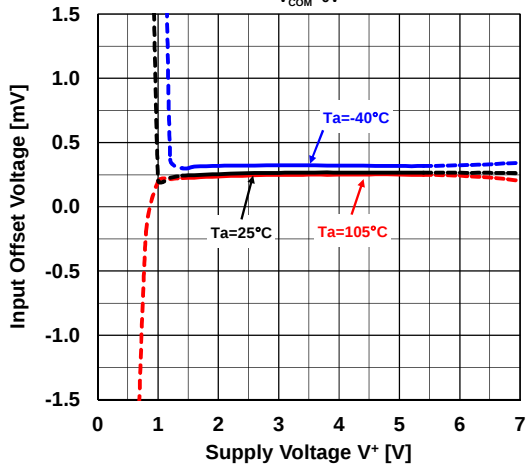
Input Offset Voltage
 vs. Common-Mode Input Voltage
 $V^+=5.0\text{V}$



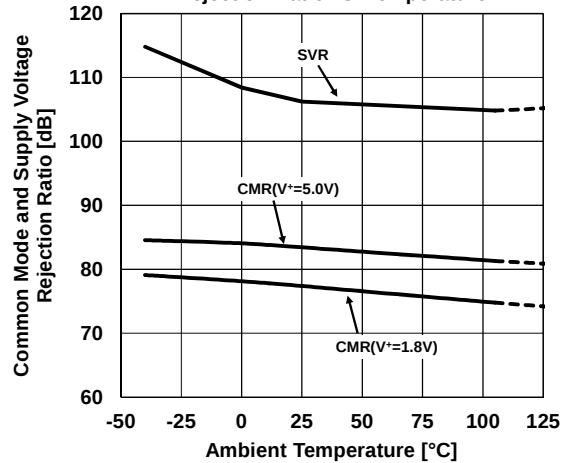
Input Offset Voltage
 vs. Common-Mode Input Voltage
 $V^+=1.8\text{V}$



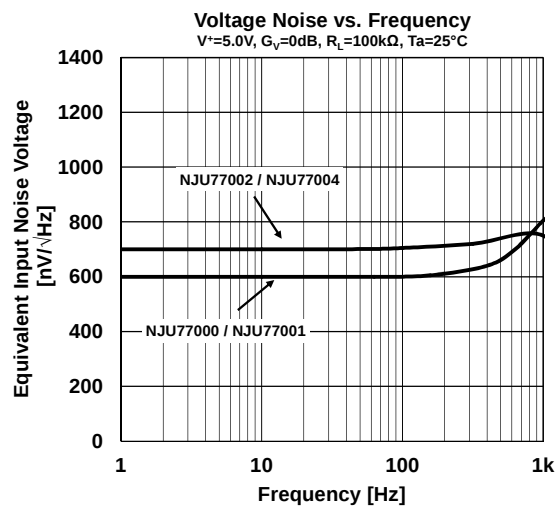
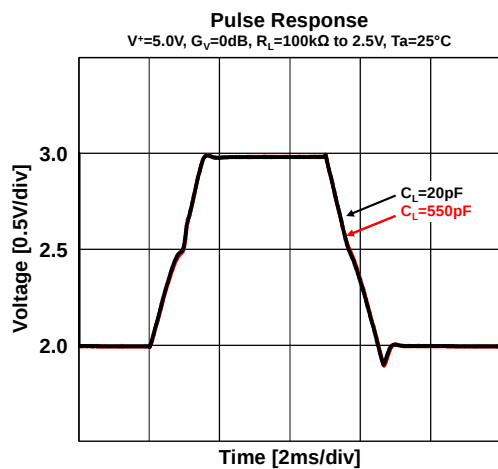
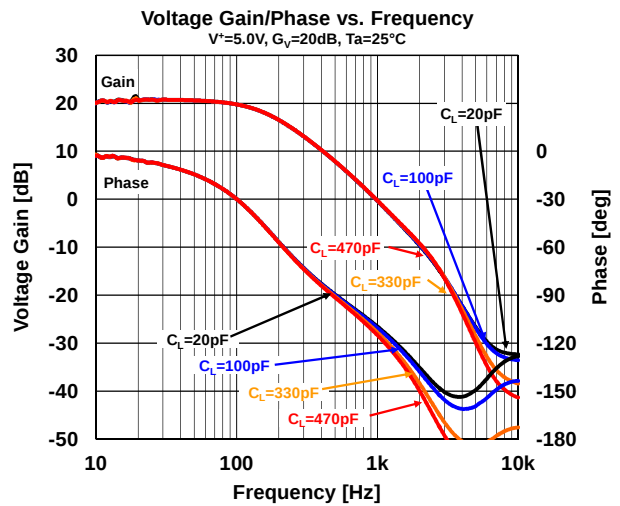
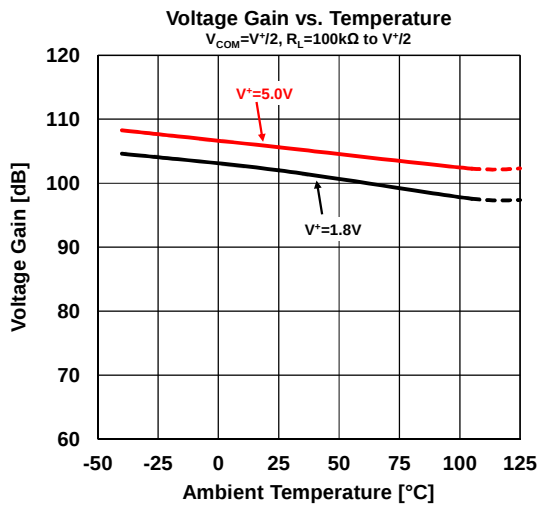
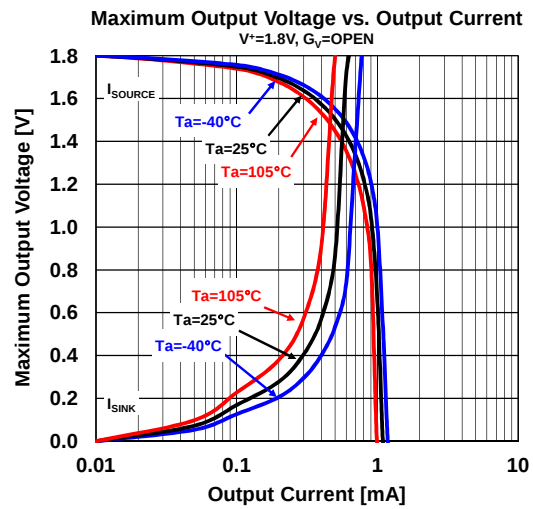
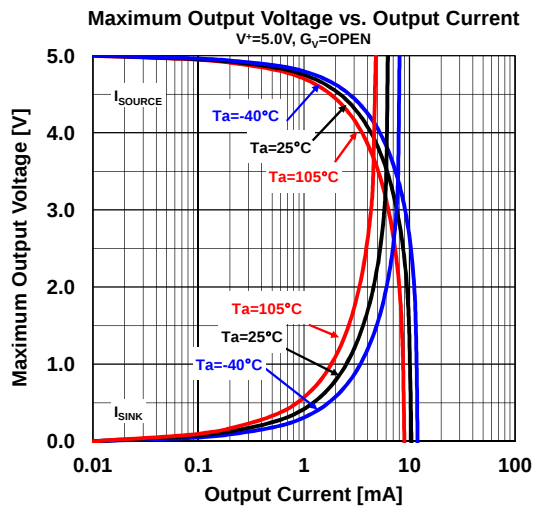
Input Offset Voltage vs. Supply Voltage
 $V_{\text{COM}}=0\text{V}$



Common Mode and Supply Voltage
 Rejection Ratio vs. Temperature

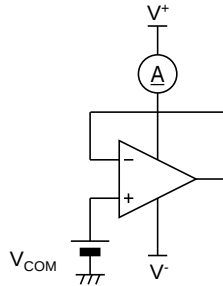


■ TYPICAL CHARACTERISTICS



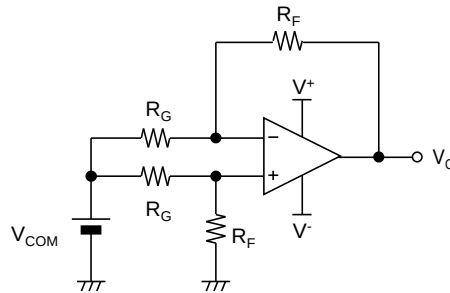
■ TEST CIRCUIT

• I_{SUPPLY}



• V_{IO} , CMR, SVR

$R_G=50\Omega$, $R_F=50k\Omega$



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

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

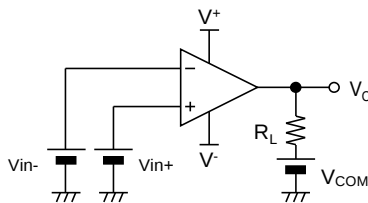
$$SVR = 20 \log \frac{\Delta V_S \left(1 + \frac{R_F}{R_G}\right)}{\Delta V_O}$$

$V_S = V^+ - V^-$

• V_{OH} , V_{OL}

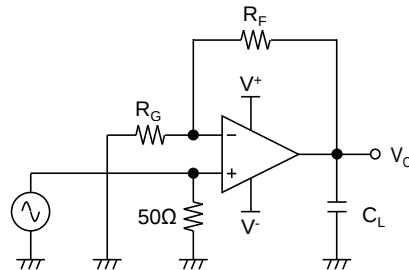
V_{OH} : $V_{in+} = V^+/2 + 0.1V$, $V_{in-} = V^+/2$, $V_{COM} = V^+/2$

V_{OL} : $V_{in+} = V^+/2$, $V_{in-} = V^+/2 + 0.1V$, $V_{COM} = V^+/2$

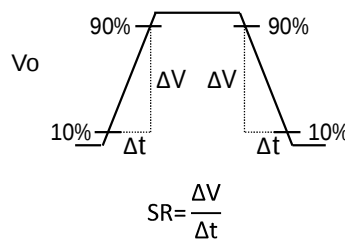
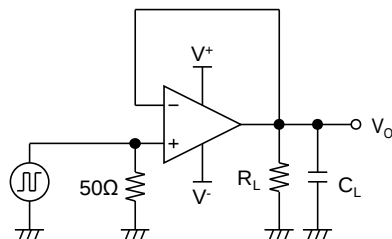


• GBW

$R_G=1k\Omega$, $R_F=100k\Omega$



• SR



■ APPLICATION NOTE

Capacitive Load

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 be either underdamped or the amplifier will oscillate.

The NJU77000/NJU77001/NJU77002/NJU77004 can directly drive capacitive loads of up to 470pF without oscillating. To drive heavier capacitive loads, an isolation resistor, R_{ISO} as shown Figure1, 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 shows R_{ISO} values at unity gain follower without oscillating. After selecting R_{ISO} for your circuit, double-check the resulting frequency response peaking and step response overshoot. Modify R_{ISO} 's value until the response is reasonable.

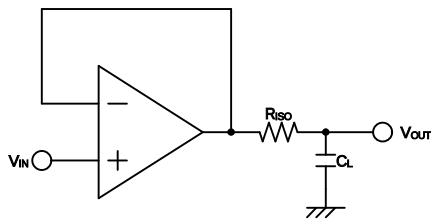


Figure1. Isolating capacitive load

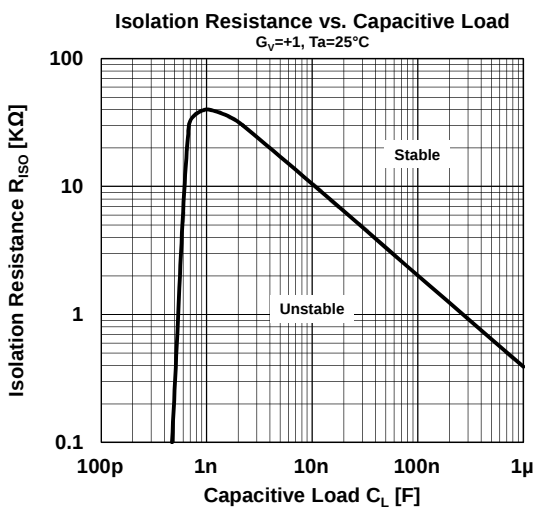


Figure2. Isolation resistance to improve stability

EMIRR (EMI Rejection Ratio) Definition

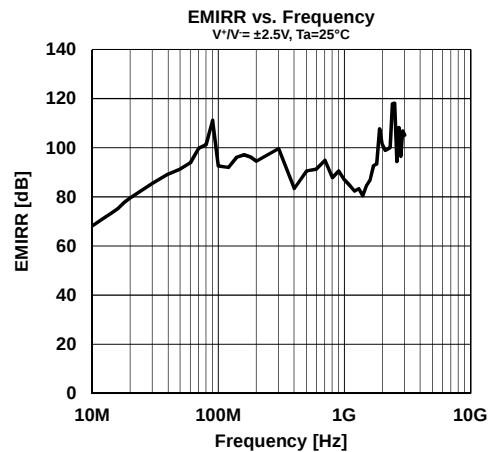
EMIRR is a parameter indicating the EMI robustness of an Op-Amp. The definition of EMIRR is given by the following equation1.

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

V_{RF_PEAK} : RF Signal Amplitude [VP]

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.



*For details, refer to "Application Note for EMI Immunity" in our HP: <http://www.njr.com/>

Unit: mm

Technical drawing of a mechanical part, showing three views: front view, side view, and top view.

Front View Dimensions:

- Overall width: 2.9 ± 0.2
- Distance between side slots: 1.9 ± 0.2
- Slot width: $0.6_{\max}$
- Distance between side slots and central slot: 0.95 ± 0.1
- Slot depth: $1.6^{+0.2}_{-0.1}$
- Overall height: 2.8 ± 0.2

Side View Dimensions:

- Angle: $0 \sim 15^\circ$
- Slot depth: 0.2
- Slot width: 0.6
- Slot depth: $0.1^{+0.1}_{-0.03}$

Top View Dimensions:

- Slot width: 0.4 ± 0.1
- Slot depth: 1.1 ± 0.1
- Slot depth: $0.1_{\max}$

Surface Texture Symbol:

- Symbol: $\sqrt{0.1}$

Unit: mm

Technical drawing of a mechanical part, showing three views: front view (top left), side view (top right), and top view (bottom left).

Front View (Top Left): Shows a rectangular part with five mounting holes. Dimensions include overall width 2.0 ± 0.2 , distance between top holes 1.3 ± 0.2 , hole diameter 0.425 ± 0.2 , distance between bottom holes 0.65 ± 0.07 , and overall height 2.1 ± 0.2 . Individual hole spacing from the bottom is 0.425 ± 0.2 , 1.25 ± 0.1 , and 0.425 ± 0.2 . A surface texture symbol indicates a value of 0.23 with a range of $+0.1$ to -0.05 .

Side View (Top Right): Shows the profile of the part with a maximum thickness of 0.13 (range $+0.1$ to -0.03) and a height of (0.245) . A fillet radius is specified as $0 \sim 10^\circ$.

Top View (Bottom Left): Shows the top of the part with three mounting holes. Dimensions include overall width 0.05 ± 0.05 , hole diameter 0.2 (range $+0.2$ to -0.1), distance between holes 0.9 ± 0.1 , and overall depth 0.95 (range $+0.05$ to -0.15). A surface texture symbol indicates a value of 0.1 .

Unit: mm

Technical drawing of a rectangular component with dimensions and surface finish specifications.

Top View Dimensions:

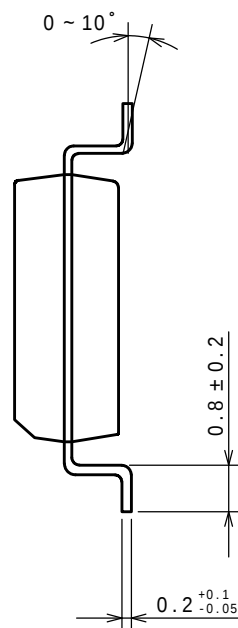
- Overall width: 5.0 ± 0.3
- Overall height: 6.0 ± 0.4
- Inner height: 3.9 ± 0.2
- Pin 1 width: 8
- Pin 5 width: 5
- Pin 1 to Pin 4 spacing: 1.27
- Pin 1 to Pin 4 offset: 0.74 max

Bottom View Dimensions:

- Overall width: 1.5 ± 0.15
- Overall height: 0.15 ± 0.1
- Pin 1 to Pin 4 offset: 0.4 ± 0.1

Surface Finish Specifications:

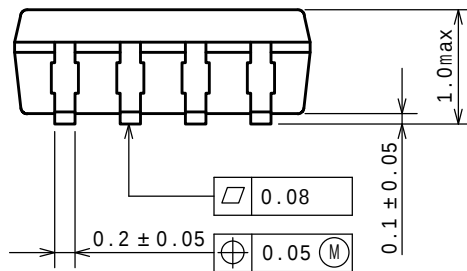
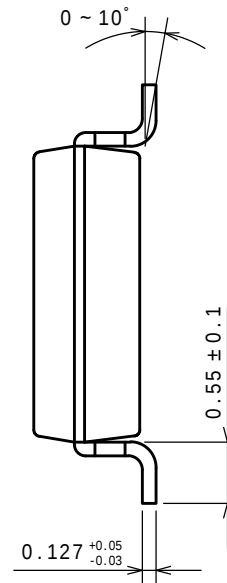
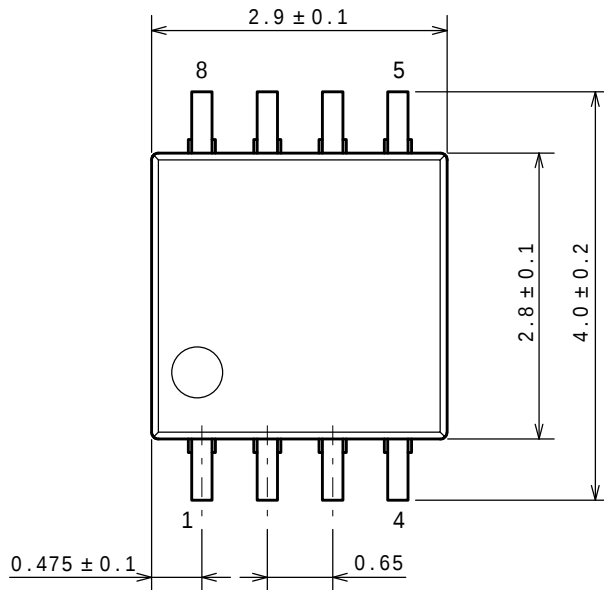
- Pin 1: $R_a 0.1$
- Pin 5: $R_a 0.12$
- Pin 4: $R_a 0.12$
- Pin 1 to Pin 4: $R_a 0.12$



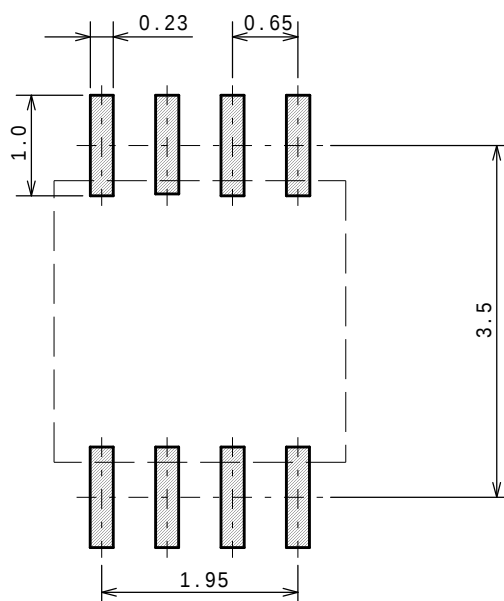
MSOP8 (TVSP8) MEET JEDEC MO-187-DA/THIN TYPE

Unit: mm

■ PACKAGE DIMENSIONS

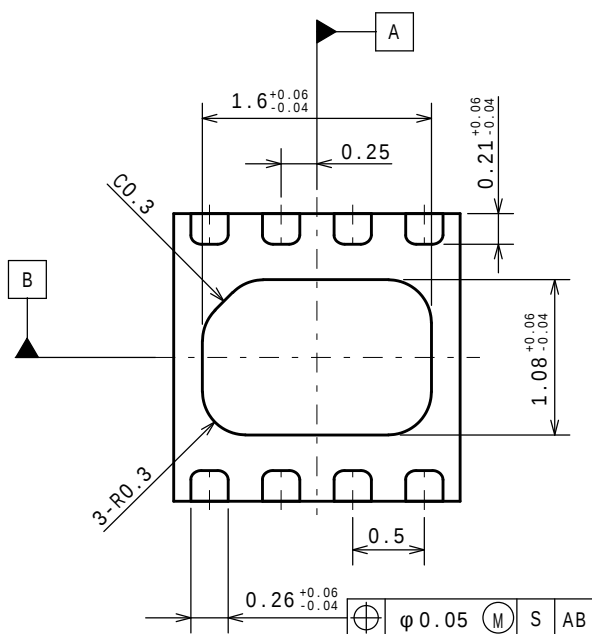
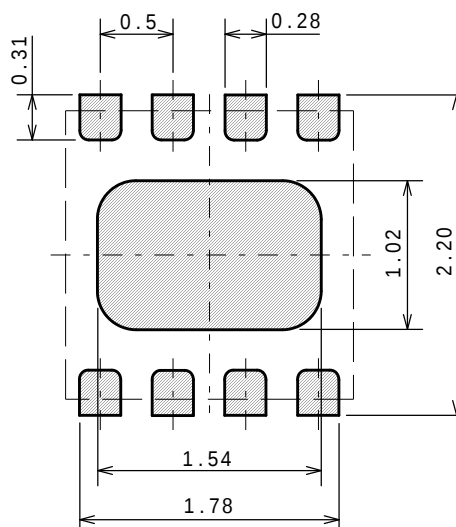


■ EXAMPLE OF SOLDER PADS DIMENSIONS



Unit: mm

■EXAMPLE OF SOLDER PADS DIMENSIONS



Unit: mm

Technical drawing of a rectangular component with dimensions and tolerances. The drawing includes a top view and a side view.

Top View Dimensions:

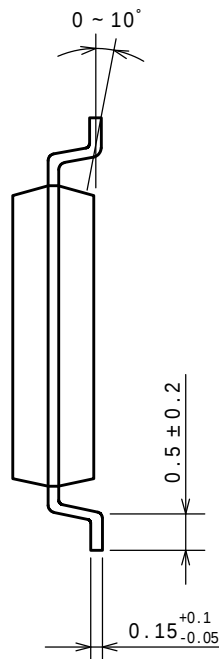
- Overall width: $5.0^{+0.3}_{-0.1}$
- Overall height: 6.4 ± 0.3
- Distance from top edge to first row of pins: 14
- Distance from top edge to last row of pins: 8
- Distance between pins: 0.65
- Distance from left edge to first pin: $0.67 \max$
- Distance from left edge to last pin: 1
- Distance from right edge to last pin: 7
- Distance from bottom edge to first row of pins: 4.4 ± 0.2

Side View Dimensions:

- Overall height: 1.15 ± 0.1
- Distance from bottom edge to first row of pins: 0.1 ± 0.1
- Distance from bottom edge to last row of pins: 0.22 ± 0.1

Surface Features and Tolerances:

- Surface texture symbol: 0.10
- Surface texture symbol: 0.10 (M)



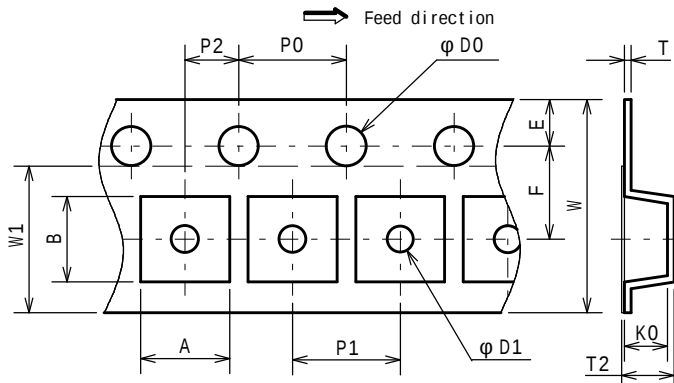
Technical drawing of a rectangular frame (Fig. 10). The drawing shows a rectangular frame with dimensions 3.90 (width) and 5.90 (height). The frame is reinforced with 10 bars (10Ф12) and 10 bars (10Ф12). The reinforcement is distributed as follows: 4 bars (4Ф12) on the top and bottom edges, and 3 bars (3Ф12) on the left and right edges. The spacing between the bars is 0.35 and 0.65. The height of the frame is 5.90, and the width is 3.90. The drawing also shows a detail of the reinforcement bars, indicating a diameter of 12 mm (Ф12).

SOT-23-5

PACKING SPEC

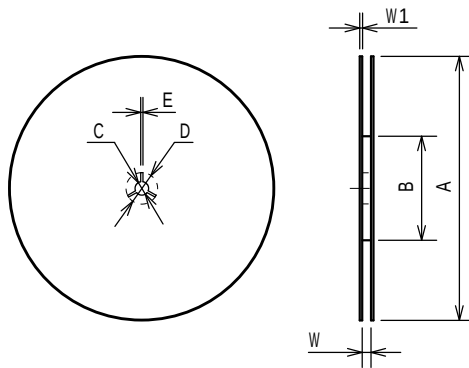
Unit: mm

TAPING DIMENSIONS



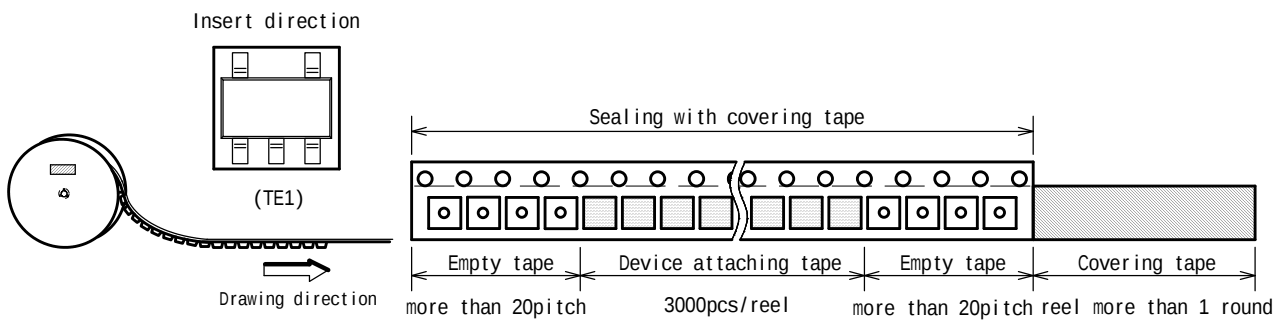
SYMBOL	DIMENSION	REMARKS
A	3.3±0.1	BOTTOM DIMENSION
B	3.2±0.1	BOTTOM DIMENSION
D0	1.55	
D1	1.05	
E	1.75±0.1	
F	3.5±0.05	
P0	4.0±0.1	
P1	4.0±0.1	
P2	2.0±0.05	
T	0.25±0.05	
T2	1.82	
K0	1.5±0.1	
W	8.0±0.3	
W1	5.5	THICKNESS 0.1MAX

REEL DIMENSIONS

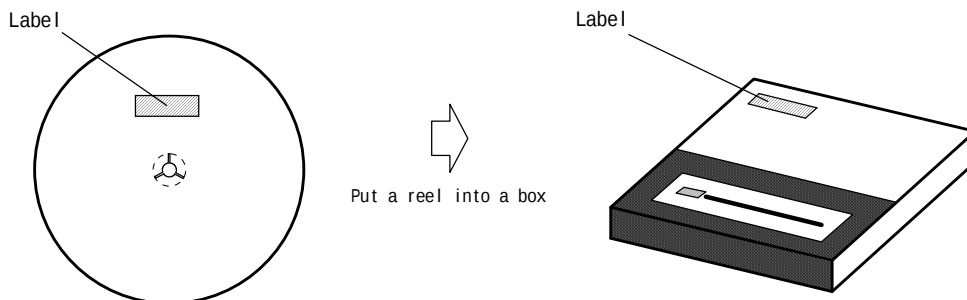


SYMBOL	DIMENSION
A	φ 180 ± 1
B	φ 60 ± 1
C	φ 13 ± 0.2
D	φ 21 ± 0.8
E	2 ± 0.5
W	9 ± 0.5
W1	1.2 ± 0.2

TAPING STATE



PACKING STATE

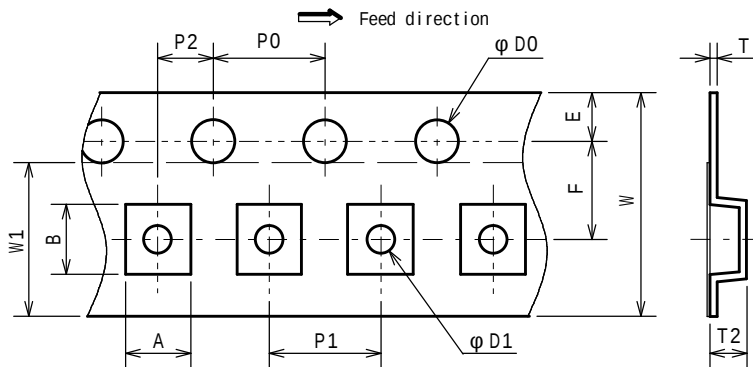


SC-88A

PACKING SPEC

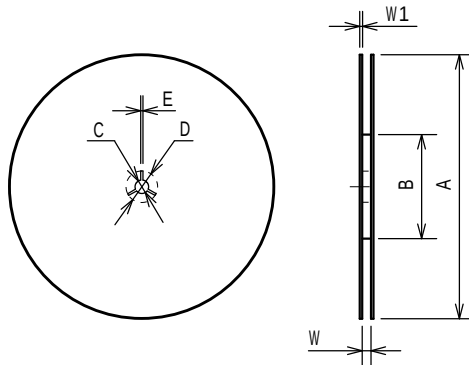
Unit: mm

TAPING DIMENSIONS



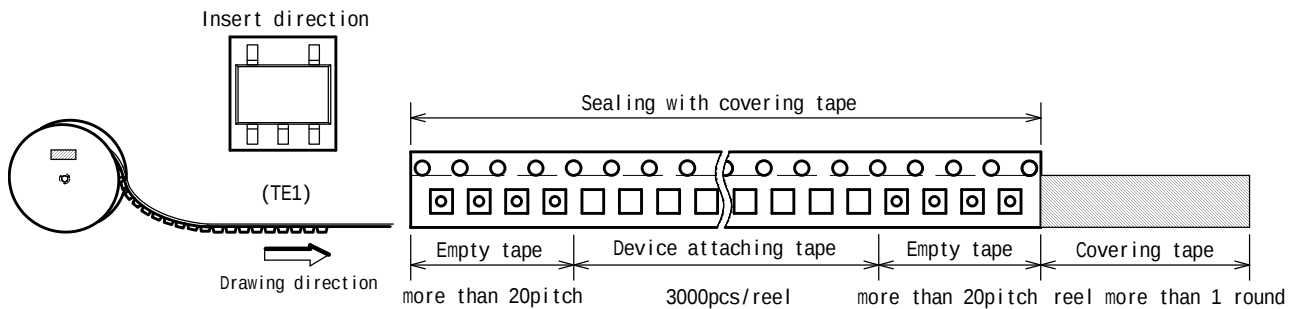
SYMBOL	DIMENSION	REMARKS
A	2.3 ± 0.1	BOTTOM DIMENSION
B	2.5 ± 0.1	BOTTOM DIMENSION
D0	1.55 ± 0.05	
D1	1.05 ± 0.05	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.3 ± 0.1	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

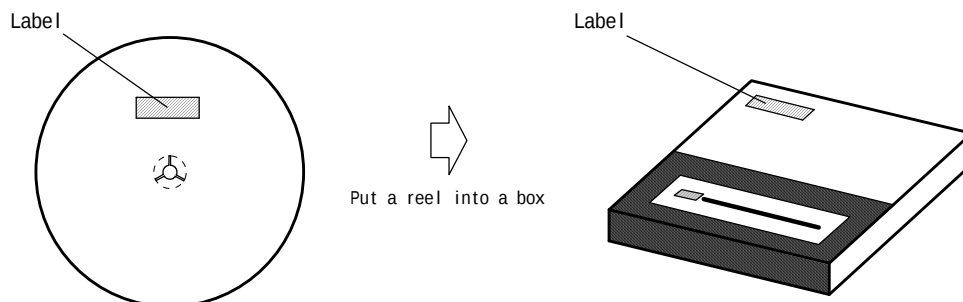


SYMBOL	DIMENSION
A	$\phi 180 \pm 1$
B	$\phi 60 \pm 1$
C	$\phi 13 \pm 0.2$
D	$\phi 21 \pm 0.8$
E	2 ± 0.5
W	9 ± 0.5
W1	1.2 ± 0.2

TAPING STATE



PACKING STATE

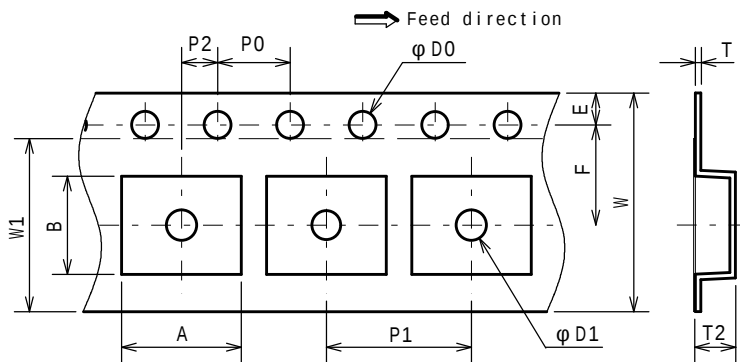


SOP8 JEDEC 150mil (EMP8)

■ PACKING SPEC

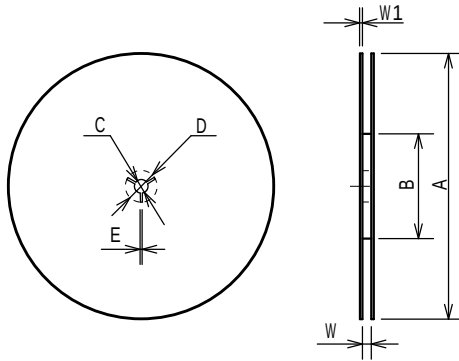
Unit: mm

TAPING DIMENSIONS



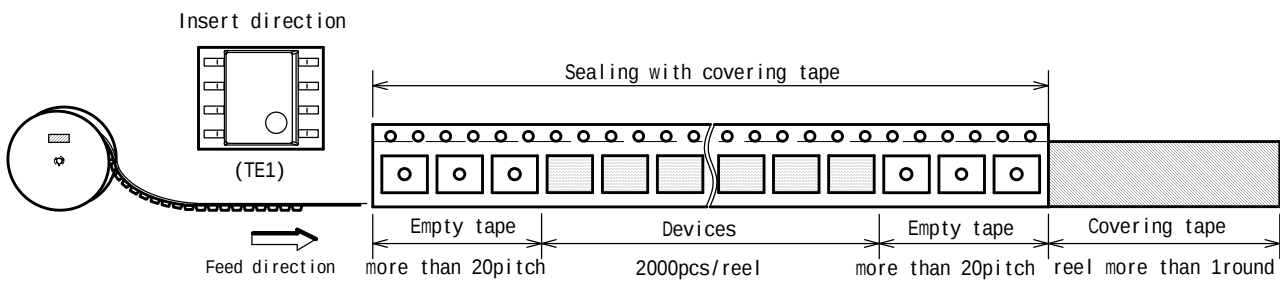
SYMBOL	DIMENSION	REMARKS
A	6.6	BOTTOM DIMENSION
B	5.4	BOTTOM DIMENSION
D0	$1.5^{+0.1}_0$	
D1	1.7 ± 0.1	
E	1.75 ± 0.1	
F	5.5 ± 0.05	
P0	4.0 ± 0.1	
P1	8.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.30 ± 0.05	
T2	2.2	
W	12.0 ± 0.3	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

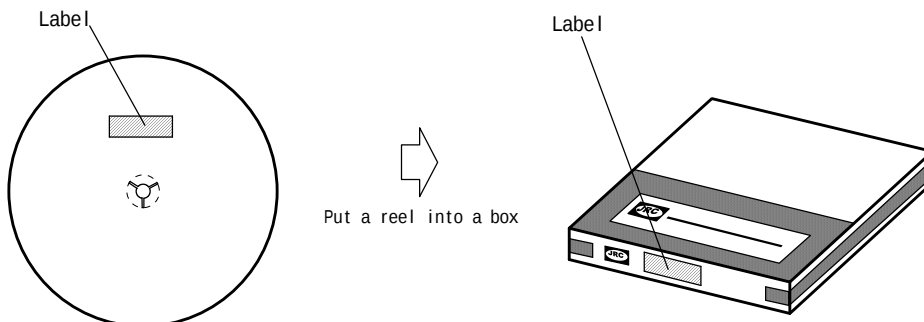


SYMBOL	DIMENSION
A	$\phi 330 \pm 2$
B	$\phi 80 \pm 1$
C	$\phi 13 \pm 0.2$
D	$\phi 21 \pm 0.8$
E	2 ± 0.5
W	13.5 ± 0.5
W1	2.0 ± 0.2

TAPING STATE



PACKING STATE

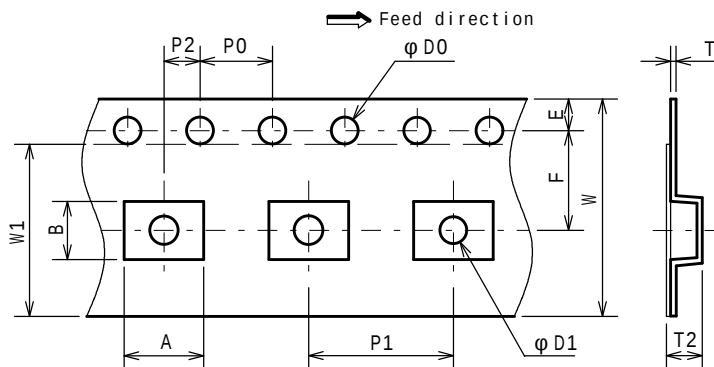


MSOP8 MEET JEDEC MO-187-DA/THIN TYPE

PACKING SPEC

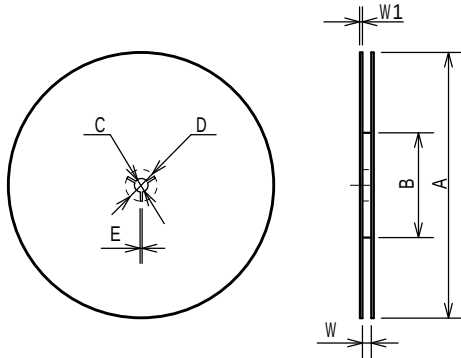
Unit: mm

TAPING DIMENSIONS



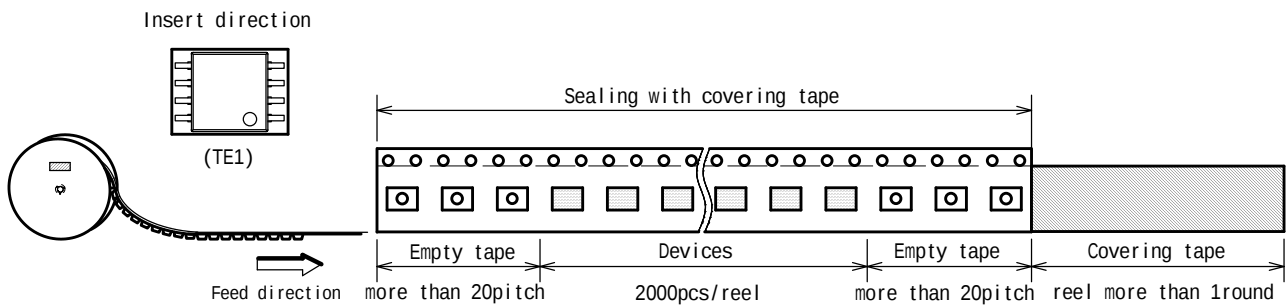
SYMBOL	DIMENSION	REMARKS
A	4.4	BOTTOM DIMENSION
B	3.2	BOTTOM DIMENSION
D0	$1.5^{+0.1}_0$	
D1	$1.5^{+0.1}_0$	
E	1.75 ± 0.1	
F	5.5 ± 0.05	
P0	4.0 ± 0.1	
P1	8.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.30 ± 0.05	
T2	1.75 (MAX.)	
W	12.0 ± 0.3	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

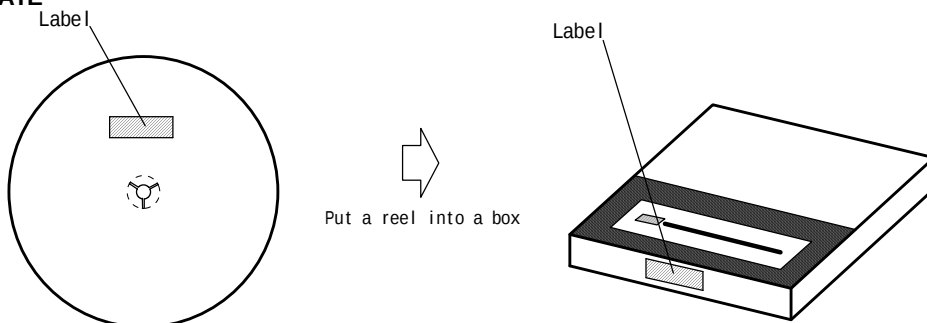


SYMBOL	DIMENSION
A	$\phi 254 \pm 2$
B	$\phi 100 \pm 1$
C	$\phi 13 \pm 0.2$
D	$\phi 21 \pm 0.8$
E	2 ± 0.5
W	13.5 ± 0.5
W1	2.0 ± 0.2

TAPING STATE



PACKING STATE

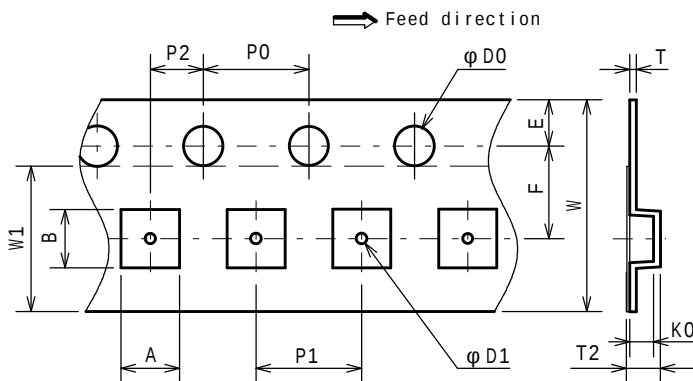


DFN8-U1 (ESON8-U1)

PACKING SPEC

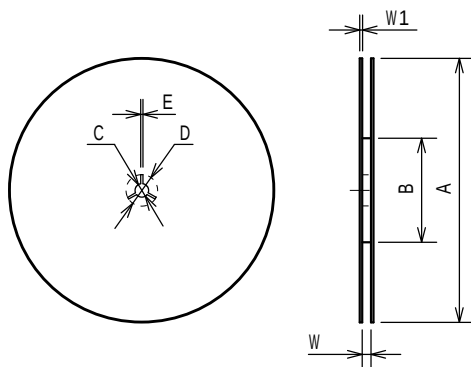
Unit: mm

TAPING DIMENSIONS



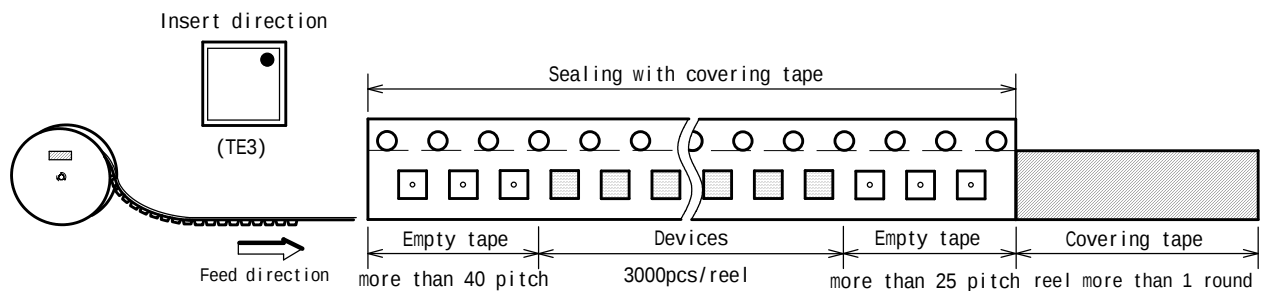
SYMBOL	DIMENSION	REMARKS
A	2.25 ± 0.05	BOTTOM DIMENSION
B	2.25 ± 0.05	BOTTOM DIMENSION
D0	$1.5^{+0.1}_0$	
D1	0.5 ± 0.1	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.00 ± 0.07	
K0	0.65 ± 0.05	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

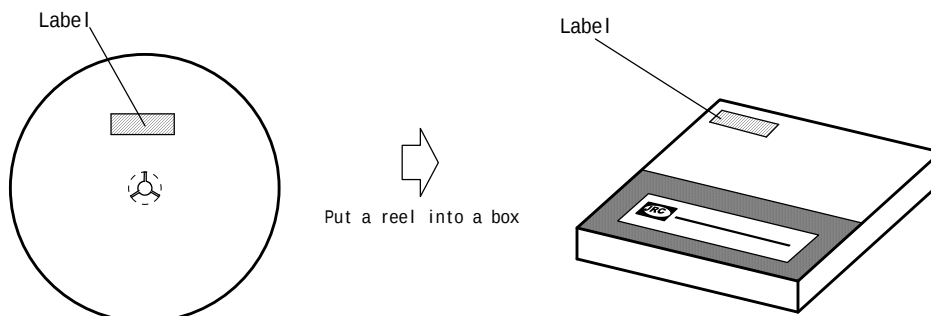


SYMBOL	DIMENSION
A	$\phi 180^{+0}_{-1.5}$
B	$\phi 60^{+1}_{-0}$
C	$\phi 13 \pm 0.2$
D	$\phi 21 \pm 0.8$
E	2 ± 0.5
W	$9^{+0.3}_0$
W1	1.2

TAPING STATE



PACKING STATE

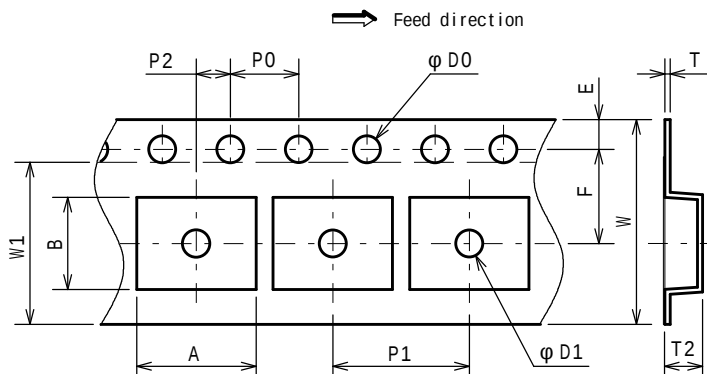


SSOP14

PACKING SPEC

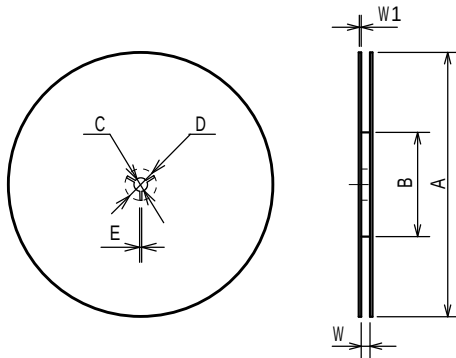
Unit: mm

TAPING DIMENSIONS



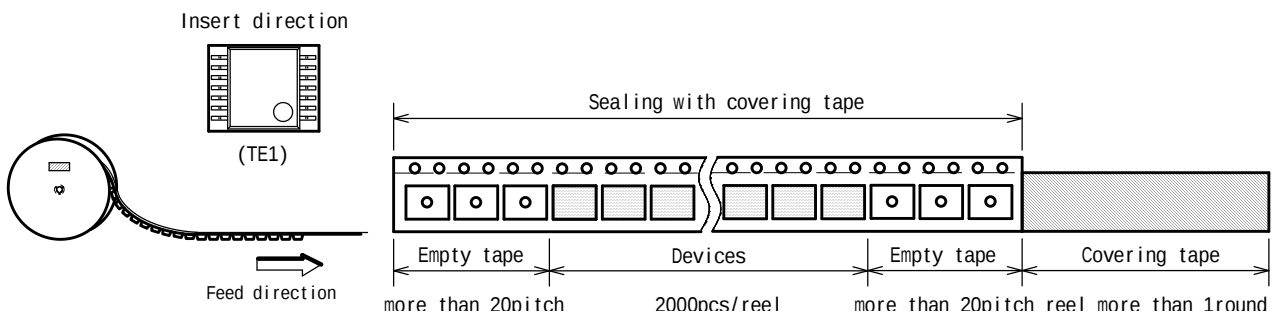
SYMBOL	DIMENSION	REMARKS
A	6.95	BOTTOM DIMENSION
B	5.4	BOTTOM DIMENSION
D0	1.55 ± 0.05	
D1	1.55 ± 0.1	
E	1.75 ± 0.1	
F	5.5 ± 0.05	
P0	4.0 ± 0.1	
P1	8.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.3 ± 0.05	
T2	2.2	
W	12.0 ± 0.3	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

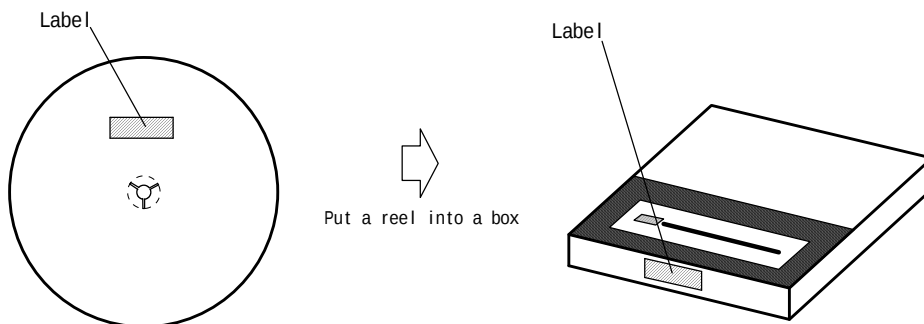


SYMBOL	DIMENSION
A	$\phi 254 \pm 2$
B	$\phi 100 \pm 1$
C	$\phi 13 \pm 0.2$
D	$\phi 21 \pm 0.8$
E	2 ± 0.5
W	13.5 ± 0.5
W1	2 ± 0.2

TAPING STATE

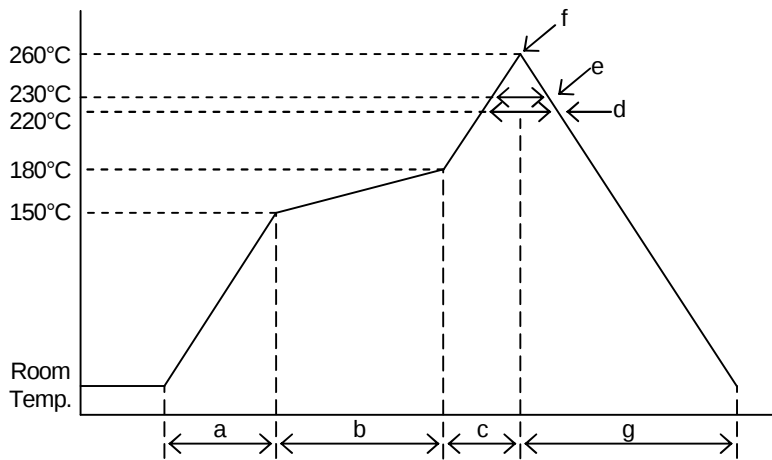


PACKING STATE



■ RECOMMENDED MOUNTING METHOD

INFRARED REFLOW SOLDERING PROFILE



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

The temperature indicates at the surface of mold package.

[CAUTION]

1. NJR strives to produce reliable and high quality semiconductors. NJR's semiconductors are intended for specific applications and require proper maintenance and handling. To enhance the performance and service of NJR's semiconductors, the devices, machinery or equipment into which they are integrated should undergo preventative maintenance and inspection at regularly scheduled intervals. Failure to properly maintain equipment and machinery incorporating these products can result in catastrophic system failures
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The introduction of external contaminants (e.g. dust, oil or cosmetics) can result in failures of semiconductor products.
4. NJR offers a variety of semiconductor products intended for particular applications. It is important that you select the proper component for your intended application. You may contact NJR's Sale's Office if you are uncertain about the products listed in this datasheet.
5. Special care is required in designing devices, machinery or equipment which demand high levels of reliability. This is particularly important when designing critical components or systems whose failure can foreseeably result in situations that could adversely affect health or safety. In designing such critical devices, equipment or machinery, careful consideration should be given to amongst other things, their safety design, fail-safe design, back-up and redundancy systems, and diffusion design.
6. The products listed in this datasheet may not be appropriate for use in certain equipment where reliability is critical or where the products may be subjected to extreme conditions. You should consult our sales office before using the products in any of the following types of equipment.
 - 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 (Airplane, railroad, ship, etc.)
 - Various Safety Devices
7. NJR's 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. NJR 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. The products are sold without warranty of any kind, either express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose.
8. 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.
9. The product specifications and descriptions listed in this datasheet are subject to change at any time, without notice.



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