

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

### FEATURES (V<sup>+</sup>=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

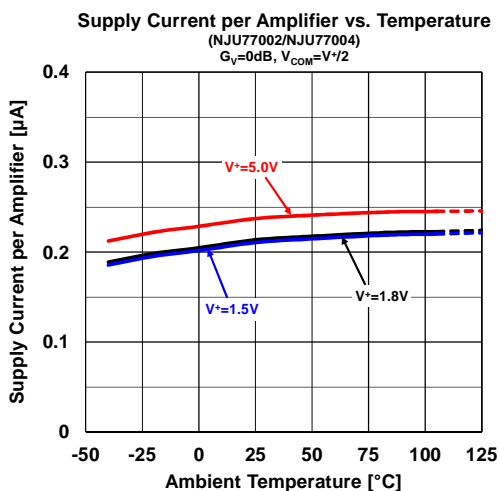
The NJU77000/NJU77001/NJU77002/NJU77004 are single/dual/quad ultra-low power CMOS operational amplifiers designed specifically to extend battery life and performance for portable applications. The supply voltage range is 1.5V to 5.5V and supply current is 0.29µA typ. (single), 0.23µA/ch typ. (dual/quad). 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.

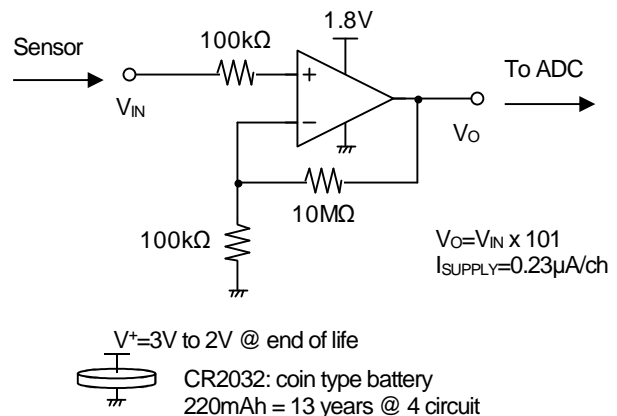
NJU77000 series has normal grade (NJU7700x) and A-Grade (NJU7700xA). A-Grade has improved offset voltage and supply voltage than normal grade, and other characteristics are also guaranteed from -40 to 105 °C.

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



40dB micro power sensor amplifier

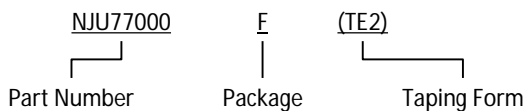
## ■ PRODUCT INFORMATION (Ta = 25°C)

Vo max.	ISUPPLY max.	Ib 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 NJU77001F	-	-	-	-
1.0mV	0.39µA	10pA	NJU77001AF3	NJU77000AF NJU77001AF	-	-	-	-
2.0mV	0.76µA	-	-	-	NJU77002E	NJU77002RB1	NJU77002KU1	-
1.3mV	0.66µA	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					
PRODUCT NAME	NJU77002KU1 NJU77002AKU1	NJU77004V / NJU77004AV			
Package	DFN8-U1 (ESON8-U1)	SSOP14			
Pin Functions					

## ■ PRODUCT NAME INFORMATION





■ 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	-	Sn2Bi	77002	76	2000
NJU77002AE	SOP8 JEDEC 150 mil	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

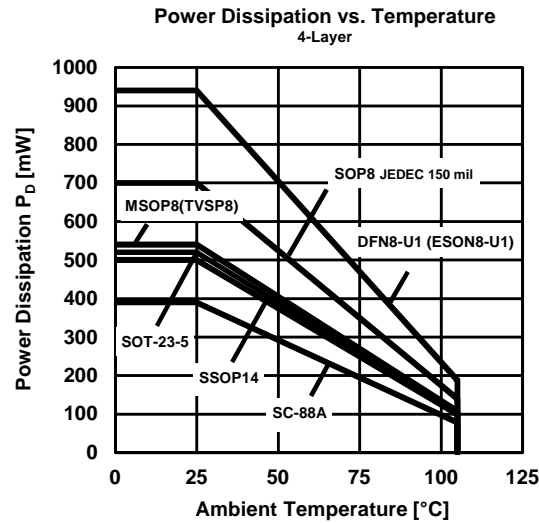
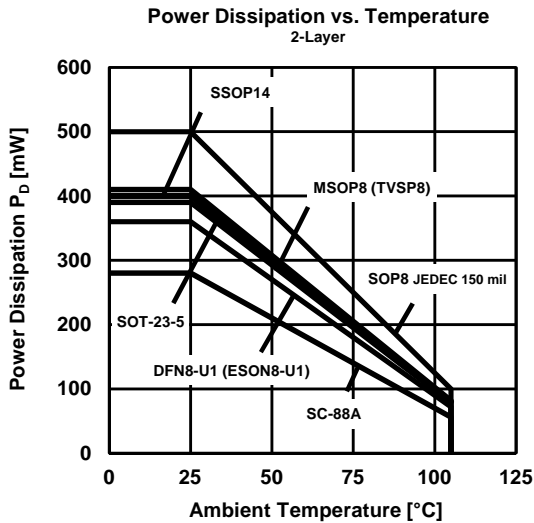
PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V^+ - V^-$	7	V
Differential Input Voltage <sup>(1)</sup>	$V_{ID}$	$\pm 7^{(2)}$	V
Input Voltage	$V_{IN}$	$V^- - 0.3$ to $V^+ + 0.3^{(3)}$	V
Power Dissipation ( $T_a = 25^\circ\text{C}$ )	$P_D$	2-Layer / 4-Layer <sup>(4)</sup>	
SOT-23-5		390 / 520	mW
SC-88A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

## ■ THERMAL CHARACTERISTICS

PACKAGE	SYMBOL	VALUE	UNIT
Junction-to-Ambient Thermal Resistance	$\Theta_{ja}$	2-Layer / 4-Layer <sup>(4)</sup>	°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 <sup>(5)</sup>	
SSOP14	250 / 200		
Junction-to-Top of Package Characterization Parameter	$\Psi_{jt}$	2-Layer / 4-Layer <sup>(4)</sup>	°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 <sup>(5)</sup>	
SSOP14	53 / 52		

- (1) Differential voltage is the voltage difference between +INPUT and -INPUT.
- (2) For supply voltage less than 7V, 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. (76.2x114.3x1.6mm: based on EIA/JDEC standard, 2-layer FR-4)  
4-Layer: Mounted on glass epoxy board. (76.2x114.3x1.6mm: based on EIA/JDEC standard, 4-layer FR-4), internal Cu area: 74.2x74.2mm
- (5) 2-Layer: Mounted on glass epoxy board (101.5 mm x 114.5 mm x 1.6 mm: based on EIA/JEDEC standard, 2-Layer FR-4) with exposed pad.  
4-Layer: Mounted on glass epoxy board (101.5 mm x 114.5 mm x 1.6 mm: based on EIA/JEDEC standard, 4-Layer FR-4) with exposed pad.  
(For 4-layer: Applying 99.5 mm x 99.5 mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5.)

## ■ POWER DISSIPATION vs. AMBIENT TEMPERATURE



## ■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	VALUE	UNIT
Supply Voltage	V <sup>+</sup> - V <sup>-</sup>	T <sub>a</sub> =25°C	1.5 to 5.5	V
Operating Temperature	T <sub>opr</sub>		-40 to 105	°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.)

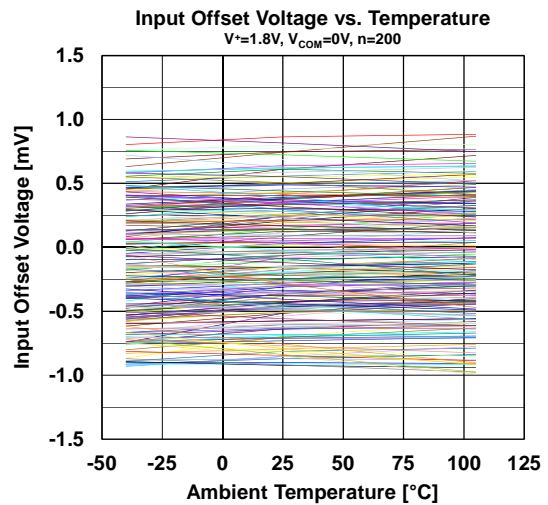
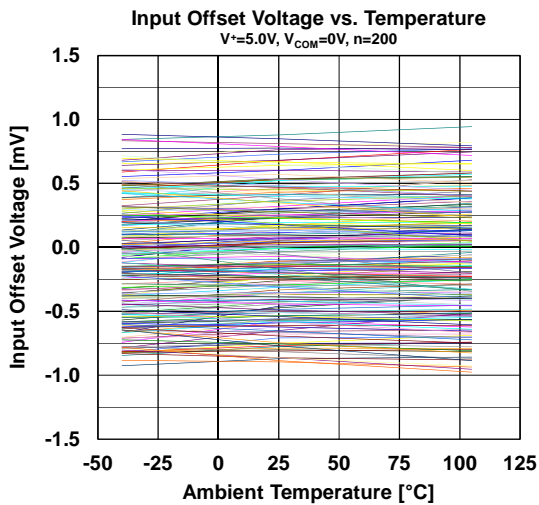
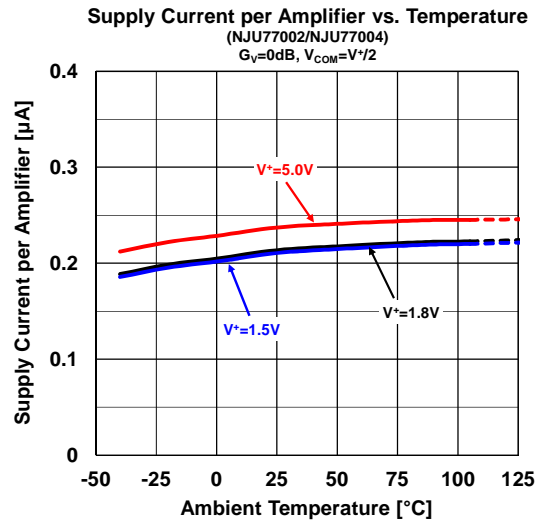
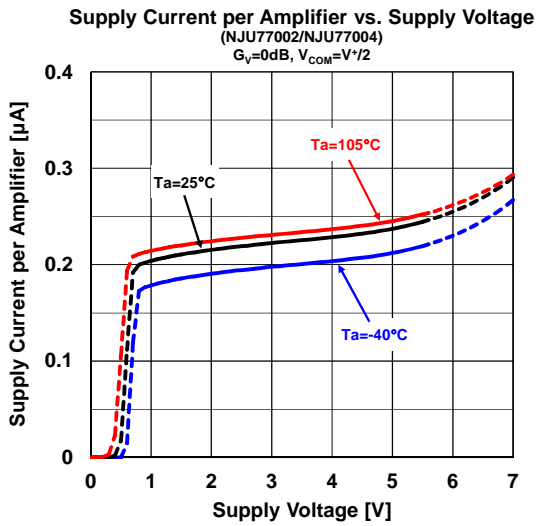
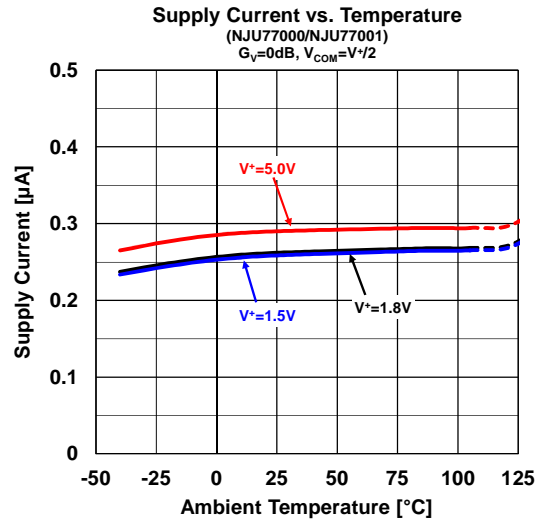
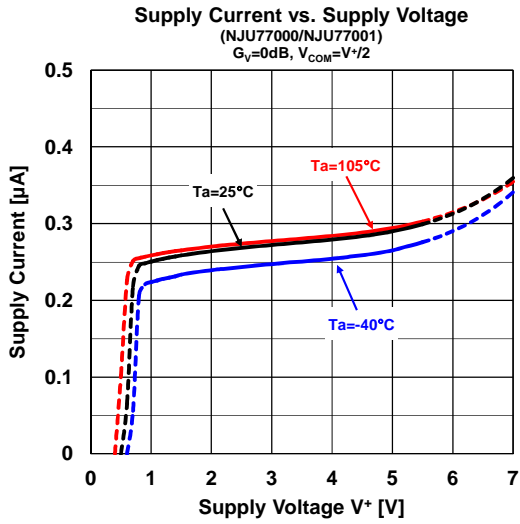
PARAMETER	SYMBOL	TEST CONDITIONS	NJU7700xA			NJU7700x			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
<b>INPUT CHARACTERISTICS</b>									
Input Offset Voltage NJU77000 / NJU77001	$V_{IO}$	$V_{COM}=0V$	-	0.35	1	-	0.35	1.8	mV
NJU77002		$T_a=-40^\circ C$ to $105^\circ C$	-	-	1.2	-	-	-	
NJU77004		$T_a=-40^\circ C$ to $105^\circ C$	-	0.35	1.3	-	0.35	2.0	
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	1.5	-	-	-	
Input Offset Voltage Drift NJU77000 / NJU77001 NJU77002 NJU77004	$\Delta V_{IO}/\Delta T$	$V_{COM}=0V$ , $T_a=-40^\circ C$ to $105^\circ C$	-	0.65	17	-	0.65	-	$\mu V/^\circ C$
Input Bias Current	$I_B$	$T_a=-40^\circ C$ to $105^\circ C$	-10 -100	1 -	10 100	- -	1 -	- -	pA
Input Offset Current	$I_{IO}$	$T_a=-40^\circ C$ to $105^\circ C$	-10 -100	1 -	10 100	- -	1 -	- -	pA
Open-Loop Voltage Gain	$A_V$	$V_O=0.5V$ to $4.5V$ $T_a=-40^\circ C$ to $105^\circ C$	70 70	100 -	- -	70 -	100 -	- -	dB
Common-Mode Rejection Ratio	CMR	$V_{COM}=0V$ to $5V$ $T_a=-40^\circ C$ to $105^\circ C$	60 60	80 -	- -	60 -	80 -	- -	dB
Common-Mode Input Voltage Range	$V_{ICM}$	CMR $\geq 60$ dB $T_a=-40^\circ C$ to $105^\circ C$	0 0	- -	5 5	0 -	- -	5 -	V
<b>OUTPUT CHARACTERISTICS</b>									
Maximum Output Voltage	$V_{OH}$	$T_a=-40^\circ C$ to $105^\circ C$	4.9 4.9	4.95 -	- -	4.9 -	4.95 -	- -	V
	$V_{OL}$	$T_a=-40^\circ C$ to $105^\circ C$	- -	0.05 -	0.1 0.1	- -	0.05 -	0.1 -	V
<b>POWER SUPPLY</b>									
Supply Current (All Amplifiers) NJU77000 / NJU77001 NJU77002 NJU77004	$I_{SUPPLY}$	No Signal	-	0.29	0.39	-	0.29	0.49	$\mu A$
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	0.39	-	-	-	
		$T_a=-40^\circ C$ to $105^\circ C$	-	0.46	0.66	-	0.46	0.76	
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	0.66	-	-	-	
Supply Voltage Rejection Ratio	SVR	$V^+=1.5V$ to $5.5V$ , $V_{COM}=0V$ $T_a=-40^\circ C$ to $105^\circ C$	70 70	90 -	- -	70 -	90 -	- -	dB
<b>AC CHARACTERISTICS</b>									
Slew Rate NJU77000 / NJU77001 NJU77002 / NJU77004	SR	$G_V=0$ dB, $C_L=20$ pF, $V_{IN}=1$ V <sub>PP</sub>	- -	0.8 0.7	- -	- -	0.8 0.7	- -	V/ms
Unity-Gain Frequency NJU77000 / NJU77001 NJU77002 / NJU77004	$f_T$	$G_V=20$ dB, $C_L=20$ pF	- -	1.1 1.0	- -	- -	1.1 1.0	- -	kHz
Phase Margin	$\Phi_M$	$C_L=20$ pF	-	60	-	-	60	-	deg
Gain Margin	$G_M$	$C_L=20$ pF	-	30	-	-	30	-	dB
Equivalent Input Noise Current NJU77000 / NJU77001 NJU77002 / NJU77004	$V_{NI}$	$f=100$ Hz	- -	600 700	- -	- -	600 700	- -	nV/ $\sqrt{Hz}$

## ■ 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.)

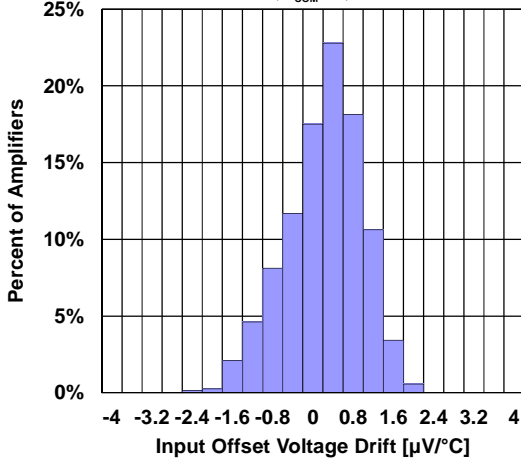
PARAMETER	SYMBOL	TEST CONDITIONS	NJU7700xA			NJU7700x			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
<b>INPUT CHARACTERISTICS</b>										
Input Offset Voltage NJU77000 / NJU77001	$V_{IO}$	$V_{COM}=0V$	-	0.35	1	-	0.35	1.8	mV	
NJU77002		$T_a=-40^\circ C$ to $105^\circ C$	-	-	1.2	-	-	-		
NJU77004		$T_a=-40^\circ C$ to $105^\circ C$	-	0.35	1.3	-	0.35	2.0		
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	1.5	-	-	-		
Input Offset Voltage Drift NJU77000 / NJU77001 NJU77002 NJU77004	$\Delta V_{IO}/\Delta T$	$V_{COM}=0V$ , $T_a=-40^\circ C$ to $105^\circ C$	-	0.65	17	-	0.65	-	$\mu V/^\circ C$	
			-	0.65	21	-	0.65	-		
				-	0.65	24	-	0.65		-
				-	-	1.7	-	-		-
Input Bias Current	$I_B$	$T_a=-40^\circ C$ to $105^\circ C$	-10	1	10	-	1	-	pA	
				-100	-	100	-	-		-
Input Offset Current	$I_{IO}$	$T_a=-40^\circ C$ to $105^\circ C$	-10	1	10	-	1	-	pA	
				-100	-	100	-	-		-
Open-Loop Voltage Gain	$A_V$	$V_O=0.5V$ to $1.3V$	70	100	-	70	100	-	dB	
			$T_a=-40^\circ C$ to $105^\circ C$	70	-	-	-	-		-
Common-Mode Rejection Ratio	CMR	$V_{COM}=0V$ to $1.8V$	55	80	-	55	80	-	dB	
			$T_a=-40^\circ C$ to $105^\circ C$	55	-	-	-	-		-
Common-Mode Input Voltage Range	$V_{ICM}$	CMR $\geq 55$ dB	0	-	1.8	0	-	1.8	V	
			$T_a=-40^\circ C$ to $105^\circ C$	0	-	1.8	-	-		-
<b>OUTPUT CHARACTERISTICS</b>										
Maximum Output Voltage	$V_{OH}$	$T_a=-40^\circ C$ to $105^\circ C$	1.7	1.75	-	1.7	1.75	-	V	
	$V_{OL}$	$T_a=-40^\circ C$ to $105^\circ C$	-	0.05	0.1	-	0.05	0.1	V	
<b>POWER SUPPLY</b>										
Supply Current (All Amplifiers) NJU77000 / NJU77001	$I_{SUPPLY}$	No Signal	-	0.26	0.36	-	0.26	0.49	$\mu A$	
NJU77002		$T_a=-40^\circ C$ to $105^\circ C$	-	-	0.36	-	-	-		
NJU77004		$T_a=-40^\circ C$ to $105^\circ C$	-	0.42	0.62	-	0.42	0.72		
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	0.62	-	-	-		
Supply Voltage Rejection Ratio	SVR	$V^+=1.5V$ to $5.5V$ , $V_{COM}=0V$	70	90	-	70	90	-	dB	
			$T_a=-40^\circ C$ to $105^\circ C$	70	-	-	-	-		-
<b>AC CHARACTERISTICS</b>										
Slew Rate NJU77000 / NJU77001 NJU77002 / NJU77004	SR	$G_V=0$ dB, $C_L=20$ pF, $V_{IN}=1$ V <sub>PP</sub>	-	0.7	-	-	0.7	-	V/ms	
				-	0.6	-	-	0.6		-
Unity-Gain Frequency NJU77000 / NJU77001 NJU77002 / NJU77004	$f_t$	$G_V=20$ dB, $C_L=20$ pF	-	1.0	-	-	1.0	-	kHz	
				-	0.9	-	-	0.9		-
Phase Margin	$\Phi_M$	$C_L=20$ pF	-	60	-	-	60	-	deg	
Gain Margin	$G_M$	$C_L=20$ pF	-	30	-	-	30	-	dB	
Equivalent Input Noise Current NJU77000 / NJU77001 NJU77002 / NJU77004	$V_{NI}$	$f=100$ Hz	-	700	-	-	700	-	nV/ $\sqrt{Hz}$	
				-	800	-	-	800		-

## ■ TYPICAL CHARACTERISTICS

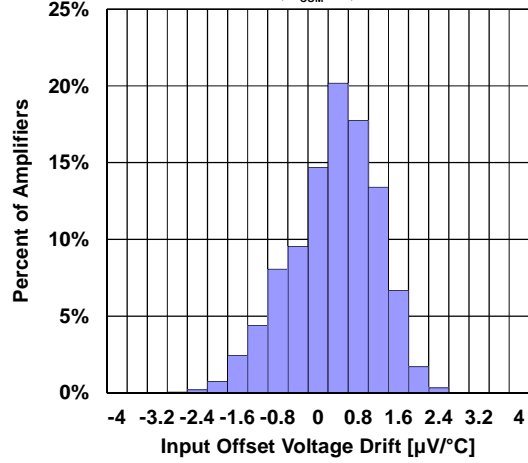


## ■ TYPICAL CHARACTERISTICS

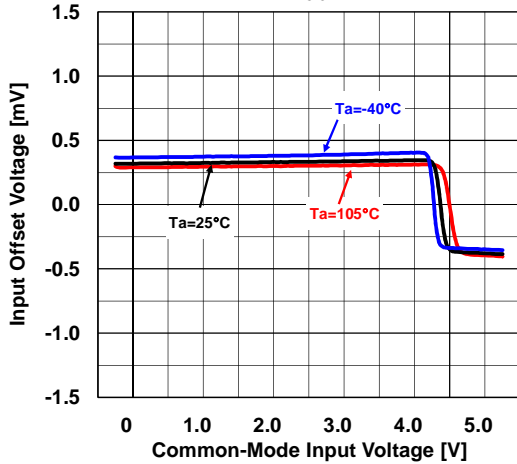
Input Offset Voltage Drift Distribution  
 $V^+=5.0V, V_{COM}=0V, n=3000$



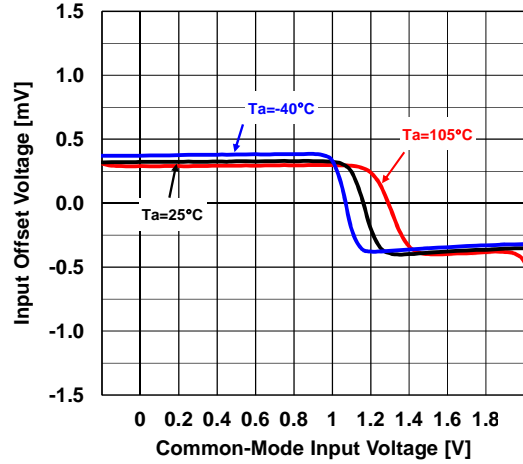
Input Offset Voltage Drift Distribution  
 $V^+=1.8V, V_{COM}=0V, n=3000$



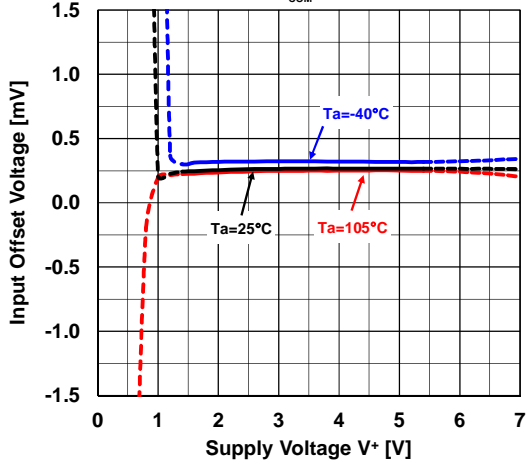
Input Offset Voltage vs. Common-Mode Input Voltage  
 $V^+=5.0V$



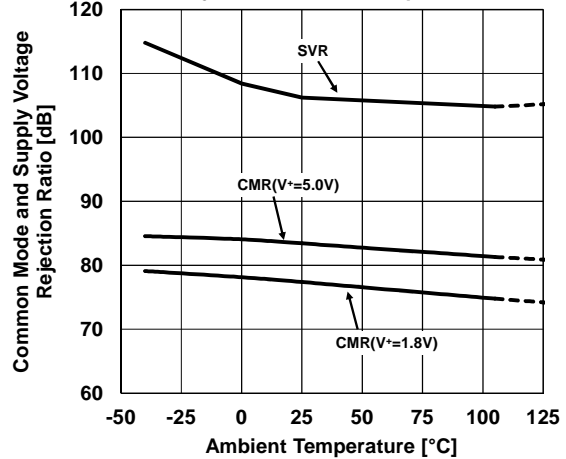
Input Offset Voltage vs. Common-Mode Input Voltage  
 $V^+=1.8V$



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

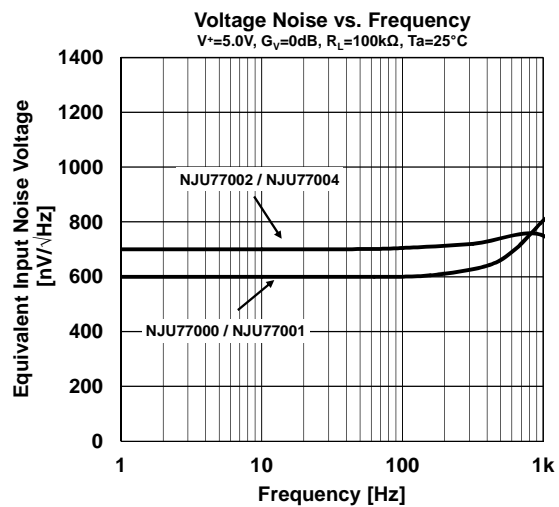
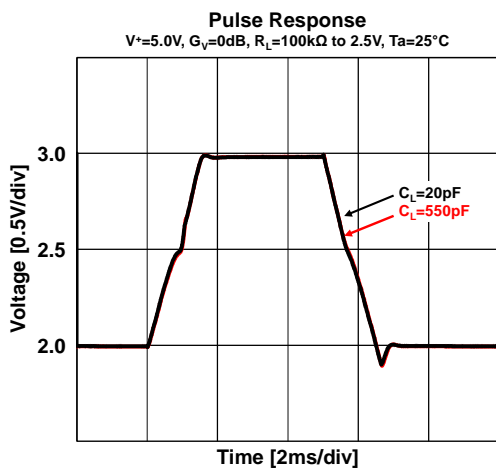
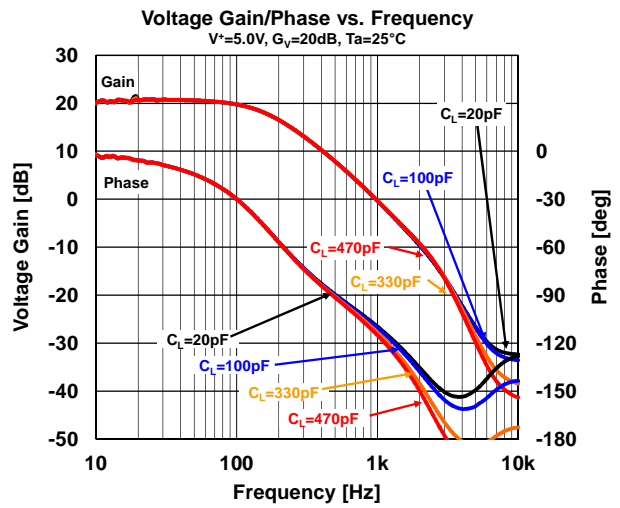
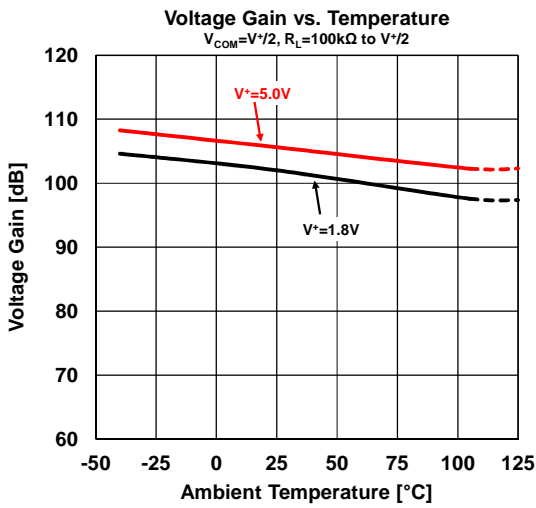
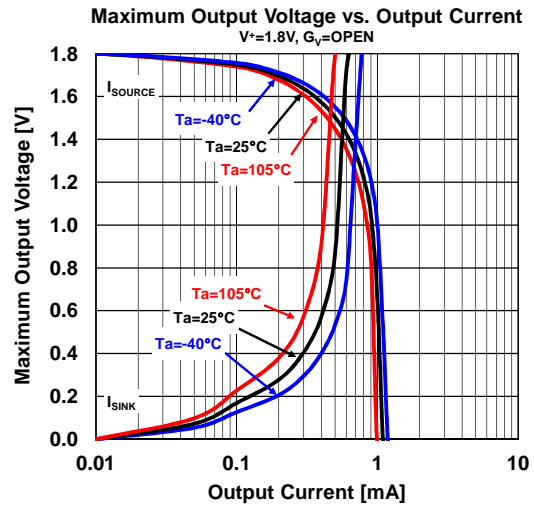
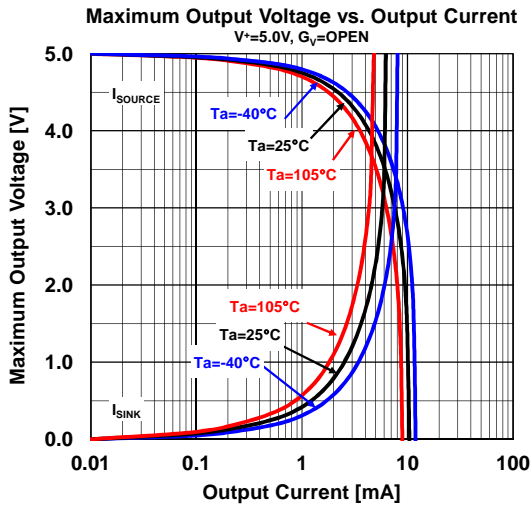


Common-Mode and Supply Voltage Rejection Ratio vs. Temperature



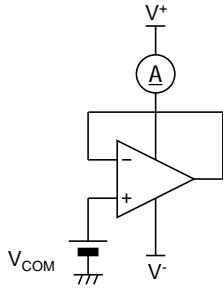


## ■ TYPICAL CHARACTERISTICS



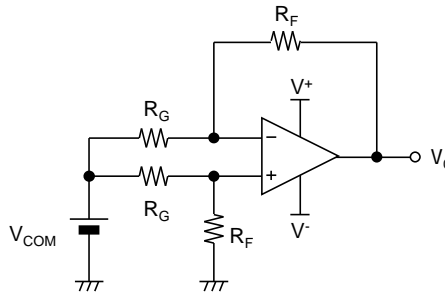
## ■ TEST CIRCUIT

- I<sub>SUPPLY</sub>



- V<sub>IO</sub>, CMR, SVR

R<sub>G</sub>=50Ω, R<sub>F</sub>=50kΩ



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

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

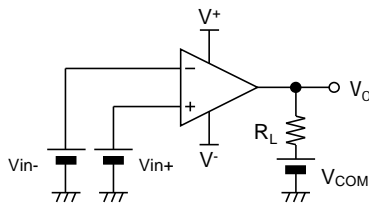
$$SVR = 20 \log \frac{\Delta V_S \left(1 + \frac{R_F}{R_G}\right)}{\Delta V_O}$$

$V_S = V^+ - V^-$

- V<sub>OH</sub>, V<sub>OL</sub>

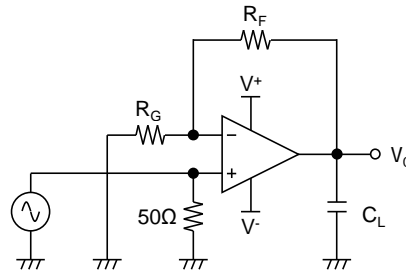
V<sub>OH</sub>: V<sub>in+</sub> = V<sup>+</sup>/2 + 0.1V, V<sub>in-</sub> = V<sup>+</sup>/2, V<sub>COM</sub> = V<sup>+</sup>/2

V<sub>OL</sub>: V<sub>in+</sub> = V<sup>+</sup>/2, V<sub>in-</sub> = V<sup>+</sup>/2 + 0.1V, V<sub>COM</sub> = V<sup>+</sup>/2

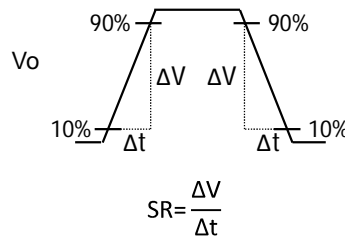
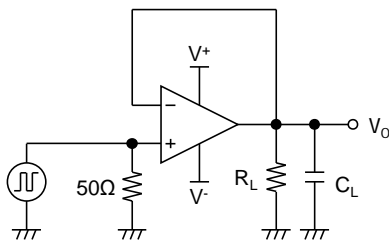


- GBW

R<sub>G</sub>=1kΩ, R<sub>F</sub>=100kΩ



- 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.

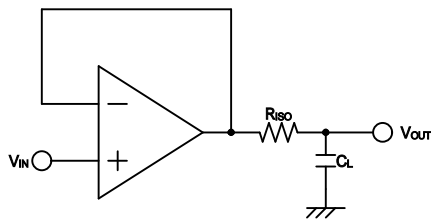


Figure1. Isolating capacitive load

### EMIRR (EMI Rejection Ratio) Definition

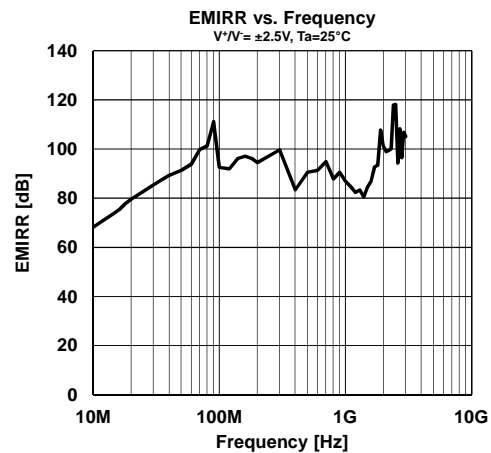
EMIRR is a parameter indicating the EMI robustness of an Op-Amp. The definition of EMIRR is given by the following equation1.

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

$V_{RF\_PEAK}$ : RF Signal Amplitude [VP]

$\Delta V_{IO}$ : 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/>

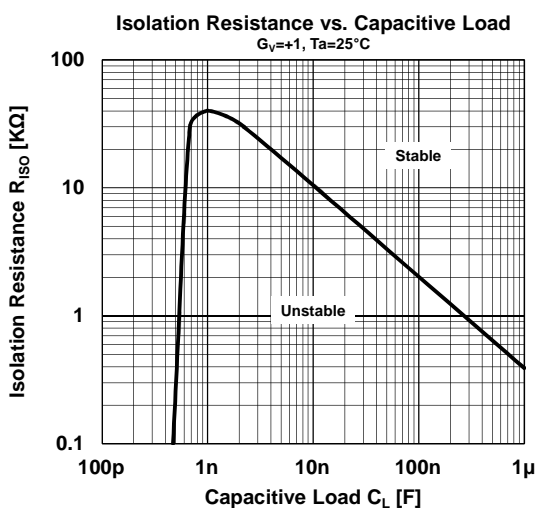
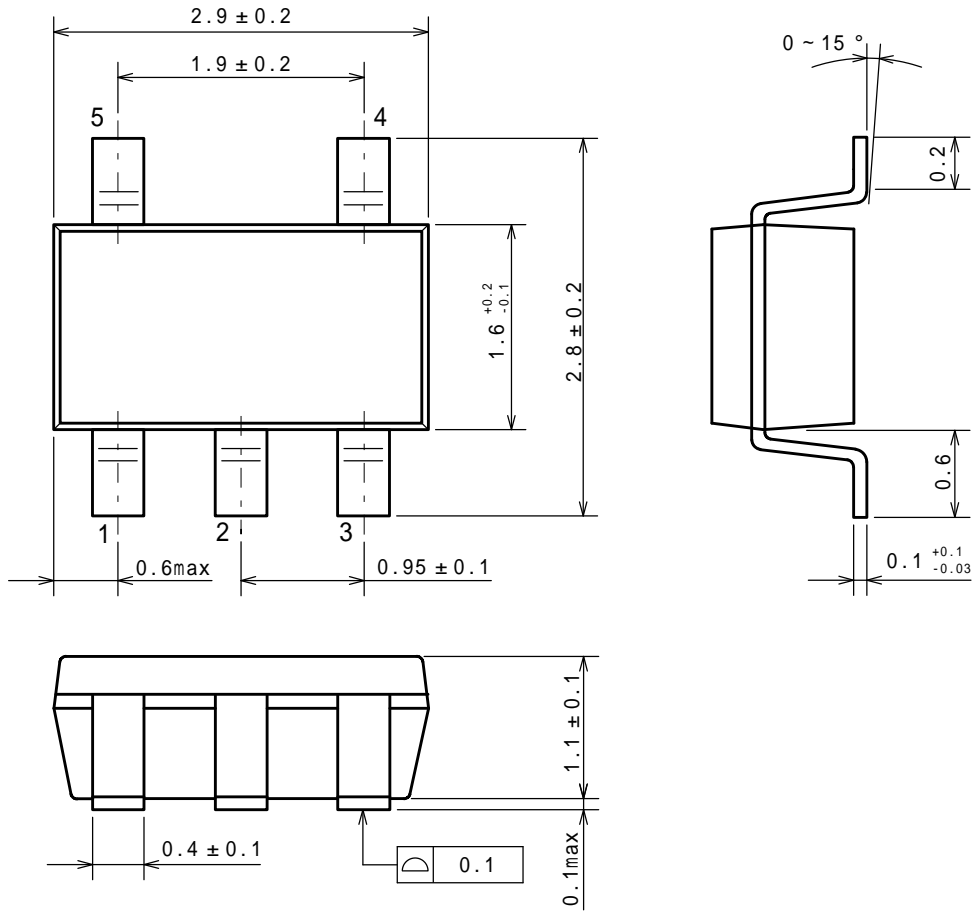


Figure2. Isolation resistance to improve stability

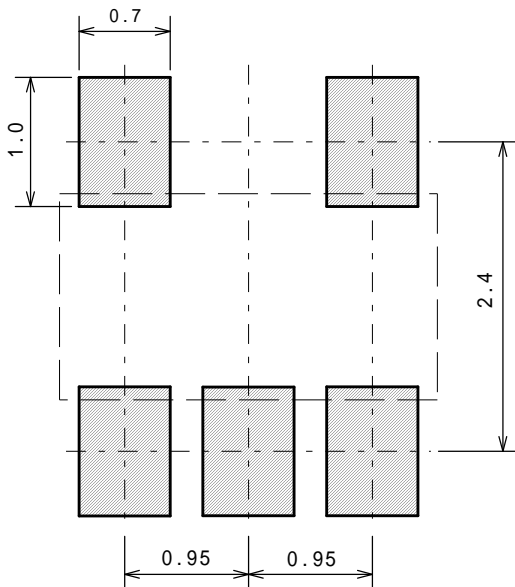
SOT-23-5

Unit: mm

■ PACKAGE DIMENSIONS



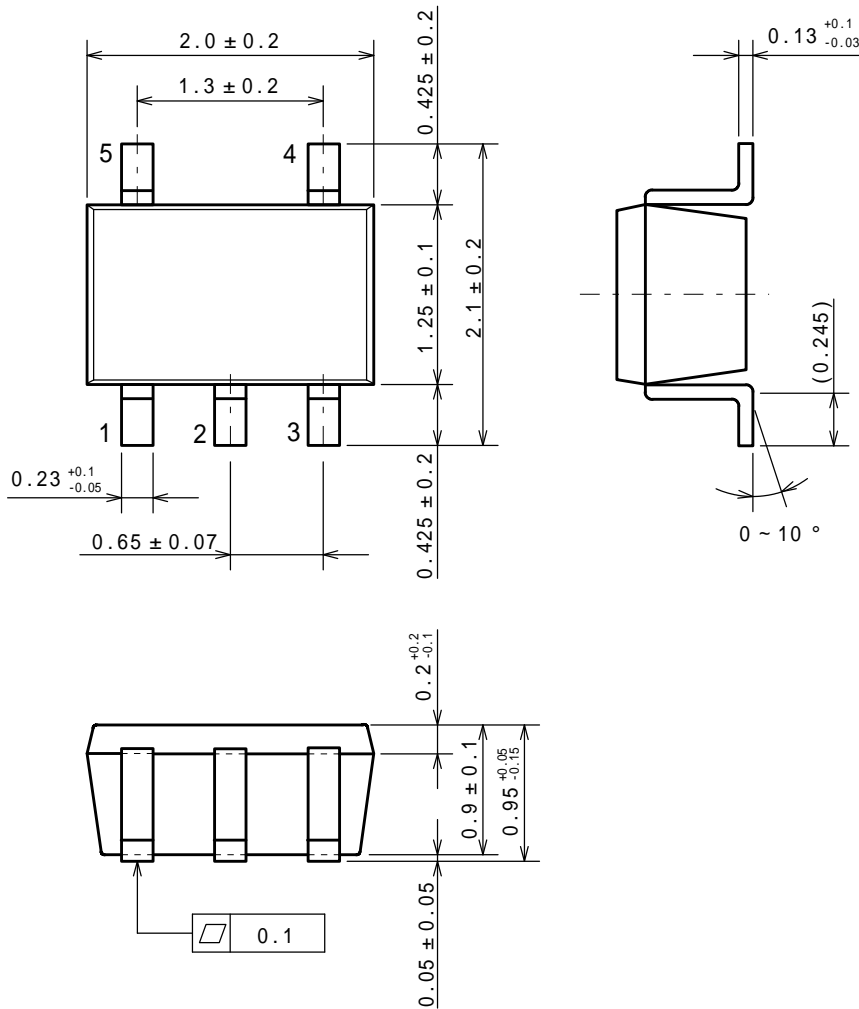
■ EXAMPLE OF SOLDER PADS DIMENSIONS



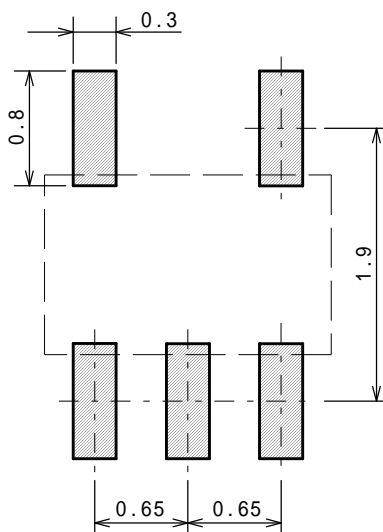
## SC-88A

Unit: mm

### ■ PACKAGE DIMENSIONS



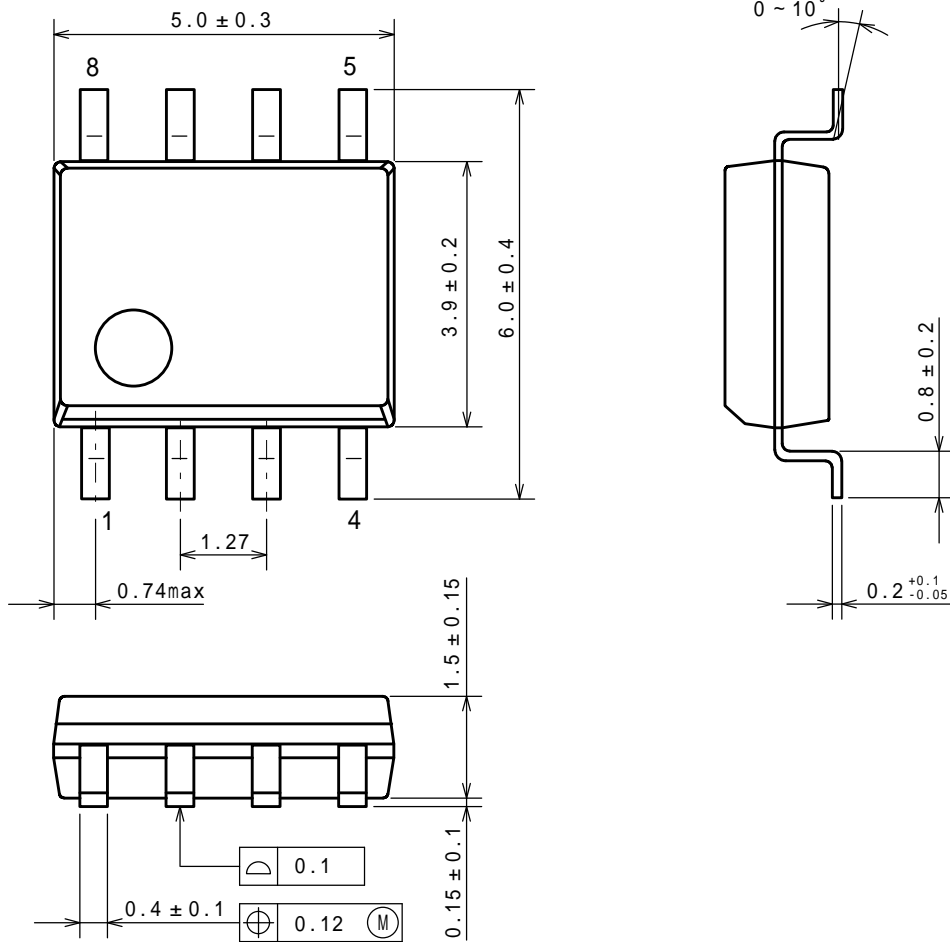
### ■ EXAMPLE OF SOLDER PADS DIMENSIONS



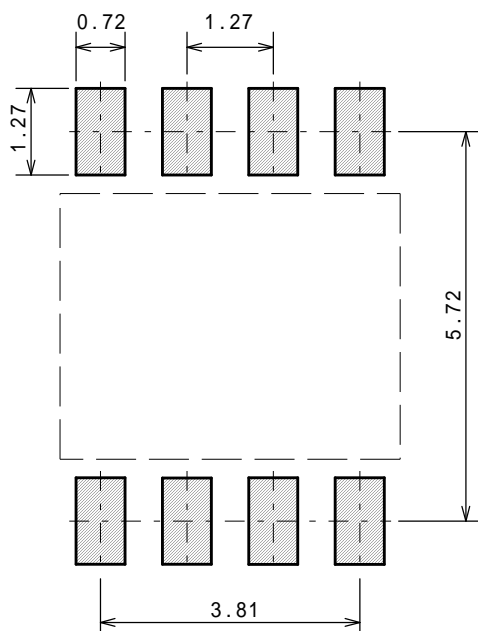
## SOP8 JEDEC 150mil (EMP8)

Unit: mm

### ■ PACKAGE DIMENSIONS



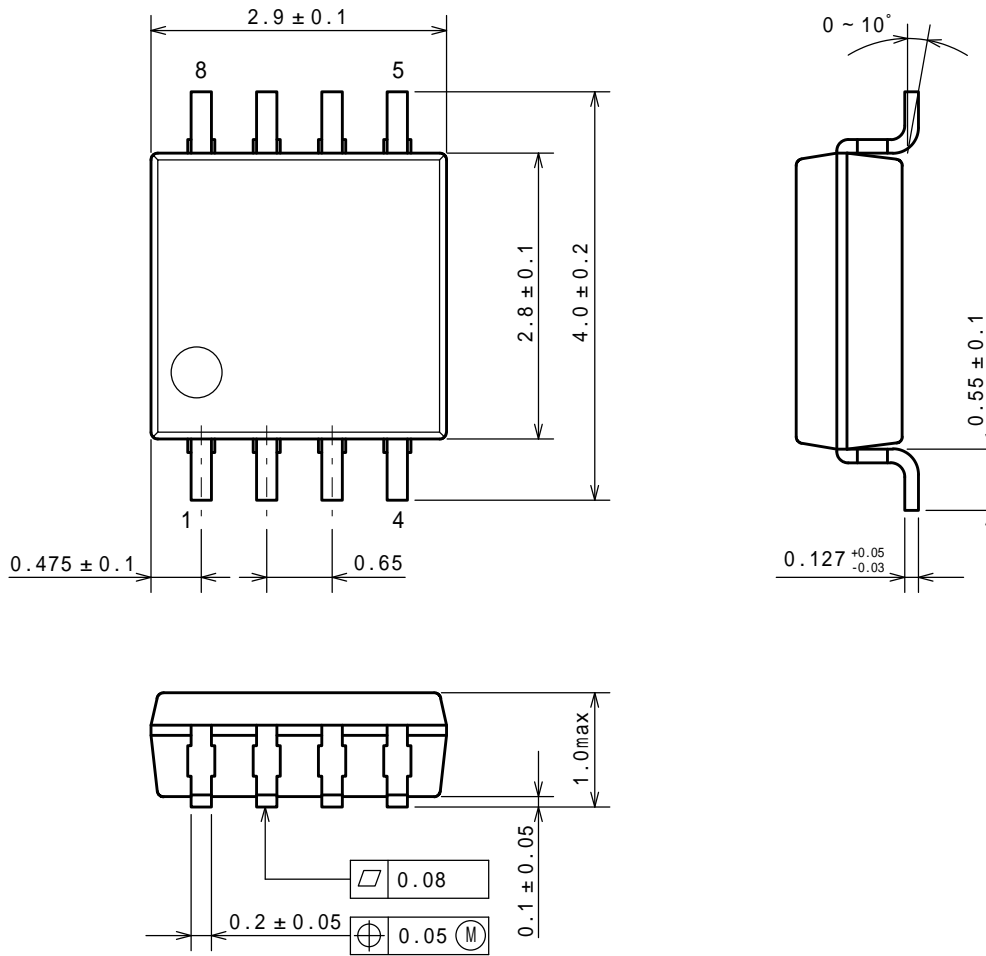
### ■ EXAMPLE OF SOLDER PADS DIMENSIONS



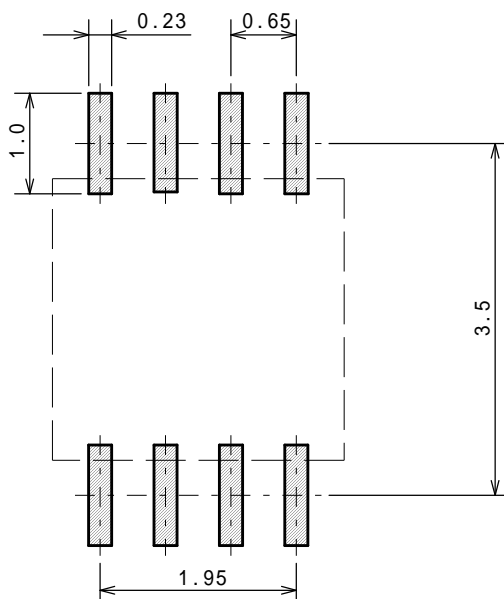
## MSOP8 (TVSP8) MEET JEDEC MO-187-DATHIN TYPE

Unit: mm

### ■ PACKAGE DIMENSIONS



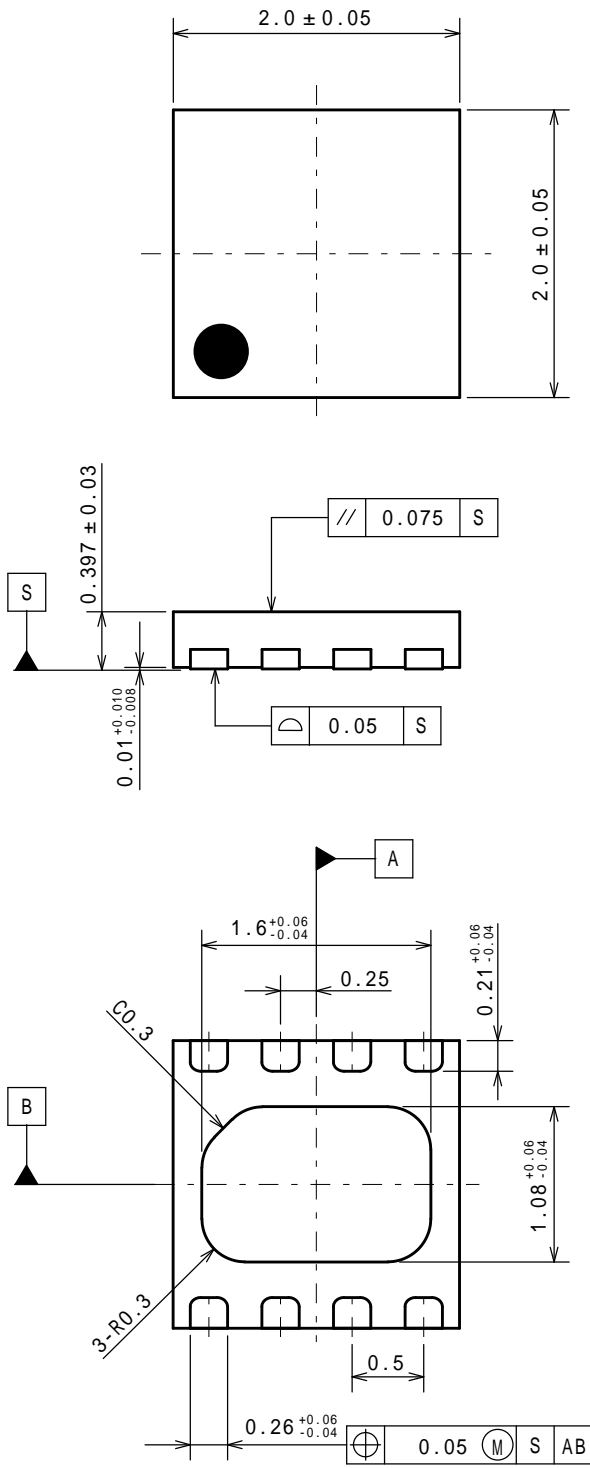
### ■ EXAMPLE OF SOLDER PADS DIMENSIONS



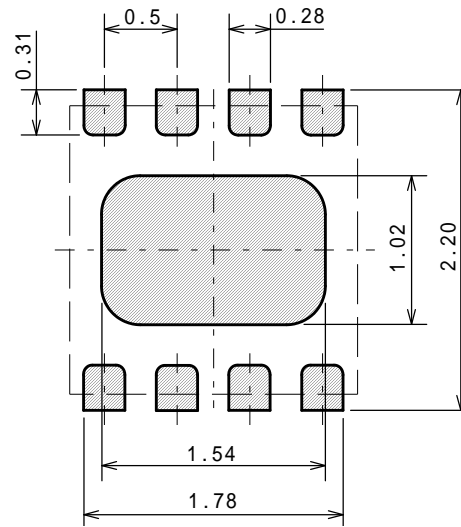
## DFN8-U1 (ESON8-U1)

Unit: mm

### ■ PACKAGE DIMENSIONS



### ■ EXAMPLE OF SOLDER PADS DIMENSIONS

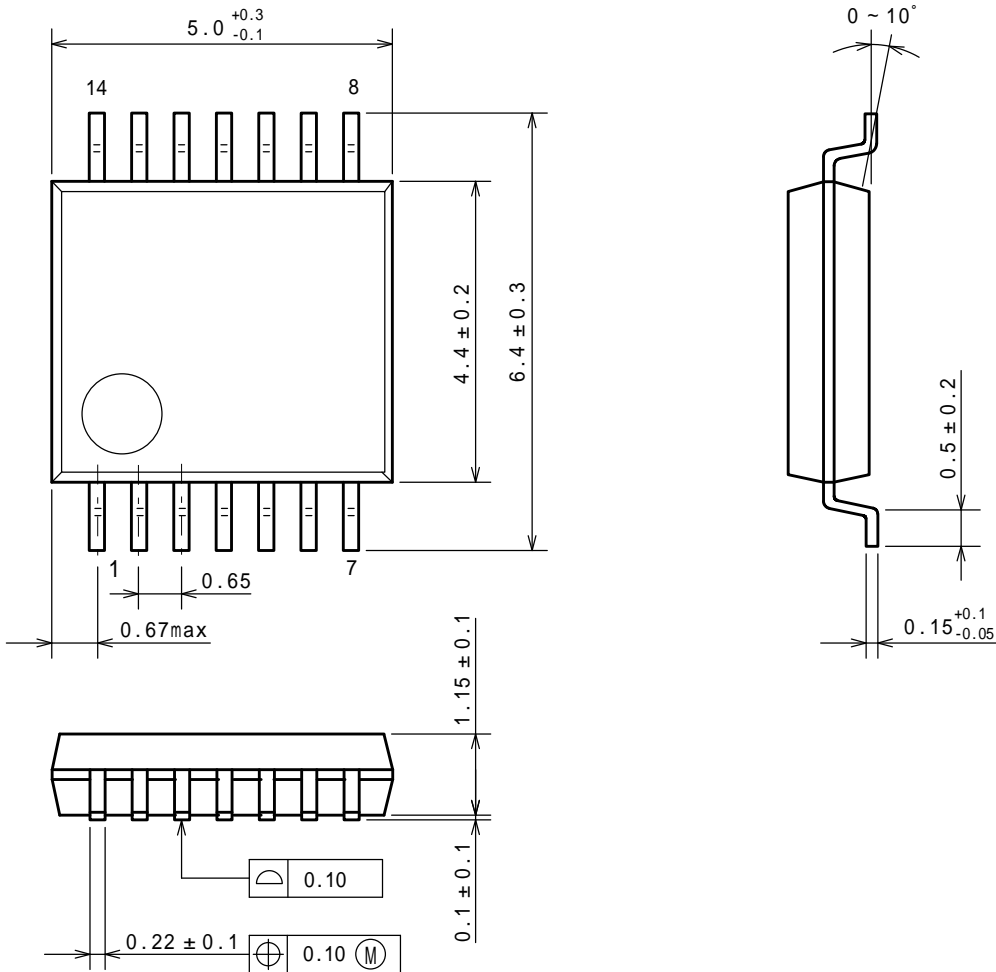




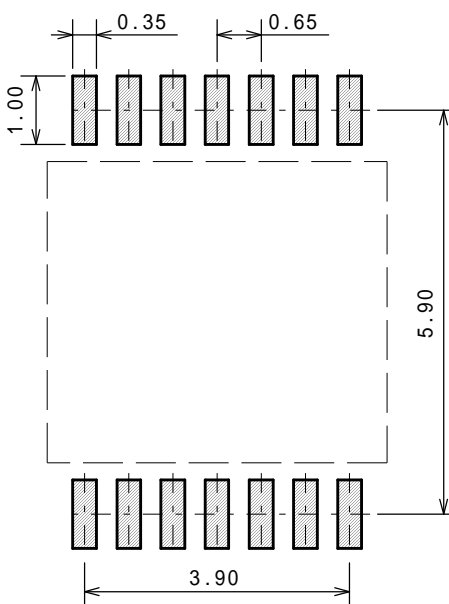
## SSOP14

Unit: mm

### ■ PACKAGE DIMENSIONS



### ■ EXAMPLE OF SOLDER PADS DIMENSIONS

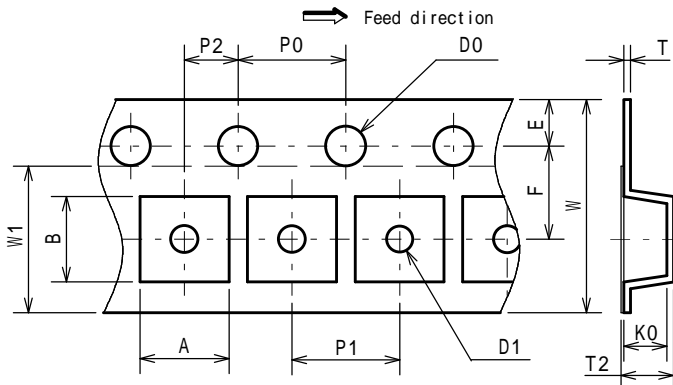


## SOT-23-5

### PACKING SPEC

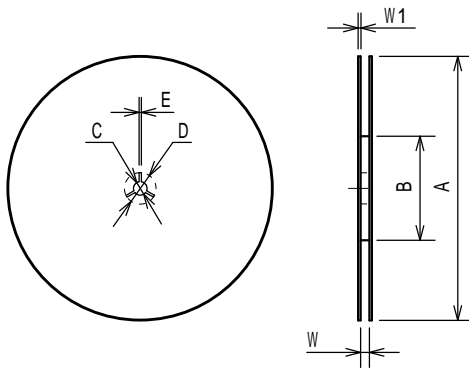
Unit: mm

#### TAPING DIMENSIONS



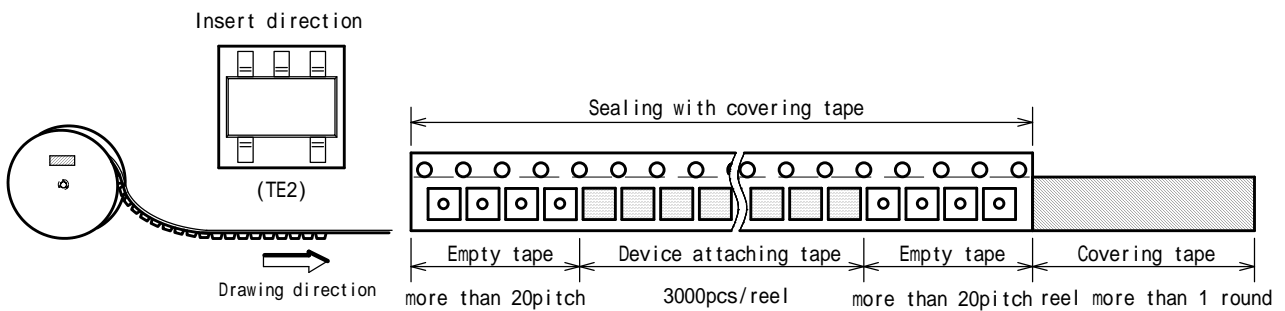
SYMBOL	DIMENSION	REMARKS
A	3.3 ± 0.1	BOTTOM DIMENSION
B	3.2 ± 0.1	BOTTOM DIMENSION
D0	1.55	
D1	1.05	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.82	
KO	1.5 ± 0.1	
W	8.0 ± 0.3	
W1	5.5	THICKNESS 0.1MAX

#### REEL DIMENSIONS

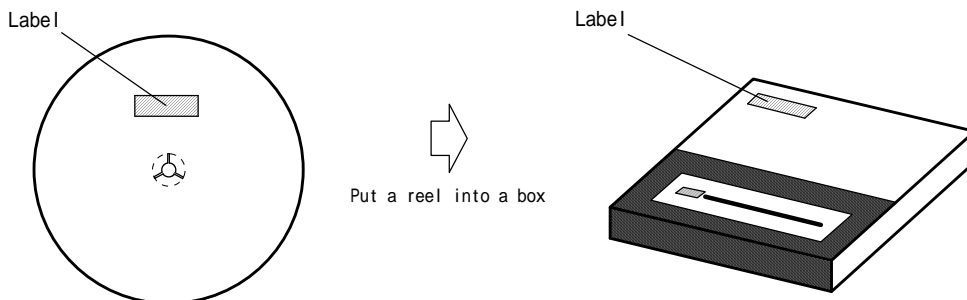


SYMBOL	DIMENSION
A	180 ± 1
B	60 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ± 0.5
W1	1.2 ± 0.2

#### TAPING STATE



#### PACKING STATE

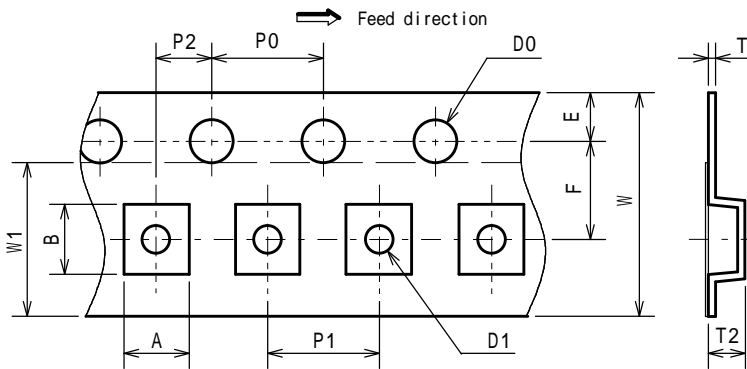


## SC-88A

### PACKING SPEC

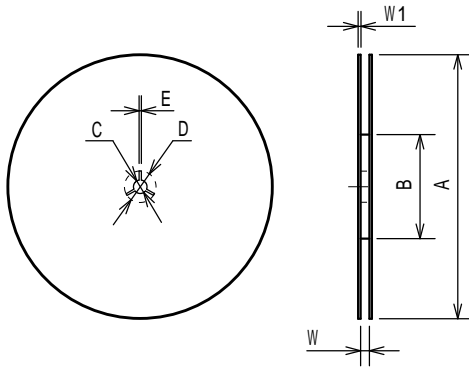
Unit: mm

#### TAPING DIMENSIONS



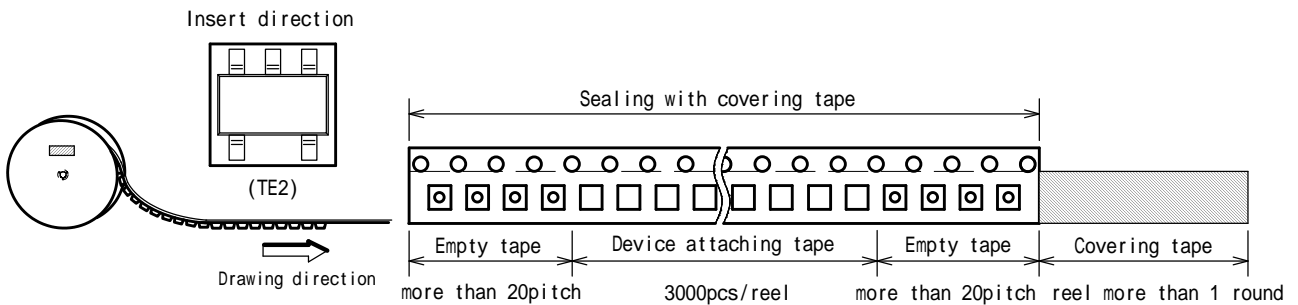
SYMBOL	DIMENSION	REMARKS
A	2.3 ± 0.1	BOTTOM DIMENSION
B	2.5 ± 0.1	BOTTOM DIMENSION
D0	1.55 ± 0.05	
D1	1.05 ± 0.05	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.3 ± 0.1	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

#### REEL DIMENSIONS

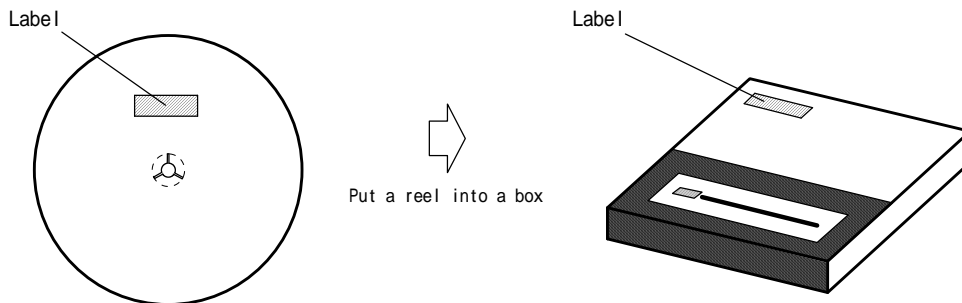


SYMBOL	DIMENSION
A	180 ± 1
B	60 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ± 0.5
W1	1.2 ± 0.2

#### TAPING STATE



#### PACKING STATE

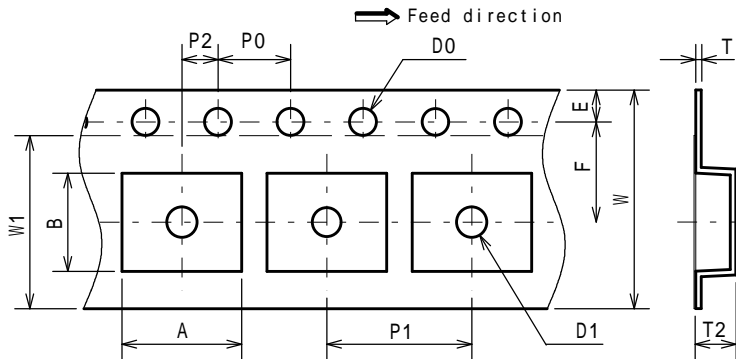


## SOP8 JEDEC 150mil (EMP8)

### PACKING SPEC

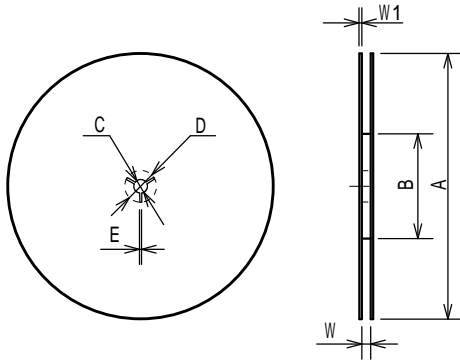
Unit: mm

#### TAPING DIMENSIONS



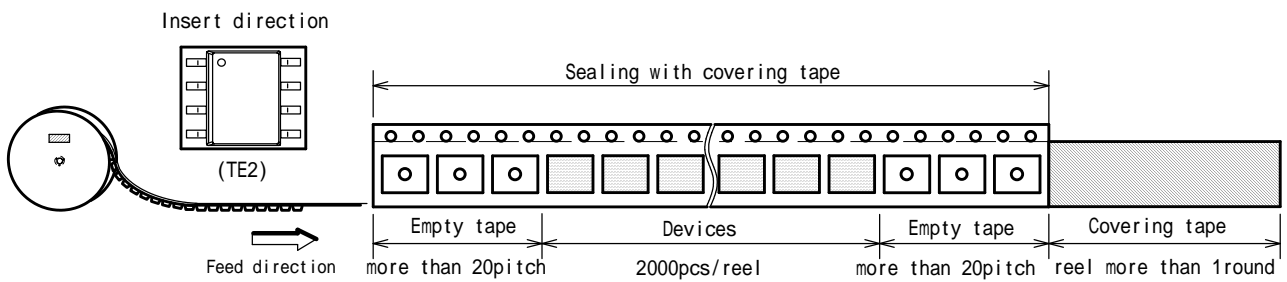
SYMBOL	DIMENSION	REMARKS
A	6.6	BOTTOM DIMENSION
B	5.4	BOTTOM DIMENSION
D0	1.5 <sup>+0.1</sup> <sub>0</sub>	
D1	1.7 ± 0.1	
E	1.75 ± 0.1	
F	5.5 ± 0.05	
P0	4.0 ± 0.1	
P1	8.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.30 ± 0.05	
T2	2.2	
W	12.0 ± 0.3	
W1	9.5	THICKNESS 0.1max

#### REEL DIMENSIONS

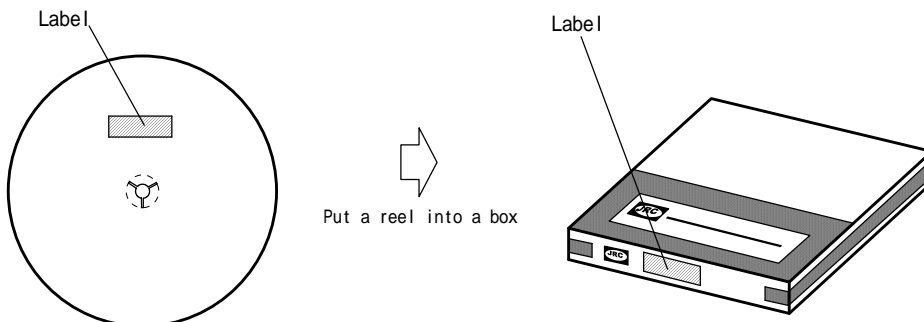


SYMBOL	DIMENSION
A	330 ± 2
B	80 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	13.5 ± 0.5
W1	2.0 ± 0.2

#### TAPING STATE



#### PACKING STATE

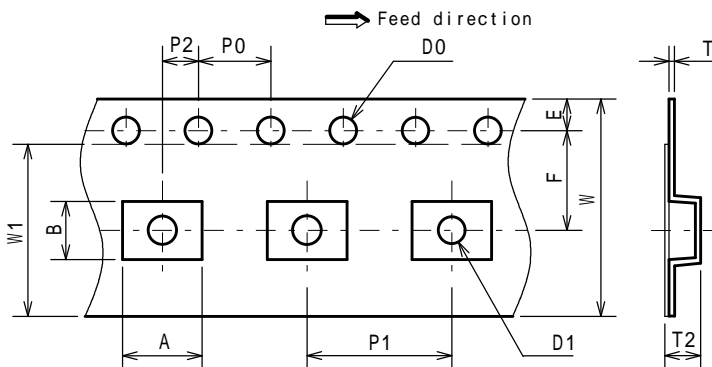


## MSOP8 MEET JEDEC MO-187-DA/THIN TYPE

### PACKING SPEC

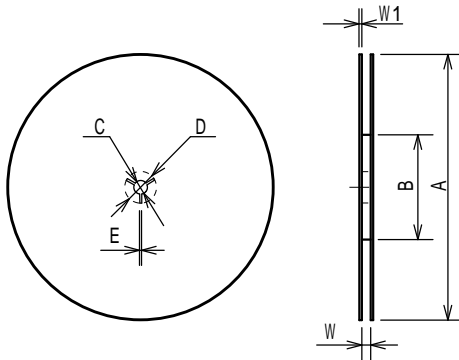
Unit: mm

#### TAPING DIMENSIONS



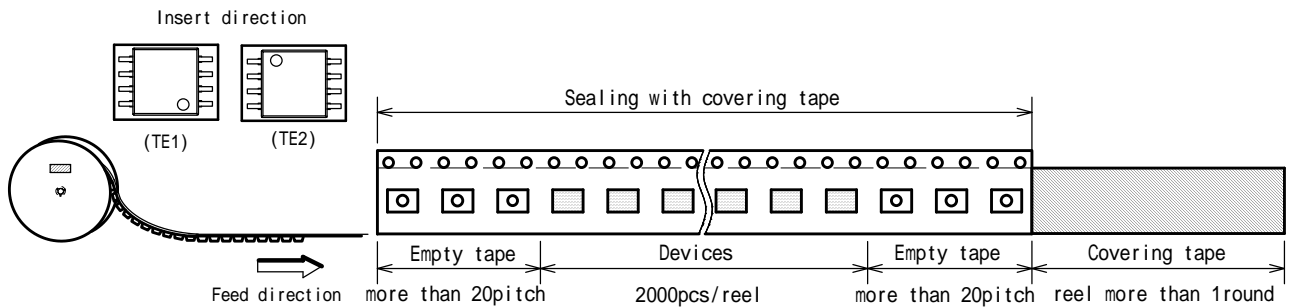
SYMBOL	DIMENSION	REMARKS
A	4.4	BOTTOM DIMENSION
B	3.2	BOTTOM DIMENSION
D0	1.5 <sup>+0.1</sup> <sub>0</sub>	
D1	1.5 <sup>+0.1</sup> <sub>0</sub>	
E	1.75 ± 0.1	
F	5.5 ± 0.05	
P0	4.0 ± 0.1	
P1	8.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.30 ± 0.05	
T2	1.75 (MAX.)	
W	12.0 ± 0.3	
W1	9.5	THICKNESS 0.1max

#### REEL DIMENSIONS

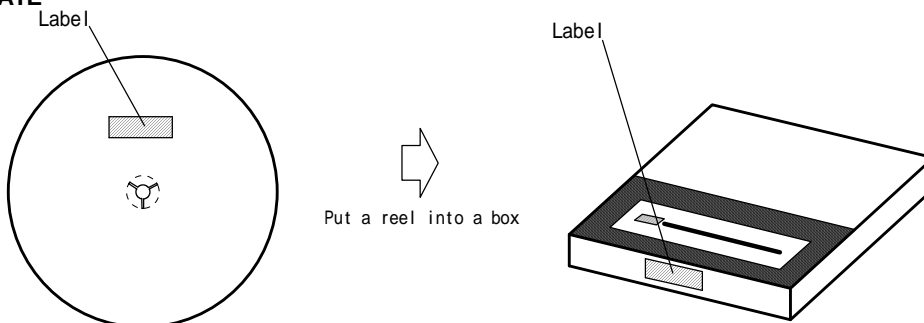


SYMBOL	DIMENSION
A	254 ± 2
B	100 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	13.5 ± 0.5
W1	2.0 ± 0.2

#### TAPING STATE



#### PACKING STATE

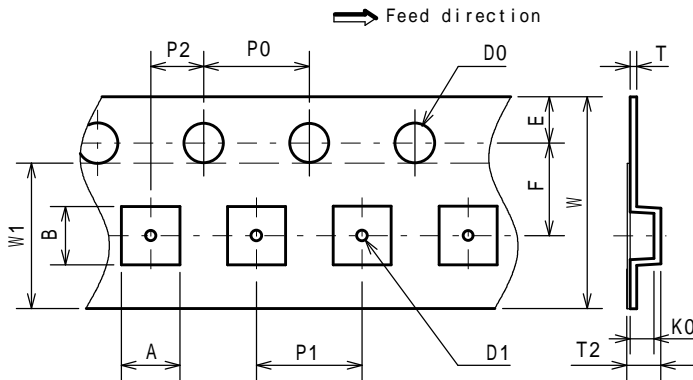


## DFN8-U1 (ESON8-U1)

■ PACKING SPEC

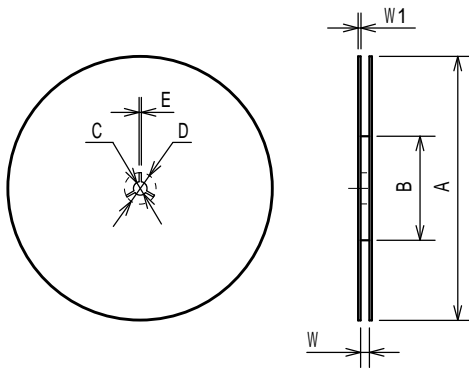
Unit: mm

### TAPING DIMENSIONS



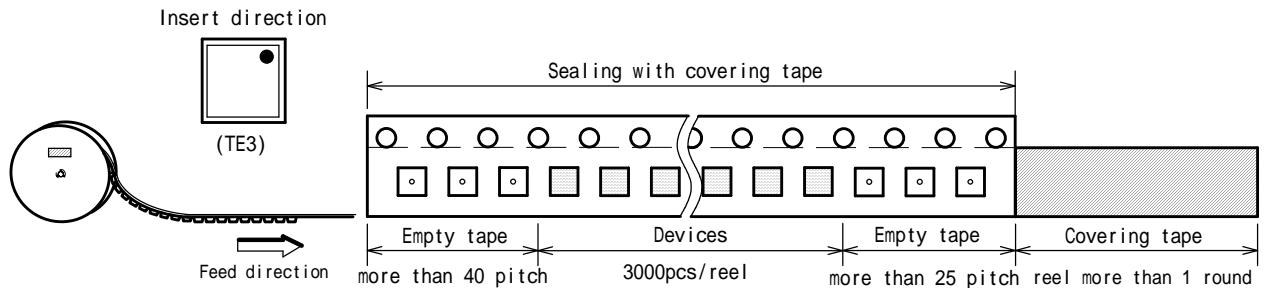
SYMBOL	DIMENSION	REMARKS
A	2.25 ± 0.05	BOTTOM DIMENSION
B	2.25 ± 0.05	BOTTOM DIMENSION
D0	1.5 <sup>+0.1</sup> <sub>0</sub>	
D1	0.5 ± 0.1	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.00 ± 0.07	
KO	0.65 ± 0.05	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

### REEL DIMENSIONS

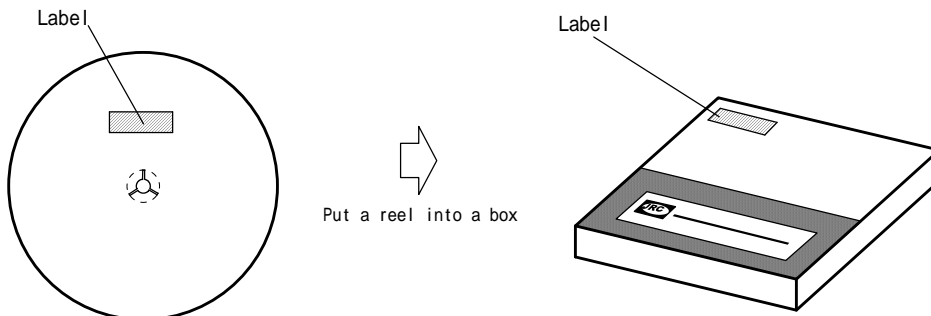


SYMBOL	DIMENSION
A	180 <sup>0</sup> <sub>-1.5</sub>
B	60 <sup>+1</sup> <sub>0</sub>
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 <sup>+0.3</sup> <sub>0</sub>
W1	1.2

### TAPING STATE



### PACKING STATE

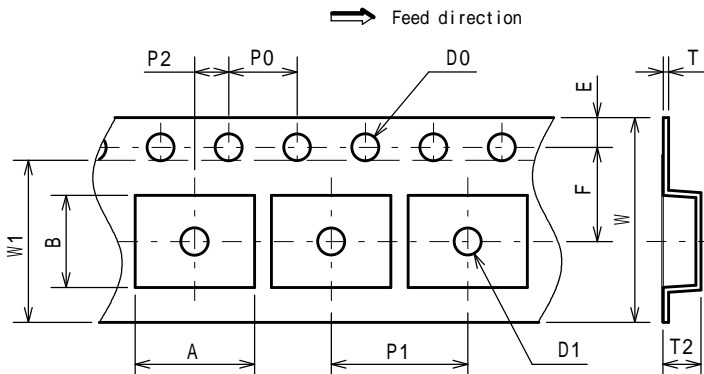


## SSOP14

### PACKING SPEC

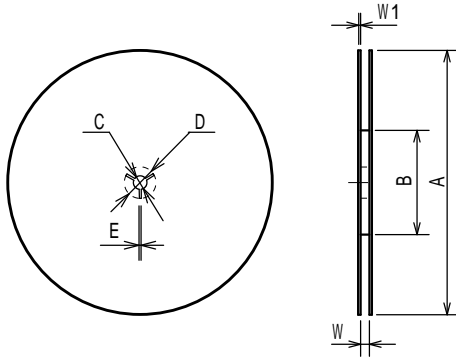
Unit: mm

#### TAPING DIMENSIONS



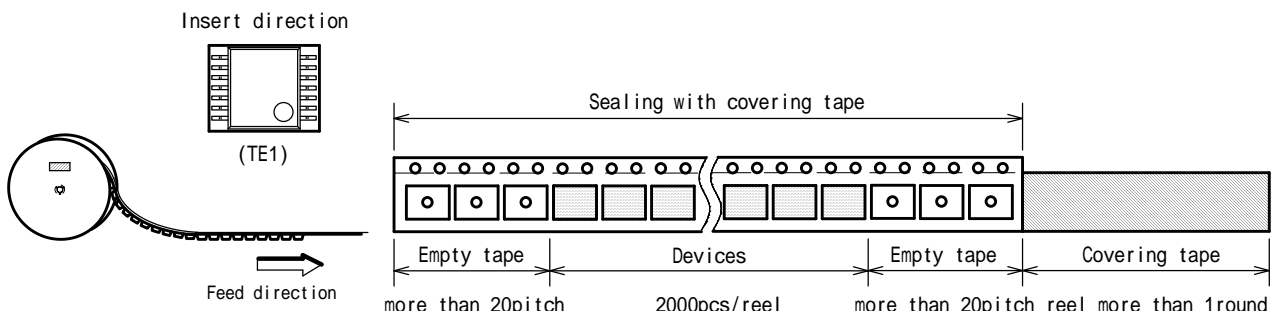
SYMBOL	DIMENSION	REMARKS
A	6.95	BOTTOM DIMENSION
B	5.4	BOTTOM DIMENSION
D0	1.55 ± 0.05	
D1	1.55 ± 0.1	
E	1.75 ± 0.1	
F	5.5 ± 0.05	
P0	4.0 ± 0.1	
P1	8.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.3 ± 0.05	
T2	2.2	
W	12.0 ± 0.3	
W1	9.5	THICKNESS 0.1max

#### REEL DIMENSIONS

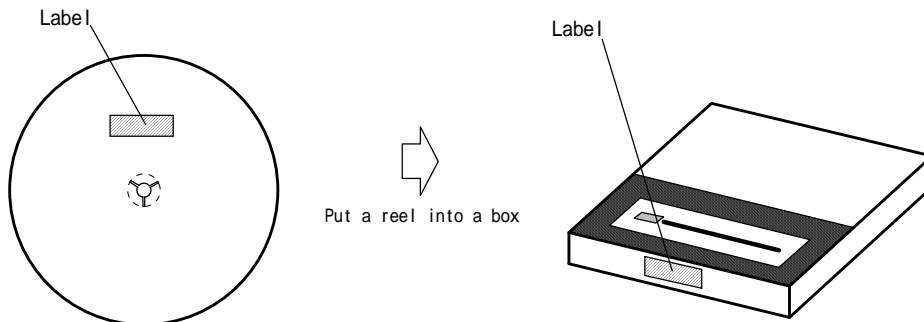


SYMBOL	DIMENSION
A	254 ± 2
B	100 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	13.5 ± 0.5
W1	2 ± 0.2

#### TAPING STATE

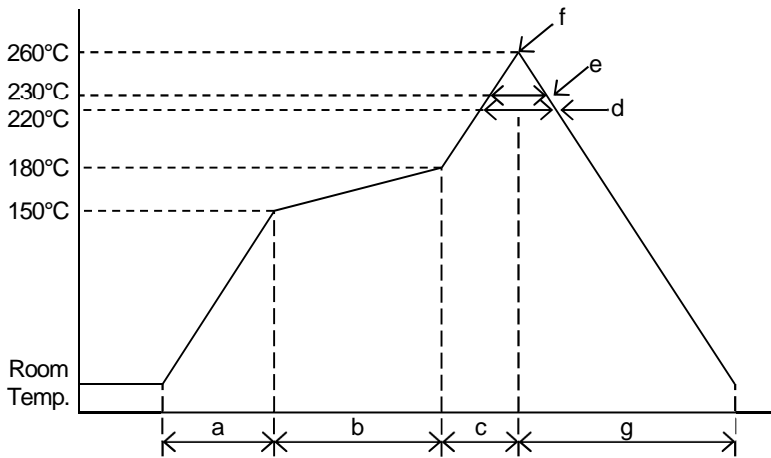


#### PACKING STATE



■ 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.

■ REVISION HISTORY

Date	Revision	Changes
November 24, 2021	Ver.6.1	Changed datasheet format. Updated about EMIRR in application notes. Corrected order information.



## [ 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
2. The specifications on this datasheet are only given for information without any guarantee as regards either mistakes or omissions. The application circuits in this datasheet are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial property rights.  
All other trademarks mentioned herein are the property of their respective companies.
3. To ensure the highest levels of reliability, NJR products must always be properly handled.  
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.

