

LOW POWER SINGLE CHANNEL OP-AMPS

FEATURES ($V^+=5V$, $V^-=0V$, $T_a=25^\circ C$)

- Guaranteed Temperature -40 to 125
- Input Offset Voltage 2mV max.
- Input Offset Voltage Drift $17\mu V/$ max.
- Supply Current 0.7mA max.
- Operating Voltage 3V to 36V or $\pm 1.5V$ to $\pm 18V$
- Integrated EMI filter EMIRR=84dB typ. @f=1.8GHz
- GBW 1.1 MHz typ.
- GND sensing
- Internal ESD protection Human Body Model $\pm 2000V$ typ.
- Package
 - NJM8020 SOT-23-5, SC-88A
 - NJM8021 SOT-23-5, SC-88A, DFN6-G1 (ESON6-G1)

GENERAL DESCRIPTION

The NJM8020/NJM8021 are single OP-Amps designed specifically to operate wide range of supply voltage and temperature.

These OP-Amps featured low input offset voltage of 2mV max. low supply current of 0.7mA max. DC characteristics are also 100% tested and guaranteed from -40 to 125 .

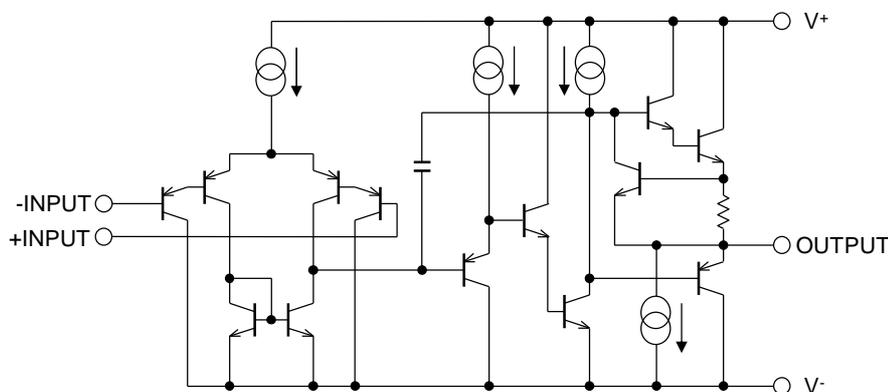
The NJM8020/NJM8021 are available in DFN6-G1 (1616) of small size Package, significantly reducing the required portable application's board area.

PIN CONFIGURATIONS

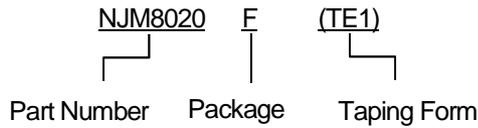
PRODUCT NAME	NJM8020F	NJM8020F3	NJM8021F	NJM8021F3	NJM8021KG1
Package	SOT-23-5	SC-88A	SOT-23-5	SC-88A	DFN6-G1(*)
Pin Functions	<p>(Top View) Pin 1: OUTPUT Pin 2: V⁻ Pin 3: +INPUT Pin 4: -INPUT Pin 5: V⁺</p>	<p>(Top View) Pin 1: +INPUT Pin 2: V⁻ Pin 3: -INPUT Pin 4: OUTPUT Pin 5: V⁺</p>	<p>(Top View) Pin 1: +INPUT Pin 2: V⁻ Pin 3: -INPUT Pin 4: OUTPUT Pin 5: V⁺</p>	<p>(Top View) Pin 1: V⁺ Pin 2: N.C. Pin 3: OUTPUT Pin 4: -INPUT Pin 5: +INPUT Pin 6: V⁻</p>	<p>(Top View) Pin 1: V⁺ Pin 2: N.C. Pin 3: OUTPUT Pin 4: -INPUT Pin 5: +INPUT Pin 6: V⁻</p> <p>Exposed Pad on Underside</p>

(*)Connect to exposed pad to V⁻

EQUIVALENT CIRCUIT



■ PRODUCT NAME INFORMATION



■ ORDERING INFORMATION

PRODUCT NAME	PACKAGE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJM8020F	SOT-23-5	Yes	Yes	Sn2Bi	A5Z	15	3000
NJM8020F3	SC-88A	Yes	Yes	Sn2Bi	2E	7.5	3000
NJM8021F	SOT-23-5	Yes	Yes	Sn2Bi	A5Y	15	3000
NJM8021F3	SC-88A	Yes	Yes	Sn2Bi	2D	7.5	3000
NJM8021KG1	DFN6-G1	Yes	Yes	Sn2Bi	8021	3.5	3000

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V^+ - V^-$	36	V
Input Voltage ⁽¹⁾	V_{IN}	$V^- - 0.3$ to $V^+ + 36$	V
Output Terminal Input Voltage	V_o	$V^- - 0.3$ to $V^+ + 0.3$	V
Differential Input Voltage	V_{ID}	± 36	V
Input Current ⁽²⁾	I_{IN}	5	mA
Power Dissipation (Ta=25 °C) SOT-23-5 SC-88A DFN6-G1 (ESON6-G1)	P_D	2-Layer / 4-Layer 480 ⁽⁴⁾ / 650 ⁽⁵⁾ 360 ⁽⁴⁾ / 490 ⁽⁵⁾ 330 ⁽⁶⁾ / 1200 ⁽⁷⁾	mW
Junction Temperature	T_{jmax}	150	°C
Storage Temperature Range	T_{stg}	- 65 to 150	°C

(1) Input voltage is the voltage should be allowed to apply to the input terminal independent of the magnitude of V^+

The normal amplifier operation input voltage is within "Common Mode Input Voltage Range" specified in the Electrical characteristics.

(2) This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward-biased and thereby acting as input diode clamp. In addition to this diode action, there is NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the OP-Amps to go to the V^+ voltage level (or to ground for a large overdrive) for the time during which an input is driven negative.

(3) Short-circuit can cause excessive heating and destructive dissipation. Values are typical.

(4) Mounted on glass epoxy board. (76.2x114.3x1.6mm:based on EIA/JEDEC standard, 2-layer FR-4)

(5) Mounted on glass epoxy board. (76.2x114.3x1.6mm:based on EIA/JEDEC standard, 4-layer FR-4), internal Cu area: 74.2x74.2mm

(6) Mounted on glass epoxy board. (101.5x114.5x1.6mm: based on EIA/JEDEC standard, 2-layer FR-4, with Exposed Pad)

(7) Mounted on glass epoxy board. (101.5x114.5x1.6mm: based on EIA/JEDEC standard, 4-layer FR-4, with Exposed Pad)

*For 4-layer: Applying 99.5x99.5mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5

■ THERMAL CHARACTERISTICS

PARAMETER	SYMBOL	VALUE	UNIT
Junction-to-ambient thermal resistance SOT-23-5 ⁽⁸⁾ SC-88A ⁽⁸⁾ DFN6-G1 (ESON6-G1) ⁽⁹⁾	θ_{ja}	2-Layer / 4-Layer 260 / 195 355 / 260 385 / 110	$^{\circ}\text{C}/\text{W}$
Junction-to-Top of package characterization parameter SOT-23-5 ⁽⁸⁾ SC-88A ⁽⁸⁾ DFN6-G1 (ESON6-G1) ⁽⁹⁾	ψ_{jt}	2-Layer / 4-Layer 68 / 58 91 / 74 65 / 26	$^{\circ}\text{C}/\text{W}$

(8) Mounted on glass epoxy board. (76.2x114.3x1.6mm:based on EIA/JDEC standard, 2Layers FR4)

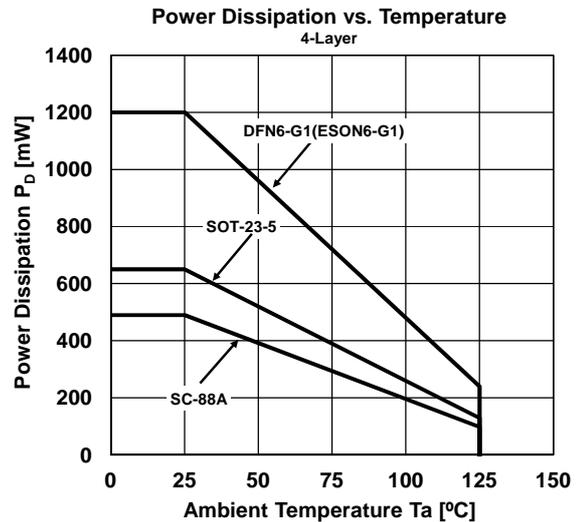
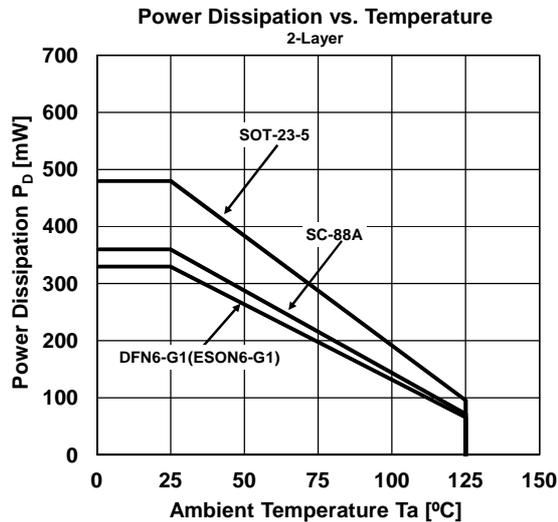
Mounted on glass epoxy board. (76.2x114.3x1.6mm:based on EIA/JDEC standard, 4Layers FR4), internal Cu area: 74.2 x 74.2mm

(9) Mounted on glass epoxy board. (101.5x114.5x1.6mm: based on EIA/JEDEC standard, 2Layers FR-4, with Exposed Pad)

Mounted on glass epoxy board. (101.5x114.5x1.6mm: based on EIA/JEDEC standard, 4Layers FR-4, with Exposed Pad)

*For 4Layers: Applying 99.5x99.5mm 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	VALUE	UNIT
Supply Voltage	$V^+ - V^-$	3 to 36	V
Operating Ambient Temperature	T_{opr}	- 40 to 125	$^{\circ}\text{C}$

■ ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, $V^+=5V$, $V=0V$, $R_L=OPEN$, $T_a=25$)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Offset Voltage ⁽¹⁰⁾	V_{IO}		-	0.5	2	mV
		$T_a=-40$ to 125	-	-	3	
Input Offset Voltage Drift ⁽¹¹⁾	V_{IO}/T	$T_a=-40$ to 125	-	5	17	$\mu V/$
Input Offset Current	I_{IO}		-	2	30	nA
		$T_a=-40$ to 125	-	-	40	
Input Offset Current Drift ⁽¹¹⁾	I_{IO}/T	$T_a=-40$ to 125	-	-	300	pA/
Input Bias Current ⁽¹²⁾	I_B		-	20	150	nA
		$T_a=-40$ to 125	-	-	200	
Open-Loop Voltage Gain	A_V	$V^+=15V, R_L = 2k$, $V_o=1.4V$ to 11.4V	50	100	-	V/mV
		$V^+=15V, R_L = 2k$, $V_o=1.4V$ to 11.4V $T_a=-40$ to 125	25	-	-	
Supply Voltage Rejection Ratio	SVR	$V^+=5V$ to 30V, $R_S < 10k$	65	100	-	dB
		$V^+=5V$ to 30V, $R_S < 10k$ $T_a=-40$ to 125	65	-	-	
Supply Current	I_{SUPPLY}	$T_a=-40$ to 125	-	0.45	0.7	mA
		$V^+=30V$, $T_a=-40$ to 125	-	-	1	
Common Mode Input Voltage Range	V_{ICM}	$V^+=30V^{(13)}$	0	-	$V^+-1.5$	V
		$V^+=30V$, $T_a=-40$ to 125	0	-	$V^+-2.0$	
Common-Mode Rejection Ratio	CMR	$R_S < 10k$	70	100	-	dB
		$R_S < 10k$, $T_a=-40$ to 125	60	-	-	
Output Source Current	I_{SOURCE}	$V^+=15V, V_{IN+}=1V, V_{IN-}=0V$, $V_o=2V$	20	40	-	mA
Output Sink Current	I_{SINK}	$V^+=15V, V_{IN+}=0V, V_{IN-}=1V$, $V_o=2V$	10	20	-	mA
		$V^+=15V, V_{IN+}=0V, V_{IN-}=1V$, $V_o=0.2V$	12	50	-	μA
High-level Output Voltage	V_{OH}	$V^+=30V, R_L = 2k$	26	27	-	V
		$V^+=30V, R_L = 2k$ $T_a=-40$ to 125	26	-	-	
		$V^+=30V, R_L = 10k$	27	28	-	
		$V^+=30V, R_L = 10k$ $T_a=-40$ to 125	27	-	-	
Low-level Output Voltage	V_{OL}	$R_L = 10k$	-	5	20	mV
		$R_L = 10k$ $T_a=-40$ to 125	-	-	20	

■ ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, $V^+=5V$, $V=0V$, $R_L=OPEN$, $T_a=25$)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Slew Rate	SR	$V^+=15V$, $V_{IN}=0.5V$ to $3V$, $R_L=2k$, $C_L=100pF$ Unity gain	-	0.6	-	V/ μ s
Gain Bandwidth Product	GBW	$V^+=30V$, $f=100kHz$, $V_{IN}=10mV$, $R_L=2k$, $C_L=100pF$	-	1.1	-	MHz
Total Harmonic Distortion + Noise	THD+N	$f=1kHz$, $G_v=20dB$, $R_L=2k$ $V_O=2V_{PP}$, $C_L=100pF$	-	0.02	-	%
Equivalent Input Noise Voltage	e_n	$f=1kHz$, $R_s=100$ $V^+=30V$	-	30	-	nV/ Hz

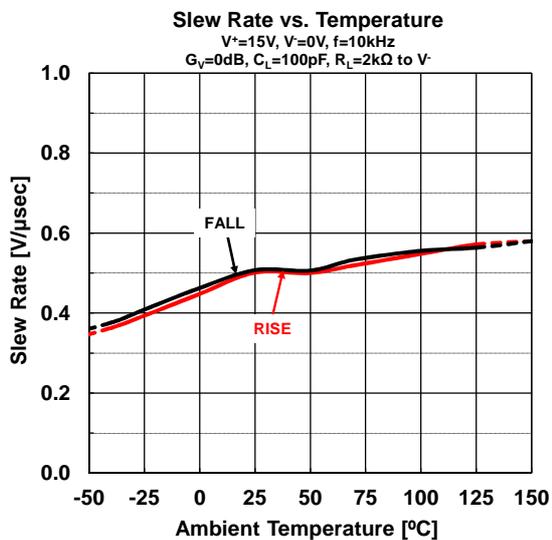
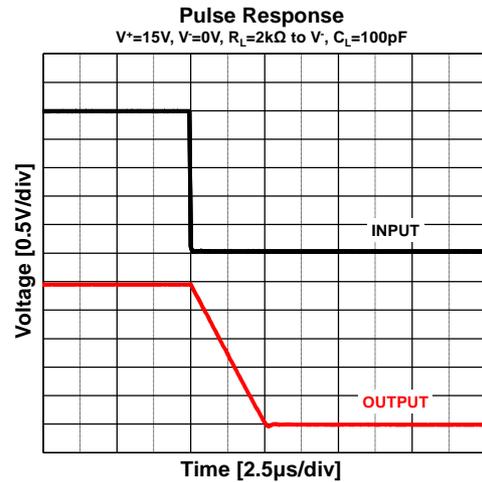
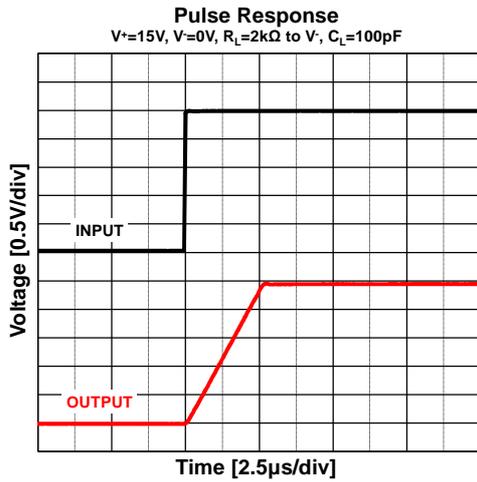
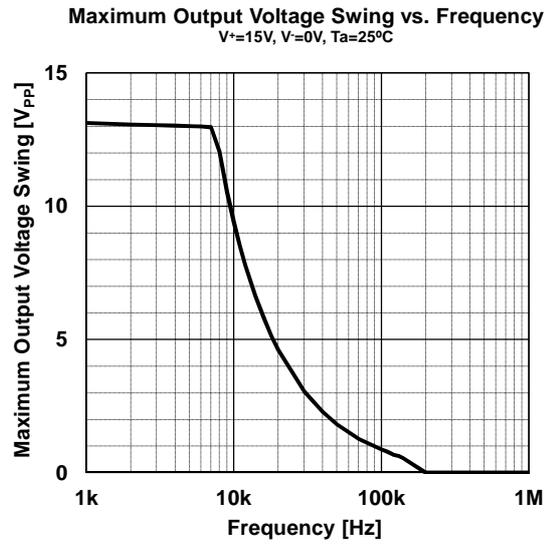
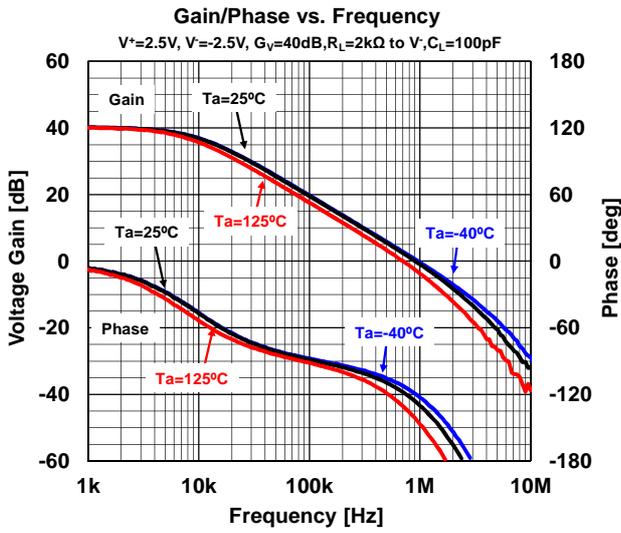
(10) $5V < V^+ < 30V$, $0 < V_{com} < V^+ - 1.5V$.

(11) This parameter is not 100% test.

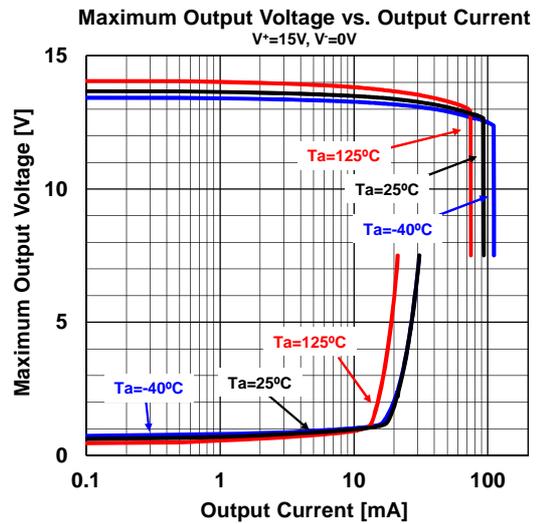
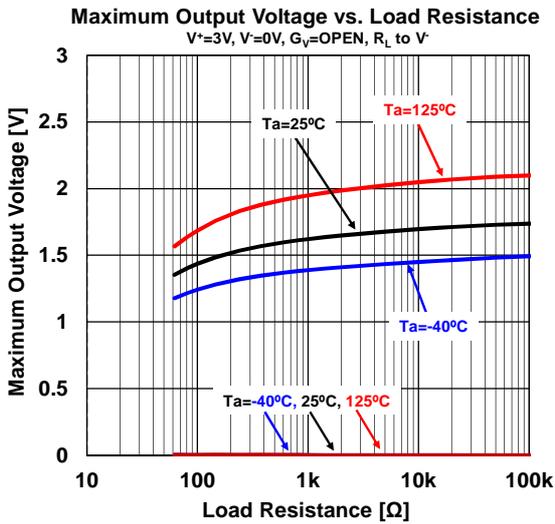
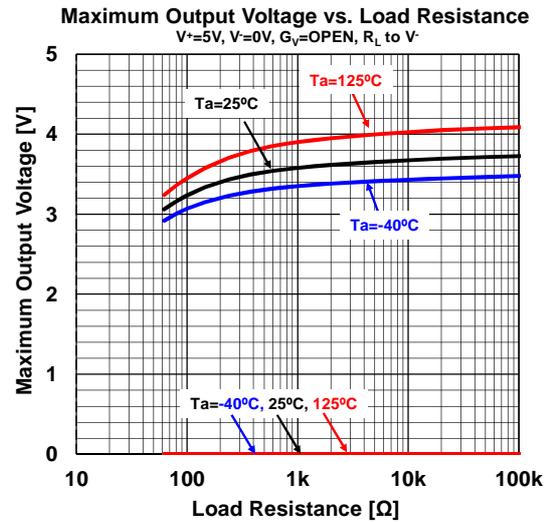
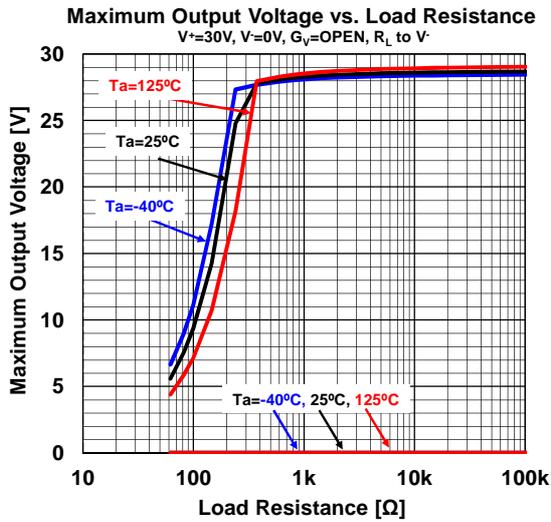
(12) The direction of the input current is out of the IC.

(13) The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is $V^+ - 1.5V$, but either or both inputs can go to +36V without damage.

■ TYPICAL CHARACTERISTICS

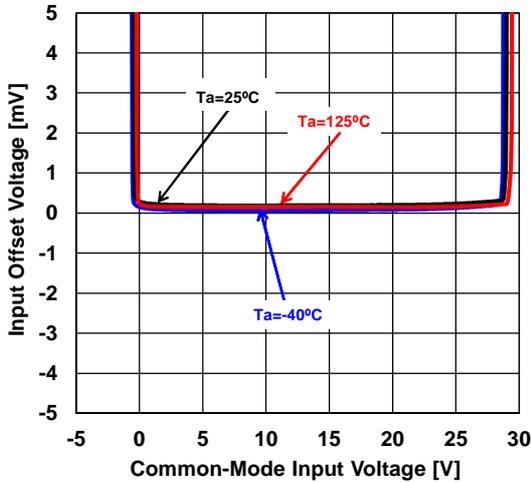


■ TYPICAL CHARACTERISTICS

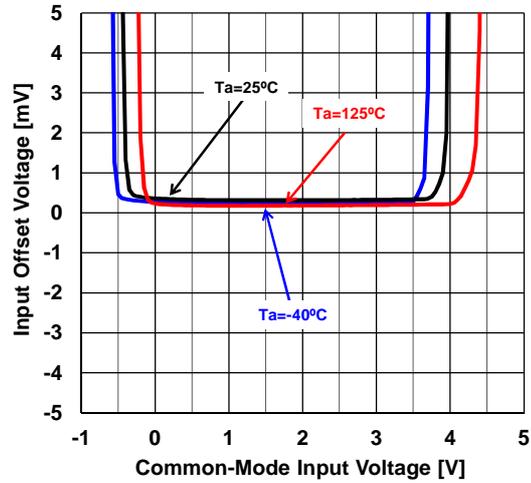


■ TYPICAL CHARACTERISTICS

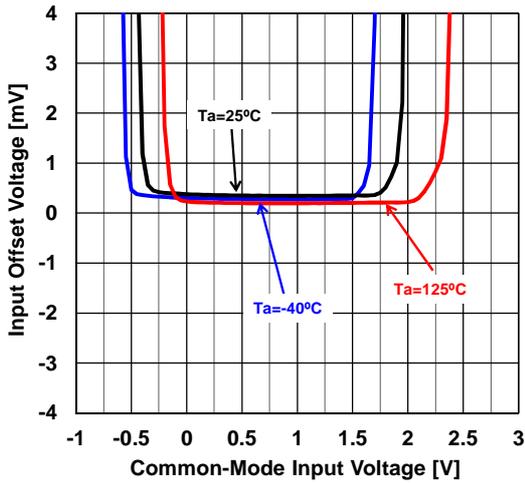
Input Offset Voltage vs. Common-Mode Input Voltage
 $V^+=30V, V=0V$



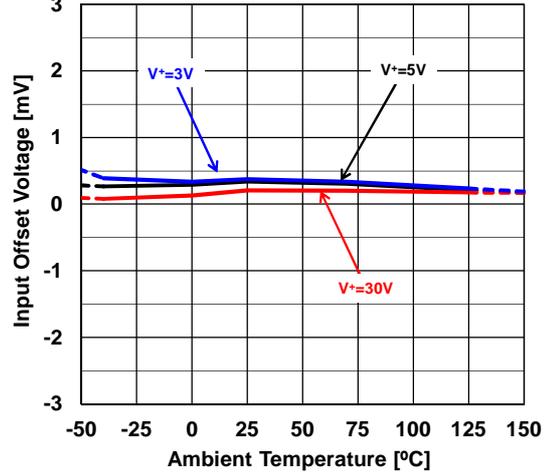
Input Offset Voltage vs. Common-Mode Input Voltage
 $V^+=5V, V=0V$



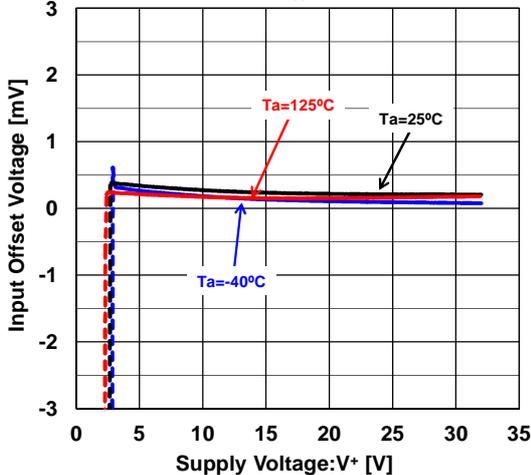
Input Offset Voltage vs. Common-Mode Input Voltage
 $V^+=3V, V=0V$



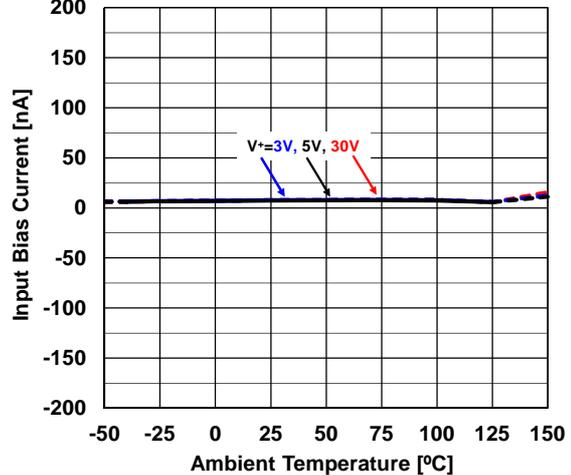
Input Offset Voltage vs. Temperature
 $V_{COM}=V^+/2$



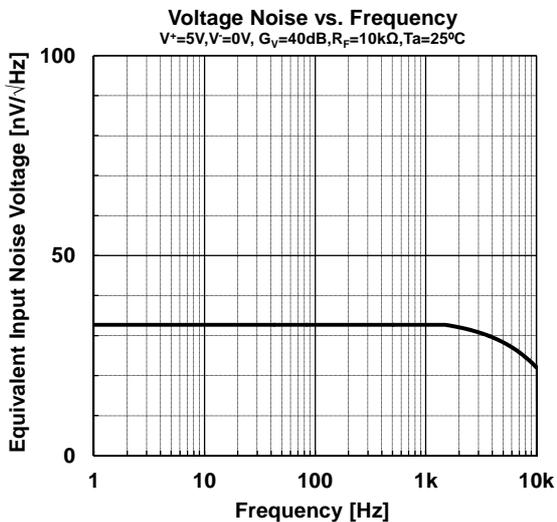
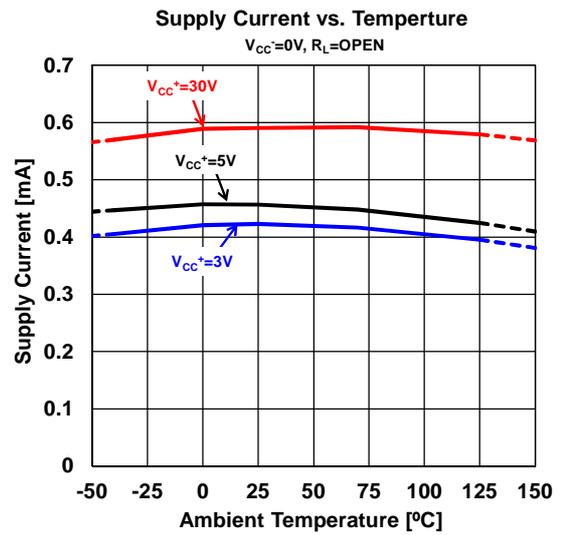
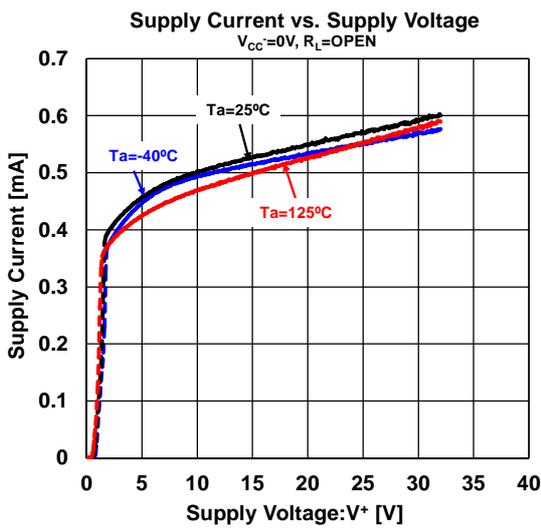
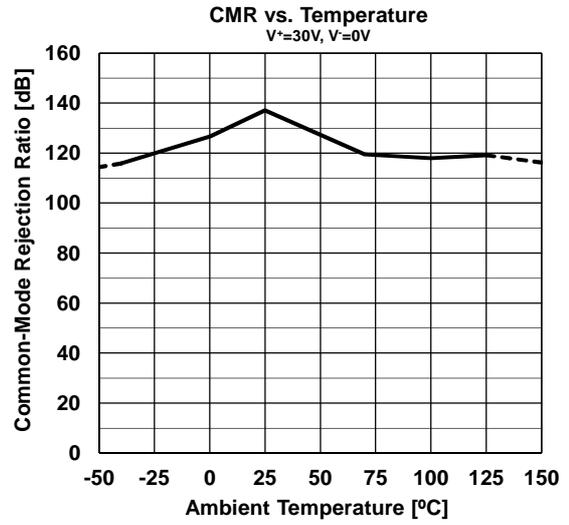
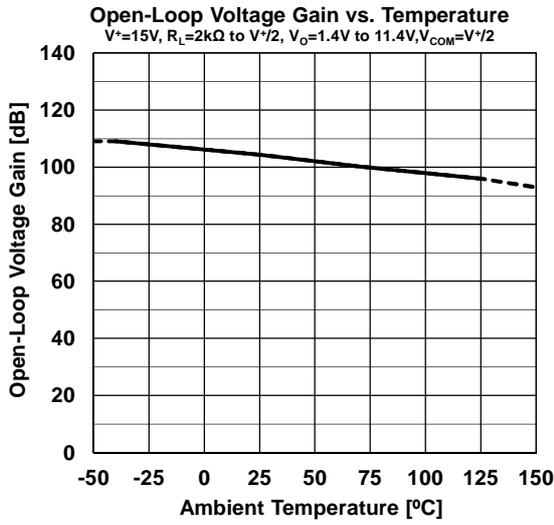
Input Offset Voltage vs. Supply Voltage
 $V=0V, V_{COM}=V^+/2$



Input Bias Current vs. Temperature
 $V=0V, V_{COM}=0V$

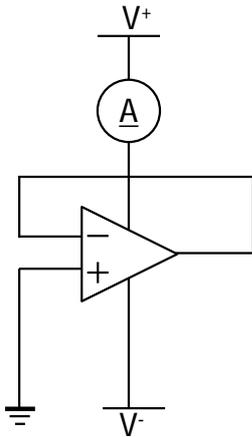


■ TYPICAL CHARACTERISTICS



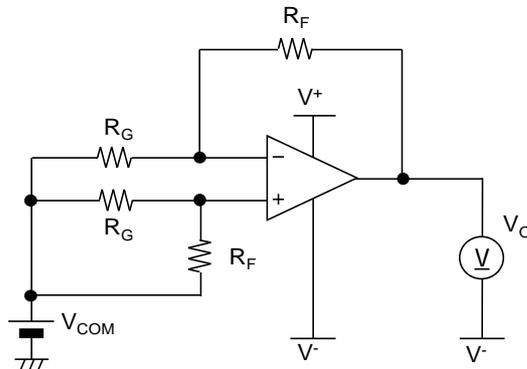
■ TYPICAL TEST CIRCUIT

• Supply Current



• Input Offset Voltage

$$R_G=50, R_F=50k, V_{IO} = \frac{R_G}{R_G + R_F} \times (V_O - V_{COM})$$

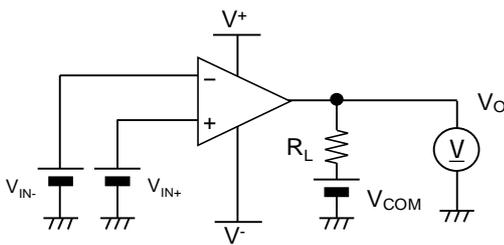


• High-level Output Voltage

$$V_{COM}=V^+/2, V_{IN+}=1V, V_{IN-}=0V, R_L=10k$$

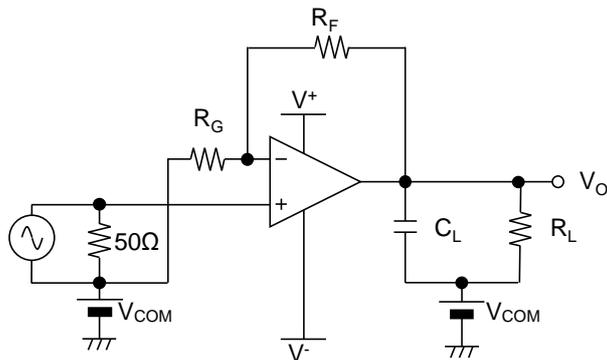
• Low-level Output Voltage

$$V_{COM}=V^+/2, V_{IN+}=0V, V_{IN-}=1V, R_L=10k$$



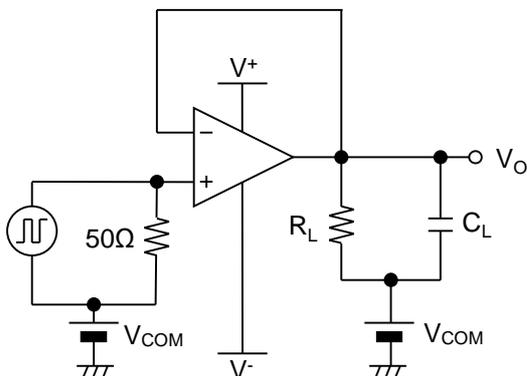
• Gain Bandwidth Product

$$V_{COM}=V^+/2, R_G=20, R_F=2k, R_L=2k, C_L=100pF$$

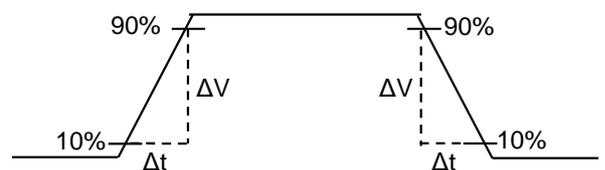


• Slew Rate

$$V_{COM}=V^+/2, R_L=2k, C_L=100pF$$



Output Wave



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

■ APPLICATION NOTE

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 formula (1). We can grasp the tolerance of the RF signal by measuring an RF signal and offset voltage shift quantity.

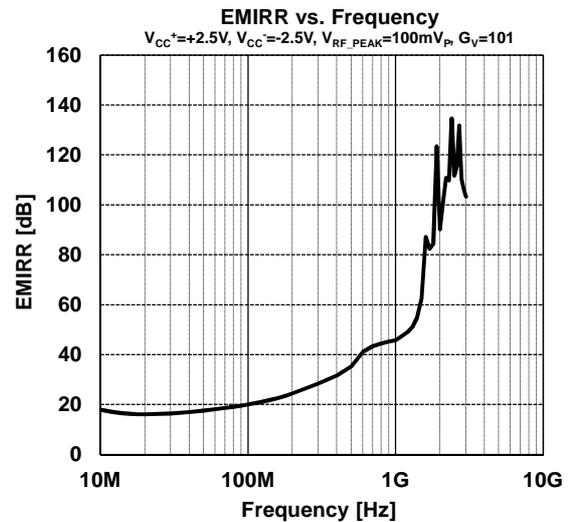
$$EMIRR = 20 \cdot \log \left(\frac{V_{RF_PEAK}}{|\Delta V_{IO}|} \right) \quad \dots(1)$$

V_{RF_PEAK} : RF Signal Amplitude [V_p]

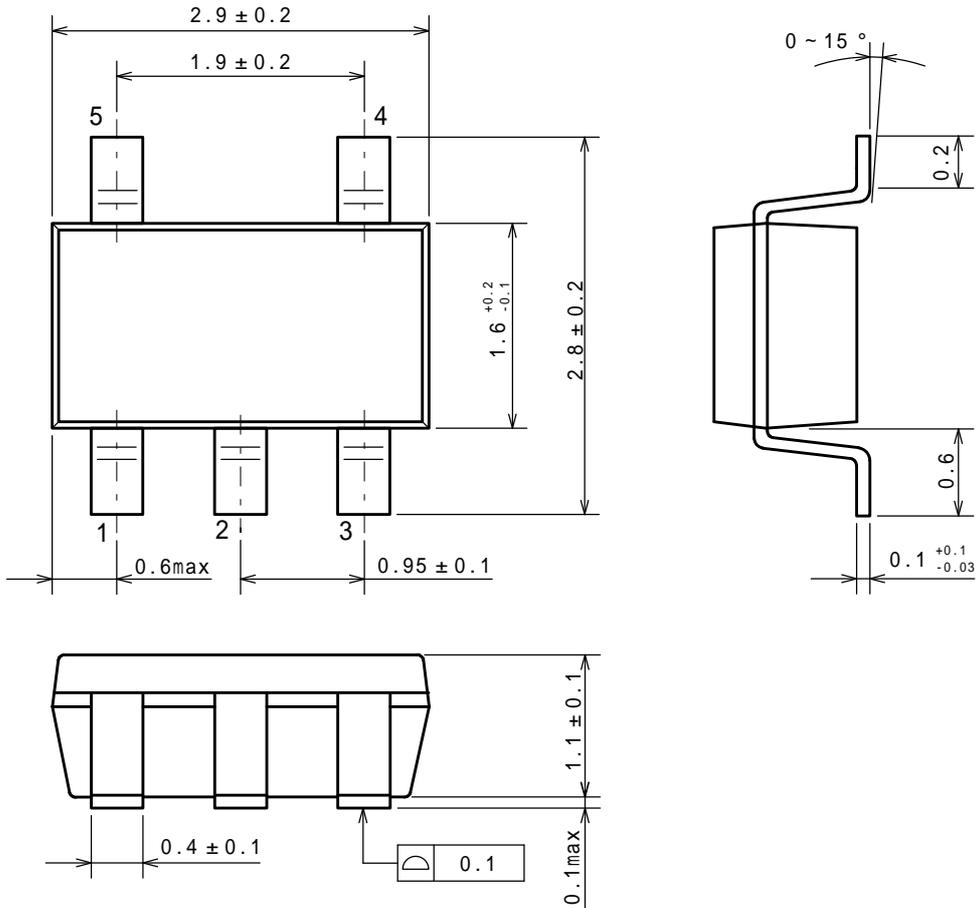
V_{IO} : Input offset voltage shift quantity [V]

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.

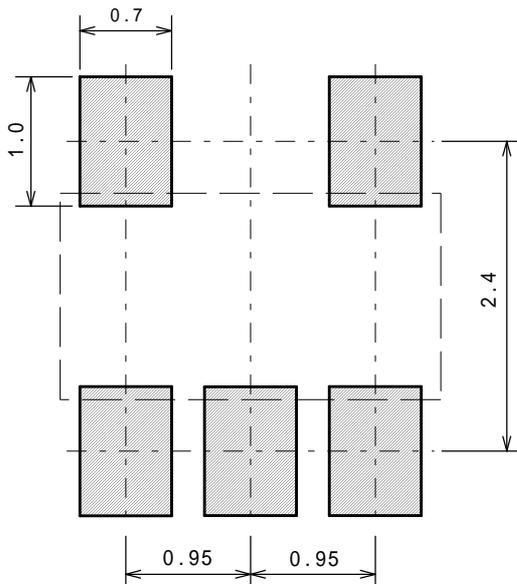
*For details, refer to "Application Note for EMI Immunity" in our HP: <http://www.njr.com/>



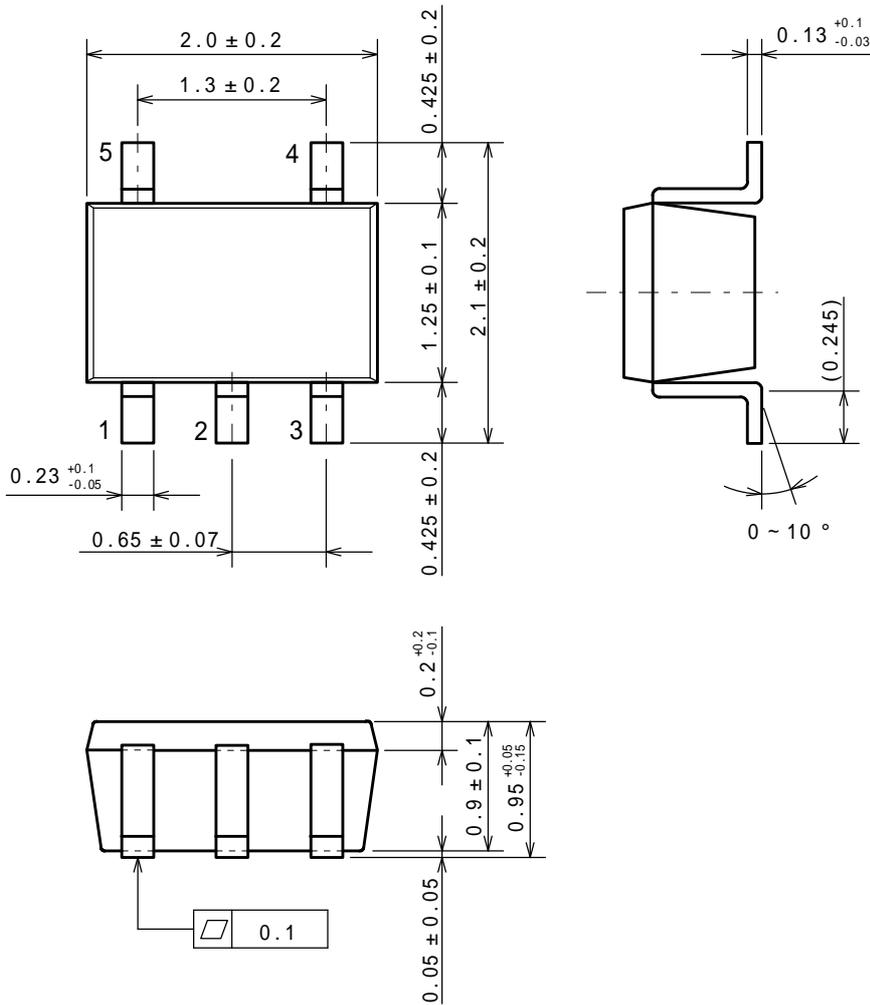
■ PACKAGE DIMENSIONS



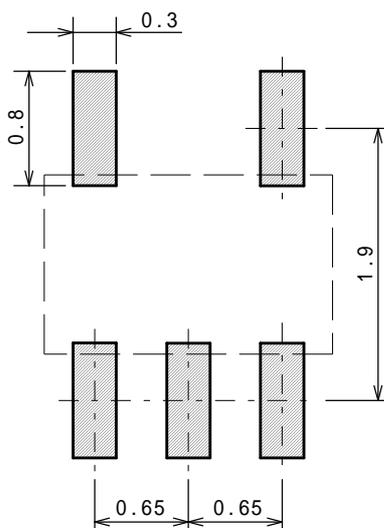
■ EXAMPLE OF SOLDER PADS DIMENSIONS



■ PACKAGE DIMENSIONS

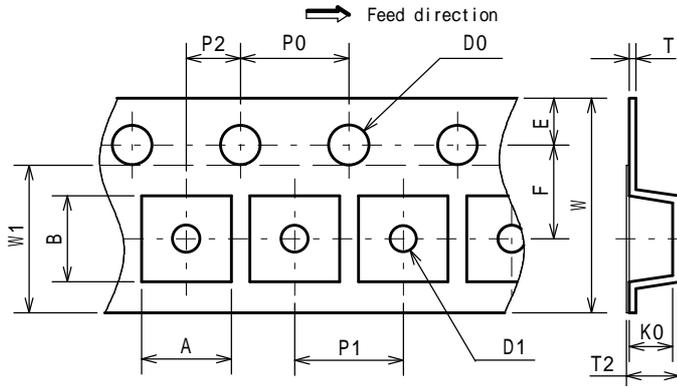


■ EXAMPLE OF SOLDER PADS DIMENSIONS



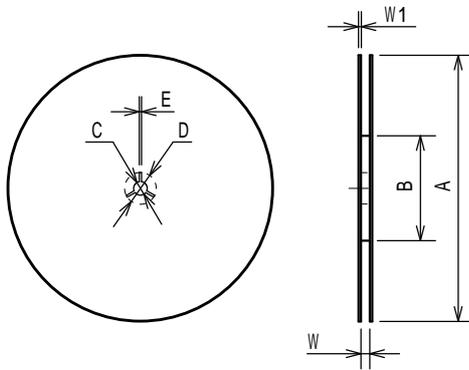
PACKING SPEC

TAPING DIMENSIONS



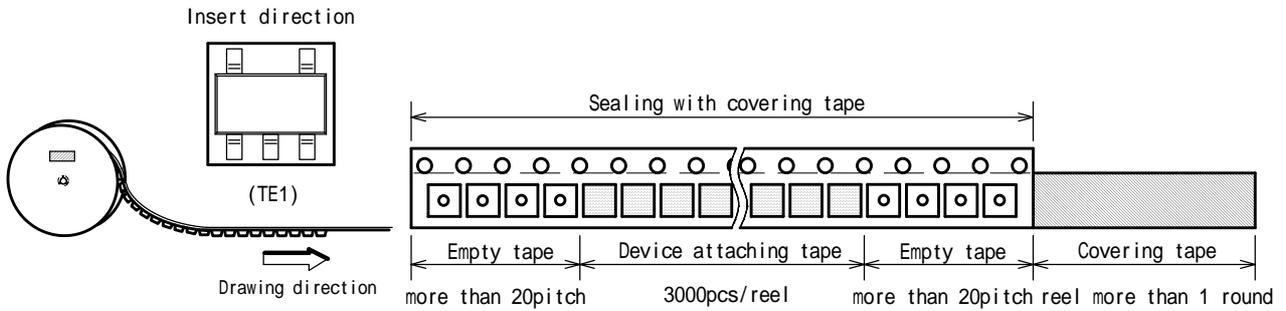
SYMBOL	DIMENSION	REMARKS
A	3.3 ± 0.1	BOTTOM DIMENSION
B	3.2 ± 0.1	BOTTOM DIMENSION
D0	1.55	
D1	1.05	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.82	
K0	1.5 ± 0.1	
W	8.0 ± 0.3	
W1	5.5	THICKNESS 0.1MAX

REEL DIMENSIONS

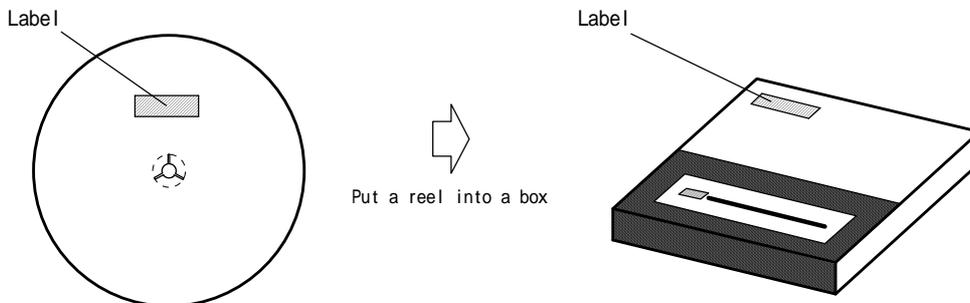


SYMBOL	DIMENSION
A	180 ± 1
B	60 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ± 0.5
W1	1.2 ± 0.2

TAPING STATE

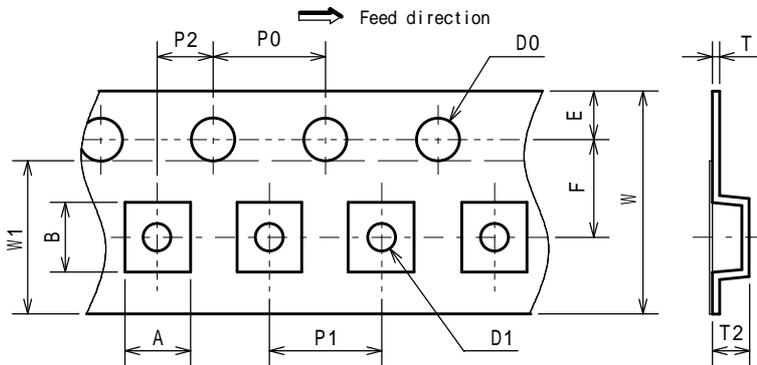


PACKING STATE



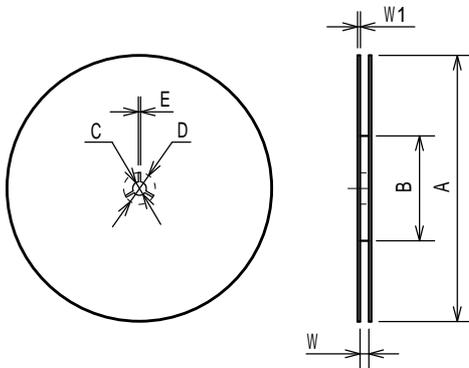
PACKING SPEC

TAPING DIMENSIONS



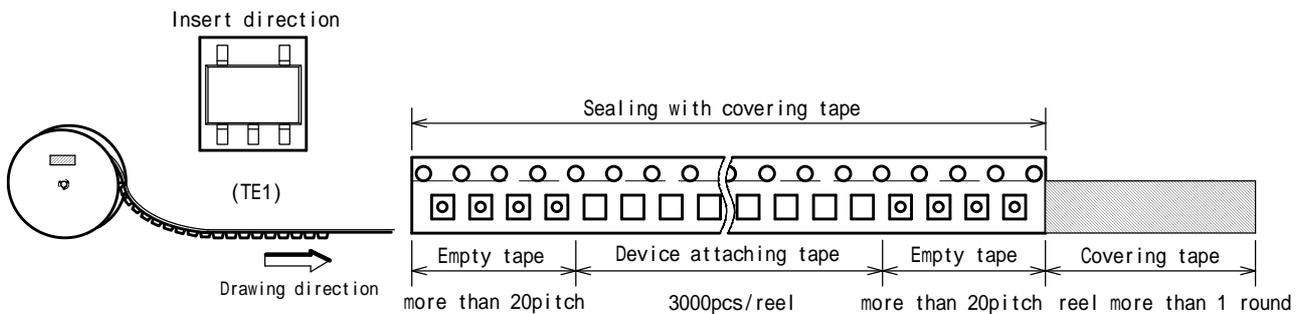
SYMBOL	DIMENSION	REMARKS
A	2.3 ± 0.1	BOTTOM DIMENSION
B	2.5 ± 0.1	BOTTOM DIMENSION
D0	1.55 ± 0.05	
D1	1.05 ± 0.05	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.3 ± 0.1	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

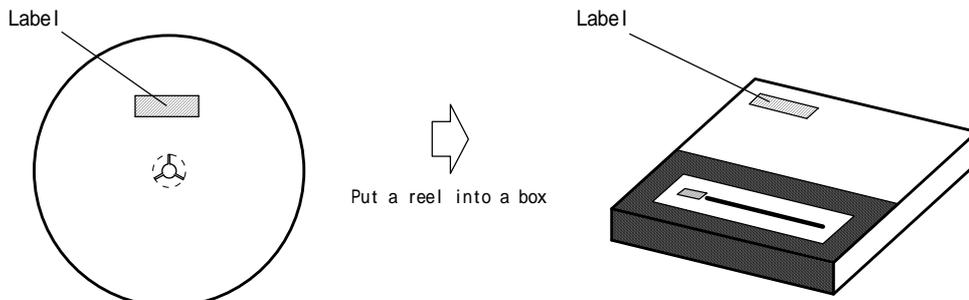


SYMBOL	DIMENSION
A	180 ± 1
B	60 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ± 0.5
W1	1.2 ± 0.2

TAPING STATE

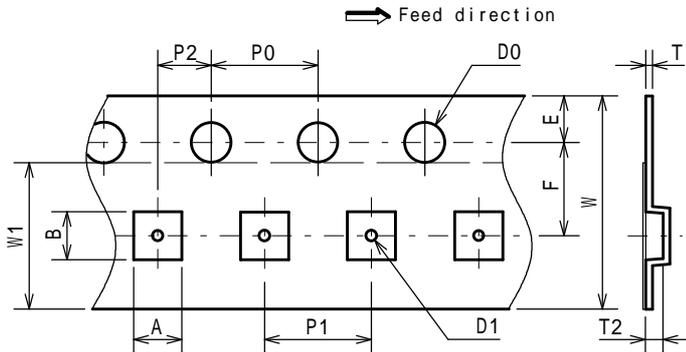


PACKING STATE



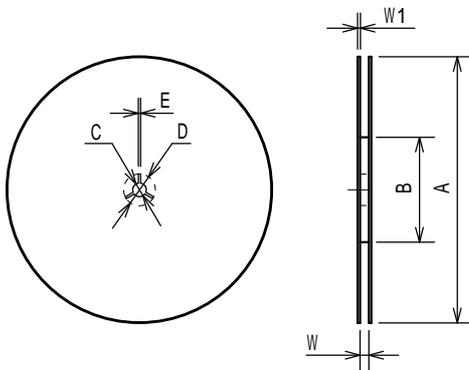
PACKING SPEC

TAPING DIMENSIONS



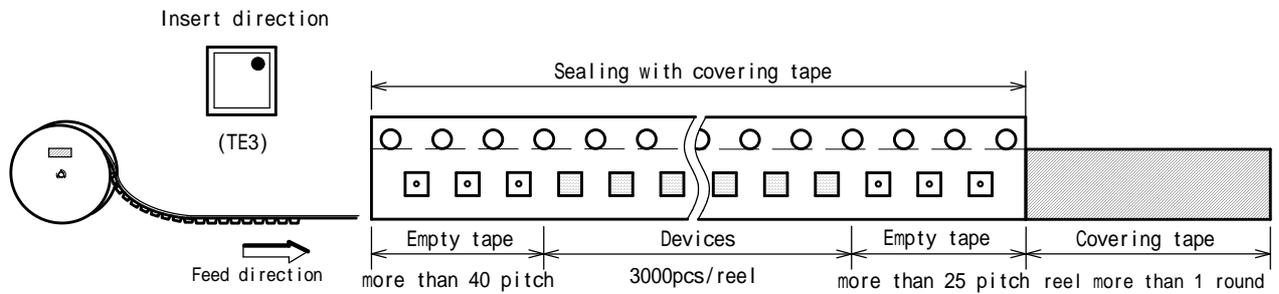
SYMBOL	DIMENSION	REMARKS
A	1.85 ± 0.05	BOTTOM DIMENSION
B	1.85 ± 0.05	BOTTOM DIMENSION
D0	1.5 ^{+0.1} ₀	
D1	0.5 ± 0.1	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	0.65 ± 0.05	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

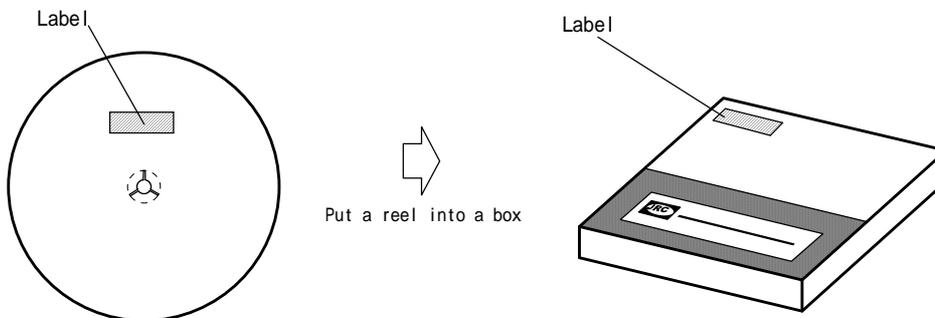


SYMBOL	DIMENSION
A	180 ⁰ _{-1.5}
B	60 ⁺¹ ₀
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ^{+0.3} ₀
W1	1.2

TAPING STATE

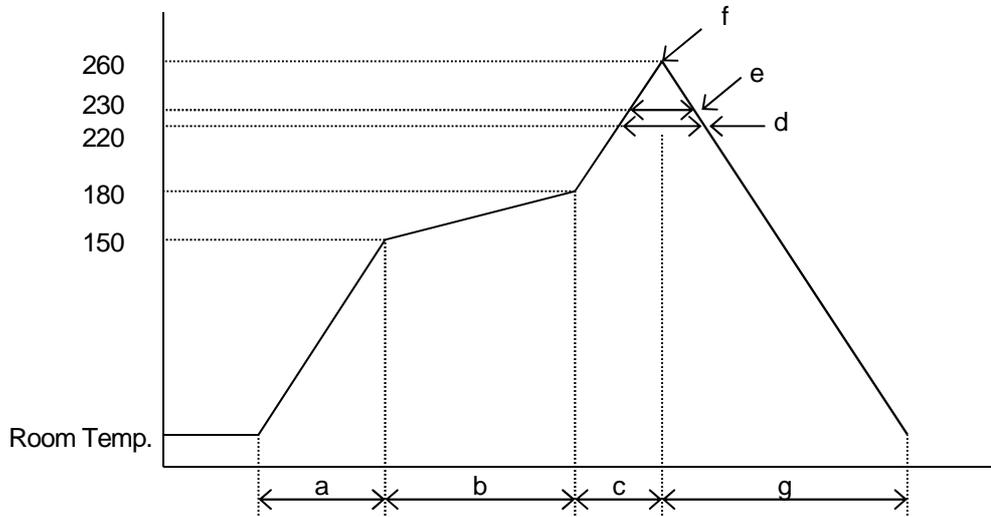


PACKING STATE



RECOMMENDED MOUNTING METHOD

*Recommended reflow soldering procedure



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

*The temperature indicates at the surface of mold package.

REVISION HISTORY

Date	Revision	Changes
1.NOV.2017	Ver.0	Initial Version
3.APR.2019	Ver.1	Changed Low-level Output Voltage of TEST CONDITIONS in ELECTRICAL CHARACTERISTICS.

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 - Power Generator Control Equipment (Nuclear, steam, hydraulic, etc.)
 - Life Maintenance Medical Equipment
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