

## Low Noise, Low Offset Voltage Drift, Rail-to-Rail Output, Excellent EMI Immunity, CMOS Operational Amplifier

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

- Low Noise 15nV/ $\sqrt{Hz}$
  - Low Offset Voltage Drift 0.7 $\mu V/^\circ C$  typ.
  - Offset Voltage 4mV max.
  - Rail-to-Rail Output
    - $R_L=10k\Omega$  50mV from rail
    - $R_L=600\Omega$  140mV from rail
  - Gain Bandwidth Product 2.1MHz
  - Slew Rate 0.8V/ $\mu s$
  - Supply Current 260 $\mu A$ /ch typ.
  - Supply Voltage 1.8V to 5.5V
  - Thin and Ultra Small Package DFN8-U1(ESON8-U1)  
2.0x2.0x0.4 mm
  - Integrated EMI Filter EMIRR=59dB typ. @f=900MHz
  - Ground Sensing
  - Unity-Gain Stable
  - Package
    - NJU7056 SOT-23-5, SC-88A
    - NJU7057 MSOP8(TVSP8)\*
    - NJU7058 DFN8-U1(ESON8-U1)  
SSOP14
- \*meet JEDEC MO-187-DA / thin type

### ■ DESCRIPTION

The NJU7056/NJU7057/NJU7058 are Single/Dual/Quad rail-to-rail output CMOS operational amplifiers. Low noise of 15nV/ $\sqrt{Hz}$  and low offset drift of 0.7 $\mu V/^\circ C$  typ. make them suitable for several sensor amplifiers and preamplifiers.

NJU7056/NJU7057/NJU7058 operate from 1.8V to 5.5V supply voltage. They are optimized for 2-cell battery systems and 1-cell Li-ion battery systems. The NJU7056/NJU7057/NJU7058 have high-impedance inputs with ground sensing, rail-to-rail output that swings within 50mV from rail with 10k $\Omega$  load at 1.8V supply, 2.1MHz gain bandwidth and 0.8V/ $\mu s$  Slew rate. These characteristics make them excellent performance for general-purpose applications.

The NJU7056 is available in 5-pin SC-88A and SOT-23 packages. NJU7057 is offered in 8-pin MSOP (TVSP): meet JEDEC MO-187-DA / thin type package and DFN that is thin and 2mm square small package. NJU7058 is offered in 14-pin SSOP package.

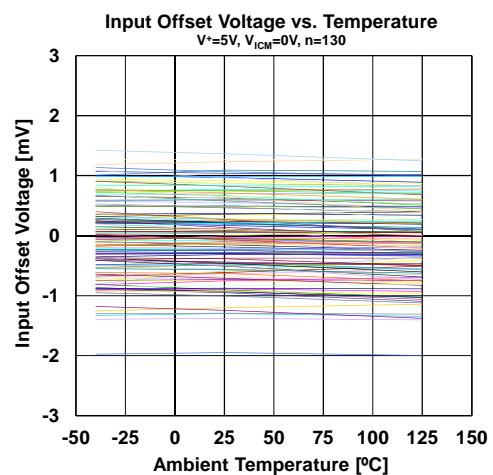
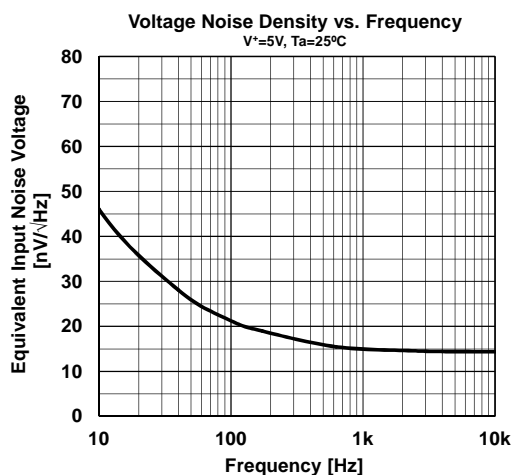
### ■ APPLICATIONS

- Battery-Powered Instruments
- Current Sensor Amplifiers
- Audio Pre/Microphone Amplifiers
- Power Line Monitoring
- Current to Voltage Converter

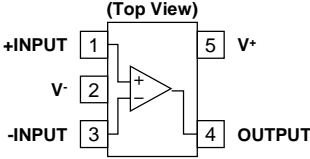
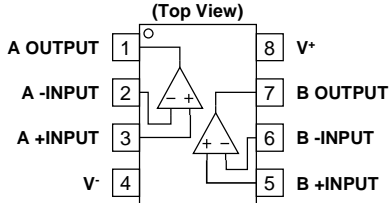
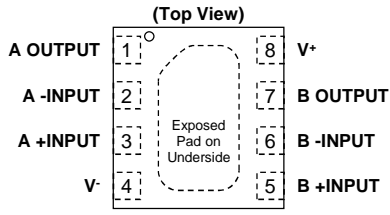
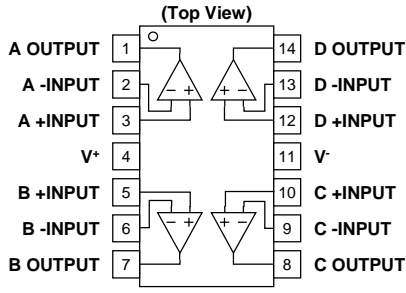
### ■ RELATED PRODUCTS

| Features   | Single  | Dual    | Quad    |
|--|---------|---------|---------|
| 13 $\mu A$ /ch, Rail-to-Rail Output (Low power type)       | NJU7026 | NJU7027 | NJU7028 |
| 9V/ $\mu s$ , 5MHz, Rail-to-Rail I/O (High slew rate type) | NJU7046 | NJU7047 | NJU7048 |

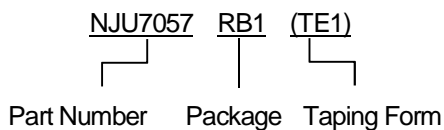
### ■ TYPICAL CHARACTERISTICS



## ■ PIN CONFIGURATIONS

|               |  |   |
|---------------|--|---|
| PRODUCT NAME  | NJU7056F   | NJU7056F3   |
| Package       | SOT-23-5   | SC-88A  |
| Pin Functions |    |   |
| PRODUCT NAME  | NJU7057RB1   | NJU7057KU1  |
| Package       | MSOP8 (TVSP8)  | ESON8-U1  |
| Pin Functions |     |  <p>*Connect to exposed pad to V</p> |
| PRODUCT NAME  | NJU7058V   |   |
| Package       | SSOP14   |   |
| Pin Functions |  |   |

## ■ PRODUCT NAME INFORMATION



## ■ ORDERING INFORMATION

| PRODUCT NAME | PACKAGE            | RoHS | HALOGEN-FREE | TERMINAL FINISH | MARKING | WEIGHT (mg) | MOQ (pcs) |
|--------------|--------------------|------|--------------|-----------------|---------|-------------|-----------|
| NJU7056F     | SOT-23-5           | Yes  | Yes          | Sn2Bi           | 115     | 15          | 3000      |
| NJU7056F3    | SC-88A             | Yes  | Yes          | Sn2Bi           | AG      | 7.5         | 3000      |
| NJU7057RB1   | MSOP8(TVSP8)       | Yes  | Yes          | Sn2Bi           | 7057    | 18          | 2000      |
| NJU7057KU1   | DFN8-U1 (ESON8-U1) | Yes  | Yes          | Sn2Bi           | 7057    | 5.3         | 3000      |
| NJU7058V     | SSOP14             | Yes  | Yes          | Sn2Bi           | 7058    | 65          | 2000      |

## ■ ABSOLUTE MAXIMUM RATINGS

| PARAMETER   | SYMBOL      | RATING  | UNIT             |
|---|-------------|---|------------------|
| Supply Voltage  | $V^+ - V^-$ | 7   | V                |
| Input Voltage <sup>(1)</sup>  | $V_{IN}$    | $V^- - 0.3$ to $V^+ + 0.3$  | V                |
| Input Current <sup>(2)</sup>  | $I_{IN}$    | 10  | mA               |
| Differential Input Voltage <sup>(3)</sup>   | $V_{ID}$    | $\pm 7$   | V                |
| Power Dissipation( $T_a=25^\circ\text{C}$ )<br>SOT-23-5 <sup>(4)</sup><br>SC-88A <sup>(4)</sup><br>MSOP8 (TVSP8) <sup>(4)</sup><br>DFN8-U1 (ESON8-U1) <sup>(5)</sup><br>SSOP14 <sup>(4)</sup> | $P_D$       | 2-Layer / 4-Layer<br>480 / 650<br>360 / 490<br>510 / 680<br>450 / 1200<br>500 / 620 | mW               |
| Junction Temperature Range  | $T_{jmax}$  | 150   | $^\circ\text{C}$ |
| Storage Temperature Range   | $T_{stg}$   | - 55 to 150   | $^\circ\text{C}$ |

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

(2) Input voltages outside the supply voltage will be clamped by ESD protection diodes. If the input voltage exceeds the supply voltage, the input current must be limited 10 mA or less by using a restriction resistance.

(3) Differential voltage is the voltage difference between +INPUT and - INPUT.  
For supply voltage less than 7V, the absolute maximum rating is equal to the supply voltage.

## ■ THERMAL CHARACTERISTICS

| PARAMETER   | SYMBOL        | VALUE  | UNIT                        |
|---|---------------|--|-----------------------------|
| Junction-to-ambient thermal resistance<br>SOT-23-5 <sup>(4)</sup><br>SC-88A <sup>(4)</sup><br>MSOP8 (TVSP8) <sup>(4)</sup><br>DFN8-U1 (ESON8-U1) <sup>(5)</sup><br>SSOP14 <sup>(5)</sup>                | $\theta_{ja}$ | 2-Layer / 4-Layer<br>259 / 193<br>352 / 256<br>244 / 185<br>278 / 107<br>249 / 201 | $^\circ\text{C} / \text{W}$ |
| Junction-to-Top of package characterization parameter<br>SOT-23-5 <sup>(4)</sup><br>SC-88A <sup>(4)</sup><br>MSOP8 (TVSP8) <sup>(4)</sup><br>DFN8-U1 (ESON8-U1) <sup>(5)</sup><br>SSOP14 <sup>(4)</sup> | $\psi_{jt}$   | 2-Layer / 4-Layer<br>67 / 58<br>91 / 73<br>51 / 45<br>42 / 25<br>53 / 52           | $^\circ\text{C} / \text{W}$ |

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

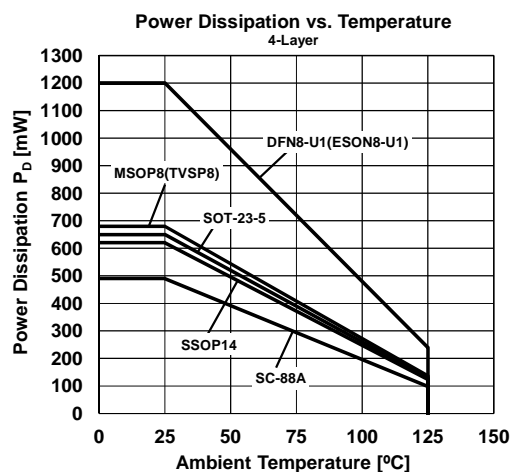
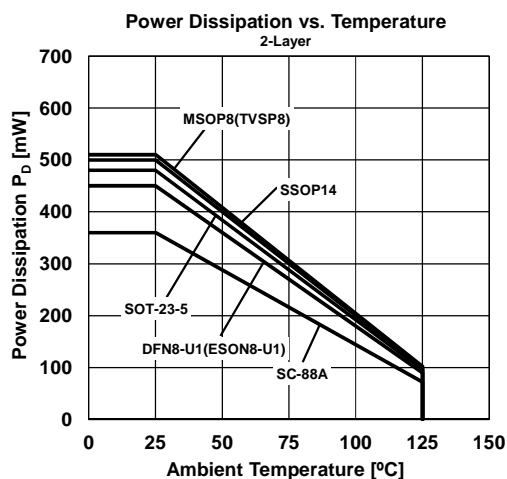
Mounted on glass epoxy board. (76.2x114.3x1.6mm:based on EIA/JDEC standard, 4-layer FR-4), internal Cu area: 74.2 x 74.2mm

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

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)

## ■ POWER DISSIPATION vs. AMBIENT TEMPERATURE



## RECOMMENDED OPERATING CONDITIONS

| PARAMETER                   | SYMBOL      | RATING                  | UNIT |
|-----------------------------|-------------|-------------------------|------|
| Supply Voltage              |             |                         |      |
| Single Supply               | $V^+ - V^-$ | 1.8 to 5.5              | V    |
| Dual Supply                 | $V^+ / V^-$ | $\pm 0.9$ to $\pm 2.75$ |      |
| Operating Temperature Range | $T_{opr}$   | - 40 to 125             | °C   |

## ELECTRICAL CHARACTERISTICS

( $V^+=5V$ ,  $V^-=0V$ ,  $T_a=25^\circ C$ , unless otherwise noted.)

| PARAMETER                         | SYMBOL                   | TEST CONDITIONS   | MIN | TYP     | MAX  | UNIT             |    |
|-----------------------------------|--------------------------|---|-----|---------|------|------------------|----|
| <b>DC CHARACTERISTICS</b>         |                          |   |     |         |      |                  |    |
| Input Offset Voltage              | $V_{IO}$                 | $V_{COM}=0V$  | -   | 0.8     | 4    | mV               |    |
| Input Offset Voltage Drift        | $\Delta V_{IO}/\Delta T$ | $T_a = -40^\circ C$ to $125^\circ C$  | -   | 0.7     | -    | $\mu V/^\circ C$ |    |
| Input Bias Current                | $I_B$                    |   | -   | 1       | -    | pA               |    |
| Input Offset Current              | $I_{IO}$                 |   | -   | 1       | -    | pA               |    |
| Open-Loop Voltage Gain            | $A_V$                    | $R_L=10k\Omega$ to 2.5V   | 70  | 90      | -    | dB               |    |
| Common-Mode Rejection Ratio       | CMR                      | $V_{ICM}=0V$ to 4.1V  | 65  | 80      | -    | dB               |    |
| Supply Voltage Rejection Ratio    | SVR                      | $V^+=1.8V$ to 5.5V  | 70  | 90      | -    | dB               |    |
| Common-Mode Input Voltage Range   | $V_{ICM}$                | CMR $\geq 65$ dB  | 0   | -       | 4.1  | V                |    |
| High-Level Output Voltage         | $V_{OH}$                 | $R_L=10k\Omega$ to 2.5V   | 4.9 | 4.95    | -    | V                |    |
|                                   |                          | $R_L=10k\Omega$ to 0V   | 4.9 | 4.95    | -    |                  |    |
|                                   |                          | $I_{SOURCE}=2mA$  | 4.8 | 4.85    | -    |                  |    |
| Low-Level Output Voltage          | $V_{OL}$                 | $R_L=10k\Omega$ to 2.5V   | -   | 0.05    | 0.1  | V                |    |
|                                   |                          | $R_L=10k\Omega$ to 0V   | -   | 0.02    | 0.05 |                  |    |
|                                   |                          | $I_{SINK}=2mA$  | -   | 0.15    | 0.2  |                  |    |
| Supply Current (All Amplifiers)   | $I_{SUPPLY}$             | No Signal   | -   | NJU7056 | 0.26 | 0.42             | mA |
| NJU7057                           |                          |   |     | 0.52    | 0.84 |                  |    |
| NJU7058                           |                          |   |     | 1.1     | 1.7  |                  |    |
|                                   |                          |   |     |         |      |                  |    |
| <b>AC CHARACTERISTICS</b>         |                          |   |     |         |      |                  |    |
| Slew Rate <sup>(6)</sup>          | SR                       | $G_V=0dB$ , $R_L=10k\Omega$ to 2.5V,<br>$C_L=20pF$ ,<br>$V_{IN}=3V_{PP}$ (1V to 4V) | -   | 0.8     | -    | V/ $\mu s$       |    |
| Gain Bandwidth Product            | GBW                      | $R_L=10k\Omega$ to 2.5V,<br>$C_L=20pF$ , $f=100kHz$                                 | -   | 2.1     | -    | MHz              |    |
| Phase Margin                      | $\Phi_M$                 | $R_L=10k\Omega$ to 2.5V, $C_L=20pF$   | -   | 80      | -    | deg              |    |
| Gain Margin                       | $G_M$                    | $R_L=10k\Omega$ to 2.5V, $C_L=20pF$   | -   | 10      | -    | dB               |    |
| Equivalent Input Noise Voltage    | $V_{NI}$                 | $f=1kHz$  | -   | 15      | -    | nV/ $\sqrt{Hz}$  |    |
| Total Harmonic Distortion + Noise | THD+N                    | $G_V=6dB$ , $V_O=4V_{PP}$ , $f=1kHz$  | -   | 0.002   | -    | %                |    |
| Channel Separation                | CS                       | $f=1kHz$ ,<br>NJU7057/NJU7058   | -   | -120    | -    | dB               |    |

(6) Slew rate is defined by the lower value of the rise or fall.

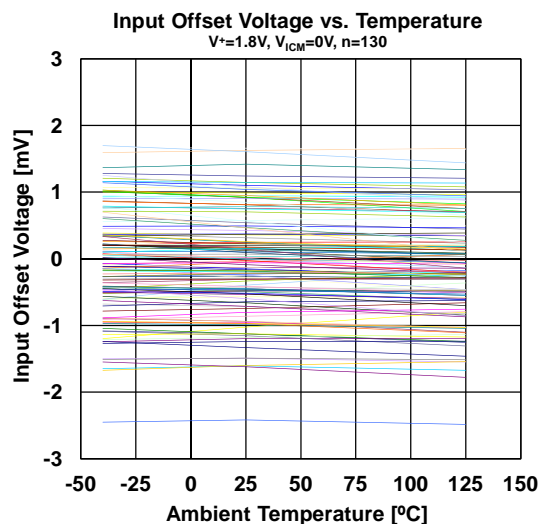
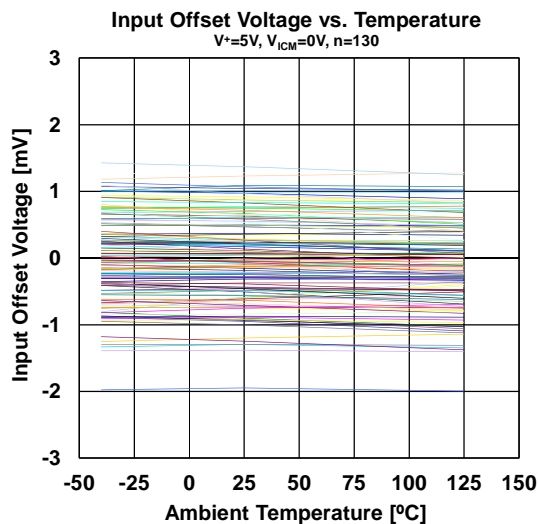
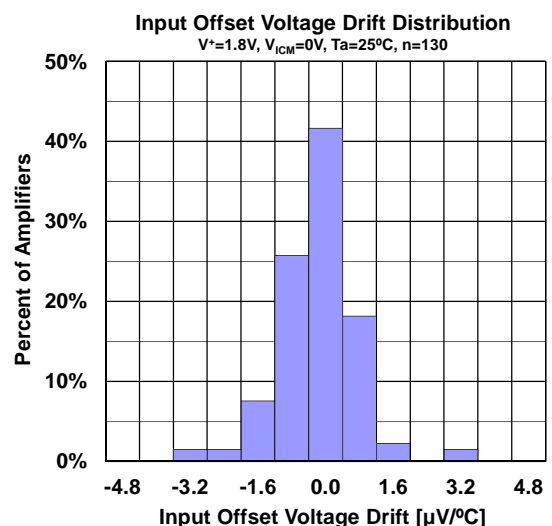
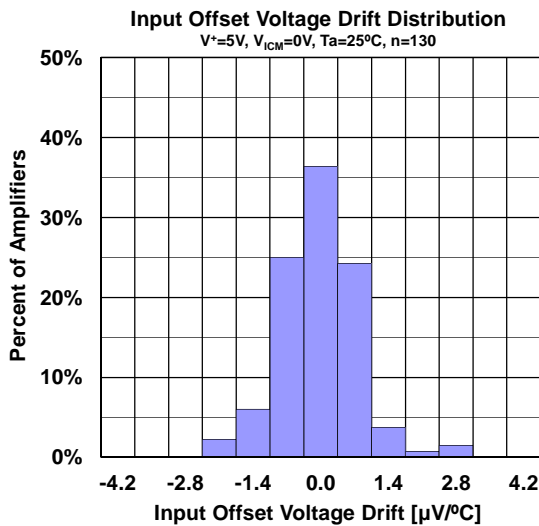
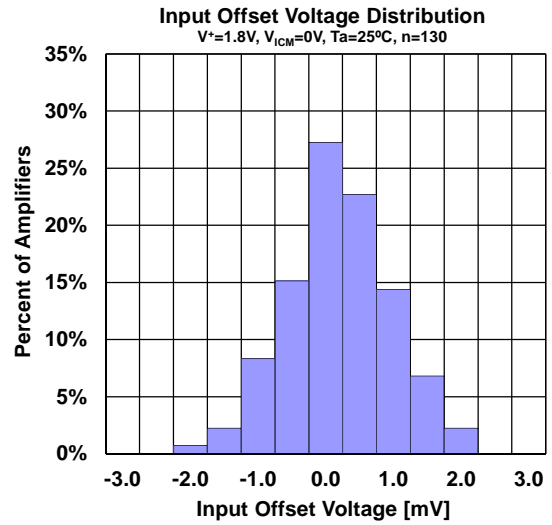
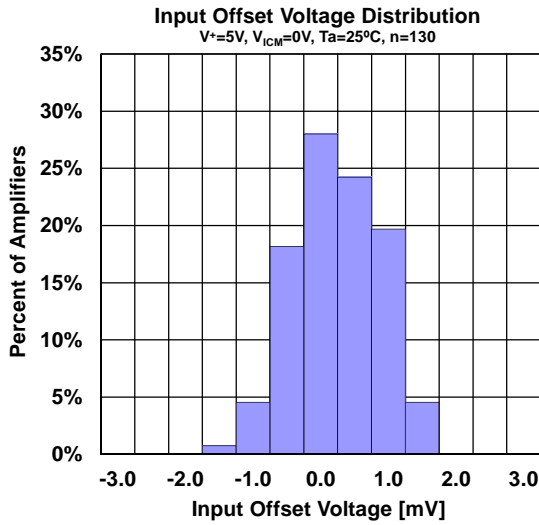
## ■ ELECTRICAL CHARACTERISTICS (continued)

( $V^+=1.8V$ ,  $V^-=0V$ ,  $T_a=25^\circ C$ , unless otherwise noted.)

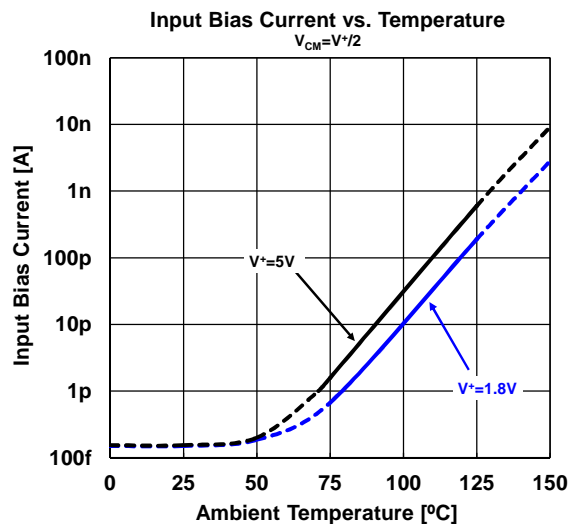
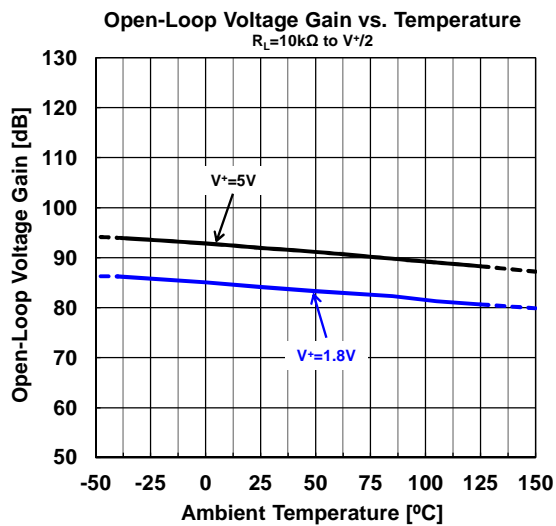
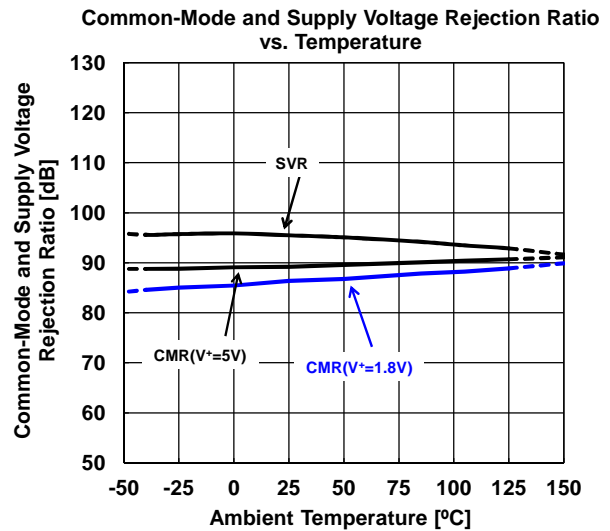
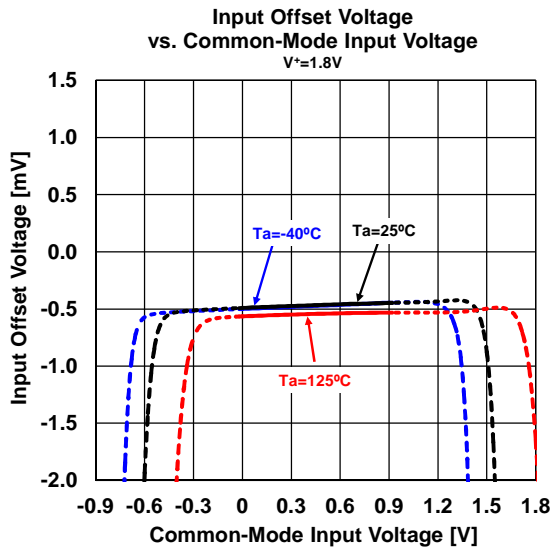
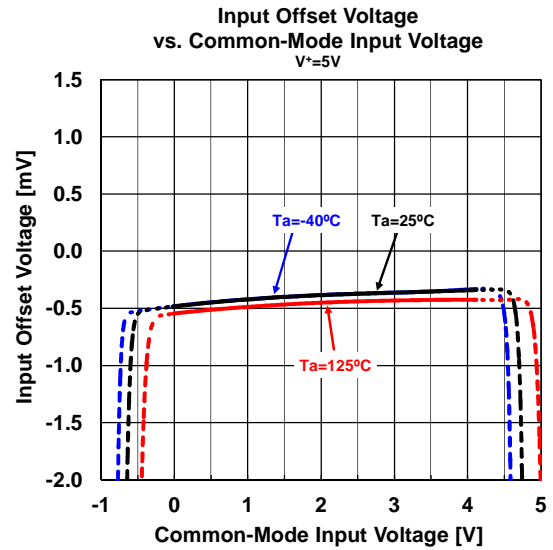
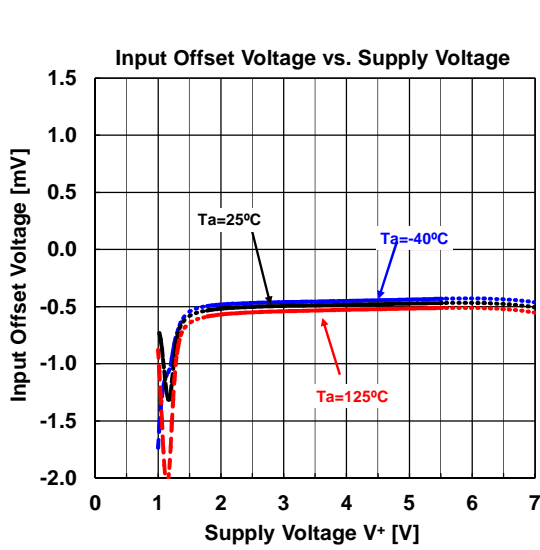
| PARAMETER                         | SYMBOL                   | TEST CONDITIONS  | MIN | TYP   | MAX  | UNIT             |
|-----------------------------------|--------------------------|--|-----|-------|------|------------------|
| <b>DC CHARACTERISTICS</b>         |                          |  |     |       |      |                  |
| Input Offset Voltage              | $V_{IO}$                 | $V_{COM}=0V$   | -   | 0.8   | 4    | mV               |
| Input Offset Voltage Drift        | $\Delta V_{IO}/\Delta T$ | $T_a = -40^\circ C$ to $125^\circ C$   | -   | 0.8   | -    | $\mu V/^\circ C$ |
| Input Bias Current                | $I_B$                    |  | -   | 1     | -    | pA               |
| Input Offset Current              | $I_{IO}$                 |  | -   | 1     | -    | pA               |
| Open-Loop Voltage Gain            | $A_V$                    | $R_L=10k\Omega$ to $0.9V$  | 65  | 90    | -    | dB               |
| Common-Mode Rejection Ratio       | CMR                      | $V_{ICM}=0V$ to $0.9V$   | 65  | 80    | -    | dB               |
| Supply Voltage Rejection Ratio    | SVR                      | $V^+=1.8V$ to $5.5V$   | 70  | 90    | -    | dB               |
| Common-Mode Input Voltage Range   | $V_{ICM}$                | CMR $\geq$ 65dB  | 0   | -     | 0.9  | V                |
| High-Level Output Voltage         | $V_{OH}$                 | $R_L=10k\Omega$ to $0.9V$  | 1.7 | 1.75  | -    | V                |
|                                   |                          | $R_L=10k\Omega$ to $0V$  | 1.7 | 1.75  | -    |                  |
|                                   |                          | $I_{SOURCE}=1mA$   | 1.5 | 1.55  | -    |                  |
| Low-Level Output Voltage          | $V_{OL}$                 | $R_L=10k\Omega$ to $0.9V$  | -   | 0.05  | 0.1  | V                |
|                                   |                          | $R_L=10k\Omega$ to $0V$  | -   | 0.02  | 0.05 |                  |
|                                   |                          | $I_{SINK}=1mA$   | -   | 0.25  | 0.3  |                  |
| Supply Current (All Amplifiers)   | $I_{SUPPLY}$             | No Signal  | -   | 0.22  | 0.38 | mA               |
| NJU7056                           |                          |  | -   | 0.44  | 0.76 |                  |
| NJU7057                           |                          |  | -   | 0.9   | 1.5  |                  |
| NJU7058                           |                          |  | -   | 0.9   | 1.5  |                  |
| <b>AC CHARACTERISTICS</b>         |                          |  |     |       |      |                  |
| Slew Rate <sup>(6)</sup>          | SR                       | $G_V=0dB$ , $R_L=10k\Omega$ to $0.9V$ ,<br>$C_L=20pF$ ,<br>$V_{IN}=0.5V_{PP}$ ( $0.3V$ to $0.8V$ ) | -   | 0.6   | -    | V/ $\mu s$       |
| Gain Bandwidth Product            | GBW                      | $R_L=10k\Omega$ to $0.9V$ ,<br>$C_L=20pF$ , $f=100kHz$   | -   | 1.7   | -    | MHz              |
| Phase Margin                      | $\Phi_M$                 | $R_L=10k\Omega$ to $0.9V$ , $C_L=20pF$   | -   | 80    | -    | deg              |
| Gain Margin                       | $G_M$                    | $R_L=10k\Omega$ to $0.9V$ , $C_L=20pF$   | -   | 13    | -    | dB               |
| Equivalent Input Noise Voltage    | $V_{NI}$                 | $f=1kHz$   | -   | 18    | -    | nV/ $\sqrt{Hz}$  |
| Total Harmonic Distortion + Noise | THD+N                    | $G_V=6dB$ , $V_O=1V_{PP}$ , $f=1kHz$   | -   | 0.005 | -    | %                |
| Channel Separation                | CS                       | $f=1kHz$ ,<br>NJU7057/NJU7058  | -   | -110  | -    | dB               |

(6) Slew rate is defined by the lower value of the rise or fall.

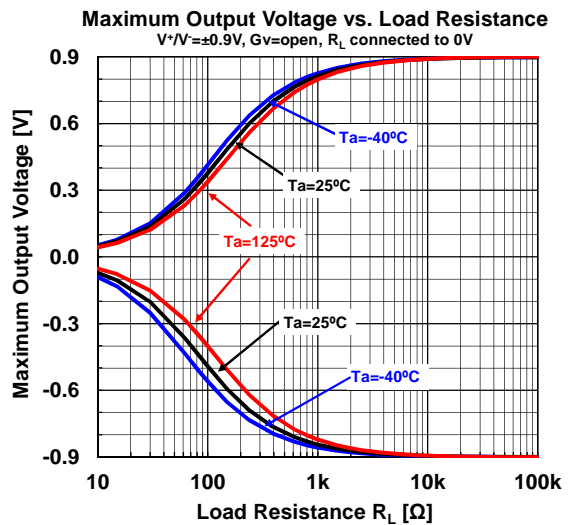
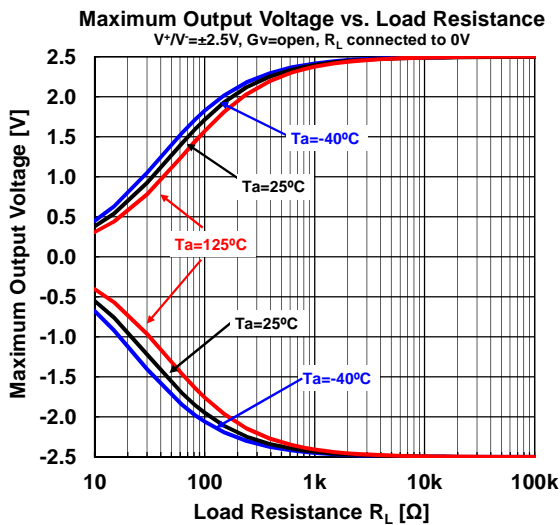
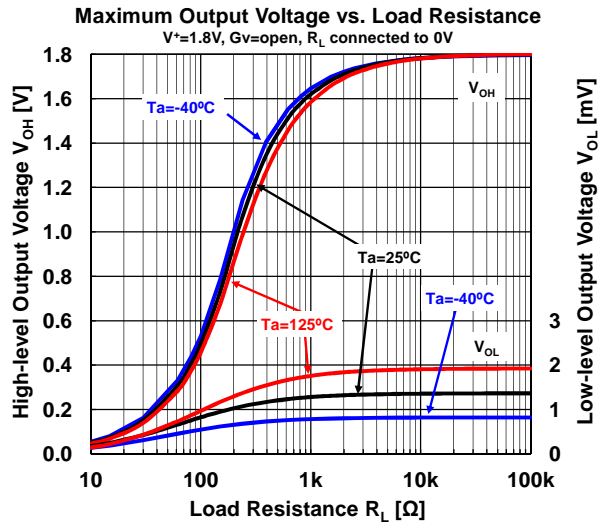
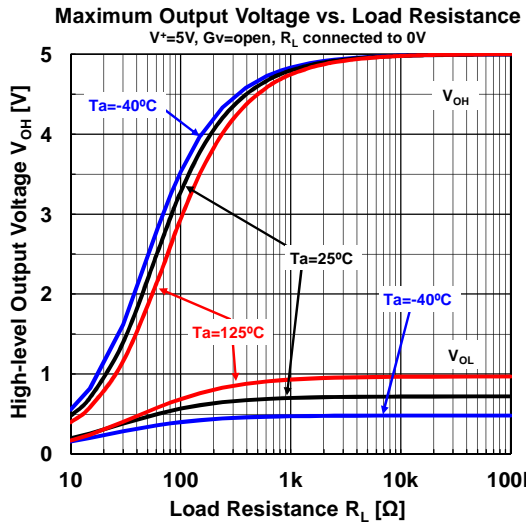
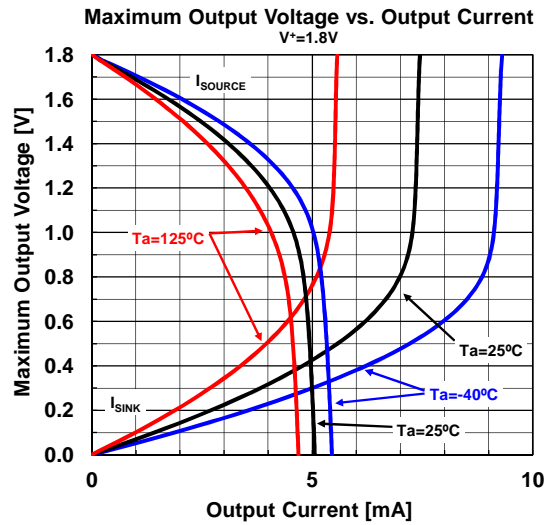
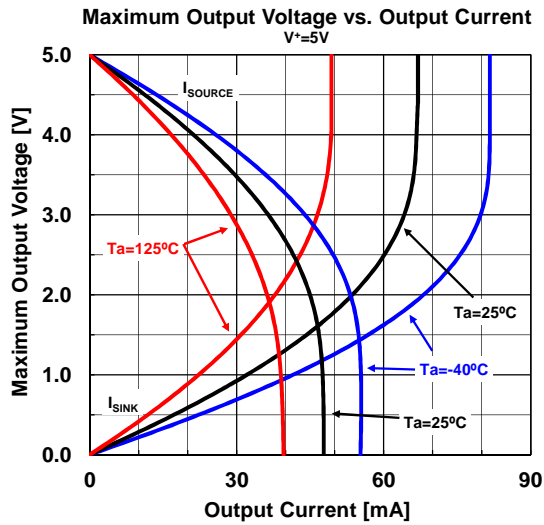
## ■ TYPICAL CHARACTERISTICS



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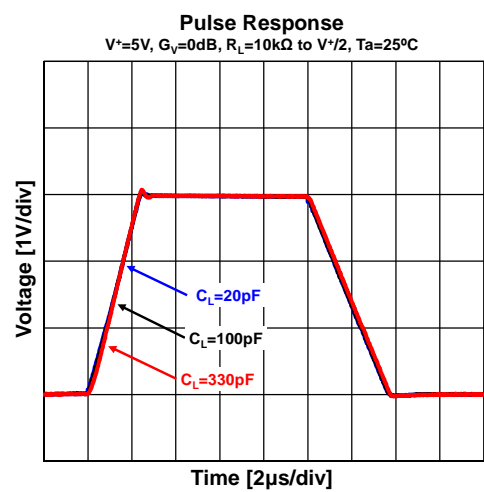
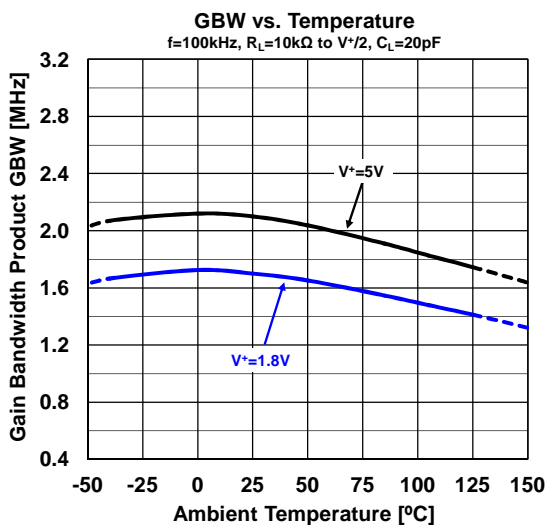
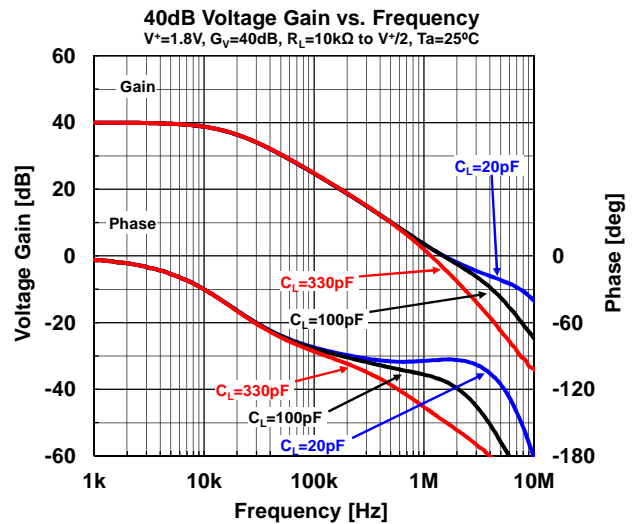
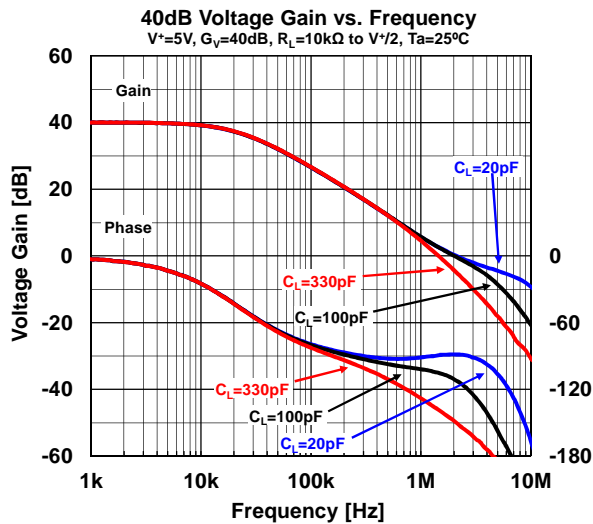
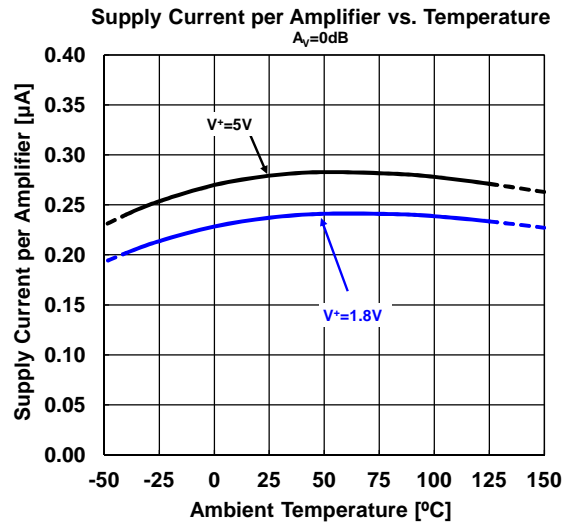
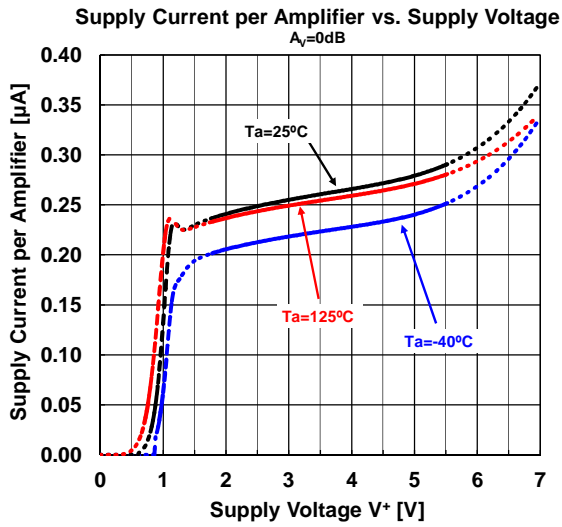


## ■ TYPICAL CHARACTERISTICS

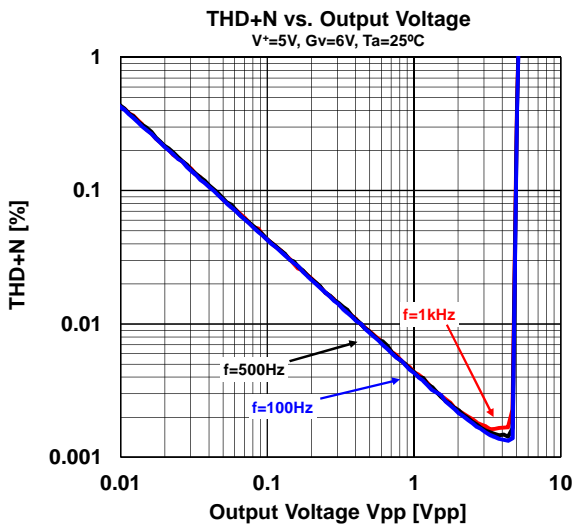
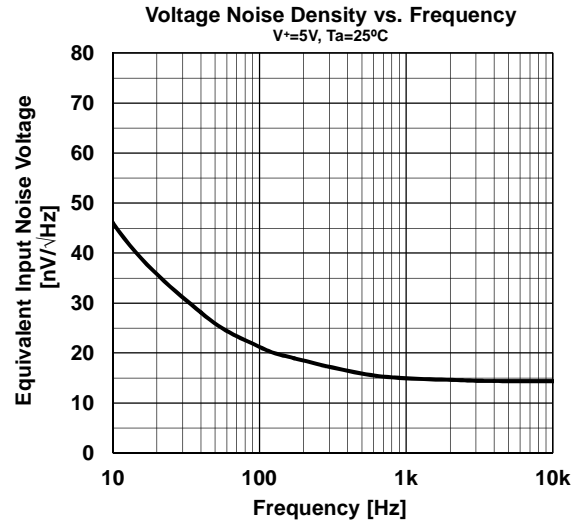
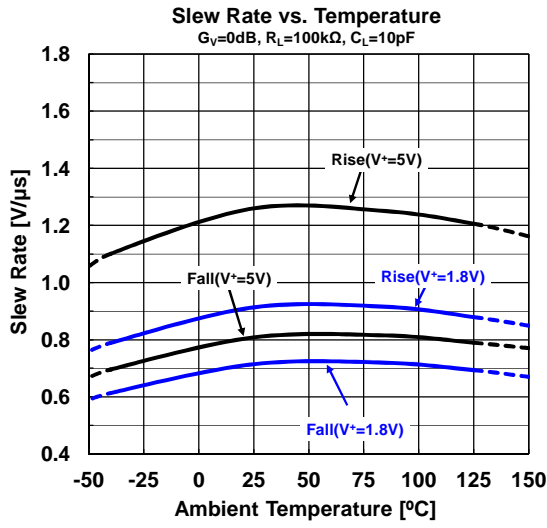




## ■ TYPICAL CHARACTERISTICS



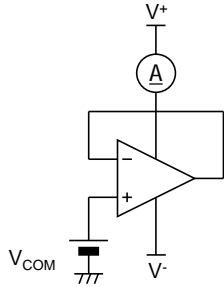
## ■ TYPICAL CHARACTERISTICS



## ■ TEST CIRCUITS

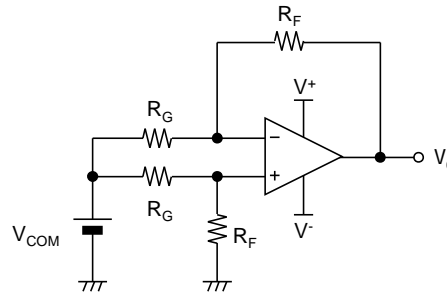
### • I<sub>SUPPLY</sub>

$$V_{COM} = V^+ / 2$$



### • V<sub>IO</sub>, CMR, SVR

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



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

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

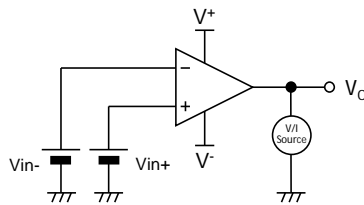
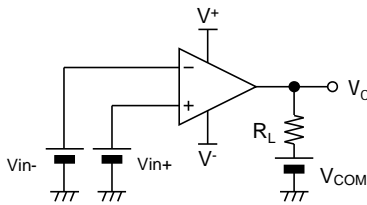
$$SVR = 20 \log \frac{\Delta V_s \left(1 + \frac{R_F}{R_G}\right)}{\Delta V_O}$$

$$V_s = V^+ - V^-$$

### • V<sub>OH</sub>, V<sub>OL</sub>

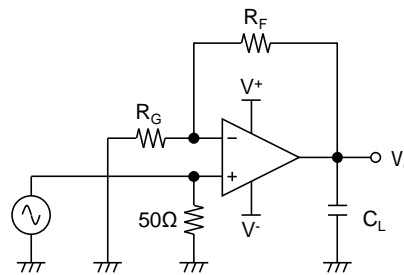
$$V_{OH}; V_{in+} = V^+ / 2 + 0.3V, V_{in-} = V^+ / 2, V_{COM} = V^+ / 2, V^-$$

$$V_{OL}; V_{in+} = V^+ / 2, V_{in-} = V^+ / 2 + 0.3V, V_{COM} = V^+ / 2, V^-$$

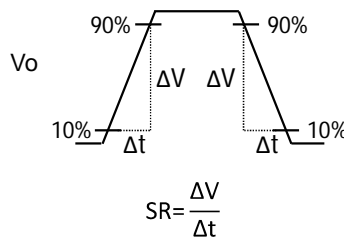
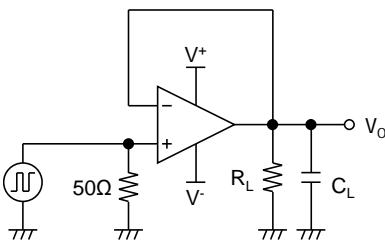


### • GBW

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



### • SR



## APPLICATION NOTE

### Single and Dual Supply Voltage Operation

The NJU7056/NJU7057/NJU7058 works with both single supply and dual supply when the voltage supplied is between  $V^+$  and  $V^-$ . These amplifiers operate from single +1.8 to +5.5V supply and dual  $\pm 0.9V$  to  $\pm 2.75V$  supply.

### Common-Mode Input Voltage Range

When the supply voltage does not meet the condition of electrical characteristics, the range of common-mode input voltage is as follows:

$$V_{ICM} (\text{typ.}) = V^- \text{ to } V^+ - 0.9 \text{ (Ta = 25}^\circ\text{C)}$$

Difference of  $V_{ICM}$  when Temperature change, refer to typical characteristic graph.

During designing, consider variations in characteristics for use with allowance.

### Maximum Output Voltage Range

When the supply voltage does not meet the condition of electrical characteristics, the range of the typ. value of the maximum output voltage is as follows:

$$V_{OM} (\text{typ.}) = V^- + 50\text{mV to } V^+ - 50\text{mV (R}_L = 20\text{k}\Omega \text{ to } V^+/2, \text{ Ta} = 25^\circ\text{C)}$$

During designing, consider variations in characteristics and temperature characteristics for use with allowance. In addition, also note that the output voltage range becomes narrow as shown in typical characteristics graph when an output current increases.

### Input Voltage Exceeding the Supply Voltage

Inputs of the NJU7056/NJU7057/NJU7058 are protected by ESD diodes (shown in Figure1) that will conduct if the input voltages exceed the power supplies by more than approximately 300mV.

Momentary voltages greater than 300mV beyond the power supply, inputs can be tolerated if the current is limited to 10mA. Figure2 is easily accomplished with an input resistor. If the input voltage exceeds the supply voltage, the input current must be limited 10mA or less by using a restriction resistance ( $R_{LIMIT}$ ) as shown in figure2.

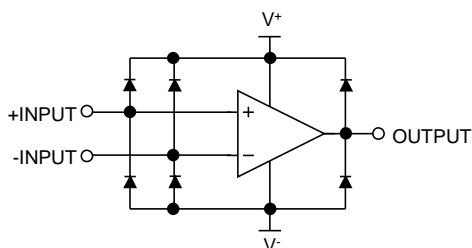


Figure1. Simplified Schematic

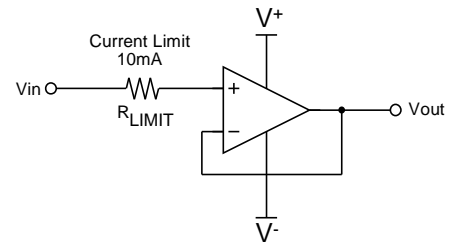


Figure2. Input Current Protection for Voltages exceeding the Supply Voltage.

### Capacitive Load

The NJU7056/NJU7057/NJU7058 can use at unity gain follower, but 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 cause overshoot and ringing in the step response.

The NJU7056/NJU7057/NJU7058 is unity gain stable for capacitive loads of 200pF. To drive heavier capacitive loads, an isolation resistor,  $R_{ISO}$  as shown Figure3, 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.

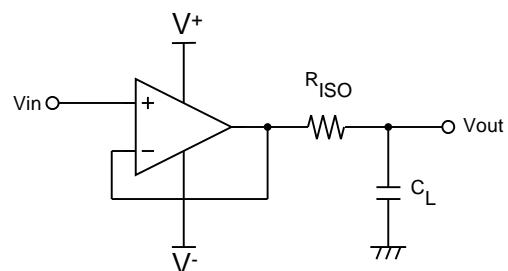


Figure3. Isolating capacitive load

## ■ APPLICATION NOTE

### EMIRR (EMI Rejection Ratio) Definition

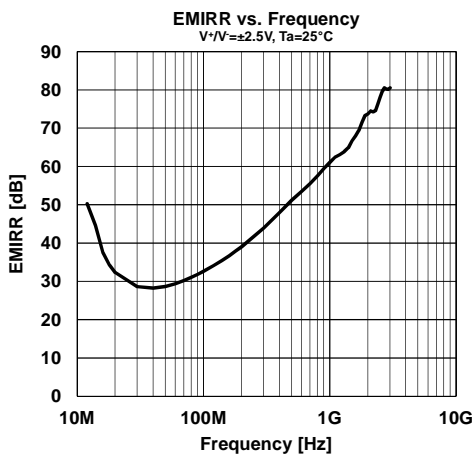
EMIRR is a parameter indicating the EMI robustness of an Op-Amp. The definition of EMIRR is given by the following equation1.

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

$V_{RF\_PEAK}$ : 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.

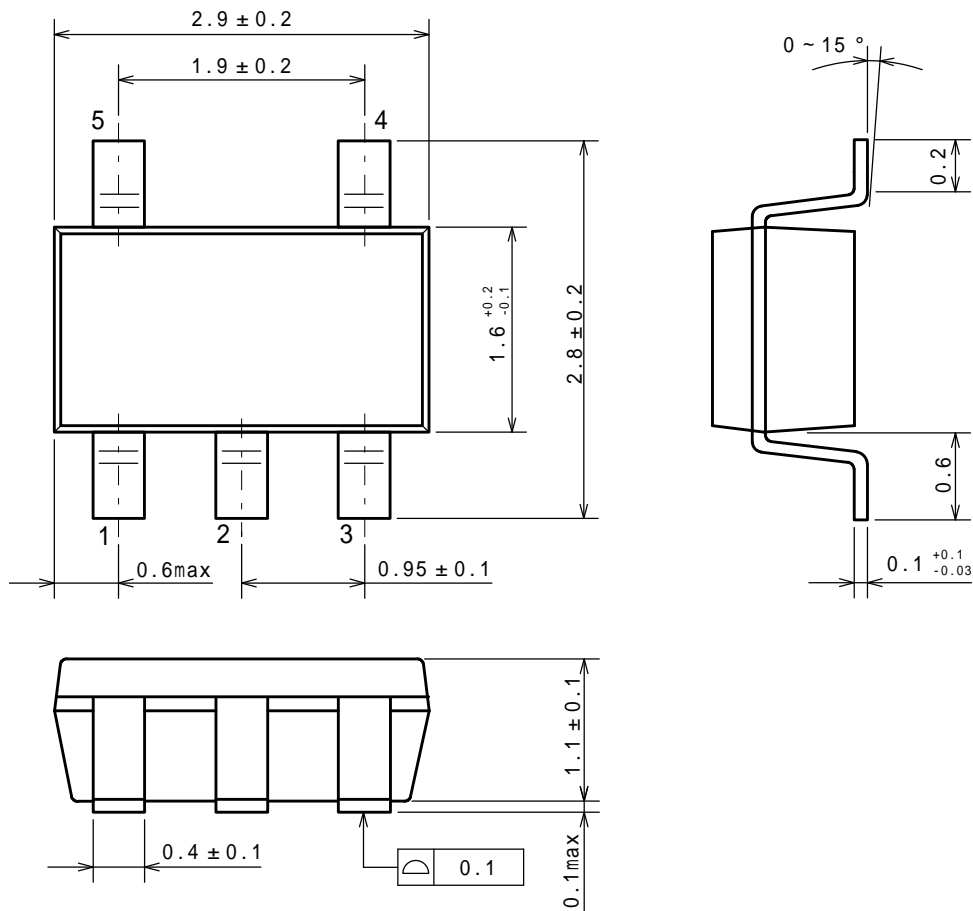


\*For details, refer to "Application Note for EMI Immunity" in our HP: <http://www.njr.com/>

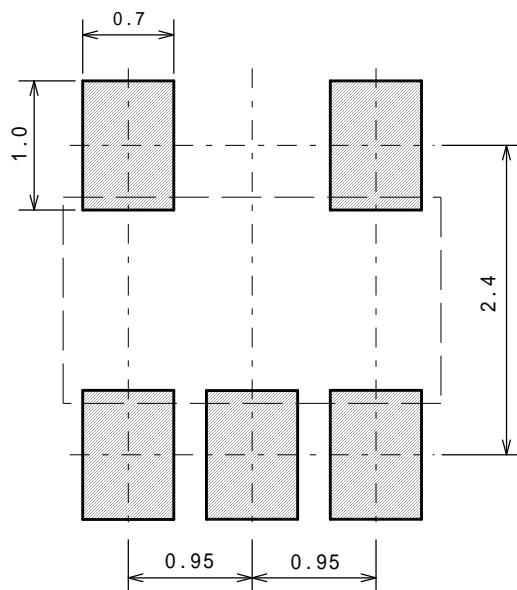
## SOT-23-5

Unit: mm

### ■ PACKAGE DIMENSIONS



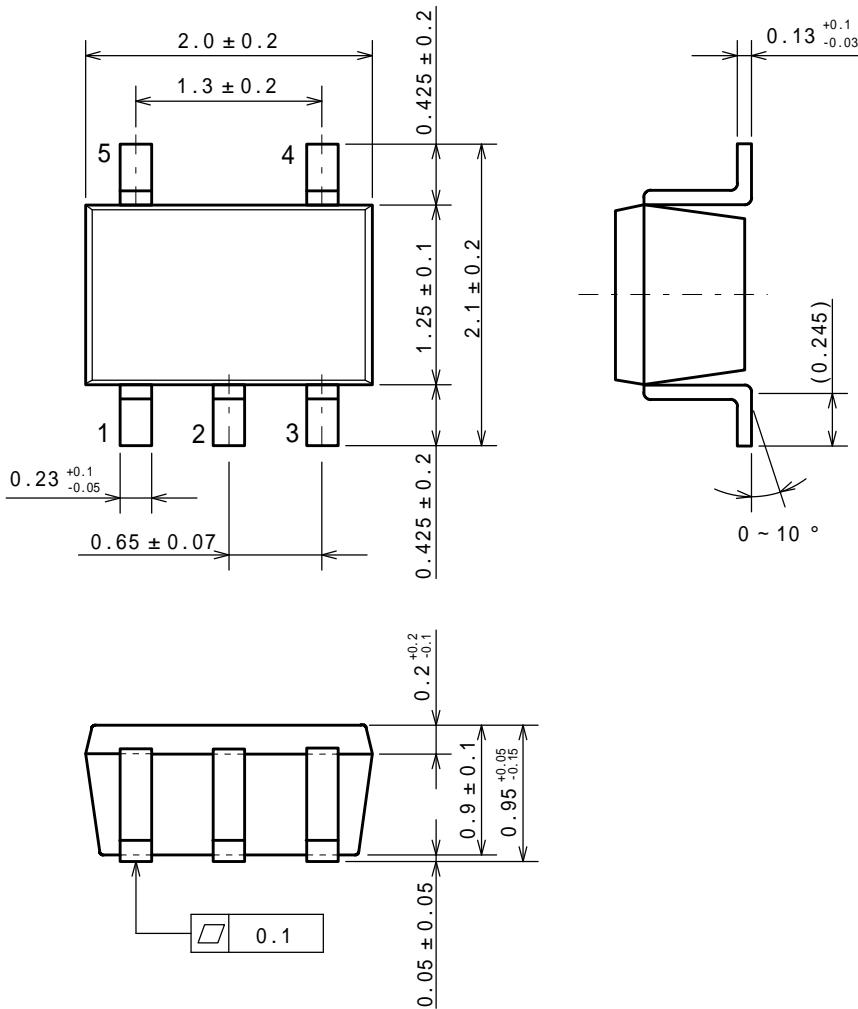
### ■ EXAMPLE OF SOLDER PADS DIMENSIONS



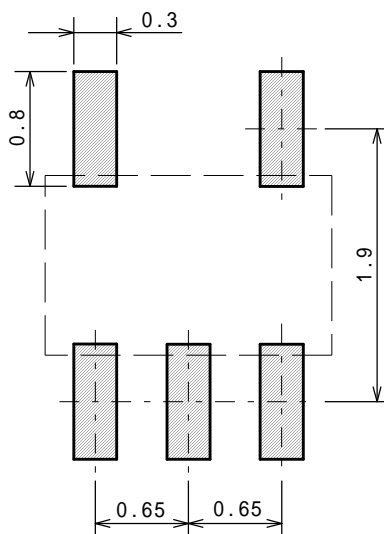
## SC-88A

Unit: mm

### ■ PACKAGE DIMENSIONS



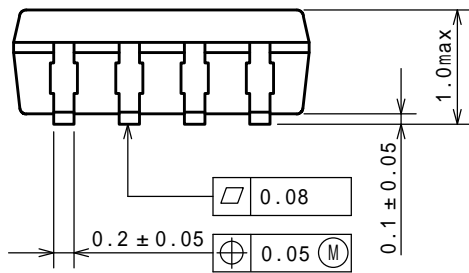
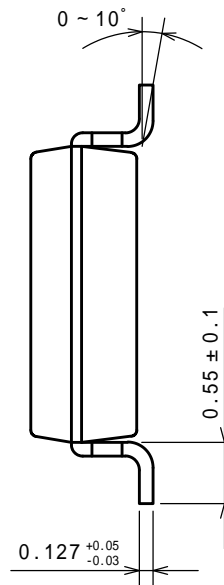
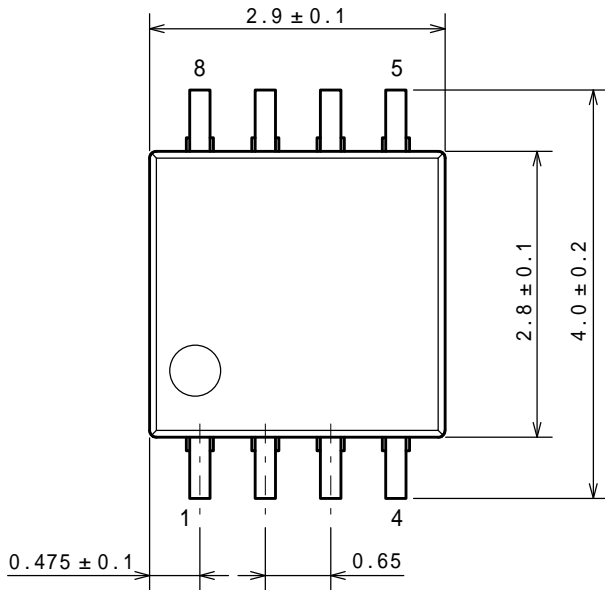
### ■ EXAMPLE OF SOLDER PADS DIMENSIONS



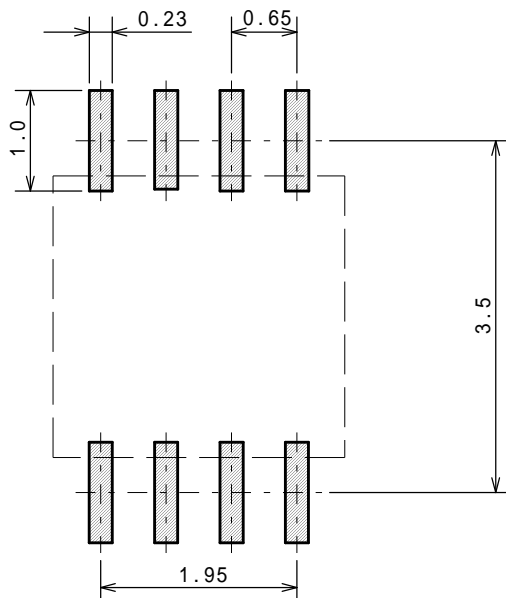
## MSOP8 (TVSP8) JEDEC MO-187-DA/THIN TYPE

Unit: mm

### ■ PACKAGE DIMENSIONS



### ■ EXAMPLE OF SOLDER PADS DIMENSIONS

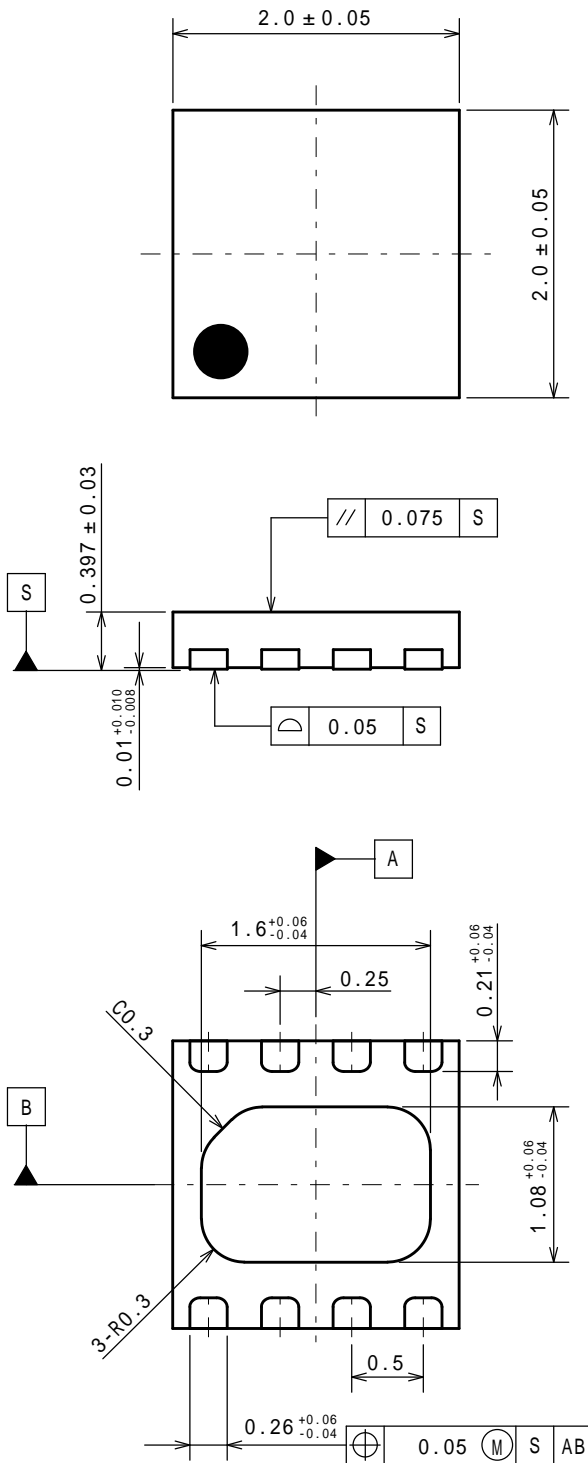




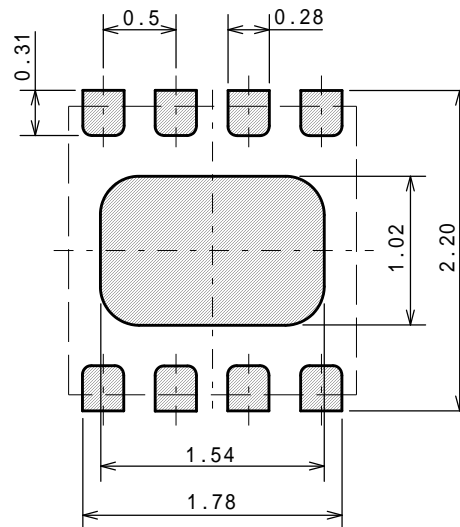
## DFN8-U1 (ESON8-U1)

Unit: mm

### ■ PACKAGE DIMENSIONS



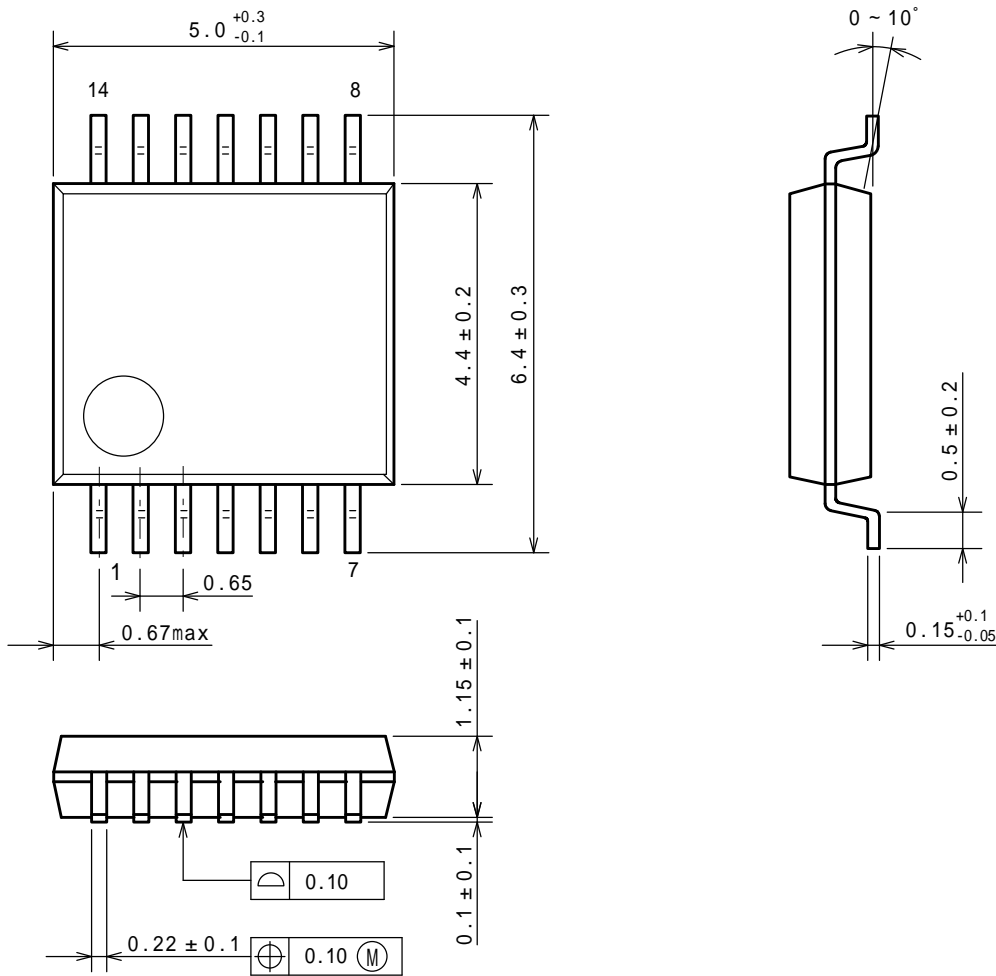
### ■ EXAMPLE OF SOLDER PADS DIMENSIONS



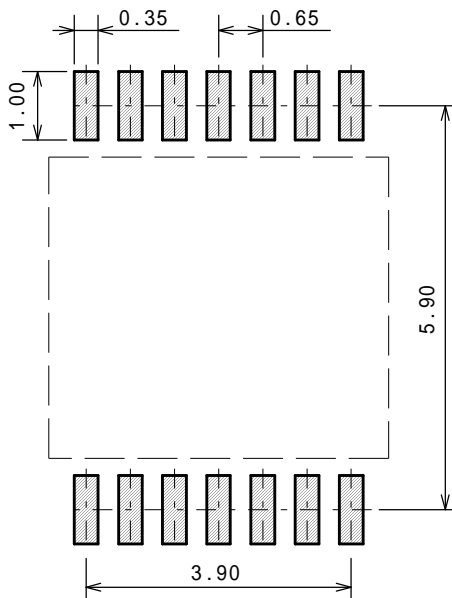
## SSOP14

Unit: mm

### ■ PACKAGE DIMENSIONS



### ■ EXAMPLE OF SOLDER PADS DIMENSIONS

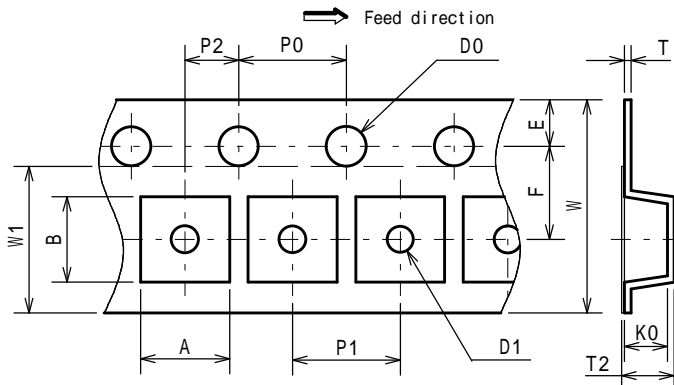


## SOT-23-5

### PACKING SPEC

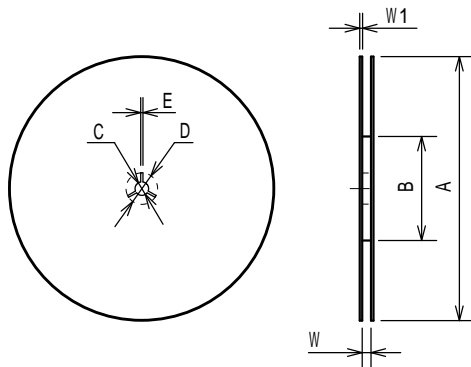
Unit: mm

#### TAPING DIMENSIONS



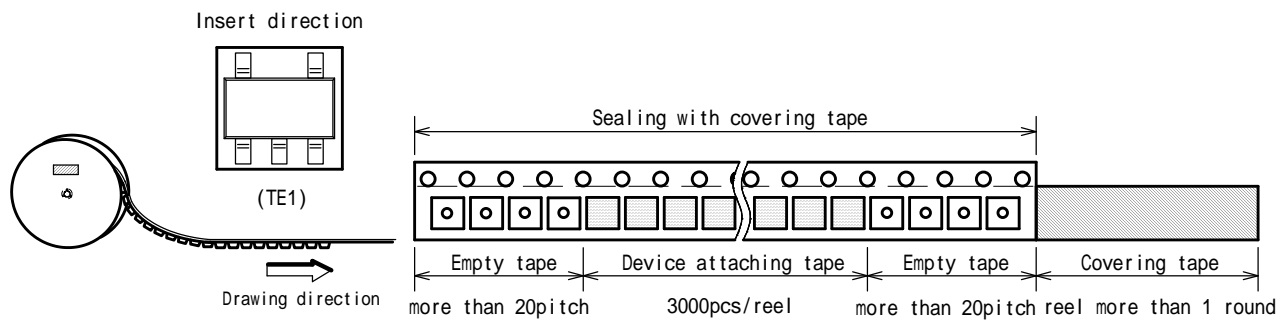
| SYMBOL | DIMENSION   | REMARKS          |
|--------|-------------|------------------|
| A      | 3.3 ± 0.1   | BOTTOM DIMENSION |
| B      | 3.2 ± 0.1   | BOTTOM DIMENSION |
| D0     | 1.55        |                  |
| D1     | 1.05        |                  |
| E      | 1.75 ± 0.1  |                  |
| 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        |                  |
| K0     | 1.5 ± 0.1   |                  |
| W      | 8.0 ± 0.3   |                  |
| W1     | 5.5         | THICKNESS 0.1MAX |

#### REEL DIMENSIONS

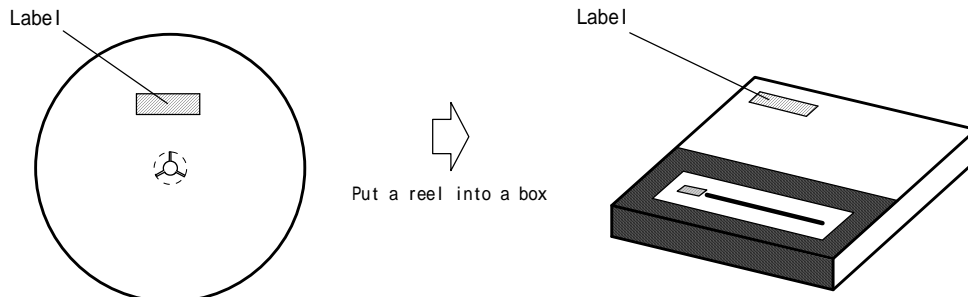


| SYMBOL | DIMENSION |
|--------|-----------|
| A      | 180 ± 1   |
| B      | 60 ± 1    |
| C      | 13 ± 0.2  |
| D      | 21 ± 0.8  |
| E      | 2 ± 0.5   |
| W      | 9 ± 0.5   |
| W1     | 1.2 ± 0.2 |

#### TAPING STATE



#### PACKING STATE

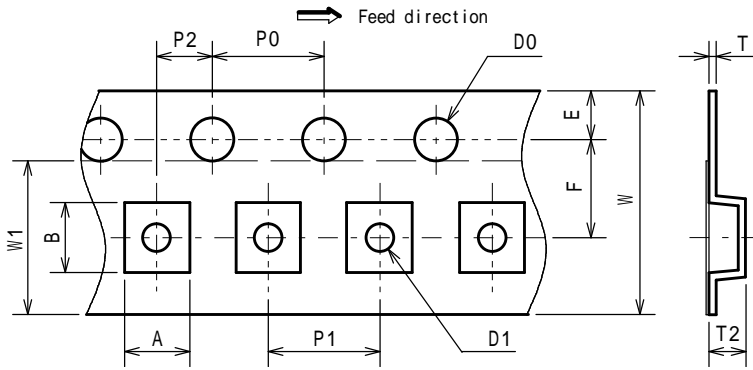


## SC-88A

### PACKING SPEC

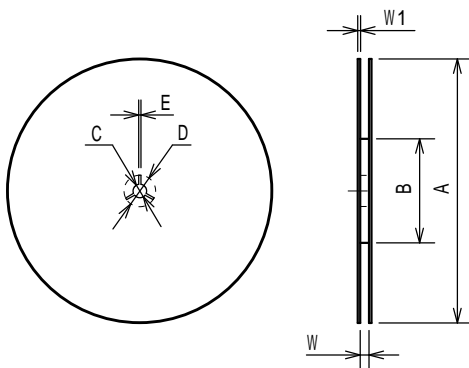
Unit: mm

#### TAPING DIMENSIONS



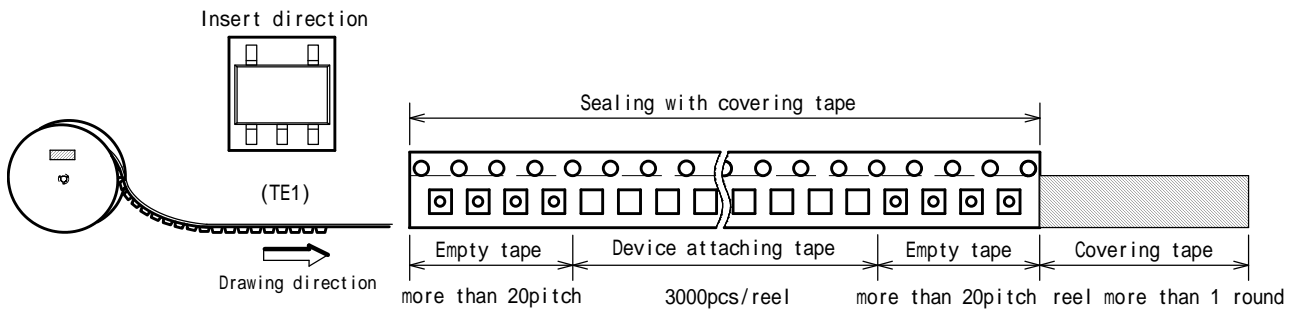
| SYMBOL | DIMENSION   | REMARKS          |
|--------|-------------|------------------|
| A      | 2.3 ± 0.1   | BOTTOM DIMENSION |
| B      | 2.5 ± 0.1   | BOTTOM DIMENSION |
| D0     | 1.55 ± 0.05 |                  |
| D1     | 1.05 ± 0.05 |                  |
| E      | 1.75 ± 0.1  |                  |
| 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

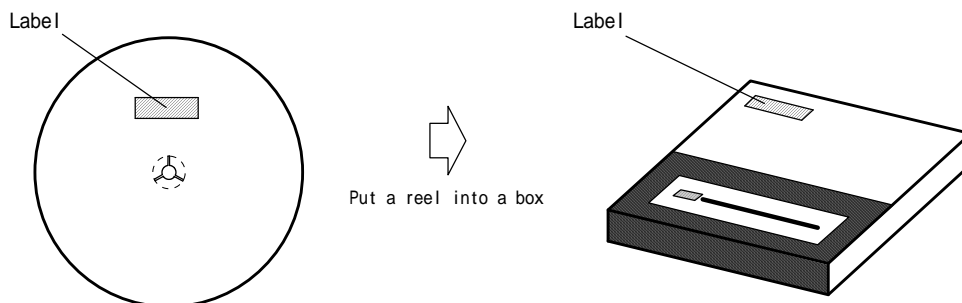


| SYMBOL | DIMENSION |
|--------|-----------|
| A      | 180 ± 1   |
| B      | 60 ± 1    |
| C      | 13 ± 0.2  |
| D      | 21 ± 0.8  |
| E      | 2 ± 0.5   |
| W      | 9 ± 0.5   |
| W1     | 1.2 ± 0.2 |

#### TAPING STATE



#### PACKING STATE

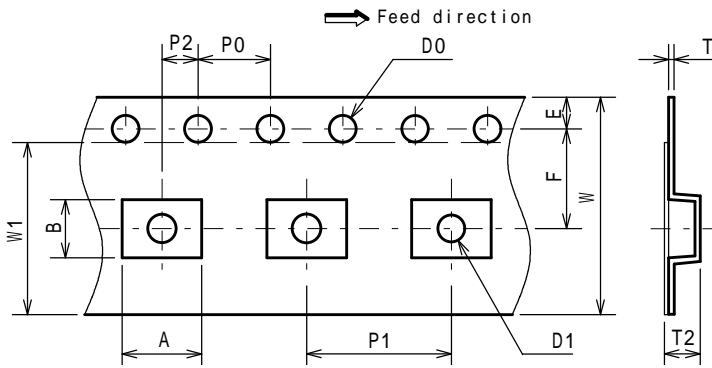


## MSOP8 (TVSP8) MEET JEDEC MO-187-DATHIN TYPE

Unit: mm

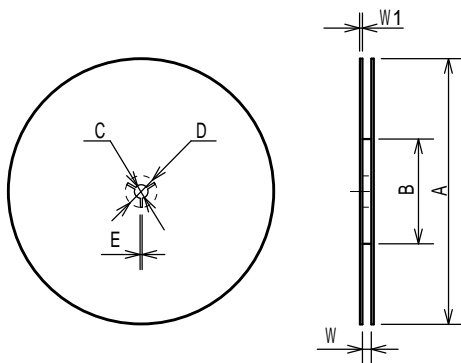
### PACKING SPEC

#### TAPING DIMENSIONS



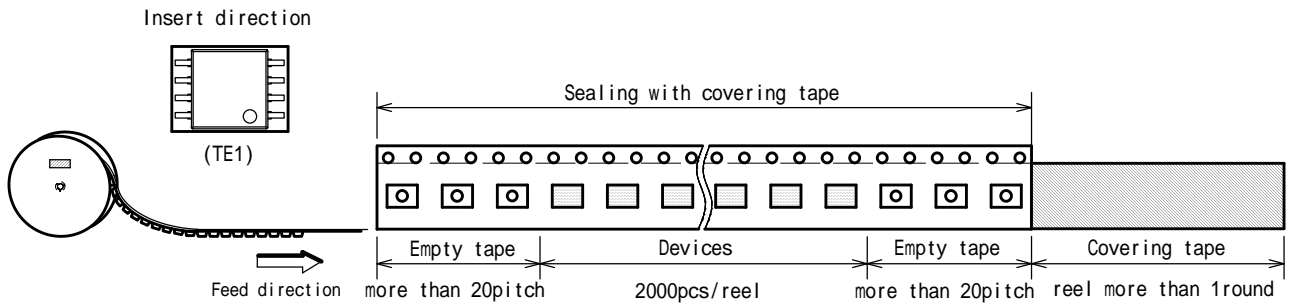
| SYMBOL | DIMENSION                        | REMARKS          |
|--------|----------------------------------|------------------|
| A      | 4.4                              | BOTTOM DIMENSION |
| B      | 3.2                              | BOTTOM DIMENSION |
| D0     | 1.5 <sup>+0.1</sup> <sub>0</sub> |                  |
| 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

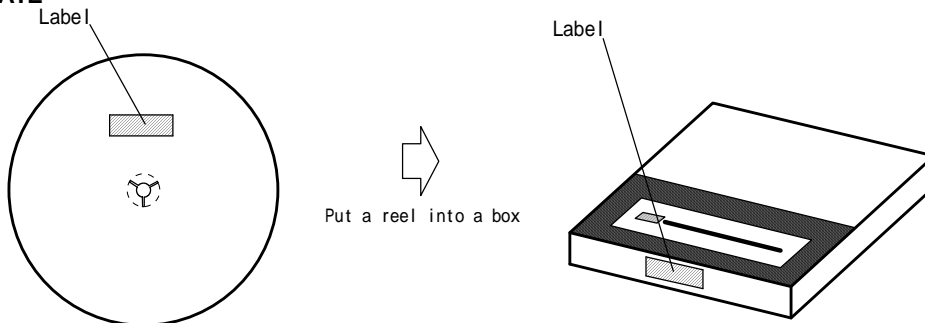


| SYMBOL | DIMENSION  |
|--------|------------|
| A      | 254 ± 2    |
| B      | 100 ± 1    |
| C      | 13 ± 0.2   |
| D      | 21 ± 0.8   |
| E      | 2 ± 0.5    |
| W      | 13.5 ± 0.5 |
| W1     | 2.0 ± 0.2  |

#### TAPING STATE



#### PACKING STATE

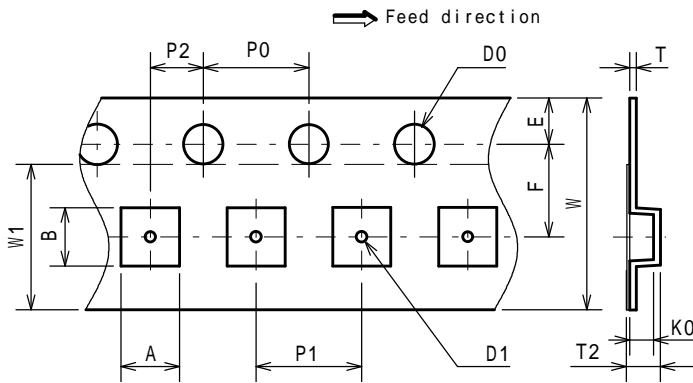


## DFN8-U1 (ESON8-U1)

Unit: mm

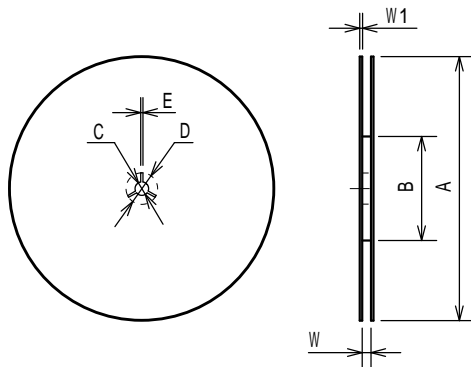
### PACKING SPEC

#### TAPING DIMENSIONS



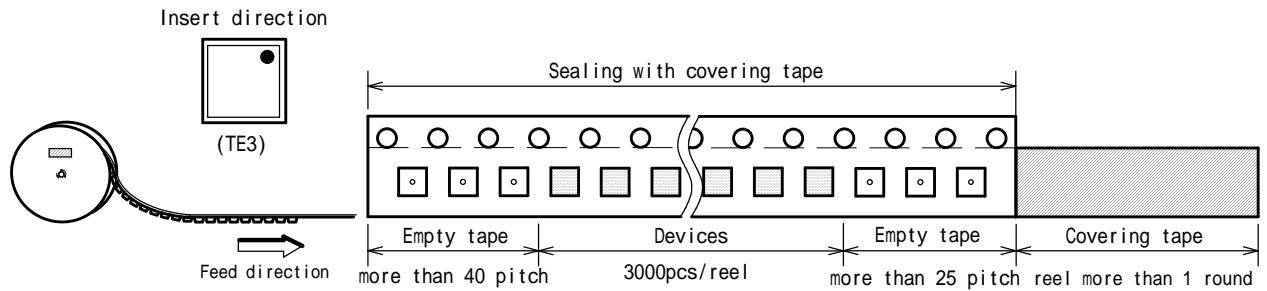
| SYMBOL | DIMENSION                        | REMARKS          |
|--------|----------------------------------|------------------|
| A      | 2.25 ± 0.05                      | BOTTOM DIMENSION |
| B      | 2.25 ± 0.05                      | BOTTOM DIMENSION |
| D0     | 1.5 <sup>+0.1</sup> <sub>0</sub> |                  |
| 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                      |                  |
| K0     | 0.65 ± 0.05                      |                  |
| W      | 8.0 ± 0.2                        |                  |
| W1     | 5.5                              | THICKNESS 0.1max |

#### REEL DIMENSIONS

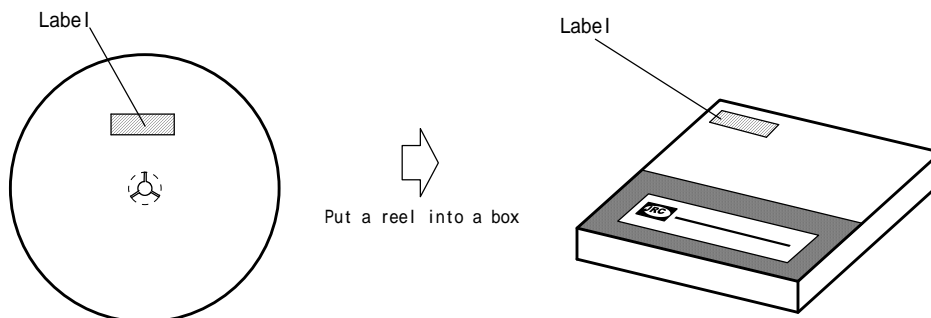


| SYMBOL | DIMENSION                        |
|--------|----------------------------------|
| A      | 180 <sup>0</sup> <sub>-1.5</sub> |
| B      | 60 <sup>+1</sup> <sub>0</sub>    |
| C      | 13 ± 0.2                         |
| D      | 21 ± 0.8                         |
| E      | 2 ± 0.5      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

#### TAPING STATE



#### PACKING STATE

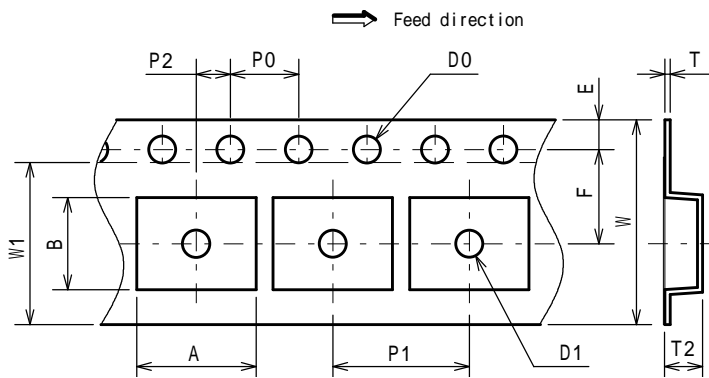


## SSOP14

### PACKING SPEC

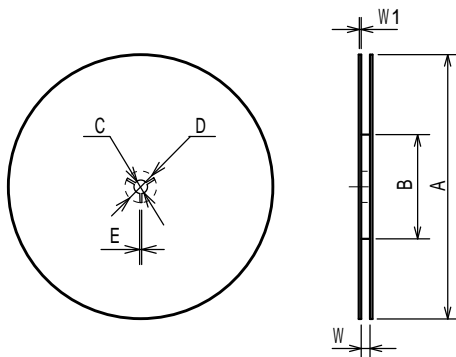
Unit: mm

#### TAPING DIMENSIONS



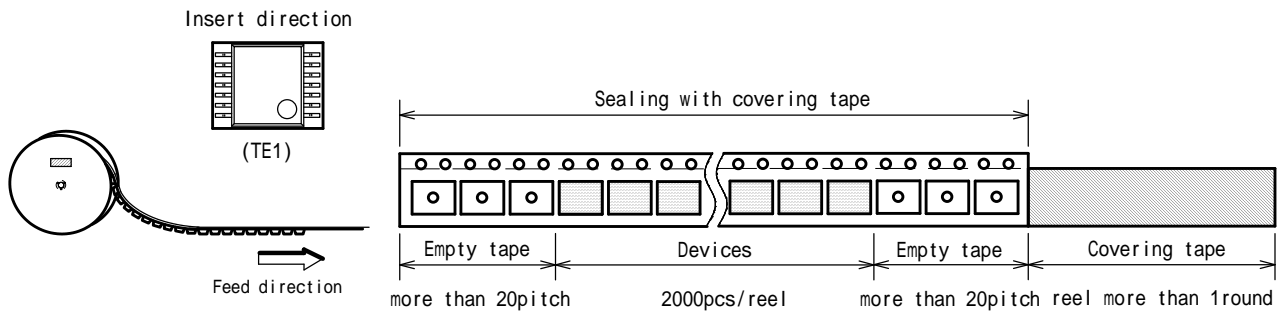
| SYMBOL | DIMENSION   | REMARKS          |
|--------|-------------|------------------|
| A      | 6.95        | BOTTOM DIMENSION |
| B      | 5.4         | BOTTOM DIMENSION |
| D0     | 1.55 ± 0.05 |                  |
| D1     | 1.55 ± 0.1  |                  |
| E      | 1.75 ± 0.1  |                  |
| 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

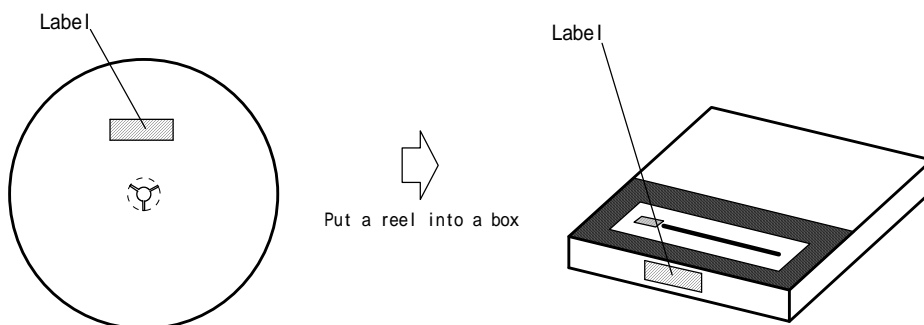


| SYMBOL | DIMENSION  |
|--------|------------|
| A      | 254 ± 2    |
| B      | 100 ± 1    |
| C      | 13 ± 0.2   |
| D      | 21 ± 0.8   |
| E      | 2 ± 0.5    |
| W      | 13.5 ± 0.5 |
| W1     | 2 ± 0.2    |

#### TAPING STATE

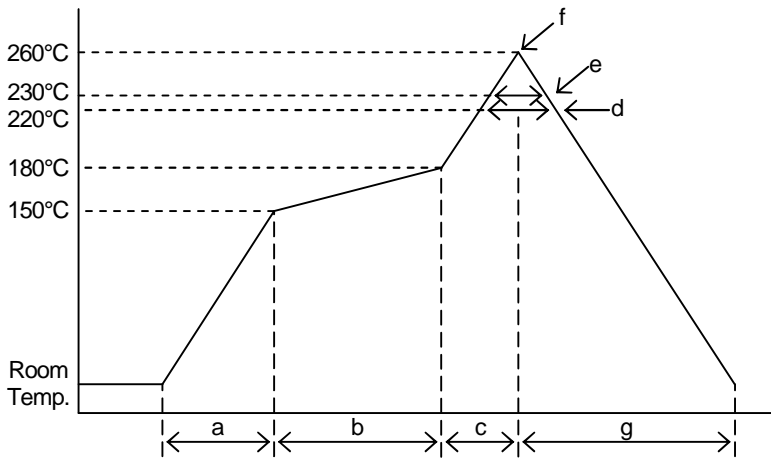


#### PACKING STATE



## ■ 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

| DATA          | REVISION | CHANGES   |
|---------------|----------|---|
| 2. Aug. 2016  | Ver.6    | Data sheet format revision.                                 |
| 12. Jun. 2017 | Ver.7    | Changed $\psi_{jt}$ data for thermal characteristics table. |
| 25. Oct. 2017 | Ver.8    | Corrected test condition of electrical characteristics.     |
| 22. Feb. 2019 | Ver.9    | Revision data sheet format, application note and add EMIRR. |



## [ 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.

