



# S-89110/89120 Series

## MINI ANALOG SERIES CMOS OPERATIONAL AMPLIFIER

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Rev.3.1\_01

The mini-analog series is a group of ICs that incorporate a general purpose analog circuit in a small package.

The S-89110/89120 Series is a CMOS type operational amplifier that has a phase compensation circuit, and operates at a low voltage with low current consumption. These features make this product the ideal solution for small battery-powered portable equipment.

The S-89110A/89120A Series is a single operational amplifier (one circuit).

The S-89110B/89120B Series is a dual operational amplifier (two circuits).

### ■ Features

- Lower operating voltage than the conventional general-purpose:  
 $V_{DD} = 1.8\text{ V to }5.5\text{ V}$
- Low current consumption (per circuit):  
 $I_{DD} = 50\text{ }\mu\text{A}$  (S-89110 Series)  
 $I_{DD} = 10\text{ }\mu\text{A}$  (S-89120 Series)
- Low input offset voltage:  
4.0 mV max.
- No external capacitors required for internal phase compensation
- Output full swing
- Lead-free, Sn 100%, halogen-free\*1

\*1. Refer to "■ Product Name Structure" for details.

### ■ Applications

- Mobile phone
- Notebook PC
- Digital camera
- Digital video camera

### ■ Packages

- SC-88A
- SOT-23-5
- SNT-8A
- TMSOP-8

## ■ Block Diagrams

### 1. S-89110A/89120A Series single operational amplifier (one circuit)

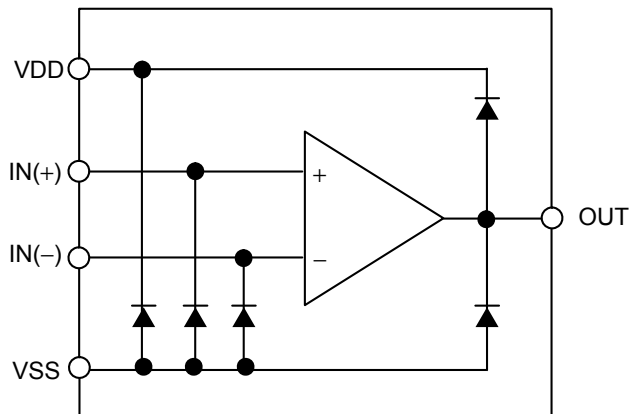


Figure 1

### 2. S-89110B/89120B Series dual operational amplifier (two circuits)

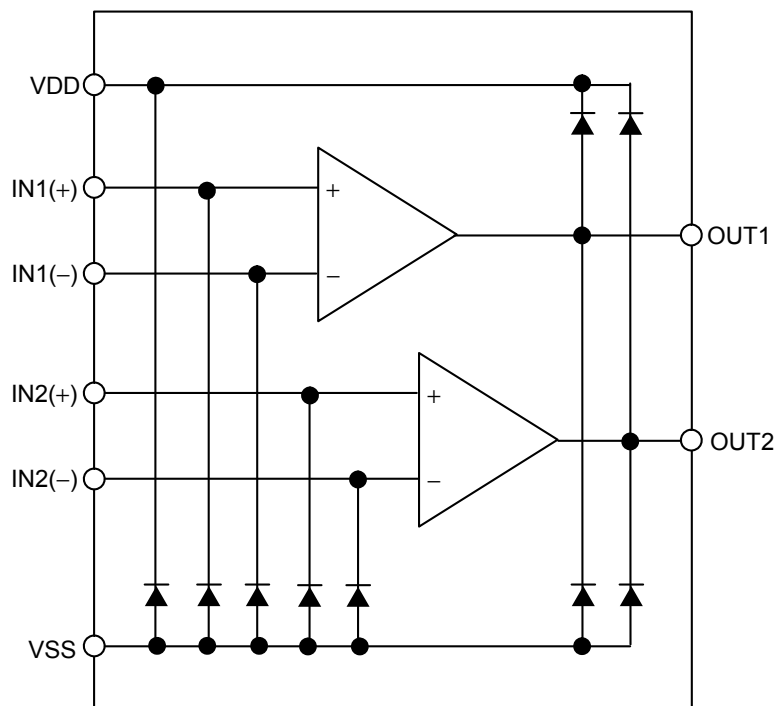


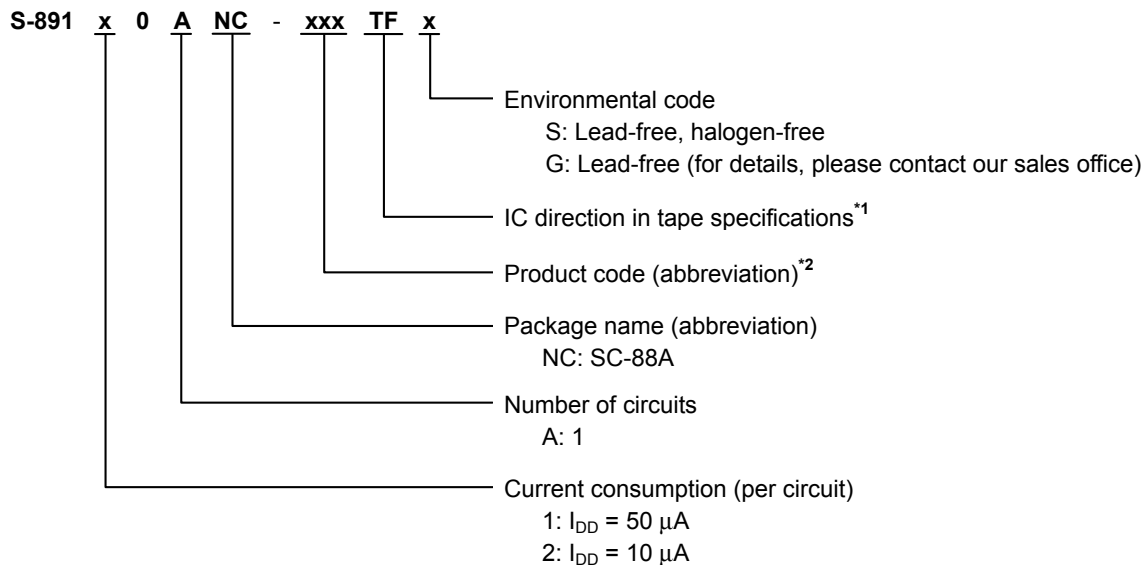
Figure 2

## ■ Product Name Structure

Users can select the product type for the S-89110/89120 Series. Refer to "1. Product name" regarding the contents of product name, "2. Packages" regarding the package drawings and "3. Product name list" regarding the product type.

### 1. Product name

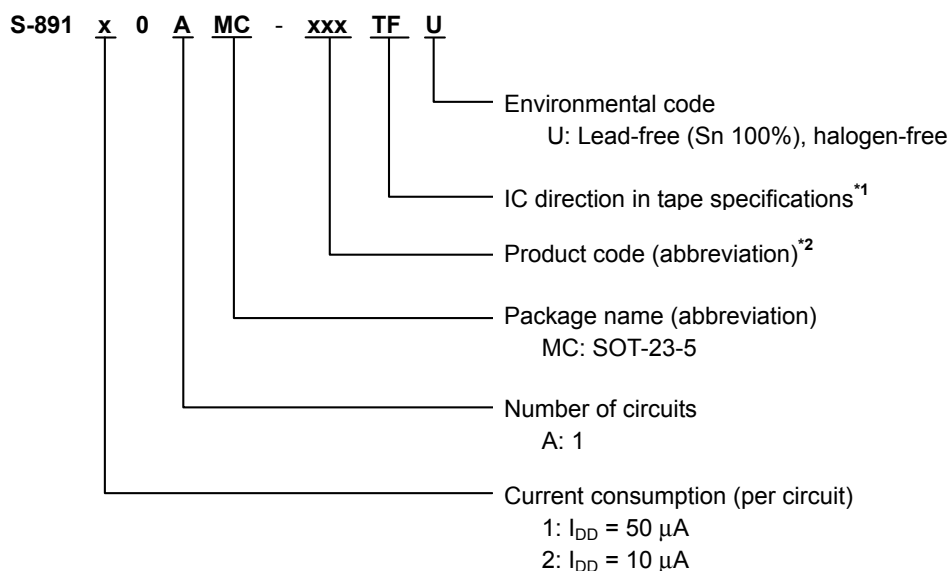
#### 1.1 SC-88A



\*1. Refer to the tape drawing.

\*2. Refer to "3. Product name list".

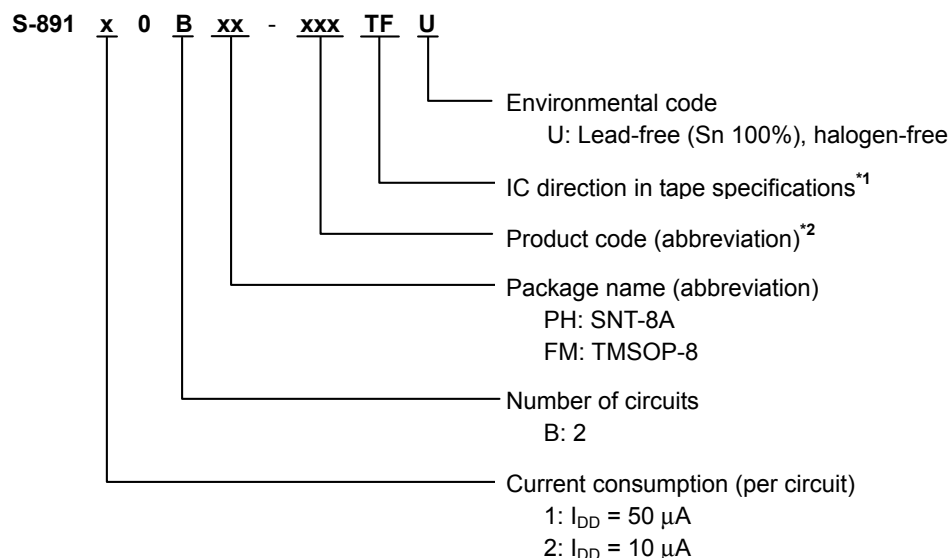
#### 1.2 SOT-23-5



\*1. Refer to the tape drawing.

\*2. Refer to "3. Product name list".

### 1.3 SNT-8A, TMSOP-8



\*1. Refer to the tape drawing.

\*2. Refer to "3. Product name list".

## 2. Packages

Table 1 Package Drawing Codes

| Package Name | Dimension    | Tape         | Reel         | Land         |
|--------------|--------------|--------------|--------------|--------------|
| SC-88A       | NP005-B-P-SD | NP005-B-C-SD | NP005-B-R-SD | —            |
| SOT-23-5     | MP005-A-P-SD | MP005-A-C-SD | MP005-A-R-SD | —            |
| SNT-8A       | PH008-A-P-SD | PH008-A-C-SD | PH008-A-R-SD | PH008-A-L-SD |
| TMSOP-8      | FM008-A-P-SD | FM008-A-C-SD | FM008-A-R-SD | —            |

## 3. Product name list

Table 2

| Product Name       | Current Consumption (per circuit) | Gain-bandwidth*1 | Number of Circuit | Package  |
|--------------------|-----------------------------------|------------------|-------------------|----------|
| S-89110ANC-1A1-TFz | 50 $\mu A$                        | 175 kHz          | 1                 | SC-88A   |
| S-89110AMC-1A1-TFU | 50 $\mu A$                        | 175 kHz          | 1                 | SOT-23-5 |
| S-89110BPH-H4A-TFU | 50 $\mu A$                        | 175 kHz          | 2                 | SNT-8A   |
| S-89110BFM-H4A-TFU | 50 $\mu A$                        | 175 kHz          | 2                 | TMSOP-8  |
| S-89120ANC-1A2-TFz | 10 $\mu A$                        | 35 kHz           | 1                 | SC-88A   |
| S-89120AMC-1A2-TFU | 10 $\mu A$                        | 35 kHz           | 1                 | SOT-23-5 |
| S-89120BPH-H4B-TFU | 10 $\mu A$                        | 35 kHz           | 2                 | SNT-8A   |
| S-89120BFM-H4B-TFU | 10 $\mu A$                        | 35 kHz           | 2                 | TMSOP-8  |

\*1. The value when  $V_{DD} = 3.0 V$

Remark 1. z: G or S

2. Please select products of environmental code = U for Sn 100%, halogen-free products.

## ■ Pin Configurations

### 1. SC-88A

Top view

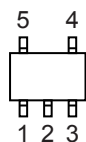


Figure 3

Table 3

(Product with 1 circuit)

| Pin No. | Symbol | Description               |
|---------|--------|---------------------------|
| 1       | IN(+)  | Non-inverted input pin    |
| 2       | VSS    | GND pin                   |
| 3       | IN(-)  | Inverted input pin        |
| 4       | OUT    | Output pin                |
| 5       | VDD    | Positive power supply pin |

### 2. SOT-23-5

Top view

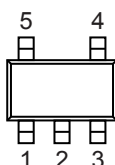


Figure 4

Table 4

(Product with 1 circuit)

| Pin No. | Symbol | Description               |
|---------|--------|---------------------------|
| 1       | IN(+)  | Non-inverted input pin    |
| 2       | VSS    | GND pin                   |
| 3       | IN(-)  | Inverted input pin        |
| 4       | OUT    | Output pin                |
| 5       | VDD    | Positive power supply pin |

### 3. SNT-8A

Top view

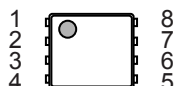


Figure 5

Table 5

(Product with 2 circuits)

| Pin No. | Symbol | Description               |
|---------|--------|---------------------------|
| 1       | OUT1   | Output pin 1              |
| 2       | IN1(-) | Inverted input pin 1      |
| 3       | IN1(+) | Non-inverted input pin 1  |
| 4       | VSS    | GND pin                   |
| 5       | IN2(+) | Non-inverted input pin 2  |
| 6       | IN2(-) | Inverted input pin 2      |
| 7       | OUT2   | Output pin 2              |
| 8       | VDD    | Positive power supply pin |

### 4. TMSOP-8

Top view

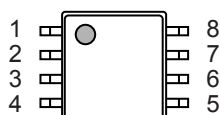


Figure 6

Table 6

(Product with 2 circuits)

| Pin No. | Symbol | Description               |
|---------|--------|---------------------------|
| 1       | OUT1   | Output pin 1              |
| 2       | IN1(-) | Inverted input pin 1      |
| 3       | IN1(+) | Non-inverted input pin 1  |
| 4       | VSS    | GND pin                   |
| 5       | IN2(+) | Non-inverted input pin 2  |
| 6       | IN2(-) | Inverted input pin 2      |
| 7       | OUT2   | Output pin 2              |
| 8       | VDD    | Positive power supply pin |

## ■ Absolute Maximum Ratings

Table 7

(Ta = +25°C unless otherwise specified)

| Item                          | Symbol              | Absolute Maximum Rating                                   | Unit |
|-------------------------------|---------------------|-----------------------------------------------------------|------|
| Power supply voltage          | V <sub>DD</sub>     | V <sub>SS</sub> – 0.3 to V <sub>SS</sub> + 10.0           | V    |
| Input voltage                 | V <sub>IN</sub>     | V <sub>SS</sub> – 0.3 to V <sub>SS</sub> + 7.0 (7.0 max.) | V    |
| Output voltage                | V <sub>OUT</sub>    | V <sub>SS</sub> – 0.3 to V <sub>DD</sub> + 0.3 (7.0 max.) | V    |
| Differential input voltage    | V <sub>IND</sub>    | ±7.0                                                      | V    |
| Output pin current            | I <sub>SINK</sub>   | 13                                                        | mA   |
|                               | I <sub>SOURCE</sub> | 9                                                         | mA   |
| Power dissipation             | SC-88A              | 350*1                                                     | mW   |
|                               | SOT-23-5            | 600*1                                                     | mW   |
|                               | SNT-8A              | 450*1                                                     | mW   |
|                               | TMSOP-8             | 650*1                                                     | mW   |
| Operating ambient temperature | T <sub>opr</sub>    | –40 to +85                                                | °C   |
| Storage temperature           | T <sub>stg</sub>    | –55 to +125                                               | °C   |

\*1. When mounted on board

[Mounted board]

(1) Board size: 114.3 mm × 76.2 mm × 1.6 mm

(2) Board name: JEDEC STANDARD51-7

**Caution** The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

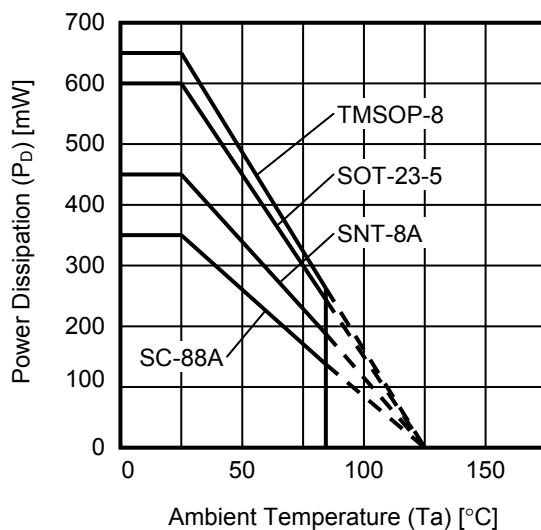


Figure 7 Power Dissipation of Package (When Mounted on Board)

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## S-89110/89120 Series

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### ■ Electrical Characteristics

Table 8

(Ta = +25°C unless otherwise specified)

| Item                                    | Symbol          | Condition | Min. | Typ. | Max. | Unit | Test Circuit |
|-----------------------------------------|-----------------|-----------|------|------|------|------|--------------|
| Range of operating power supply voltage | V <sub>DD</sub> | –         | 1.8  | –    | 5.5  | V    | –            |

#### 1. V<sub>DD</sub> = 5.0 V

Table 9

(Ta = +25°C unless otherwise specified)

#### DC Electrical Characteristics (V<sub>DD</sub> = 5.0 V)

| Item                                     | Symbol                             | Condition                                                                                         | Min.           | Typ. | Max. | Unit  | Test Circuit |   |
|------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------------|----------------|------|------|-------|--------------|---|
| Current consumption (per circuit)        | I <sub>DD</sub>                    | S-89110 Series                                                                                    | –              | 50   | 120  | μA    | 5            |   |
|                                          |                                    | S-89120 Series                                                                                    | –              | 10   | 30   | μA    | 5            |   |
| Input offset voltage                     | V <sub>IO</sub>                    | –                                                                                                 | –4             | ±3   | +4   | mV    | 1            |   |
| Input offset voltage drift               | $\frac{\Delta V_{IO}}{\Delta T_a}$ | T <sub>a</sub> = –40°C to +85°C                                                                   | –              | ±10  | –    | μV/°C | 1            |   |
| Input offset current                     | I <sub>IO</sub>                    | –                                                                                                 | –              | 1    | –    | pA    | –            |   |
| Input bias current                       | I <sub>BIAS</sub>                  | –                                                                                                 | –              | 1    | –    | pA    | –            |   |
| Common-mode input voltage range          | V <sub>CMR</sub>                   | –                                                                                                 | 0              | –    | 4.3  | V     | 2            |   |
| Voltage gain (open loop)                 | A <sub>VOL</sub>                   | V <sub>SS</sub> + 0.5 V ≤ V <sub>OUT</sub> ≤ V <sub>DD</sub> – 0.5 V,<br>V <sub>CMR</sub> = 2.5 V | 70             | 80   | –    | dB    | 8            |   |
| Maximum output swing voltage             | V <sub>OH</sub>                    | R <sub>L</sub> = 1.0 MΩ                                                                           | 4.9            | –    | –    | V     | 3            |   |
|                                          | V <sub>OL</sub>                    | R <sub>L</sub> = 1.0 MΩ                                                                           | –              | –    | 0.1  | V     | 4            |   |
| Common-mode input signal rejection ratio | CMRR                               | –                                                                                                 | 60             | 70   | –    | dB    | 2            |   |
| Power supply voltage rejection ratio     | PSRR                               | –                                                                                                 | 60             | 70   | –    | dB    | 1            |   |
| Source current                           | I <sub>SOURCE</sub>                | V <sub>OUT</sub> = 0 V                                                                            | S-89110 Series | 120  | –    | –     | μA           | 6 |
|                                          |                                    |                                                                                                   | S-89120 Series | 25   | –    | –     | μA           | 6 |
| Sink current                             | I <sub>SINK</sub>                  | V <sub>OUT</sub> = 0.5 V                                                                          | 9              | –    | –    | mA    | 7            |   |

Table 10

(Ta = +25°C unless otherwise specified)

#### AC Electrical Characteristics (V<sub>DD</sub> = 5.0 V)

| Item                   | Symbol | Condition                                                                       |                | Min. | Typ.  | Max. | Unit |
|------------------------|--------|---------------------------------------------------------------------------------|----------------|------|-------|------|------|
| Slew rate              | SR     | R <sub>L</sub> = 1.0 MΩ, C <sub>L</sub> = 15 pF<br>(Refer to <b>Figure 16</b> ) | S-89110 Series | –    | 0.07  | –    | V/μs |
|                        |        |                                                                                 | S-89120 Series | –    | 0.015 | –    | V/μs |
| Gain-bandwidth product | GBP    | S-89110 Series                                                                  |                | –    | 180   | –    | kHz  |
|                        |        | S-89120 Series                                                                  |                | –    | 40    | –    | kHz  |

**2.  $V_{DD} = 3.0\text{ V}$**

**Table 11**

**DC Electrical Characteristics ( $V_{DD} = 3.0\text{ V}$ )**

( $T_a = +25^\circ\text{C}$  unless otherwise specified)

| Item                                     | Symbol                             | Condition                                                                                         | Min.           | Typ. | Max. | Unit  | Test Circuit |   |
|------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------------|----------------|------|------|-------|--------------|---|
| Current consumption (per circuit)        | I <sub>DD</sub>                    | S-89110 Series                                                                                    | –              | 50   | 120  | μA    | 5            |   |
|                                          |                                    | S-89120 Series                                                                                    | –              | 10   | 30   | μA    | 5            |   |
| Input offset voltage                     | V <sub>IO</sub>                    | –                                                                                                 | –4             | ±3   | +4   | mV    | 1            |   |
| Input offset voltage drift               | $\frac{\Delta V_{IO}}{\Delta T_a}$ | T <sub>a</sub> = –40°C to +85°C                                                                   | –              | ±10  | –    | μV/°C | 1            |   |
| Input offset current                     | I <sub>IO</sub>                    | –                                                                                                 | –              | 1    | –    | pA    | –            |   |
| Input bias current                       | I <sub>BIAS</sub>                  | –                                                                                                 | –              | 1    | –    | pA    | –            |   |
| Common-mode input voltage range          | V <sub>CMR</sub>                   | –                                                                                                 | 0              | –    | 2.3  | V     | 2            |   |
| Voltage gain (open loop)                 | A <sub>VOL</sub>                   | V <sub>SS</sub> + 0.5 V ≤ V <sub>OUT</sub> ≤ V <sub>DD</sub> – 0.5 V,<br>V <sub>CMR</sub> = 1.5 V | 70             | 80   | –    | dB    | 8            |   |
| Maximum output swing voltage             | V <sub>OH</sub>                    | R <sub>L</sub> = 1.0 MΩ                                                                           | 2.9            | –    | –    | V     | 3            |   |
|                                          | V <sub>OL</sub>                    | R <sub>L</sub> = 1.0 MΩ                                                                           | –              | –    | 0.1  | V     | 4            |   |
| Common-mode input signal rejection ratio | CMRR                               | –                                                                                                 | 60             | 70   | –    | dB    | 2            |   |
| Power supply voltage rejection ratio     | PSRR                               | –                                                                                                 | 60             | 70   | –    | dB    | 1            |   |
| Source current                           | I <sub>SOURCE</sub>                | V <sub>OUT</sub> = 0 V                                                                            | S-89110 Series | 120  | –    | –     | μA           | 6 |
|                                          |                                    |                                                                                                   | S-89120 Series | 25   | –    | –     | μA           | 6 |
| Sink current                             | I <sub>SINK</sub>                  | V <sub>OUT</sub> = 0.5 V                                                                          | 8              | –    | –    | mA    | 7            |   |

**Table 12**

**AC Electrical Characteristics ( $V_{DD} = 3.0\text{ V}$ )**

( $T_a = +25^\circ\text{C}$  unless otherwise specified)

| Item                   | Symbol | Condition                                                                       |                | Min. | Typ.  | Max. | Unit |
|------------------------|--------|---------------------------------------------------------------------------------|----------------|------|-------|------|------|
| Slew rate              | SR     | R <sub>L</sub> = 1.0 MΩ, C <sub>L</sub> = 15 pF<br>(Refer to <b>Figure 16</b> ) | S-89110 Series | –    | 0.07  | –    | V/μs |
|                        |        |                                                                                 | S-89120 Series | –    | 0.015 | –    | V/μs |
| Gain-bandwidth product | GBP    | S-89110 Series                                                                  |                | –    | 175   | –    | kHz  |
|                        |        | S-89120 Series                                                                  |                | –    | 35    | –    | kHz  |



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## S-89110/89120 Series

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### 3. $V_{DD} = 1.8 \text{ V}$

**Table 13**

**DC Electrical Characteristics ( $V_{DD} = 1.8 \text{ V}$ )**

( $T_a = +25^\circ\text{C}$  unless otherwise specified)

| Item                                     | Symbol                             | Condition                                                                                        | Min.           | Typ.     | Max. | Unit                         | Test Circuit |
|------------------------------------------|------------------------------------|--------------------------------------------------------------------------------------------------|----------------|----------|------|------------------------------|--------------|
| Current consumption (per circuit)        | $I_{DD}$                           | S-89110 Series                                                                                   | –              | 50       | 120  | $\mu\text{A}$                | 5            |
|                                          |                                    | S-89120 Series                                                                                   | –              | 10       | 30   | $\mu\text{A}$                | 5            |
| Input offset voltage                     | $V_{IO}$                           | –                                                                                                | –4             | $\pm 3$  | +4   | mV                           | 1            |
| Input offset voltage drift               | $\frac{\Delta V_{IO}}{\Delta T_a}$ | $T_a = -40^\circ\text{C}$ to $+85^\circ\text{C}$                                                 | –              | $\pm 10$ | –    | $\mu\text{V}/^\circ\text{C}$ | 1            |
| Input offset current                     | $I_{IO}$                           | –                                                                                                | –              | 1        | –    | pA                           | –            |
| Input bias current                       | $I_{BIAS}$                         | –                                                                                                | –              | 1        | –    | pA                           | –            |
| Common-mode input voltage range          | $V_{CMR}$                          | –                                                                                                | 0              | –        | 1.1  | V                            | 2            |
| Voltage gain (open loop)                 | $A_{VOL}$                          | $V_{SS} + 0.5 \text{ V} \leq V_{OUT} \leq V_{DD} - 0.5 \text{ V}$ ,<br>$V_{CMR} = 0.9 \text{ V}$ | 70             | 80       | –    | dB                           | 8            |
| Maximum output swing voltage             | $V_{OH}$                           | $R_L = 1.0 \text{ M}\Omega$                                                                      | 1.7            | –        | –    | V                            | 3            |
|                                          | $V_{OL}$                           | $R_L = 1.0 \text{ M}\Omega$                                                                      | –              | –        | 0.1  | V                            | 4            |
| Common-mode input signal rejection ratio | CMRR                               | –                                                                                                | 60             | 70       | –    | dB                           | 2            |
| Power supply voltage rejection ratio     | PSRR                               | –                                                                                                | 60             | 70       | –    | dB                           | 1            |
| Source current                           | $I_{SOURCE}$                       | $V_{OUT} = 0 \text{ V}$                                                                          | S-89110 Series | 100      | –    | $\mu\text{A}$                | 6            |
|                                          |                                    |                                                                                                  | S-89120 Series | 20       | –    | $\mu\text{A}$                | 6            |
| Sink current                             | $I_{SINK}$                         | $V_{OUT} = 0.5 \text{ V}$                                                                        | 5              | –        | –    | mA                           | 7            |

**Table 14**

**AC Electrical Characteristics ( $V_{DD} = 1.8 \text{ V}$ )**

( $T_a = +25^\circ\text{C}$  unless otherwise specified)

| Item                   | Symbol | Condition                                                                           | Min.           | Typ. | Max.  | Unit                   |
|------------------------|--------|-------------------------------------------------------------------------------------|----------------|------|-------|------------------------|
| Slew rate              | SR     | $R_L = 1.0 \text{ M}\Omega$ , $C_L = 15 \text{ pF}$<br>(Refer to <b>Figure 16</b> ) | S-89110 Series | –    | 0.07  | $\text{V}/\mu\text{s}$ |
|                        |        |                                                                                     | S-89120 Series | –    | 0.015 | $\text{V}/\mu\text{s}$ |
| Gain-bandwidth product | GBP    | S-89110 Series                                                                      | –              | 160  | –     | kHz                    |
|                        |        | S-89120 Series                                                                      | –              | 30   | –     | kHz                    |

## ■ Test Circuit (Per Circuit)

### 1. Power supply voltage rejection ratio, input offset voltage

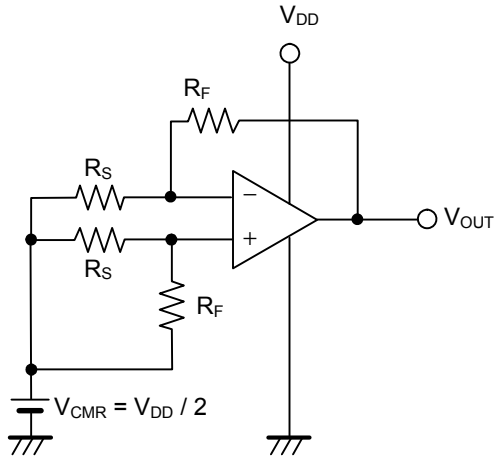


Figure 8

#### • Power supply voltage rejection ratio (PSRR)

The power supply voltage rejection ratio (PSRR) can be calculated by the following expression, with  $V_{OUT}$  measured at each  $V_{DD}$ .

Test conditions:

When  $V_{DD} = 1.8\text{ V}$ :  $V_{DD} = V_{DD1}$ ,  $V_{OUT} = V_{OUT1}$ ,

When  $V_{DD} = 5.0\text{ V}$ :  $V_{DD} = V_{DD2}$ ,  $V_{OUT} = V_{OUT2}$

$$\text{PSRR} = 20 \log \left( \left| \frac{V_{DD1} - V_{DD2}}{\left( V_{OUT1} - \frac{V_{DD1}}{2} \right) - \left( V_{OUT2} - \frac{V_{DD2}}{2} \right)} \right| \times \frac{R_F + R_S}{R_S} \right)$$

#### • Input offset voltage ( $V_{IO}$ )

$$V_{IO} = \left( V_{OUT} - \frac{V_{DD}}{2} \right) \times \frac{R_S}{R_F + R_S}$$

### 2. Common-mode input signal rejection ratio, common-mode input voltage range

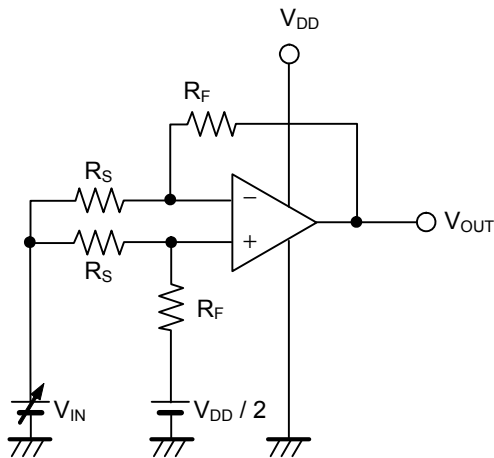


Figure 9

#### • Common-mode input signal rejection ratio (CMRR)

The common-mode input signal rejection ratio (CMRR) can be calculated by the following expression, with  $V_{OUT}$  measured at each  $V_{IN}$ .

Test conditions:

When  $V_{IN} = V_{CMR\text{ Max.}}$ :  $V_{IN} = V_{IN1}$ ,  $V_{OUT} = V_{OUT1}$ ,

When  $V_{IN} = V_{DD} / 2$ :  $V_{IN} = V_{IN2}$ ,  $V_{OUT} = V_{OUT2}$

$$\text{CMRR} = 20 \log \left( \left| \frac{V_{IN1} - V_{IN2}}{V_{OUT1} - V_{OUT2}} \right| \times \frac{R_F + R_S}{R_S} \right)$$

#### • Common-mode input voltage range ( $V_{CMR}$ )

The common-mode input voltage range is the range of  $V_{IN}$  in which  $V_{OUT}$  satisfies the common-mode input signal rejection ratio specifications.

### 3. Maximum output swing voltage ( $V_{OH}$ )

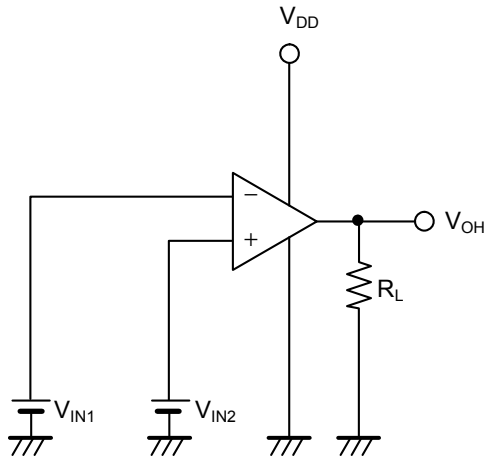


Figure 10

#### • Maximum output swing voltage ( $V_{OH}$ )

Test conditions:

$$V_{IN1} = \frac{V_{DD}}{2} - 0.1 \text{ V}$$

$$V_{IN2} = \frac{V_{DD}}{2} + 0.1 \text{ V}$$

$$R_L = 1 \text{ M}\Omega$$

### 4. Maximum output swing voltage ( $V_{OL}$ )

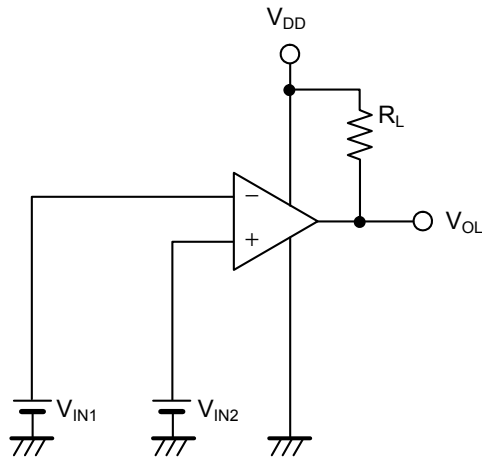


Figure 11

#### • Maximum output swing voltage ( $V_{OL}$ )

Test conditions:

$$V_{IN1} = \frac{V_{DD}}{2} + 0.1 \text{ V}$$

$$V_{IN2} = \frac{V_{DD}}{2} - 0.1 \text{ V}$$

$$R_L = 1 \text{ M}\Omega$$

### 5. Current consumption

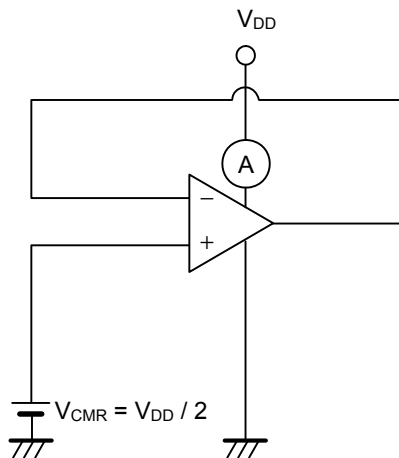


Figure 12

#### • Current consumption ( $I_{DD}$ )

## 6. Source current

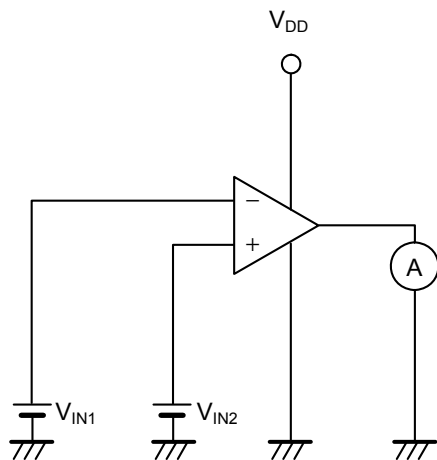


Figure 13

### • Source current ( $I_{SOURCE}$ )

Test conditions:

$$V_{IN1} = \frac{V_{DD}}{2} - 0.5 \text{ V}$$

$$V_{IN2} = \frac{V_{DD}}{2} + 0.5 \text{ V}$$

## 7. Sink current

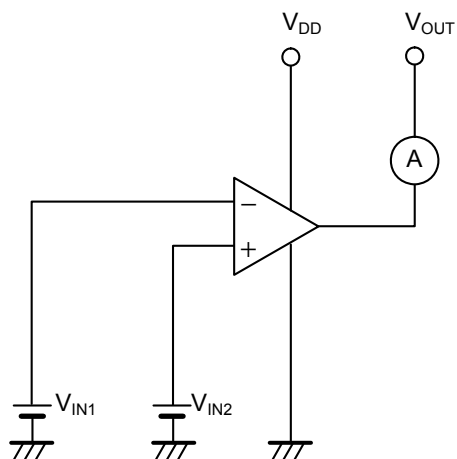


Figure 14

### • Sink current ( $I_{SINK}$ )

Test conditions:

$$V_{OUT} = V_{SS} + 0.5 \text{ V}$$

$$V_{IN1} = \frac{V_{DD}}{2} + 0.5 \text{ V}$$

$$V_{IN2} = \frac{V_{DD}}{2} - 0.5 \text{ V}$$

## 8. Voltage gain (open loop)

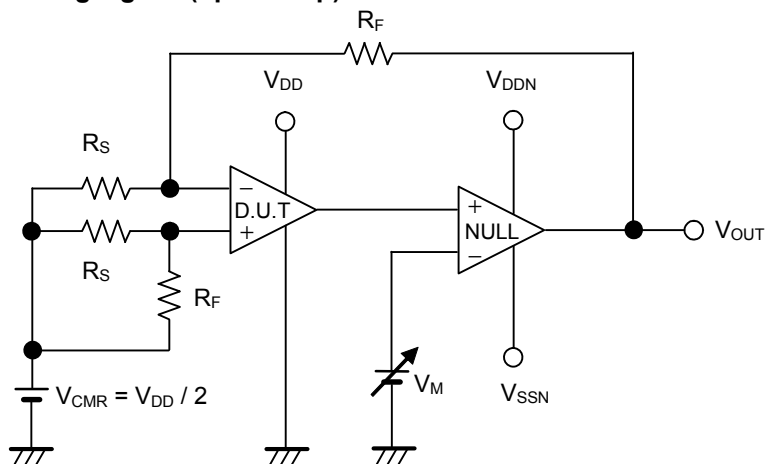


Figure 15

### • Voltage-gain (open loop) ( $A_{VOL}$ )

The voltage gain ( $A_{VOL}$ ) can be calculated by the following expression, with  $V_{OUT}$  measured at each  $V_M$ .

Test conditions:

When  $V_M = V_{DD} - 0.5\text{ V}$ :  $V_M = V_{M1}$ ,  $V_{OUT} = V_{OUT1}$ ,

When  $V_M = V_{SS} + 0.5\text{ V}$ :  $V_M = V_{M2}$ ,  $V_{OUT} = V_{OUT2}$

$$A_{VOL} = 20 \log \left( \left| \frac{V_{M1} - V_{M2}}{V_{OUT1} - V_{OUT2}} \right| \times \frac{R_F + R_S}{R_S} \right)$$

## 9. Slew rate (SR)

Measured by the voltage follower circuit.

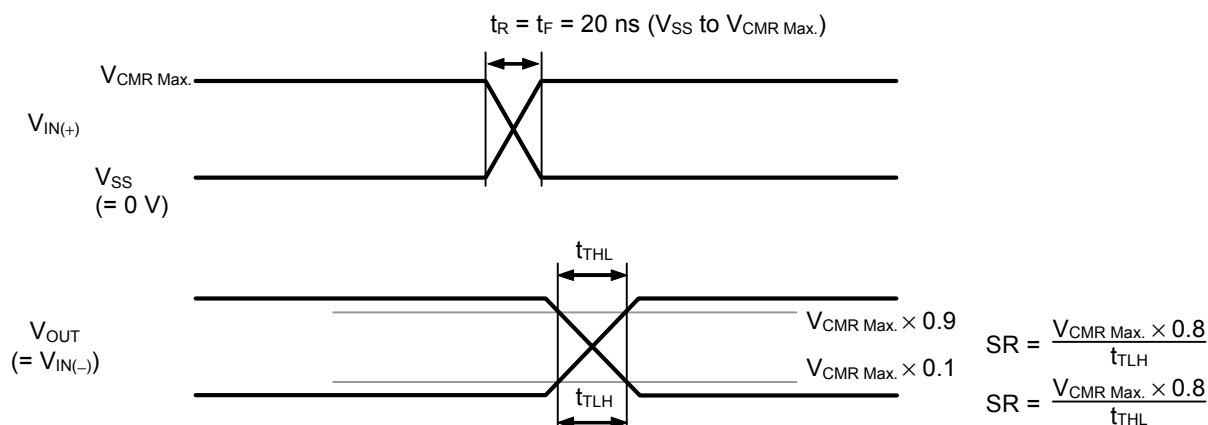


Figure 16

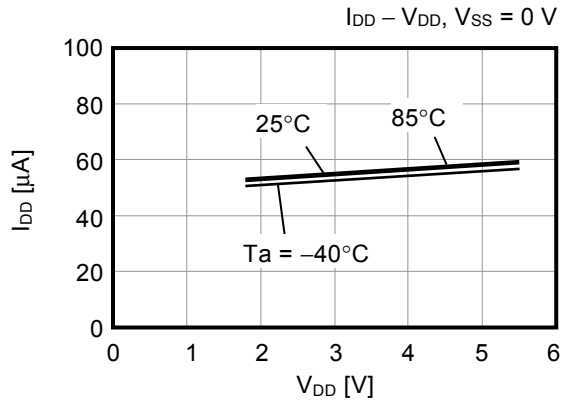
## ■ Precautions

- Generally an operational amplifier may cause oscillation, depending on the selection of external parts. Perform thorough evaluation using the actual application to set the constant.
- Do not apply an electrostatic discharge to this IC that exceeds performance ratings of the built-in electrostatic protection circuit.
- SII Semiconductor Corporation claims no responsibility for any disputes arising out of or in connection with any infringement by products including this IC of patents owned by a third party.

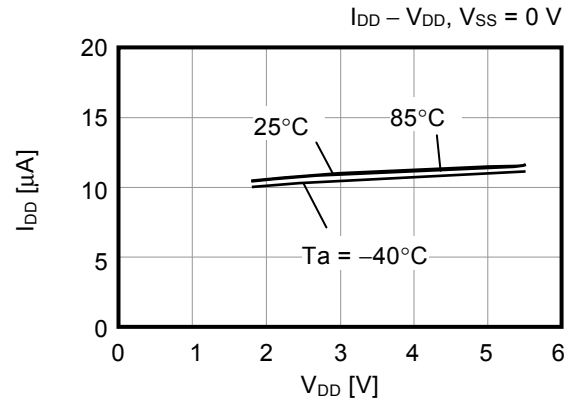
## ■ Characteristics (Typical Data)

### 1. Current consumption (per circuit) vs. Power supply voltage

#### 1.1 S-89110 Series

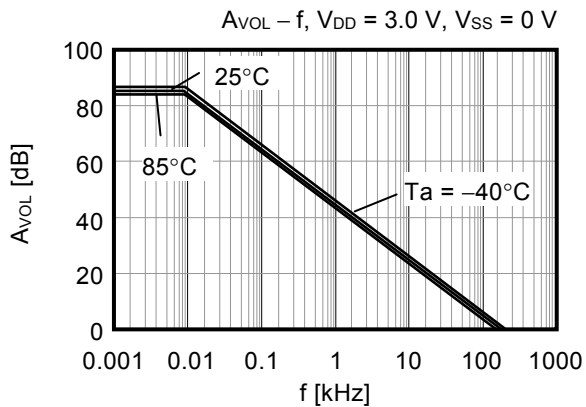


#### 1.2 S-89120 Series

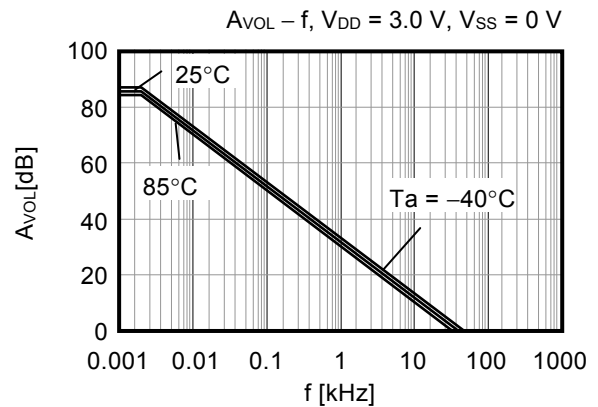


### 2. Voltage gain vs. Frequency

#### 2.1 S-89110 Series



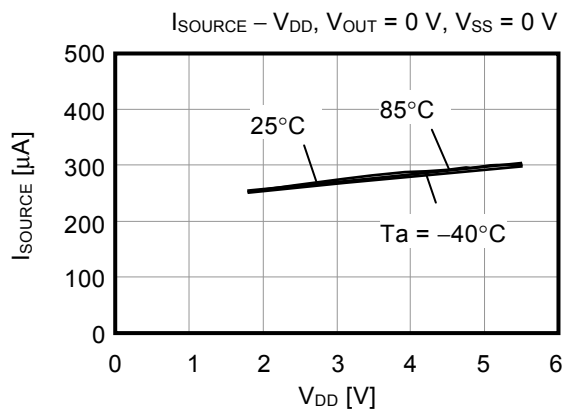
#### 2.2 S-89120 Series



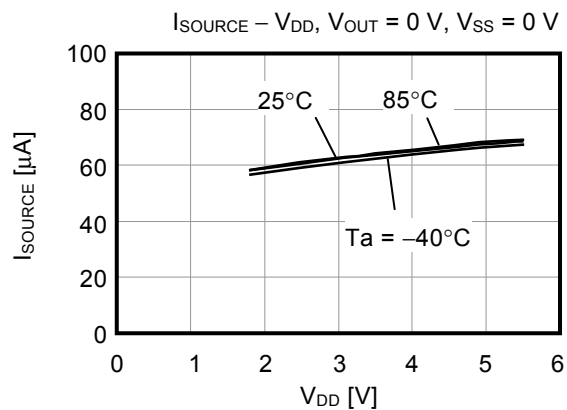
### 3. Output current

#### 3.1 $I_{SOURCE}$ vs. Power supply voltage

##### 3.1.1 S-89110 Series

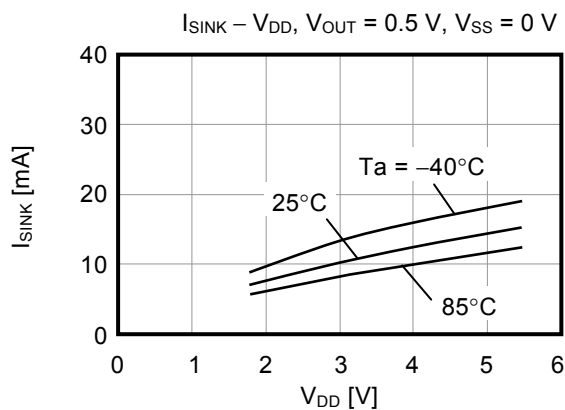


##### 3.1.2 S-89120 Series

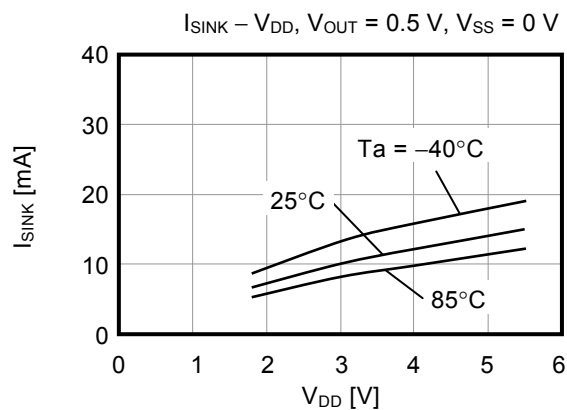


#### 3.2 $I_{SINK}$ vs. Power supply voltage

##### 3.2.1 S-89110 Series



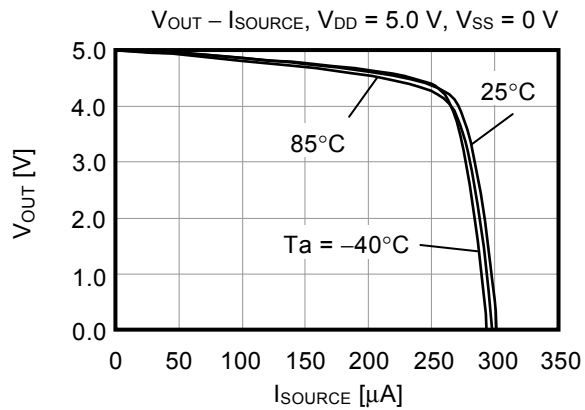
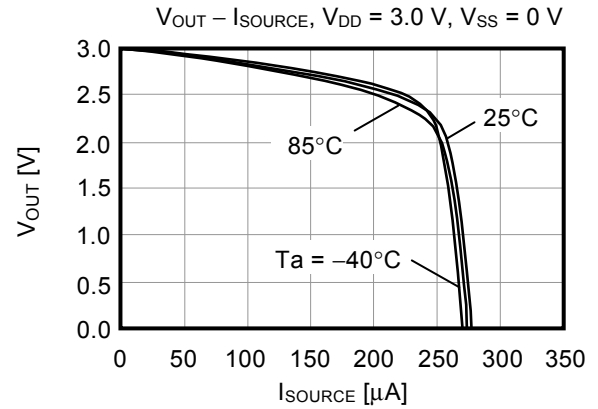
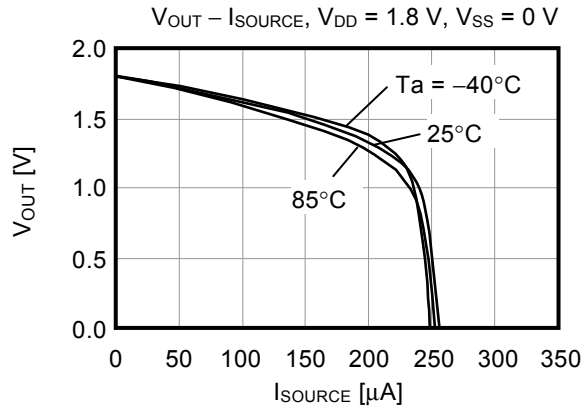
##### 3.2.2 S-89120 Series



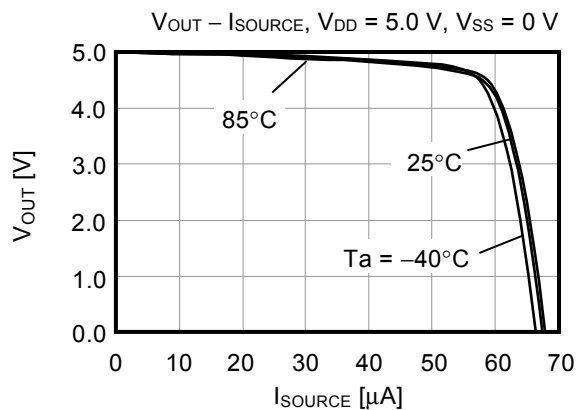
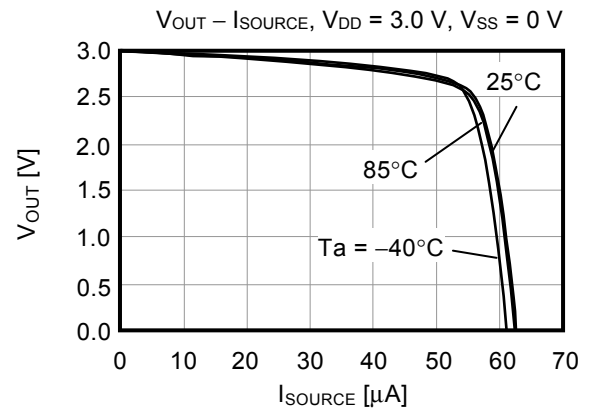
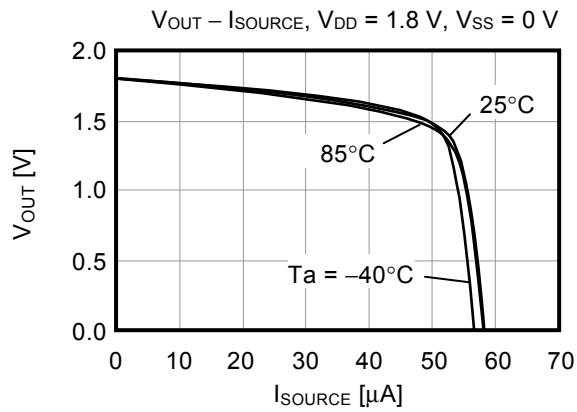


### 3.3 Output voltage ( $V_{OUT}$ ) vs. $I_{SOURCE}$

#### 3.3.1 S-89110 Series

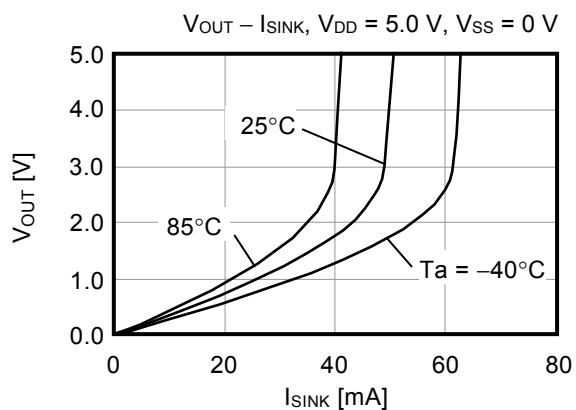
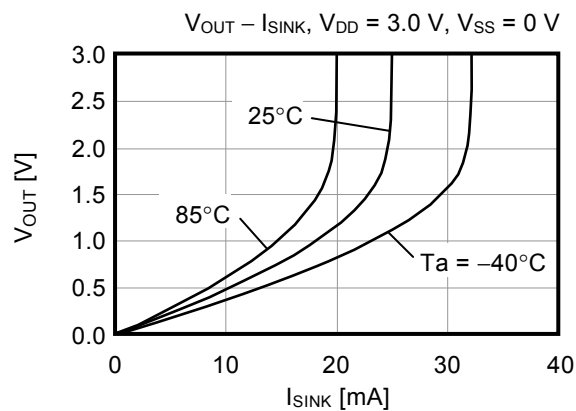
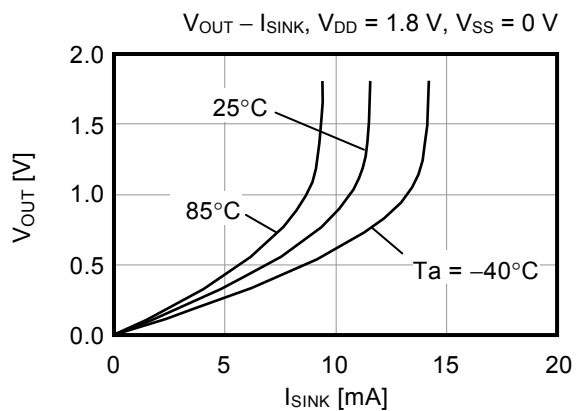


#### 3.3.2 S-89120 Series

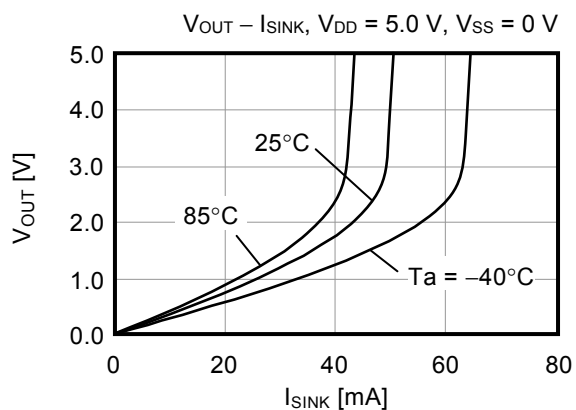
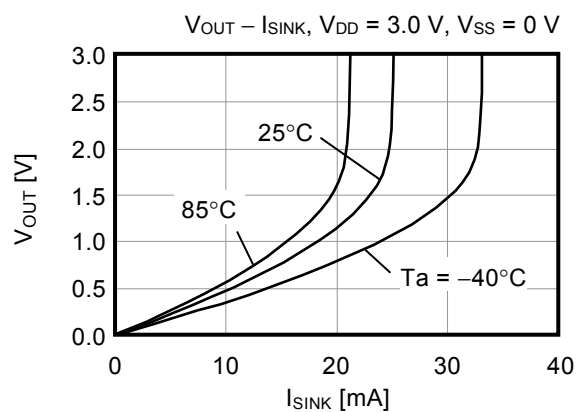
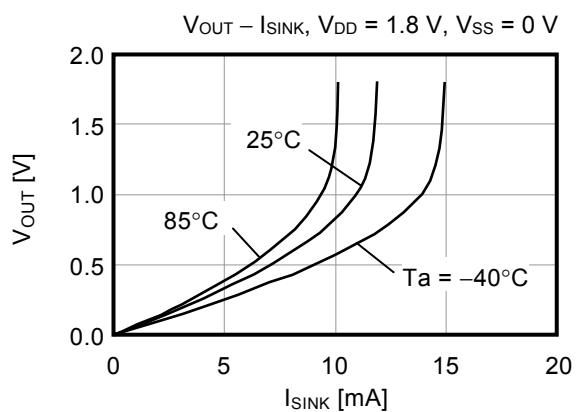


### 3.4 Output voltage ( $V_{OUT}$ ) vs. $I_{SINK}$

#### 3.4.1 S-89110 Series

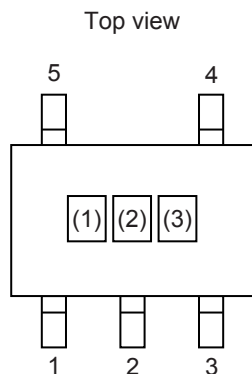


#### 3.4.2 S-89120 Series



## ■ Marking Specifications

### 1. SC-88A



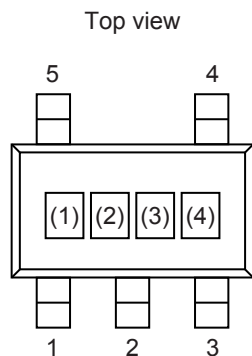
(1) to (3): Product Code (refer to **Product Name vs. Product Code**)

#### Product Name vs. Product Code

| Product Name       | Product Code |     |     |
|--------------------|--------------|-----|-----|
|                    | (1)          | (2) | (3) |
| S-89110ANC-1A1-TFz | 1            | A   | 1   |
| S-89120ANC-1A2-TFz | 1            | A   | 2   |

**Remark** z: G or S

### 2. SOT-23-5

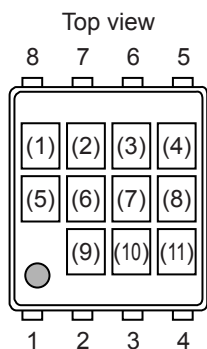


(1) to (3): Product Code (refer to **Product Name vs. Product Code**)  
(4): Lot number

#### Product Name vs. Product Code

| Product Name       | Product Code |     |     |
|--------------------|--------------|-----|-----|
|                    | (1)          | (2) | (3) |
| S-89110AMC-1A1-TFU | 1            | A   | 1   |
| S-89120AMC-1A2-TFU | 1            | A   | 2   |

### 3. SNT-8A

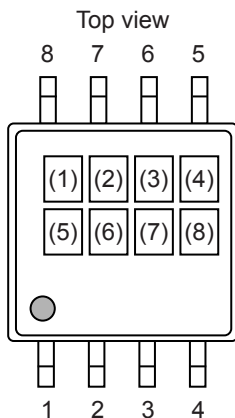


- (1): Blank
- (2) to (4): Product Code (refer to **Product Name vs. Product Code**)
- (5), (6): Blank
- (7) to (11): Lot number

**Product Name vs. Product Code**

| Product Name       | Product Code |     |     |
|--------------------|--------------|-----|-----|
|                    | (2)          | (3) | (4) |
| S-89110BPH-H4A-TFU | H            | 4   | A   |
| S-89120BPH-H4B-TFU | H            | 4   | B   |

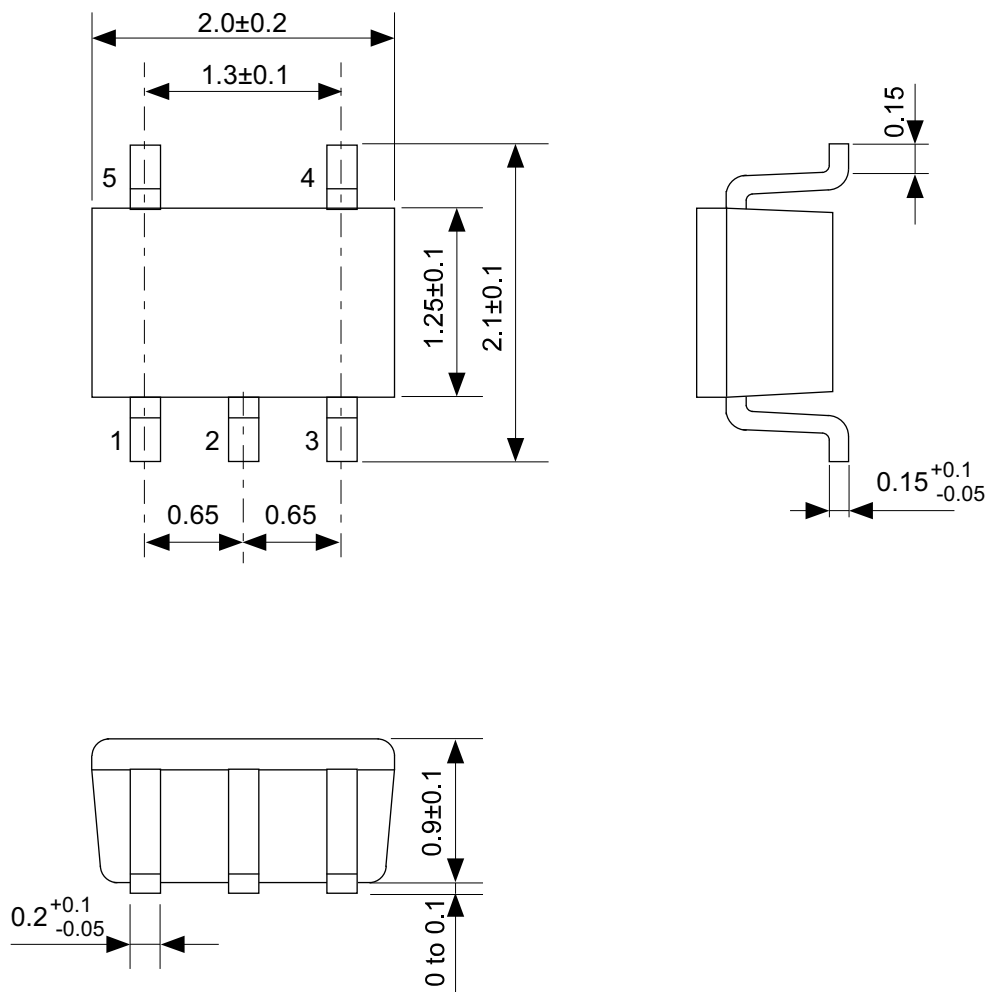
### 4. TMSOP-8



- (1): Blank
- (2) to (4): Product Code (refer to **Product Name vs. Product Code**)
- (5): Blank
- (6) to (8): Lot number

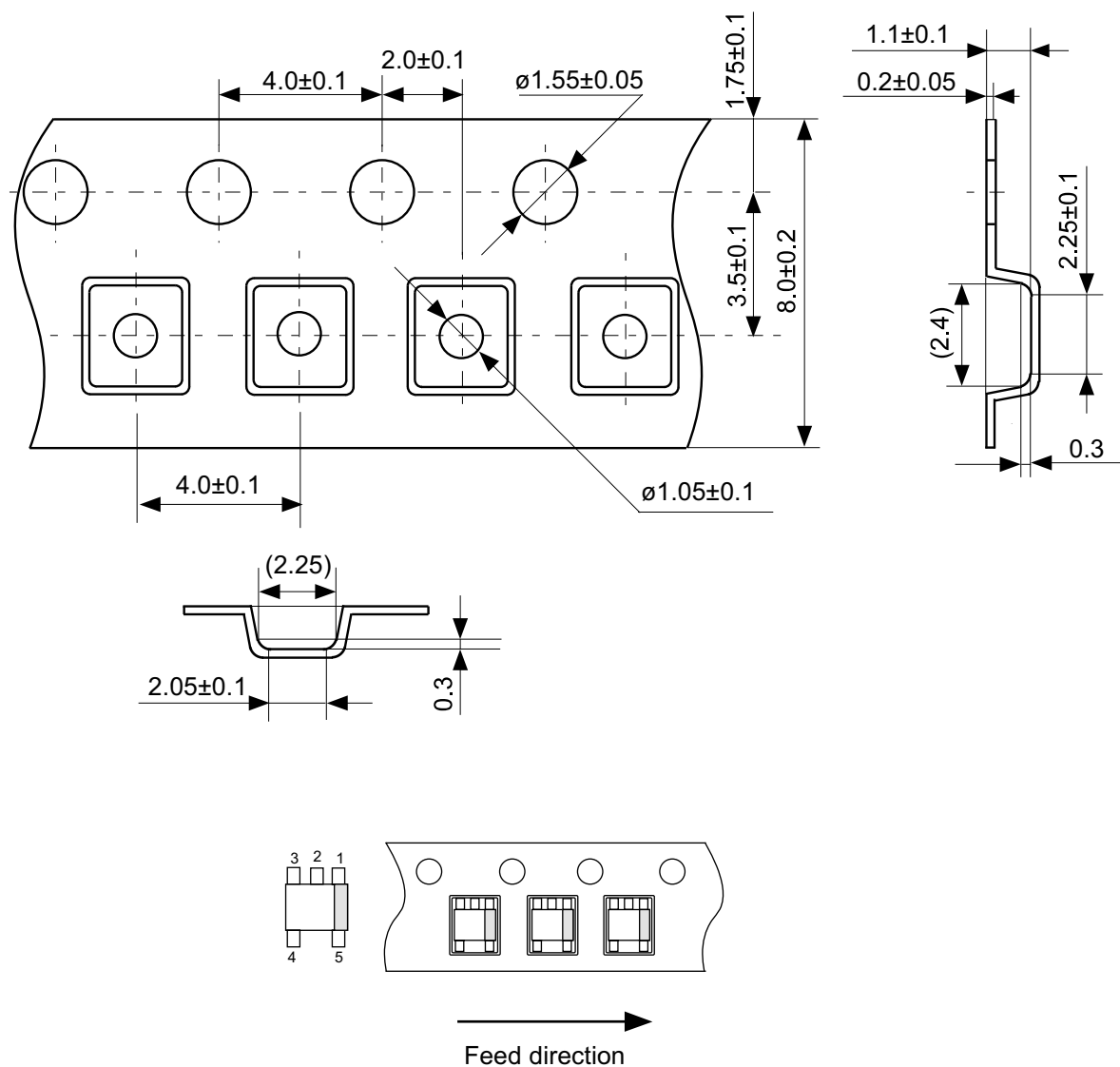
**Product Name vs. Product Code**

| Product Name       | Product Code |     |     |
|--------------------|--------------|-----|-----|
|                    | (2)          | (3) | (4) |
| S-89110BFM-H4A-TFU | H            | 4   | A   |
| S-89120BFM-H4B-TFU | H            | 4   | B   |



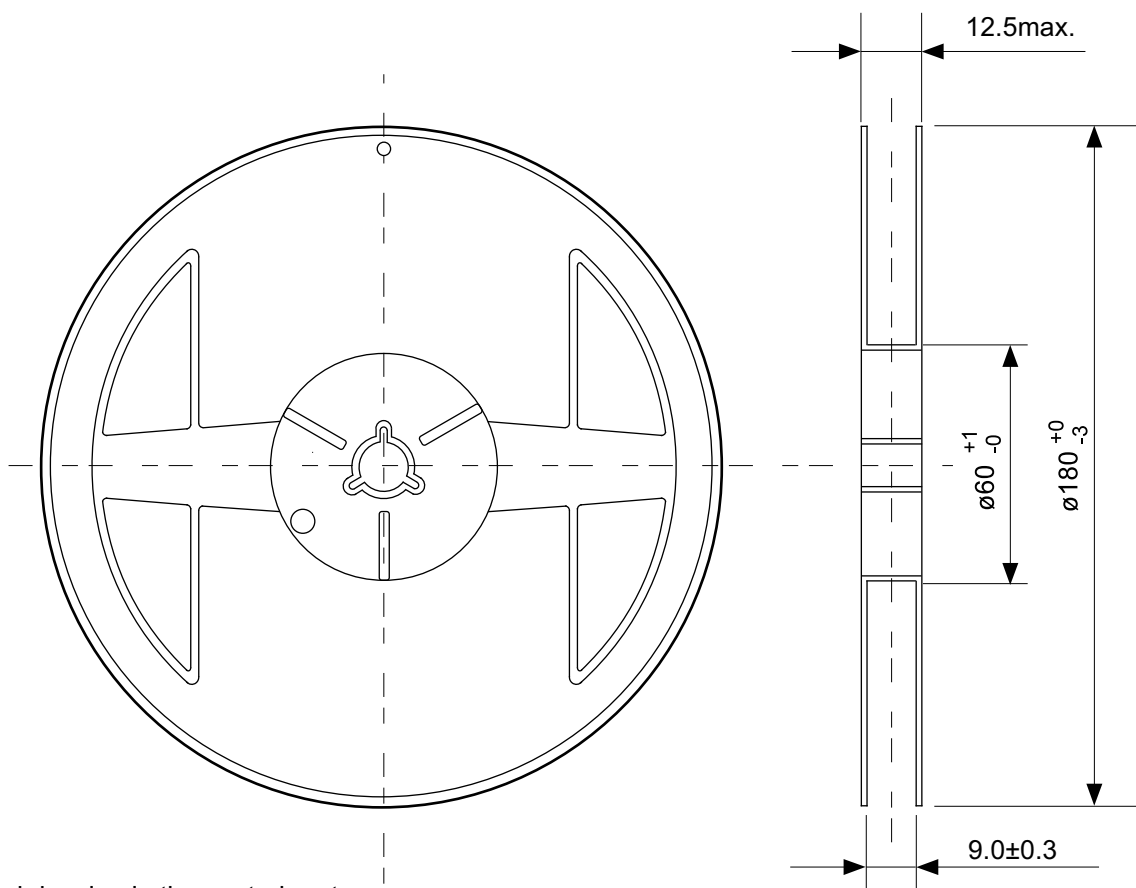
No. NP005-B-P-SD-1.1

|                               |                        |
|-------------------------------|------------------------|
| TITLE                         | SC88A-B-PKG Dimensions |
| No.                           | NP005-B-P-SD-1.1       |
| SCALE                         |                        |
| UNIT                          | mm                     |
|                               |                        |
| SII Semiconductor Corporation |                        |

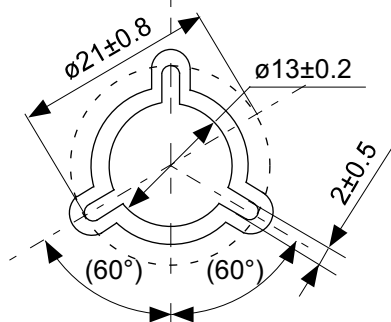


No. NP005-B-C-SD-2.0

|                               |                      |
|-------------------------------|----------------------|
| TITLE                         | SC88A-B-Carrier Tape |
| No.                           | NP005-B-C-SD-2.0     |
| SCALE                         |                      |
| UNIT                          | mm                   |
|                               |                      |
| SII Semiconductor Corporation |                      |

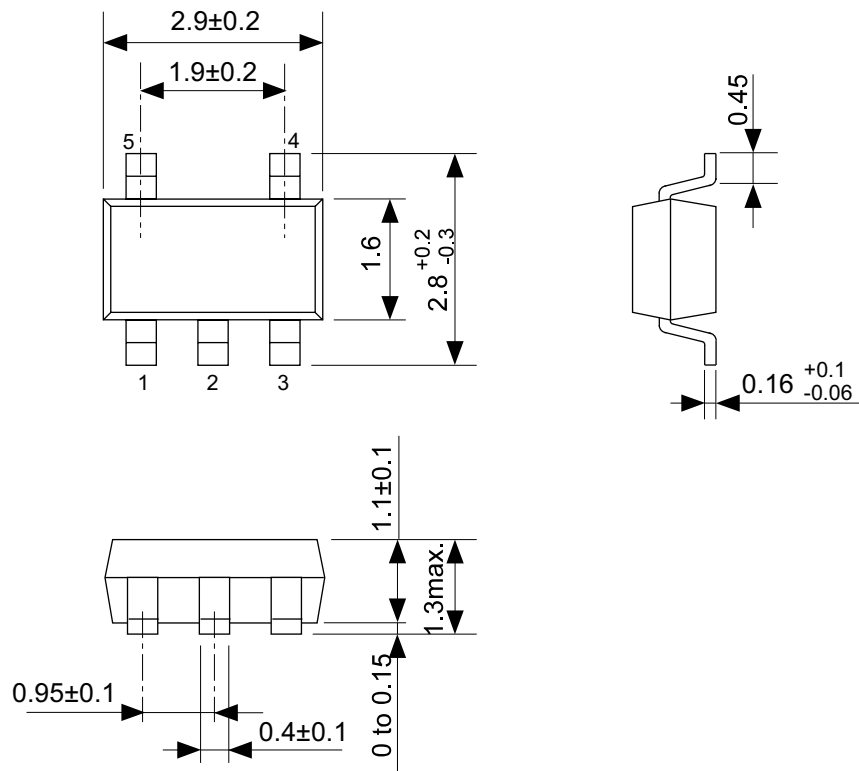


Enlarged drawing in the central part



No. NP005-B-R-SD-2.1

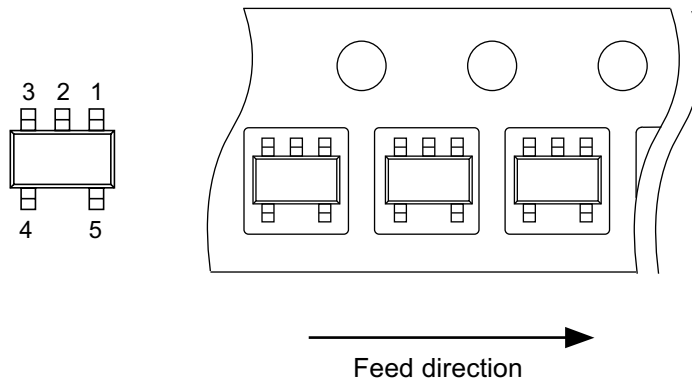
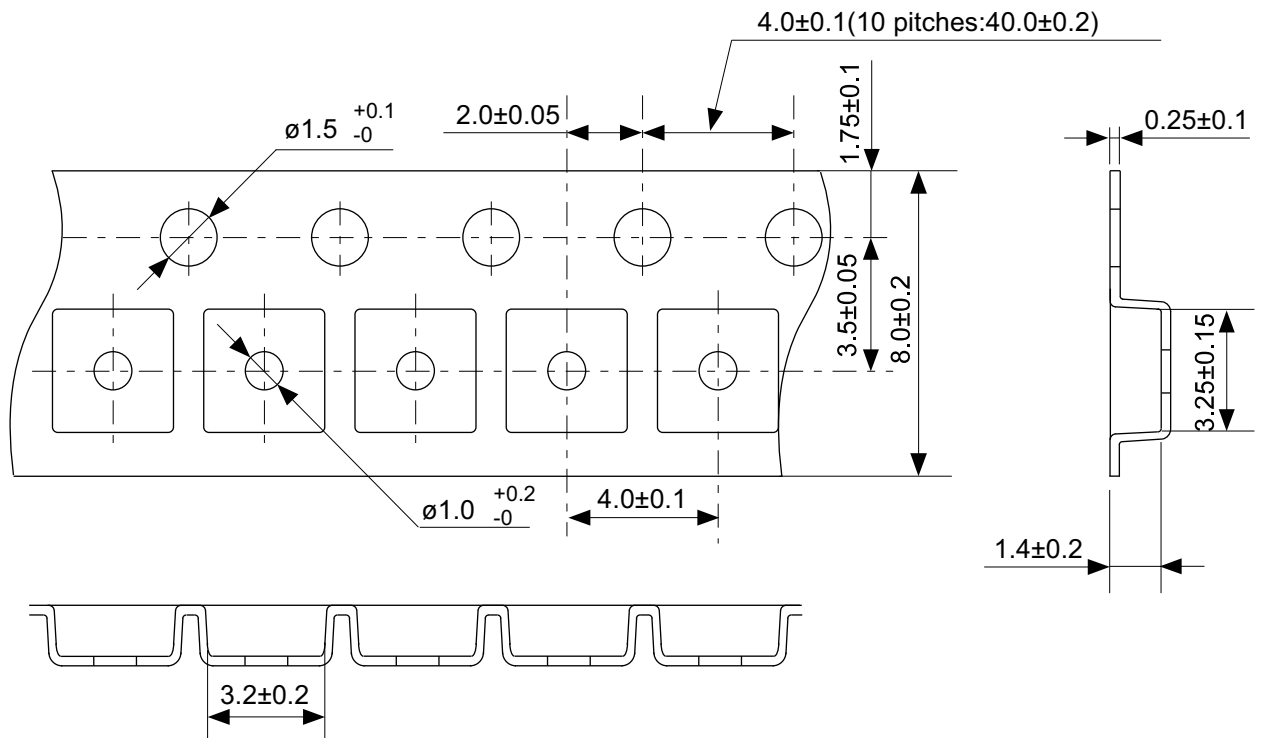
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|-------------------------------|------------------|------|------|
| TITLE                         | SC88A-B-Reel     |      |      |
| No.                           | NP005-B-R-SD-2.1 |      |      |
| SCALE                         |                  | QTY. | 3000 |
| UNIT                          | mm               |      |      |
|                               |                  |      |      |
| SII Semiconductor Corporation |                  |      |      |



No. MP005-A-P-SD-1.2

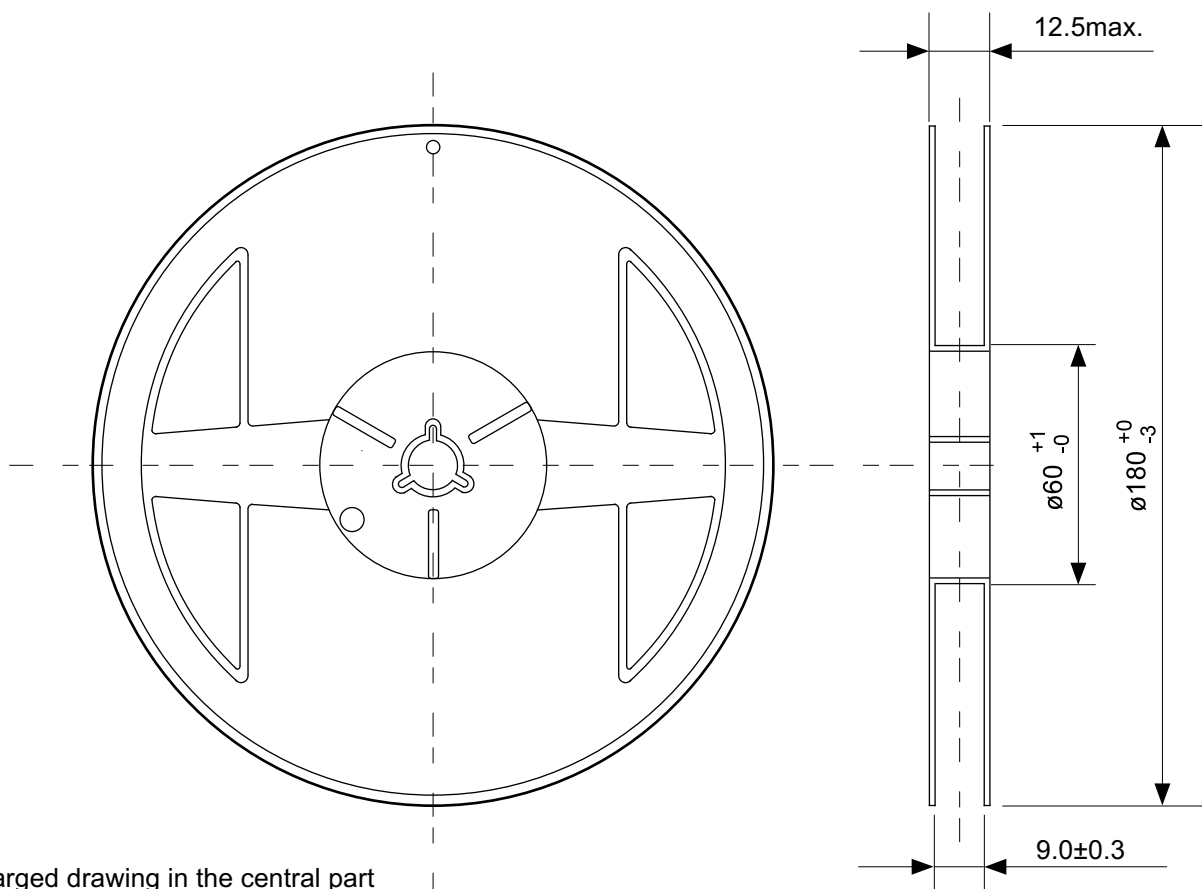
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|-------------------------------|-------------------------|
| TITLE                         | SOT235-A-PKG Dimensions |
| No.                           | MP005-A-P-SD-1.2        |
| SCALE                         |                         |
| UNIT                          | mm                      |
|                               |                         |
| SII Semiconductor Corporation |                         |



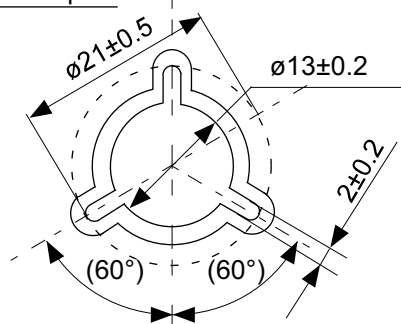


No. MP005-A-C-SD-2.1

|                               |                       |
|-------------------------------|-----------------------|
| TITLE                         | SOT235-A-Carrier Tape |
| No.                           | MP005-A-C-SD-2.1      |
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| UNIT                          | mm                    |
|                               |                       |
| SII Semiconductor Corporation |                       |

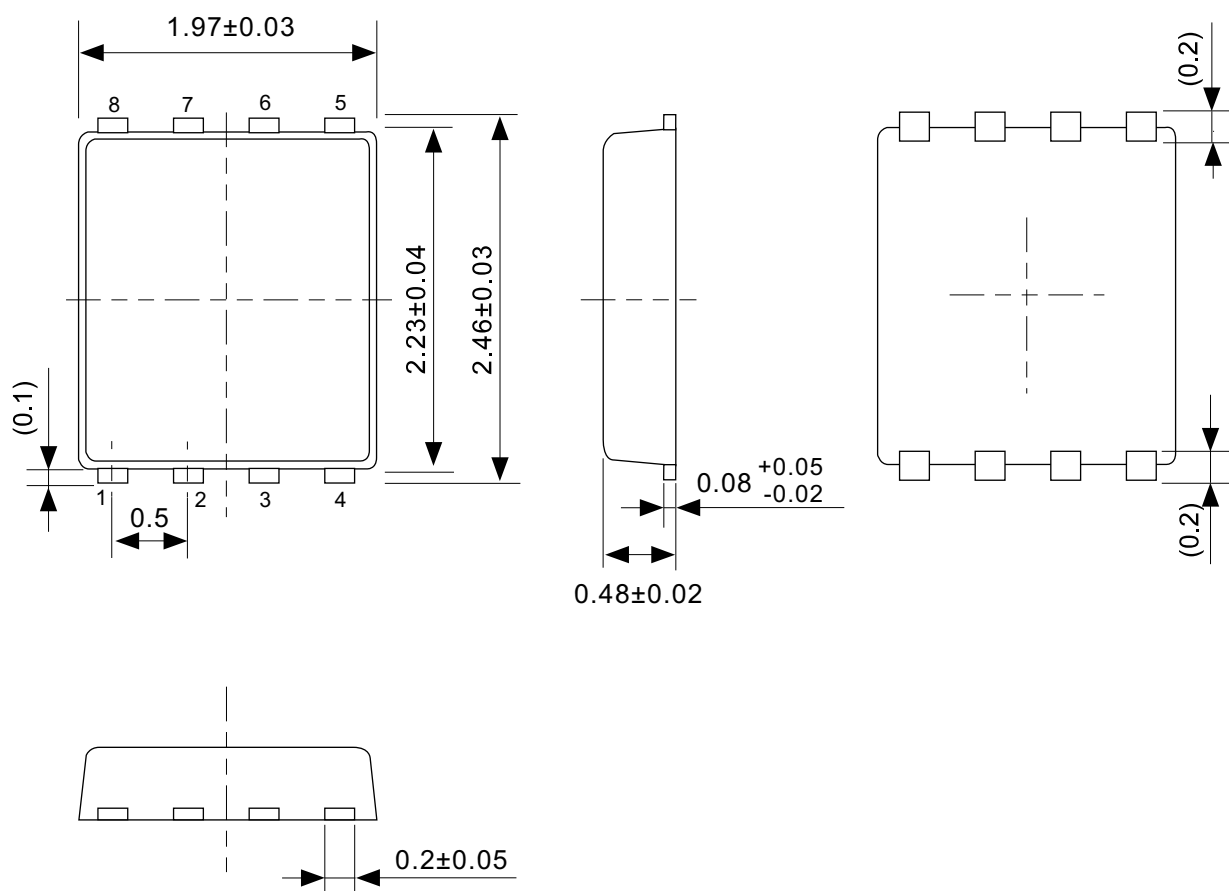


Enlarged drawing in the central part



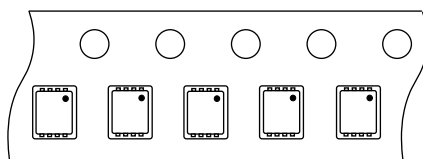
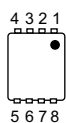
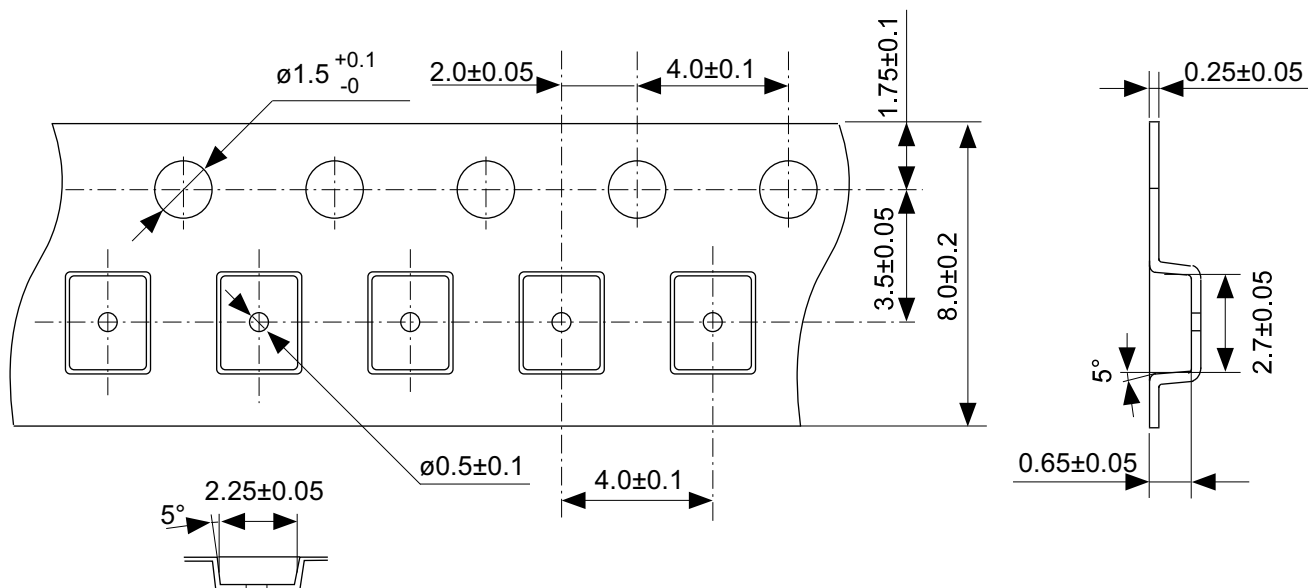
No. MP005-A-R-SD-1.1

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|-------------------------------|------------------|------|-------|
| TITLE                         | SOT235-A-Reel    |      |       |
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| SCALE                         |                  | QTY. | 3,000 |
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| SII Semiconductor Corporation |                  |      |       |



No. PH008-A-P-SD-2.0

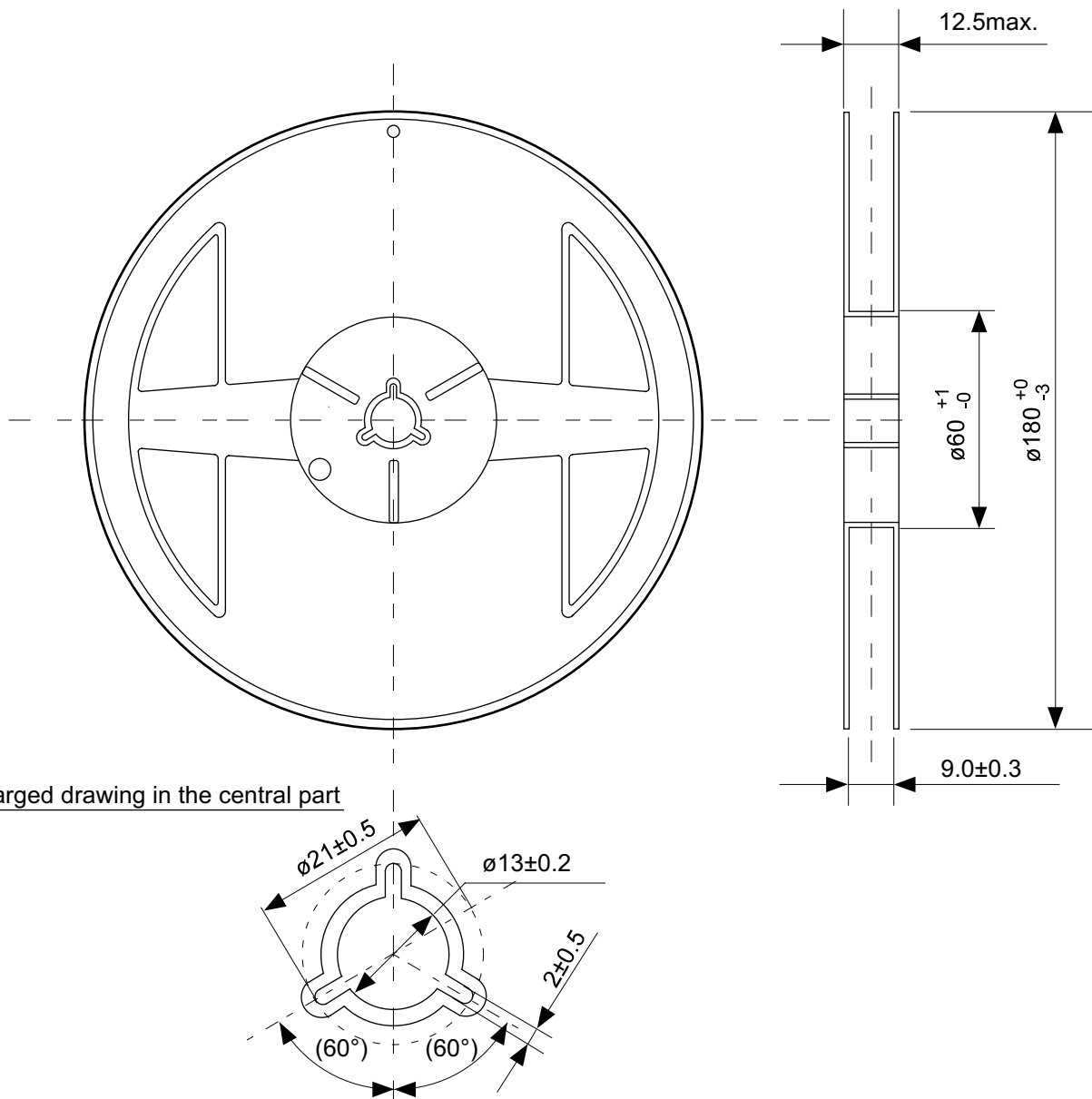
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| SCALE                         |                         |
| UNIT                          | mm                      |
|                               |                         |
| SII Semiconductor Corporation |                         |



Feed direction

No. PH008-A-C-SD-1.0

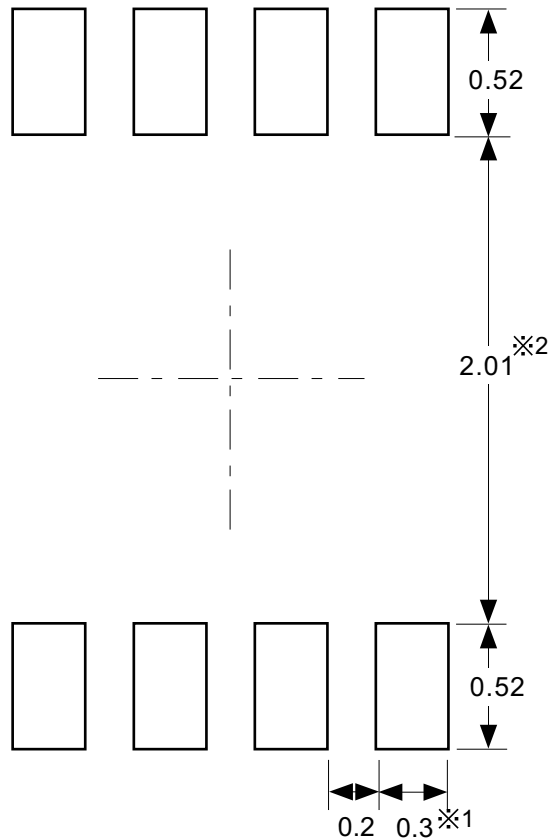
|                               |                       |
|-------------------------------|-----------------------|
| TITLE                         | SNT-8A-A-Carrier Tape |
| No.                           | PH008-A-C-SD-1.0      |
| SCALE                         |                       |
| UNIT                          | mm                    |
|                               |                       |
| SII Semiconductor Corporation |                       |



Enlarged drawing in the central part

No. PH008-A-R-SD-1.0

|                               |                  |      |       |
|-------------------------------|------------------|------|-------|
| TITLE                         | SNT-8A-A-Reel    |      |       |
| No.                           | PH008-A-R-SD-1.0 |      |       |
| SCALE                         |                  | QTY. | 5,000 |
| UNIT                          | mm               |      |       |
|                               |                  |      |       |
| SII Semiconductor Corporation |                  |      |       |



※1. ランドパターンの幅に注意してください (0.25 mm min. / 0.30 mm typ.).  
 ※2. パッケージ中央にランドパターンを広げないでください (1.96 mm ~ 2.06 mm)。

- 注意
1. パッケージのモールド樹脂下にシルク印刷やハンダ印刷などしないでください。
  2. パッケージ下の配線上のソルダーレジストなどの厚みをランドパターン表面から0.03 mm 以下にしてください。
  3. マスク開口サイズと開口位置はランドパターンと合わせてください。
  4. 詳細は "SNTパッケージ活用の手引き" を参照してください。

※1. Pay attention to the land pattern width (0.25 mm min. / 0.30 mm typ.).  
 ※2. Do not widen the land pattern to the center of the package (1.96 mm to 2.06mm).

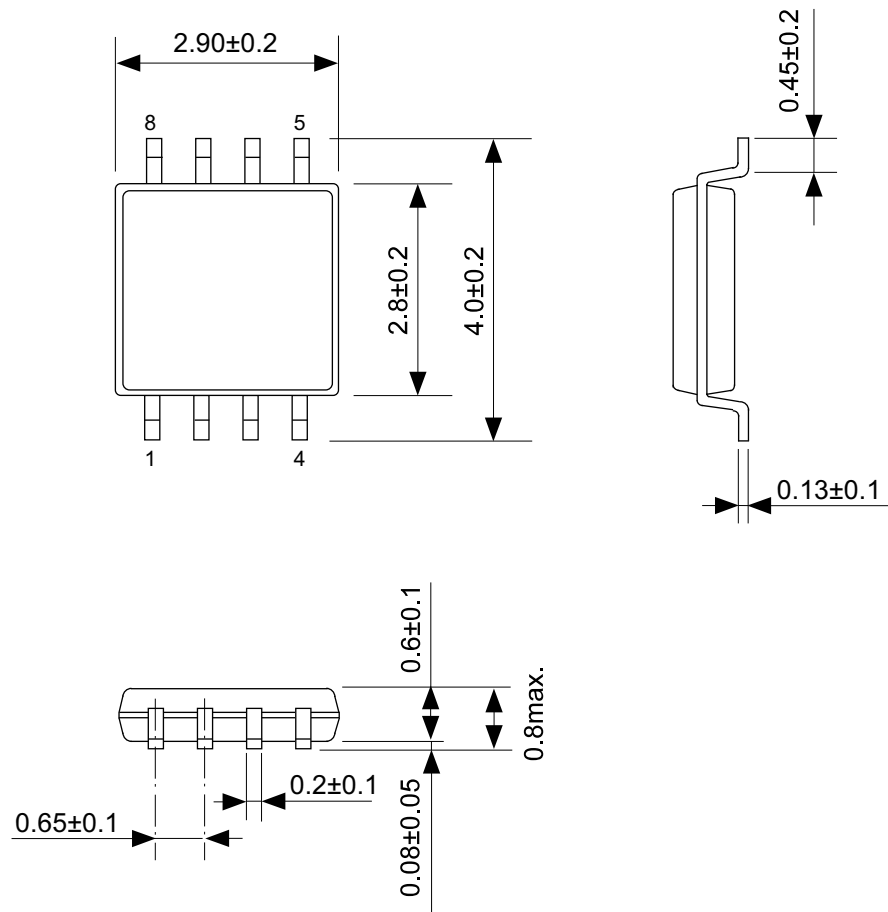
- Caution**
1. Do not do silkscreen printing and solder printing under the mold resin of the package.
  2. The thickness of the solder resist on the wire pattern under the package should be 0.03 mm or less from the land pattern surface.
  3. Match the mask aperture size and aperture position with the land pattern.
  4. Refer to "SNT Package User's Guide" for details.

※1. 请注意焊盘模式的宽度 (0.25 mm min. / 0.30 mm typ.).  
 ※2. 请勿向封装中间扩展焊盘模式 (1.96 mm ~ 2.06 mm)。

- 注意
1. 请勿在树脂型封装的下面印刷丝网、焊锡。
  2. 在封装下、布线上的阻焊膜厚度 (从焊盘模式表面起) 请控制在 0.03 mm 以下。
  3. 钢网的开口尺寸和开口位置请与焊盘模式对齐。
  4. 详细内容请参阅 "SNT 封装的应用指南"。

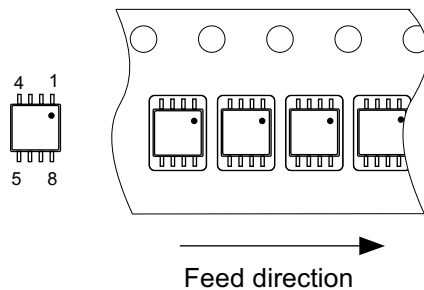
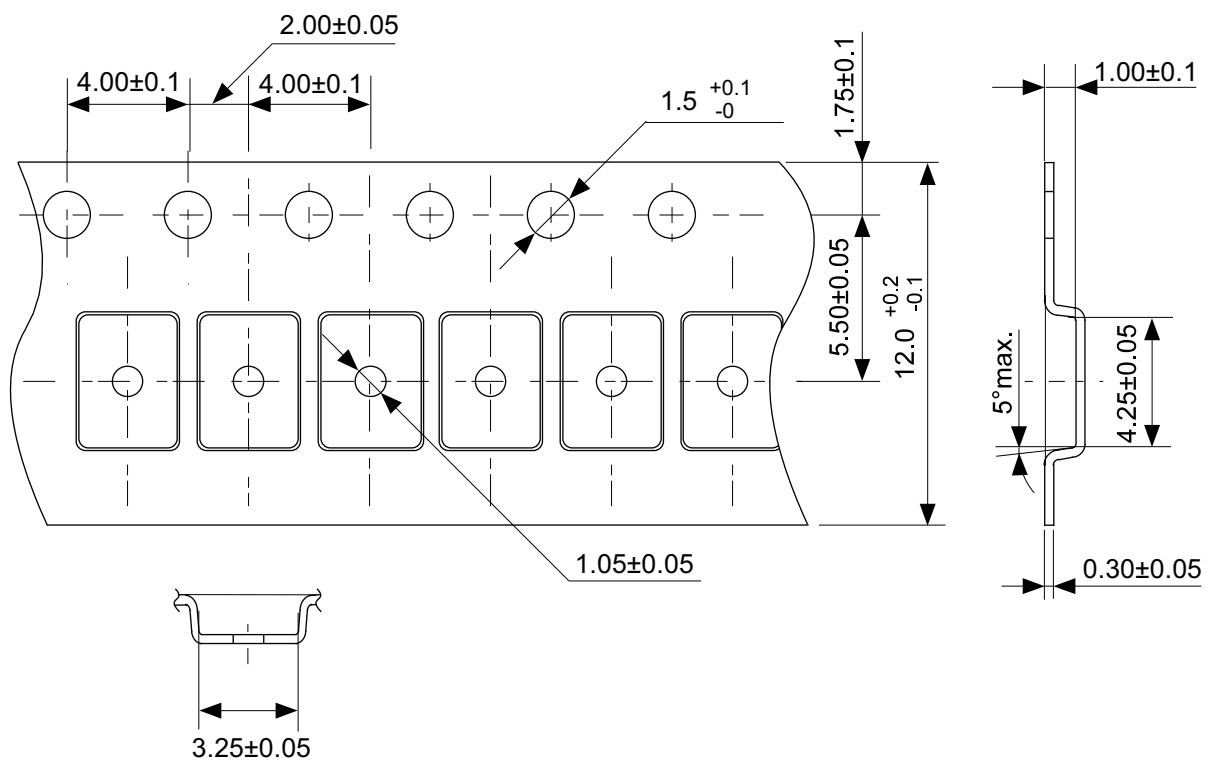
No. PH008-A-L-SD-4.1

|                               |                                  |
|-------------------------------|----------------------------------|
| TITLE                         | SNT-8A-A<br>-Land Recommendation |
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| SCALE                         |                                  |
| UNIT                          | mm                               |
|                               |                                  |
| SII Semiconductor Corporation |                                  |



No. FM008-A-P-SD-1.1

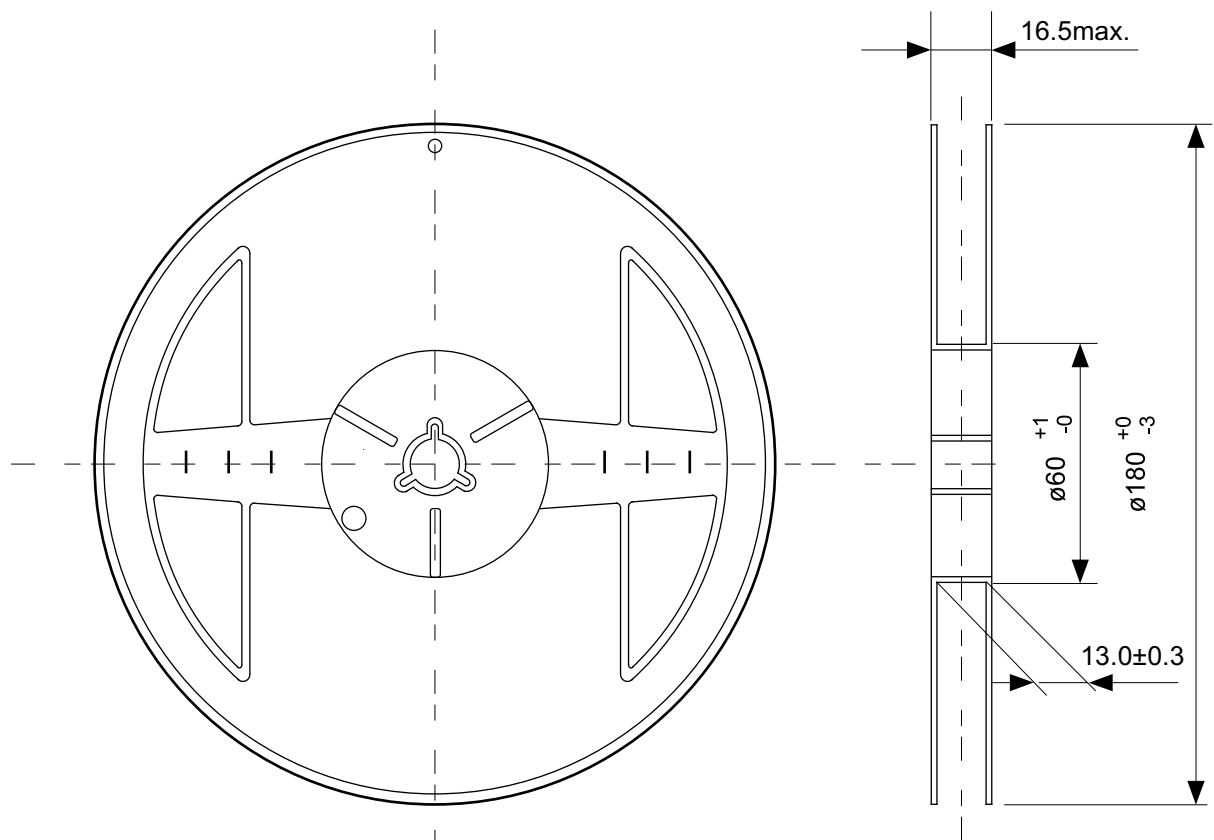
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|-------------------------------|-------------------------|
| TITLE                         | TMSOP8-A-PKG Dimensions |
| No.                           | FM008-A-P-SD-1.1        |
| SCALE                         |                         |
| UNIT                          | mm                      |
|                               |                         |
| SII Semiconductor Corporation |                         |



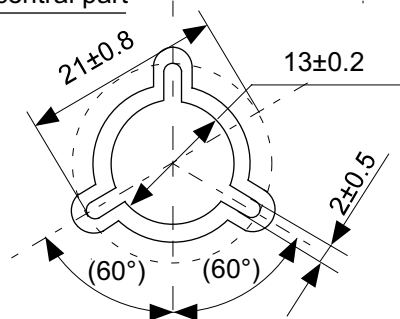
**No. FM008-A-C-SD-2.0**

|                               |                       |
|-------------------------------|-----------------------|
| TITLE                         | TMSOP8-A-Carrier Tape |
| No.                           | FM008-A-C-SD-2.0      |
| SCALE                         |                       |
| UNIT                          | mm                    |
|                               |                       |
| SII Semiconductor Corporation |                       |





Enlarged drawing in the central part



No. FM008-A-R-SD-1.0

|                               |                  |      |       |
|-------------------------------|------------------|------|-------|
| TITLE                         | TMSOP8-A-Reel    |      |       |
| No.                           | FM008-A-R-SD-1.0 |      |       |
| SCALE                         |                  | QTY. | 4,000 |
| UNIT                          | mm               |      |       |
|                               |                  |      |       |
| SII Semiconductor Corporation |                  |      |       |

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2. The circuit examples and the usages described herein are for reference only, and do not guarantee the success of any specific mass-production design.  
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5. When using the products described herein, confirm their applications, and the laws and regulations of the region or country where they are used and verify suitability, safety and other factors for the intended use.
6. When exporting the products described herein, comply with the Foreign Exchange and Foreign Trade Act and all other export-related laws, and follow the required procedures.
7. The products described herein must not be used or provided (exported) for the purposes of the development of weapons of mass destruction or military use. SII Semiconductor Corporation is not responsible for any provision (export) to those whose purpose is to develop, manufacture, use or store nuclear, biological or chemical weapons, missiles, or other military use.
8. The products described herein are not designed to be used as part of any device or equipment that may affect the human body, human life, or assets (such as medical equipment, disaster prevention systems, security systems, combustion control systems, infrastructure control systems, vehicle equipment, traffic systems, in-vehicle equipment, aviation equipment, aerospace equipment, and nuclear-related equipment), excluding when specified for in-vehicle use or other uses. Do not use those products without the prior written permission of SII Semiconductor Corporation. Especially, the products described herein cannot be used for life support devices, devices implanted in the human body and devices that directly affect human life, etc.  
Prior consultation with our sales office is required when considering the above uses.  
SII Semiconductor Corporation is not responsible for damages caused by unauthorized or unspecified use of our products.
9. Semiconductor products may fail or malfunction with some probability.  
The user of these products should therefore take responsibility to give thorough consideration to safety design including redundancy, fire spread prevention measures, and malfunction prevention to prevent accidents causing injury or death, fires and social damage, etc. that may ensue from the products' failure or malfunction.  
The entire system must be sufficiently evaluated and applied on customer's own responsibility.
10. The products described herein are not designed to be radiation-proof. The necessary radiation measures should be taken in the product design by the customer depending on the intended use.
11. The products described herein do not affect human health under normal use. However, they contain chemical substances and heavy metals and should therefore not be put in the mouth. The fracture surfaces of wafers and chips may be sharp. Take care when handling these with the bare hands to prevent injuries, etc.
12. When disposing of the products described herein, comply with the laws and ordinances of the country or region where they are used.
13. The information described herein contains copyright information and know-how of SII Semiconductor Corporation.  
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14. For more details on the information described herein, contact our sales office.

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