

## ULTRA-SMALL PACKAGE HIGH-PRECISION VOLTAGE DETECTOR

## S-1000 Series

The S-1000 series is a series of high-precision voltage detectors developed using CMOS process. The detection voltage is fixed internally with an accuracy of  $\pm 1.0\%$ . It operates with low current consumption of 350 nA typ. Two output forms, Nch open-drain and CMOS output, are available. CMOS voltage detector, S-1000 Series is the most suitable for the portable equipments with ultra low current consumption, high precision and corresponding to the small package.

### ■ Features

- Ultra-low current consumption 350 nA typ. ( $V_{DD}$  = detection voltage + 1.5 V)
- High-precision detection voltage  $\pm 1.0\%$
- Operating voltage range 0.95 to 5.5 V
- Hysteresis characteristics 5% typ.
- Detection voltage 1.5 to 4.6 V (0.1 V step)
- Output form Nch open-drain output (Active "L")  
CMOS output (Active "L")

### ■ Applications

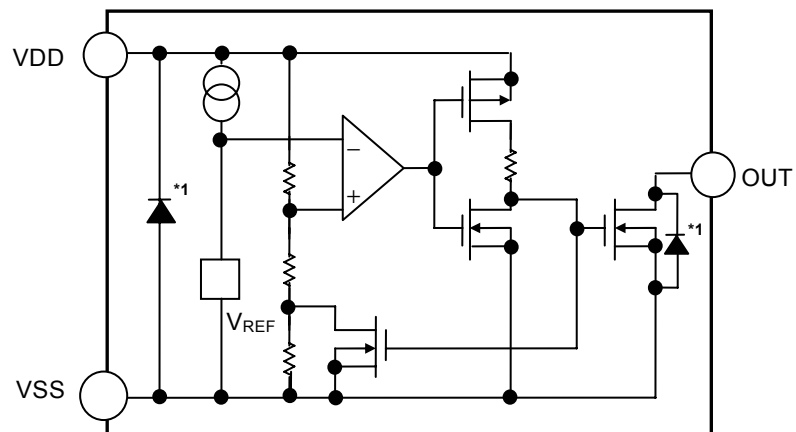
- Power monitor for microcomputers and reset for CPUs.
- Power monitor for portable equipments such as cellular phones, digital still cameras and PDAs.
- Constant voltage power monitor for cameras, video equipments and communication devices.

### ■ Packages

| Package name | Drawing code |         |         |
|--------------|--------------|---------|---------|
|              | Package      | Tape    | Reel    |
| SC-82AB      | NP004-A      | NP004-A | NP004-A |
| SOT-23-5     | MP005-A      | MP005-A | MP005-A |
| SNT-4A       | PF004-A      | PF004-A | PF004-A |

## ■ Block Diagrams

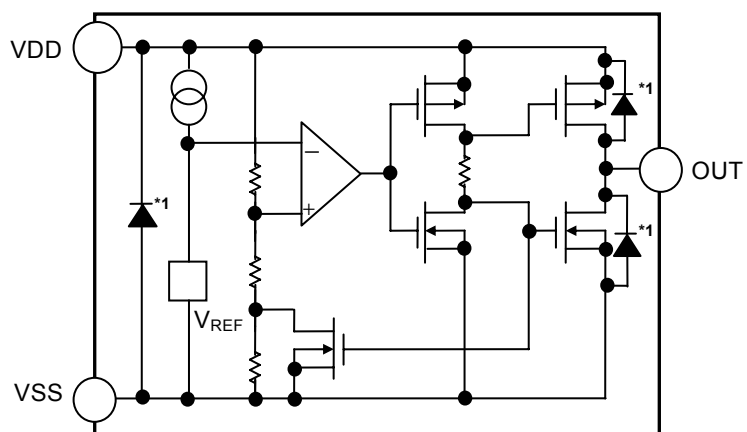
### 1. Nch open-drain output products



\*1. Parasitic diode

Figure 1

### 2. CMOS output products



\*1. Parasitic diode

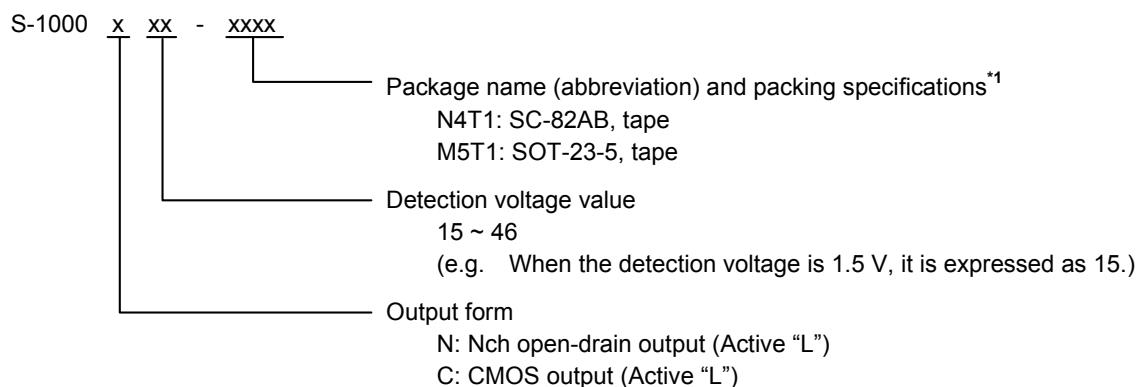
Figure 2

## ■ Product Name Structure

The detection voltage, output form and packages for S-1000 series can be selected at the user's request. Refer to the "1. Product name" for the construction of the product name and "2. Product name list" for the full product names.

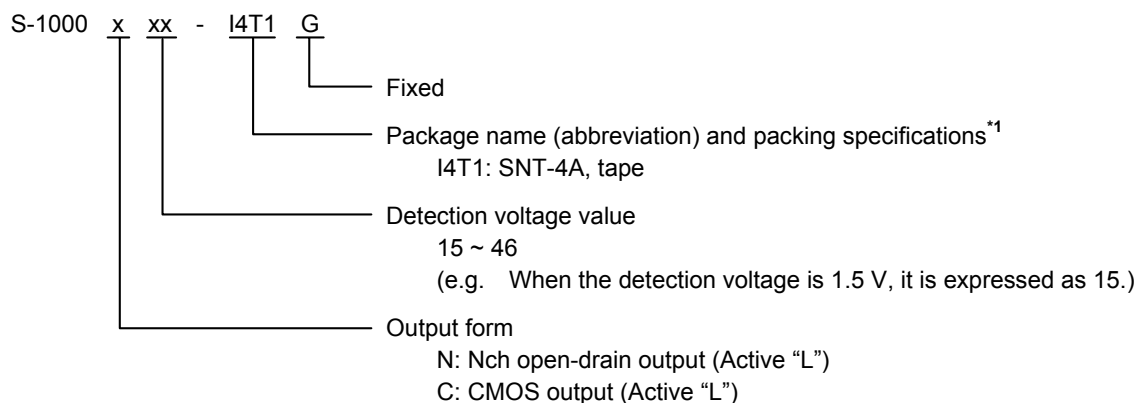
### 1. Product name

#### 1.1 SC-82AB, SOT-23-5 packages



\*1. Refer to the taping specifications at the end of this book.

#### 1.2 SNT-4A package



\*1. Refer to the taping specifications at the end of this book.

**2. Product name list**

**2.1 Nch open-drain output products**

**Table 1**

| Detection voltage range | SC-82AB        | SOT-23-5       | SNT-4A          |
|-------------------------|----------------|----------------|-----------------|
| 1.5 ± 1.0%              | S-1000N15-N4T1 | S-1000N15-M5T1 | S-1000N15-I4T1G |
| 1.6 ± 1.0%              | S-1000N16-N4T1 | S-1000N16-M5T1 | S-1000N16-I4T1G |
| 1.7 ± 1.0%              | S-1000N17-N4T1 | S-1000N17-M5T1 | S-1000N17-I4T1G |
| 1.8 ± 1.0%              | S-1000N18-N4T1 | S-1000N18-M5T1 | S-1000N18-I4T1G |
| 1.9 ± 1.0%              | S-1000N19-N4T1 | S-1000N19-M5T1 | S-1000N19-I4T1G |
| 2.0 ± 1.0%              | S-1000N20-N4T1 | S-1000N20-M5T1 | S-1000N20-I4T1G |
| 2.1 ± 1.0%              | S-1000N21-N4T1 | S-1000N21-M5T1 | S-1000N21-I4T1G |
| 2.2 ± 1.0%              | S-1000N22-N4T1 | S-1000N22-M5T1 | S-1000N22-I4T1G |
| 2.3 ± 1.0%              | S-1000N23-N4T1 | S-1000N23-M5T1 | S-1000N23-I4T1G |
| 2.4 ± 1.0%              | S-1000N24-N4T1 | S-1000N24-M5T1 | S-1000N24-I4T1G |
| 2.5 ± 1.0%              | S-1000N25-N4T1 | S-1000N25-M5T1 | S-1000N25-I4T1G |
| 2.6 ± 1.0%              | S-1000N26-N4T1 | S-1000N26-M5T1 | S-1000N26-I4T1G |
| 2.7 ± 1.0%              | S-1000N27-N4T1 | S-1000N27-M5T1 | S-1000N27-I4T1G |
| 2.8 ± 1.0%              | S-1000N28-N4T1 | S-1000N28-M5T1 | S-1000N28-I4T1G |
| 2.9 ± 1.0%              | S-1000N29-N4T1 | S-1000N29-M5T1 | S-1000N29-I4T1G |
| 3.0 ± 1.0%              | S-1000N30-N4T1 | S-1000N30-M5T1 | S-1000N30-I4T1G |
| 3.1 ± 1.0%              | S-1000N31-N4T1 | S-1000N31-M5T1 | S-1000N31-I4T1G |
| 3.2 ± 1.0%              | S-1000N32-N4T1 | S-1000N32-M5T1 | S-1000N32-I4T1G |
| 3.3 ± 1.0%              | S-1000N33-N4T1 | S-1000N33-M5T1 | S-1000N33-I4T1G |
| 3.4 ± 1.0%              | S-1000N34-N4T1 | S-1000N34-M5T1 | S-1000N34-I4T1G |
| 3.5 ± 1.0%              | S-1000N35-N4T1 | S-1000N35-M5T1 | S-1000N35-I4T1G |
| 3.6 ± 1.0%              | S-1000N36-N4T1 | S-1000N36-M5T1 | S-1000N36-I4T1G |
| 3.7 ± 1.0%              | S-1000N37-N4T1 | S-1000N37-M5T1 | S-1000N37-I4T1G |
| 3.8 ± 1.0%              | S-1000N38-N4T1 | S-1000N38-M5T1 | S-1000N38-I4T1G |
| 3.9 ± 1.0%              | S-1000N39-N4T1 | S-1000N39-M5T1 | S-1000N39-I4T1G |
| 4.0 ± 1.0%              | S-1000N40-N4T1 | S-1000N40-M5T1 | S-1000N40-I4T1G |
| 4.1 ± 1.0%              | S-1000N41-N4T1 | S-1000N41-M5T1 | S-1000N41-I4T1G |
| 4.2 ± 1.0%              | S-1000N42-N4T1 | S-1000N42-M5T1 | S-1000N42-I4T1G |
| 4.3 ± 1.0%              | S-1000N43-N4T1 | S-1000N43-M5T1 | S-1000N43-I4T1G |
| 4.4 ± 1.0%              | S-1000N44-N4T1 | S-1000N44-M5T1 | S-1000N44-I4T1G |
| 4.5 ± 1.0%              | S-1000N45-N4T1 | S-1000N45-M5T1 | S-1000N45-I4T1G |
| 4.6 ± 1.0%              | S-1000N46-N4T1 | S-1000N46-M5T1 | S-1000N46-I4T1G |

**2. 2 CMOS output products**

**Table 2**

| Detection voltage range | SC-82AB        | SOT-23-5       | SNT-4A          |
|-------------------------|----------------|----------------|-----------------|
| 1.5 ± 1.0%              | S-1000C15-N4T1 | S-1000C15-M5T1 | S-1000C15-I4T1G |
| 1.6 ± 1.0%              | S-1000C16-N4T1 | S-1000C16-M5T1 | S-1000C16-I4T1G |
| 1.7 ± 1.0%              | S-1000C17-N4T1 | S-1000C17-M5T1 | S-1000C17-I4T1G |
| 1.8 ± 1.0%              | S-1000C18-N4T1 | S-1000C18-M5T1 | S-1000C18-I4T1G |
| 1.9 ± 1.0%              | S-1000C19-N4T1 | S-1000C19-M5T1 | S-1000C19-I4T1G |
| 2.0 ± 1.0%              | S-1000C20-N4T1 | S-1000C20-M5T1 | S-1000C20-I4T1G |
| 2.1 ± 1.0%              | S-1000C21-N4T1 | S-1000C21-M5T1 | S-1000C21-I4T1G |
| 2.2 ± 1.0%              | S-1000C22-N4T1 | S-1000C22-M5T1 | S-1000C22-I4T1G |
| 2.3 ± 1.0%              | S-1000C23-N4T1 | S-1000C23-M5T1 | S-1000C23-I4T1G |
| 2.4 ± 1.0%              | S-1000C24-N4T1 | S-1000C24-M5T1 | S-1000C24-I4T1G |
| 2.5 ± 1.0%              | S-1000C25-N4T1 | S-1000C25-M5T1 | S-1000C25-I4T1G |
| 2.6 ± 1.0%              | S-1000C26-N4T1 | S-1000C26-M5T1 | S-1000C26-I4T1G |
| 2.7 ± 1.0%              | S-1000C27-N4T1 | S-1000C27-M5T1 | S-1000C27-I4T1G |
| 2.8 ± 1.0%              | S-1000C28-N4T1 | S-1000C28-M5T1 | S-1000C28-I4T1G |
| 2.9 ± 1.0%              | S-1000C29-N4T1 | S-1000C29-M5T1 | S-1000C29-I4T1G |
| 3.0 ± 1.0%              | S-1000C30-N4T1 | S-1000C30-M5T1 | S-1000C30-I4T1G |
| 3.1 ± 1.0%              | S-1000C31-N4T1 | S-1000C31-M5T1 | S-1000C31-I4T1G |
| 3.2 ± 1.0%              | S-1000C32-N4T1 | S-1000C32-M5T1 | S-1000C32-I4T1G |
| 3.3 ± 1.0%              | S-1000C33-N4T1 | S-1000C33-M5T1 | S-1000C33-I4T1G |
| 3.4 ± 1.0%              | S-1000C34-N4T1 | S-1000C34-M5T1 | S-1000C34-I4T1G |
| 3.5 ± 1.0%              | S-1000C35-N4T1 | S-1000C35-M5T1 | S-1000C35-I4T1G |
| 3.6 ± 1.0%              | S-1000C36-N4T1 | S-1000C36-M5T1 | S-1000C36-I4T1G |
| 3.7 ± 1.0%              | S-1000C37-N4T1 | S-1000C37-M5T1 | S-1000C37-I4T1G |
| 3.8 ± 1.0%              | S-1000C38-N4T1 | S-1000C38-M5T1 | S-1000C38-I4T1G |
| 3.9 ± 1.0%              | S-1000C39-N4T1 | S-1000C39-M5T1 | S-1000C39-I4T1G |
| 4.0 ± 1.0%              | S-1000C40-N4T1 | S-1000C40-M5T1 | S-1000C40-I4T1G |
| 4.1 ± 1.0%              | S-1000C41-N4T1 | S-1000C41-M5T1 | S-1000C41-I4T1G |
| 4.2 ± 1.0%              | S-1000C42-N4T1 | S-1000C42-M5T1 | S-1000C42-I4T1G |
| 4.3 ± 1.0%              | S-1000C43-N4T1 | S-1000C43-M5T1 | S-1000C43-I4T1G |
| 4.4 ± 1.0%              | S-1000C44-N4T1 | S-1000C44-M5T1 | S-1000C44-I4T1G |
| 4.5 ± 1.0%              | S-1000C45-N4T1 | S-1000C45-M5T1 | S-1000C45-I4T1G |
| 4.6 ± 1.0%              | S-1000C46-N4T1 | S-1000C46-M5T1 | S-1000C46-I4T1G |

## ■ Output Forms

### 1. Output forms in S-1000 series

Table 3

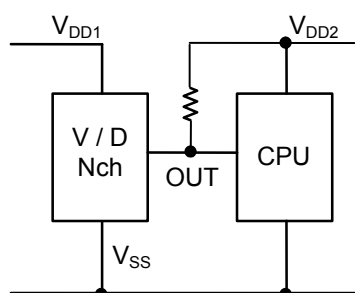
|               | Nch open-drain output products<br>(Active "L")              | CMOS output products<br>(Active "L")                        |
|---------------|-------------------------------------------------------------|-------------------------------------------------------------|
| S-1000 series | "N" is the last letter of the product name.<br>e.g. S-1000N | "C" is the last letter of the product name.<br>e.g. S-1000C |

### 2. Output form and their usage

Table 4

| Usage                                        | Nch open-drain output products<br>(Active "L") | CMOS output products<br>(Active "L") |
|----------------------------------------------|------------------------------------------------|--------------------------------------|
| Different power supplies                     | Yes                                            | No                                   |
| Active "L" reset for CPUs                    | Yes                                            | Yes                                  |
| Active "H" reset for CPUs                    | No                                             | No                                   |
| Detection voltage change by resistor divider | Yes                                            | No                                   |

- Example for two power supplies



- Example for one power supply

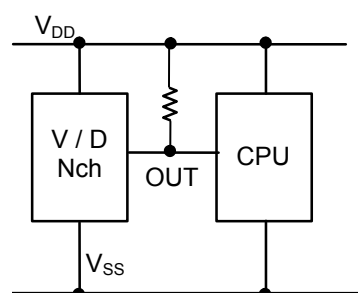
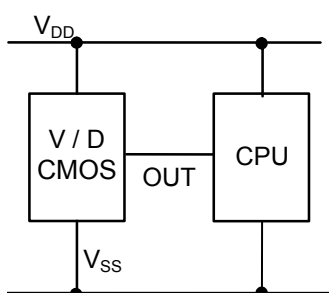


Figure 3

## ■ Pin Configurations

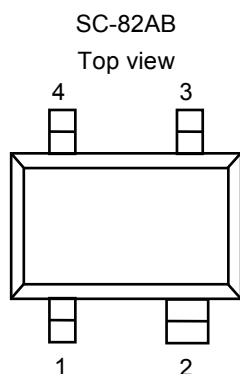


Figure 4

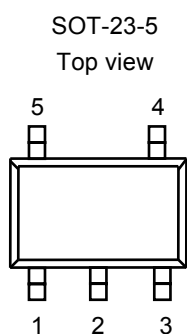


Figure 5

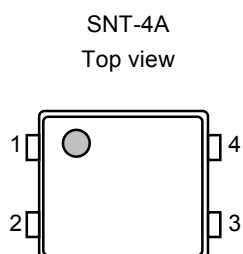


Figure 7

Table 5

| Pin No. | Pin name         | Pin description              |
|---------|------------------|------------------------------|
| 1       | OUT              | Voltage detection output pin |
| 2       | VDD              | Voltage input pin            |
| 3       | NC <sup>*1</sup> | No connection                |
| 4       | VSS              | GND pin                      |

\*1. The NC pin is electrically open.

The NC pin can be connected to VDD or VSS.

Table 6

| Pin No. | Pin name         | Pin description              |
|---------|------------------|------------------------------|
| 1       | OUT              | Voltage detection output pin |
| 2       | VDD              | Voltage input pin            |
| 3       | VSS              | GND pin                      |
| 4       | NC <sup>*1</sup> | No connection                |
| 5       | NC <sup>*1</sup> | No connection                |

\*1. The NC pin is electrically open.

The NC pin can be connected to VDD or VSS.

Table 7

| Pin No. | Pin name         | Pin description              |
|---------|------------------|------------------------------|
| 1       | OUT              | Voltage detection output pin |
| 2       | VSS              | GND pin                      |
| 3       | NC <sup>*1</sup> | No connection                |
| 4       | VDD              | Voltage input pin            |

\*1. The NC pin is electrically open.

The NC pin can be connected to VDD or VSS.

## ■ Absolute Maximum Ratings

Table 8

(Ta = 25 °C unless otherwise specified)

| Item                          |                                | Symbol            | Absolute maximum ratings         | Unit              |    |
|-------------------------------|--------------------------------|-------------------|----------------------------------|-------------------|----|
| Power supply voltage          |                                | $V_{DD} - V_{SS}$ | 6                                | V                 |    |
| Output voltage                | Nch open-drain output products | $V_{OUT}$         | $V_{SS} - 0.3$ to $V_{SS} + 6$   | V                 |    |
|                               | CMOS output products           |                   | $V_{SS} - 0.3$ to $V_{DD} + 0.3$ | V                 |    |
| Output current                |                                | $I_{OUT}$         | 50                               | mA                |    |
| Power dissipation             |                                | $P_D$             | SC-82AB                          | 200               | mW |
|                               |                                |                   | SOT-23-5                         | 300               | mW |
|                               |                                |                   | SNT-4A                           | 300 <sup>*1</sup> | mW |
| Operating ambient temperature |                                | $T_{opr}$         | -40 to +85                       | °C                |    |
| Storage temperature           |                                | $T_{stg}$         | -40 to +125                      | °C                |    |

\*1. At mounted on JEDEC high heat dissipation printed circuit board

**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.



## ■ Electrical Characteristics

### 1. Nch open-drain output products

**Table 9**

(Ta = 25 °C unless otherwise specified)

| Item                                           | Symbol                                              | Condition                                                                   |                 | Min.                          | Typ.                       | Max.                          | Unit        | Measure-<br>ment<br>circuit |
|------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------------------------------|-----------------|-------------------------------|----------------------------|-------------------------------|-------------|-----------------------------|
| Detection voltage*1                            | −V <sub>DET</sub>                                   | −                                                                           |                 | −V <sub>DET(S)</sub><br>×0.99 | −V <sub>DET(S)</sub>       | −V <sub>DET(S)</sub><br>×1.01 | V           | 1                           |
| Hysteresis width                               | V <sub>HYS</sub>                                    | −                                                                           |                 | −V <sub>DET</sub><br>×0.03    | −V <sub>DET</sub><br>×0.05 | −V <sub>DET</sub><br>×0.07    | V           | 1                           |
| Current consumption                            | I <sub>SS</sub>                                     | V <sub>DD</sub> = −V <sub>DET(S)</sub> + 1.5 V                              | S-1000N15 to 39 | −                             | 350                        | 900                           | nA          | 2                           |
|                                                |                                                     | V <sub>DD</sub> = 5.5 V                                                     | S-1000N40 to 46 | −                             | 350                        | 900                           | nA          | 2                           |
| Operating voltage                              | V <sub>DD</sub>                                     | −                                                                           |                 | 0.95                          | −                          | 5.5                           | V           | 1                           |
| Output current                                 | I <sub>OUT</sub>                                    | Output transistor,<br>Nch, V <sub>DS</sub> = 0.5 V, V <sub>DD</sub> = 1.2 V |                 | 1.36                          | 2.55                       | −                             | mA          | 3                           |
| Leakage current                                | I <sub>LEAK</sub>                                   | Output transistor,<br>Nch, V <sub>DS</sub> = 5.5 V, V <sub>DD</sub> = 5.5 V |                 | −                             | −                          | 100                           | nA          | 3                           |
| Response time                                  | t <sub>PLH</sub>                                    | −                                                                           |                 | −                             | −                          | 60                            | μs          | 1                           |
| Detection voltage<br>temperature coefficient*2 | $\frac{\Delta-V_{DET}}{\Delta Ta \bullet -V_{DET}}$ | Ta = −40 to +85 °C                                                          |                 | −                             | ±100                       | ±350                          | ppm /<br>°C | 1                           |

<sup>\*1</sup>.  $-V_{DET}$ : Actual detection voltage value,  $-V_{DET(S)}$ : Specified detection voltage value (The center value of the detection voltage range in **Table 1, 2**.)

<sup>\*2</sup>. The temperature change ratio in the detection voltage [mV / °C] is calculated by using the following equation.

$$\frac{\Delta -V_{DET}}{\Delta Ta} [\text{mV}/^{\circ}\text{C}]^{*1} = -V_{DET(S)}(\text{typ.}) [\text{V}]^{*2} \times \frac{\Delta -V_{DET}}{\Delta Ta \bullet -V_{DET}} [\text{ppm}/^{\circ}\text{C}]^{*3} \div 1000$$

<sup>\*1</sup>. Temperature change ratio of the detection voltage

<sup>\*2</sup>. Specified detection voltage

<sup>\*3</sup>. Detection voltage temperature coefficient

2. CMOS output products

Table 10

(Ta = 25 °C unless otherwise specified)

| Item                                           | Symbol                                              | Condition                                                                   |                 | Min.                          | Typ.                       | Max.                          | Unit       | Measure-<br>ment<br>circuit |
|------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------------------------------|-----------------|-------------------------------|----------------------------|-------------------------------|------------|-----------------------------|
| Detection voltage*1                            | −V <sub>DET</sub>                                   | −                                                                           |                 | −V <sub>DET(S)</sub><br>×0.99 | −V <sub>DET(S)</sub>       | −V <sub>DET(S)</sub><br>×1.01 | V          | 1                           |
| Hysteresis width                               | V <sub>HYS</sub>                                    | −                                                                           |                 | −V <sub>DET</sub><br>×0.03    | −V <sub>DET</sub><br>×0.05 | −V <sub>DET</sub><br>×0.07    | V          | 1                           |
| Current consumption                            | I <sub>SS</sub>                                     | V <sub>DD</sub> = −V <sub>DET(S)</sub> + 1.5 V                              | S-1000C15 to 39 | −                             | 350                        | 900                           | nA         | 2                           |
|                                                |                                                     | V <sub>DD</sub> = 5.5 V                                                     | S-1000C40 to 46 | −                             | 350                        | 900                           | nA         | 2                           |
| Operating voltage                              | V <sub>DD</sub>                                     | −                                                                           |                 | 0.95                          | −                          | 5.5                           | V          | 1                           |
| Output current                                 | I <sub>OUT</sub>                                    | Output transistor,<br>Nch, V <sub>DS</sub> = 0.5 V, V <sub>DD</sub> = 1.2 V |                 | 1.36                          | 2.55                       | −                             | mA         | 3                           |
|                                                |                                                     | Output transistor,<br>Pch, V <sub>DS</sub> = 0.5 V, V <sub>DD</sub> = 5.5 V |                 | 1.71                          | 2.76                       | −                             | mA         | 4                           |
| Response time                                  | t <sub>PLH</sub>                                    | −                                                                           |                 | −                             | −                          | 60                            | μs         | 1                           |
| Detection voltage<br>temperature coefficient*2 | $\frac{\Delta-V_{DET}}{\Delta Ta \bullet -V_{DET}}$ | Ta = −40 to +85 °C                                                          |                 | −                             | ±100                       | ±350                          | ppm/<br>°C | 1                           |

\*1.  $-V_{DET}$ : Actual detection voltage value,  $-V_{DET(S)}$ : Specified detection voltage value (The center value of the detection voltage range in Table 3, 4.)

\*2. The temperature change ratio in the detection voltage [mV / °C] is calculated by using the following equation.

$$\frac{\Delta - V_{DET}}{\Delta Ta} \text{ [mV/°C]}^{*1} = -V_{DET(S)(typ.)} \text{ [V]}^{*2} \times \frac{\Delta - V_{DET}}{\Delta Ta \bullet -V_{DET}} \text{ [ppm/°C]}^{*3} \div 1000$$

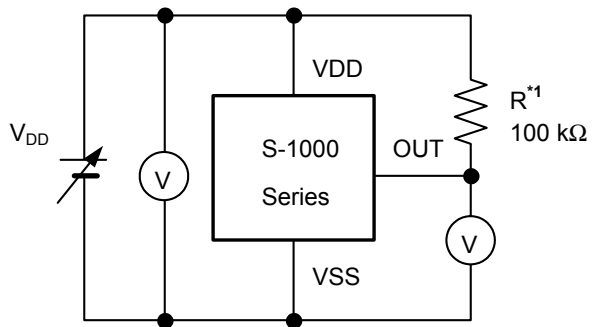
\*1. Temperature change ratio of the detection voltage

\*2. Specified detection voltage

\*3. Detection voltage temperature coefficient

## ■ Measurement Circuits

1.



1. R is unnecessary for CMOS output products.

Figure 7

2.

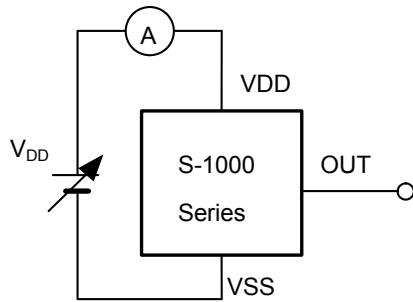


Figure 8

3.

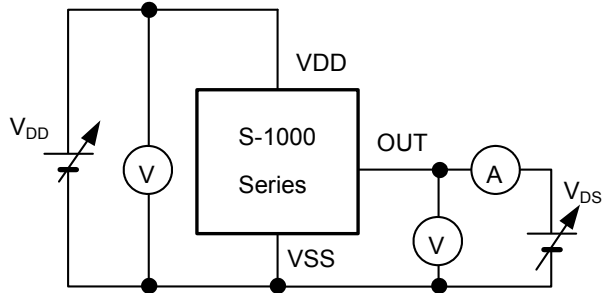


Figure 9

4.

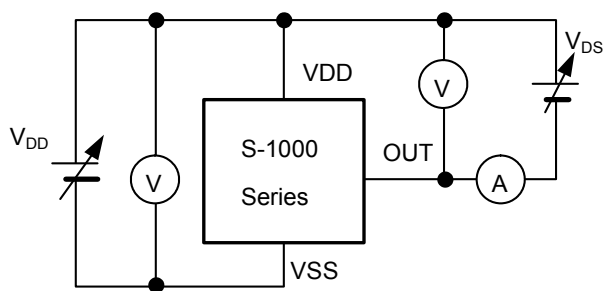


Figure 10

## ■ Timing Chart

### 1. Nch open-drain output products

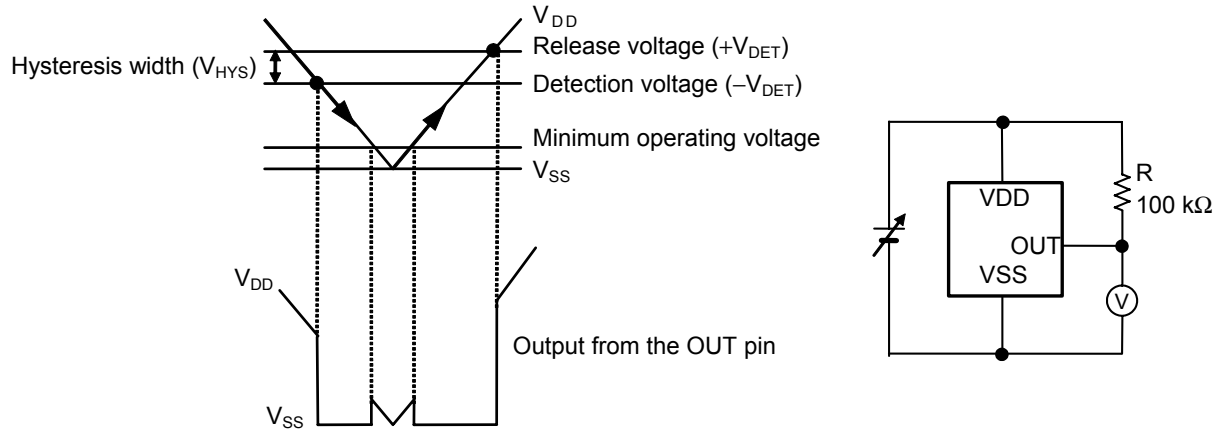
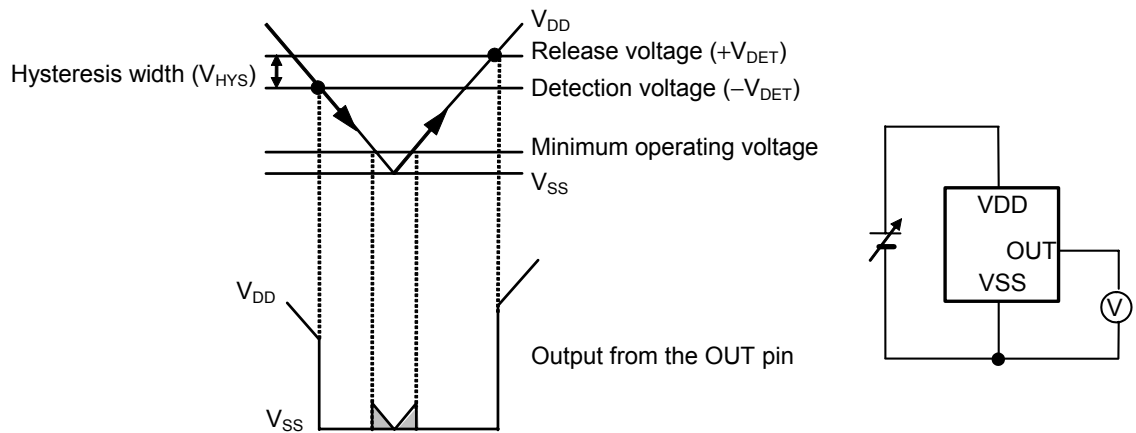


Figure 11

### 2. CMOS output products



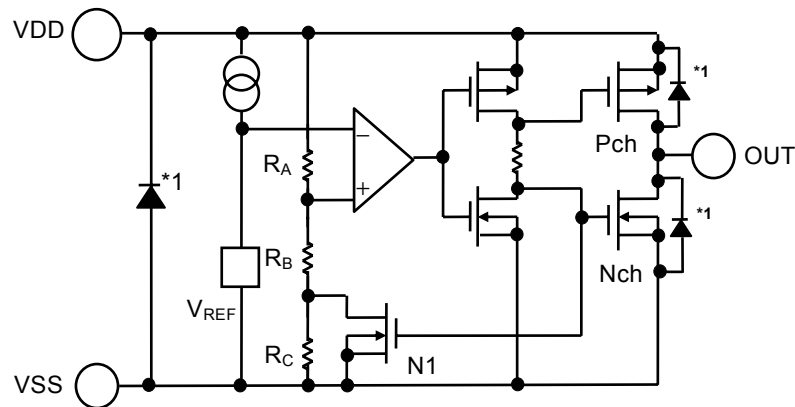
**Remark** For values of  $V_{DD}$  less than minimum operating voltage, values of OUT terminal output is free in the shaded region.

Figure 12

## ■ Operation

### 1. Basic operation: CMOS output (Active “L”)

- (1) When the power supply voltage ( $V_{DD}$ ) is higher than the release voltage ( $+V_{DET}$ ), the Nch transistor is OFF and the Pch transistor is ON to provide  $V_{DD}$  (“H”) at the output. Since the Nch transistor N1 in **Figure 13** is OFF, the comparator input voltage is  $\frac{(R_B + R_C) \cdot V_{DD}}{R_A + R_B + R_C}$ .
- (2) When the  $V_{DD}$  goes below  $+V_{DET}$ , the output provides the  $V_{DD}$  level, as long as the  $V_{DD}$  remains above the detection voltage  $-V_{DET}$ . When the  $V_{DD}$  falls below  $-V_{DET}$  (point A in **Figure 14**), the Nch transistor becomes ON, the Pch transistor becomes OFF, and the  $V_{SS}$  level appears at the output. At this time the Nch transistor N1 in **Figure 13** becomes ON, the comparator input voltage is changed to  $\frac{R_B \cdot V_{DD}}{R_A + R_B}$ .
- (3) When the  $V_{DD}$  falls below the minimum operating voltage, the output becomes undefined, or goes to the  $V_{DD}$  when the output is pulled up to the  $V_{DD}$ .
- (4) The  $V_{SS}$  level appears when the  $V_{DD}$  rises above the minimum operating voltage. The  $V_{SS}$  level still appears even when the  $V_{DD}$  surpasses  $-V_{DET}$ , as long as it does not exceed the release voltage  $+V_{DET}$ .
- (5) When the  $V_{DD}$  rises above  $+V_{DET}$  (point B in **Figure 14**), the Nch transistor becomes OFF and the Pch transistor becomes ON to provide  $V_{DD}$  level at the output.



\*1. Parasitic diode

**Figure 13 Operation 1**

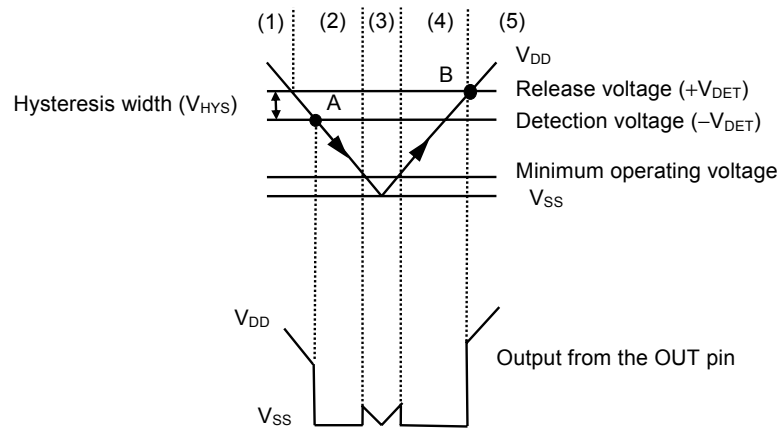
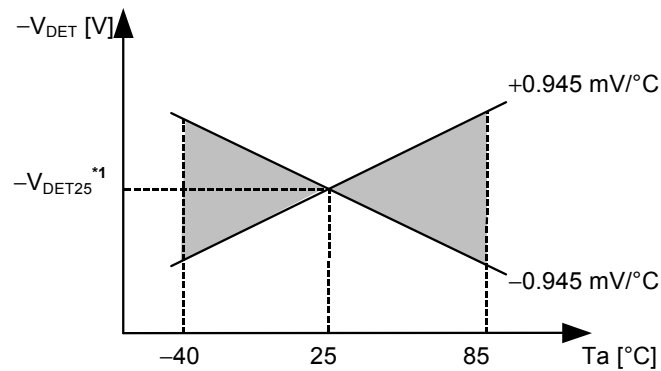


Figure 14 Operation 2

## 2. Other characteristics

### 2.1 Temperature characteristics of detection voltage

The shaded area in **Figure 15** shows the temperature characteristics of the detection voltage.



\*1.  $-V_{DET25}$  is an actual detection voltage value at 25°C.

Figure 15 Temperature characteristics of detection voltage ( Example for  $-V_{DET} = 2.7 \text{ V}$  )

### 2.2 Temperature characteristics of release voltage

The temperature change  $\frac{\Delta + V_{DET}}{\Delta T_a}$  of the release voltage is calculated by the temperature change  $\frac{\Delta - V_{DET}}{\Delta T_a}$  of the detection voltage as follows:

$$\frac{\Delta + V_{DET}}{\Delta T_a} = \frac{+V_{DET}}{-V_{DET}} \times \frac{\Delta - V_{DET}}{\Delta T_a}$$

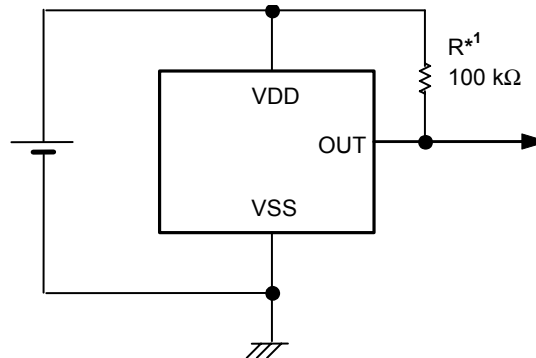
The temperature changes of the release voltage and the detection voltage have the same sign consequently.

### 2.3 Temperature characteristics of hysteresis voltage

The temperature changes of the hysteresis voltage is expressed as  $\frac{\Delta + V_{DET}}{\Delta T_a} - \frac{\Delta - V_{DET}}{\Delta T_a}$  and is calculated as follows:

$$\frac{\Delta + V_{DET}}{\Delta T_a} - \frac{\Delta - V_{DET}}{\Delta T_a} = \frac{V_{HYS}}{-V_{DET}} \times \frac{\Delta - V_{DET}}{\Delta T_a}$$

### ■ Standard Circuit



1. R is unnecessary for CMOS output products.

**Figure 16**

**Caution** The above connection diagram and constants do not guarantee correct operation. Perform sufficient evaluation using the actual application to set the constants.

### ■ Explanation of Terms

#### 1. Detection voltage ( $-V_{DET}$ ), release voltage ( $+V_{DET}$ )

The detection voltage ( $-V_{DET}$ ) is a voltage at which the output turns to “L”. The detection voltage varies slightly among products of the same specification. The variation of detection voltage between the specified minimum ( $-V_{DET}$ ) Min. and the maximum ( $-V_{DET}$ ) Max. is called the detection voltage range (Refer to **Figure 17**).

Example: For the S-1000C15, the detection voltage lies in the range of  $1.485 \leq (-V_{DET}) \leq 1.515$ .  
 This means that some S-1000C15s have 1.485 V for  $-V_{DET}$  and some have 1.515 V.

The release voltage is a voltage at which the output turns to “H”. The release voltage varies slightly among products of the same specification. The variation of release voltages between the specified minimum ( $+V_{DET}$ ) Min. and the maximum ( $+V_{DET}$ ) Max. is called the release voltage range (Refer to **Figure 18**). The range is calculated from the actual detection voltage ( $-V_{DET}$ ) of a product and is expressed by  $-V_{DET} \times 1.03 \leq +V_{DET} \leq -V_{DET} \times 1.07$ .

Example: For the S-1000C15, the release voltage lies in the range of  $1.530 \leq (+V_{DET}) \leq 1.621$ .  
 This means that some S-1000C15s have 1.530 V for  $+V_{DET}$  and some have 1.621 V.

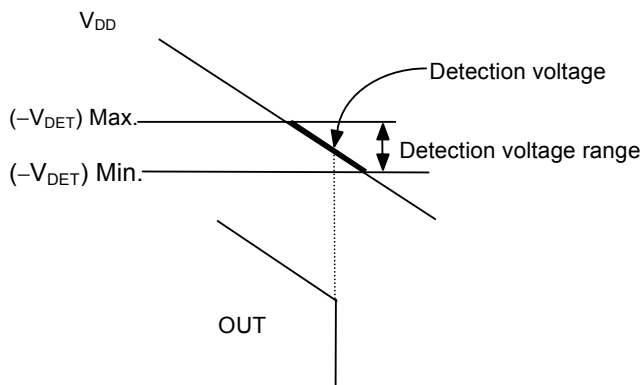


Figure 17 Detection voltage (CMOS output products)

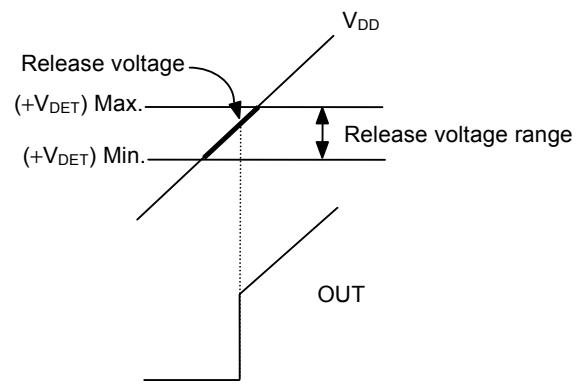


Figure 18 Release voltage (CMOS output products)

## 2. Hysteresis width ( $V_{HYS}$ )

The hysteresis width is the voltage difference between the detection voltage and the release voltage (The voltage at point B – The voltage at point A =  $V_{HYS}$  in **Figure 14**). The existence of the hysteresis width prevents malfunction caused by noise on input signal.

## 3. Through-type current

The through-type current refers to the current that flows instantaneously at the time of detection and release of a voltage detector. The through-type current is large in CMOS output products, small in Nch open-drain output products.

## 4. Oscillation

In applications where a resistor is connected to the voltage detector input (**Figure 19**), taking a CMOS active “L” product for example, the through-type current which is generated when the output goes from “L” to “H” (release) causes a voltage drop equal to [through-type current]  $\times$  [input resistance] across the resistor. When the input voltage drops below the detection voltage ( $-V_{DET}$ ) as a result, the output voltage goes to low level. In this state, the through-type current stops and its resultant voltage drop disappears, and the output goes from “L” to “H”. The through-type current is then generated again, a voltage drop appears, and repeating the process finally induces oscillation.

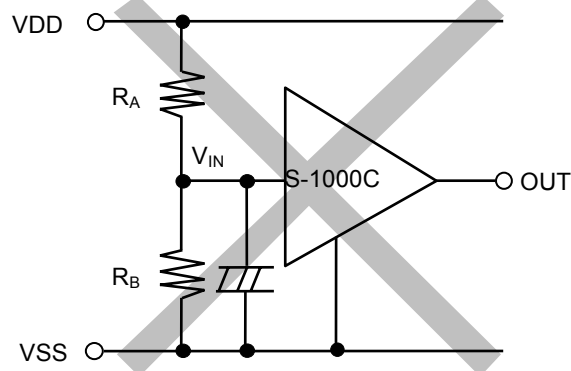


Figure 19 An example for bad implementation of input voltage divider

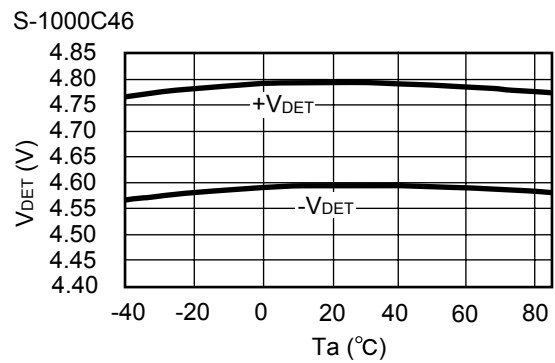
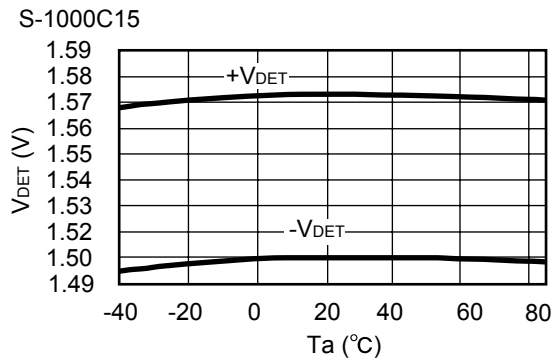


**■ Precautions**

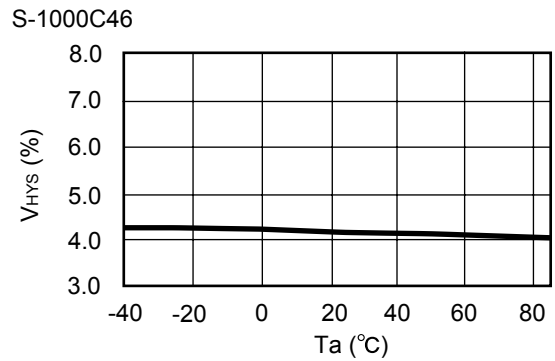
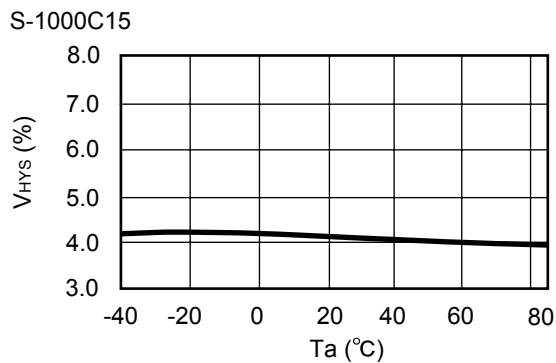
- If the input impedance is high, oscillation may occur due to the through-type current etc. In COMS output products, impedance should not be connected to the input pin. In Nch open drain output products, input impedance is recommended to be 800  $\Omega$  or less. However be sure to perform sufficient evaluation under the actual usage conditions for selection, including evaluation of temperature characteristics.
- In CMOS output products oscillation may occur when a pull-down resistor is used, and falling speed of the power supply voltage ( $V_{DD}$ ) is slow near the detection voltage.
- When designing for mass production using an application circuit described herein, the product deviation and temperature characteristics should be taken into consideration. SII shall not bear any responsibility for the products on the circuits described herein.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.
- SII claims no responsibility for any and all disputes arising out of or in connection with any infringement of the products including this IC upon patents owned by a third party.

## ■ Typical Characteristics (Typical Data)

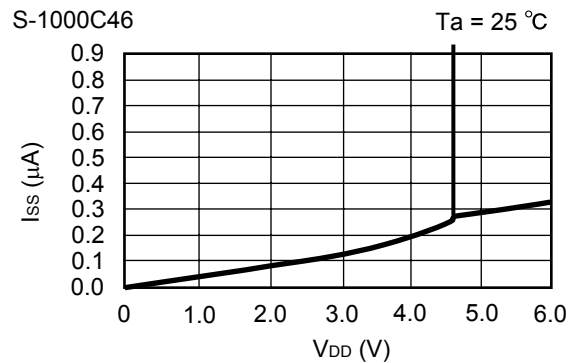
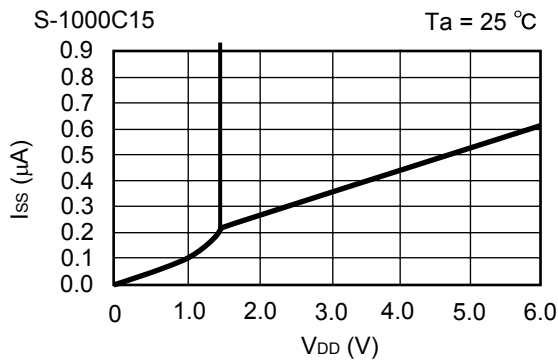
### 1. Detection voltage ( $V_{DET}$ ) – temperature ( $T_a$ )



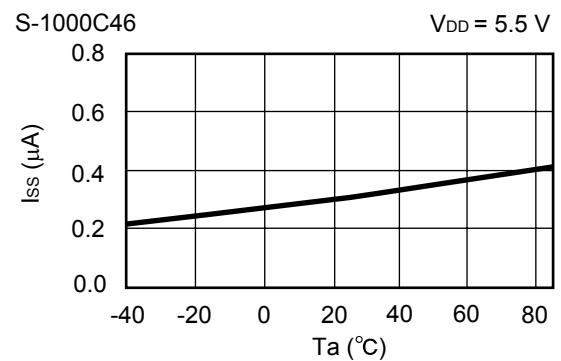
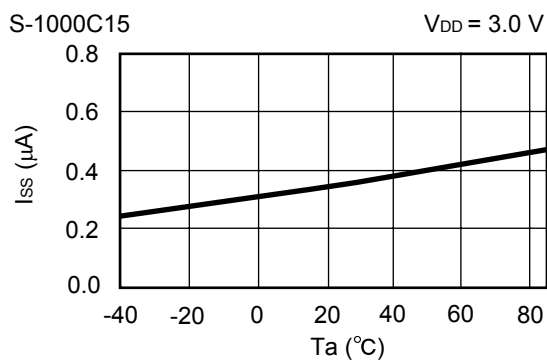
### 2. Hysteresis voltage width – ( $V_{HYS}$ ) - temperature ( $T_a$ )



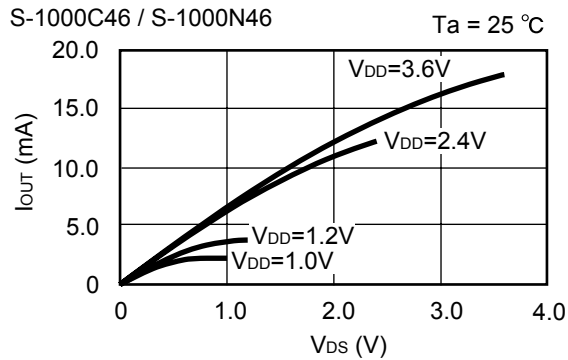
### 3. Current consumption ( $I_{SS}$ ) – input voltage ( $V_{DD}$ )



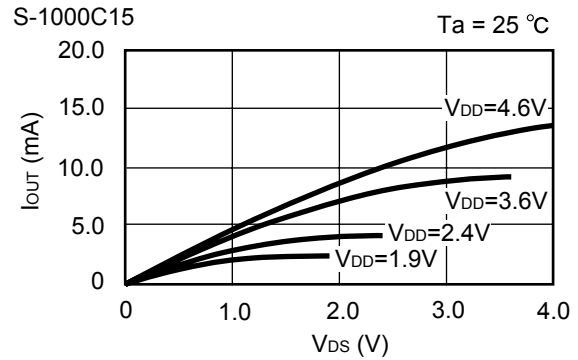
### 4. Current consumption ( $I_{SS}$ ) – temperature ( $T_a$ )



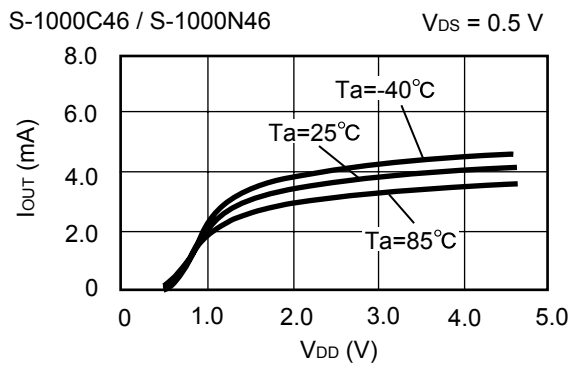
5. Nch transistor output current ( $I_{OUT}$ ) –  $V_{DS}$



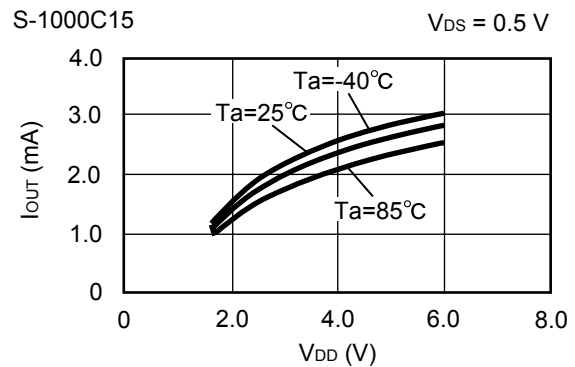
6. Pch transistor output current ( $I_{OUT}$ ) –  $V_{DS}$



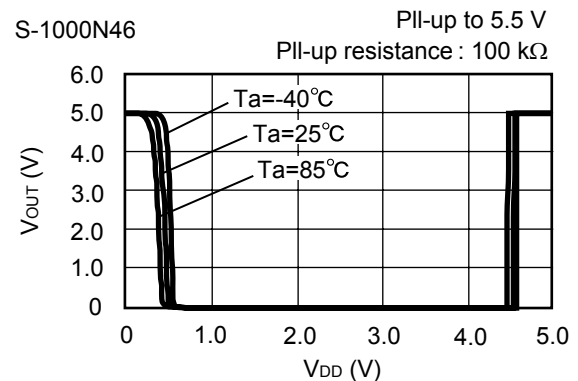
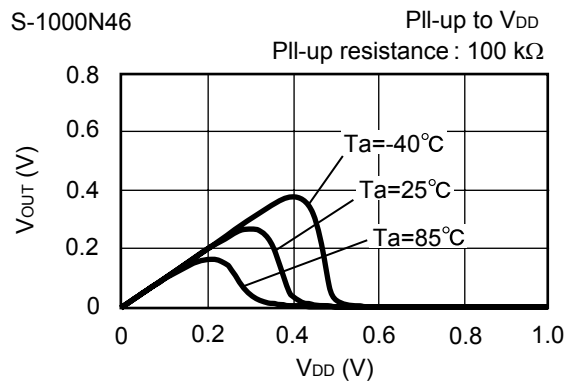
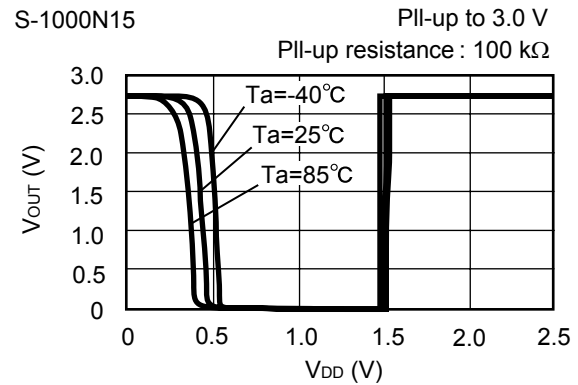
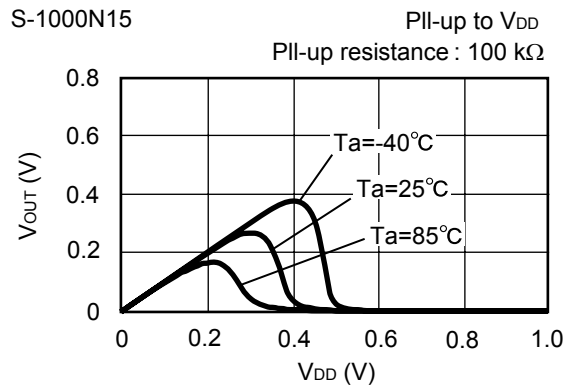
7. Nch transistor output current ( $I_{OUT}$ )

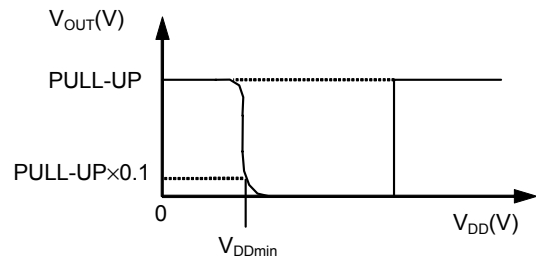
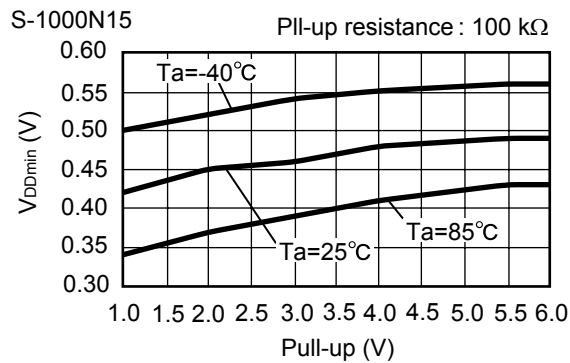


8. Pch transistor output current ( $I_{OUT}$ )



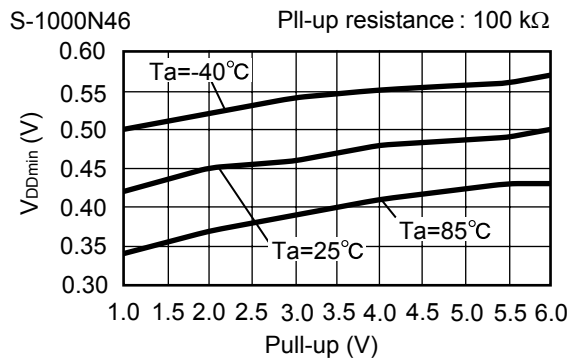
9. Minimum operating voltage - input voltage ( $V_{DD}$ )



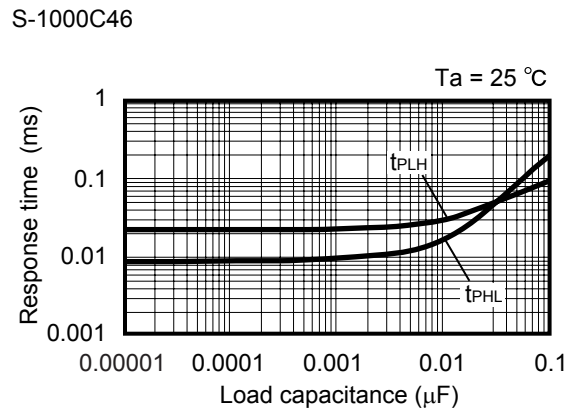
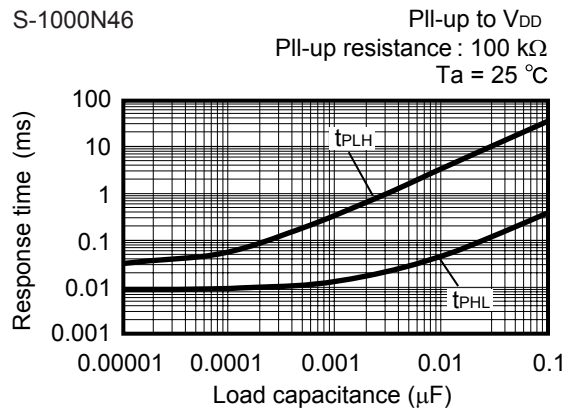
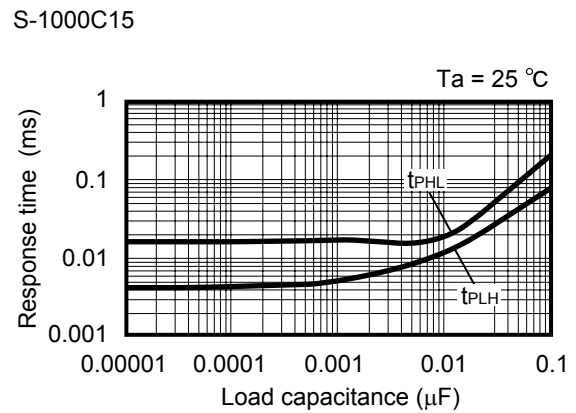
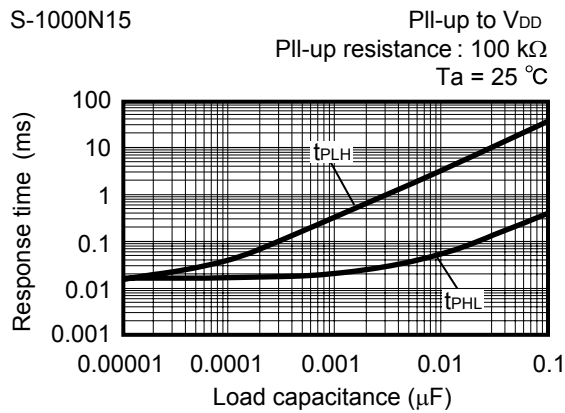


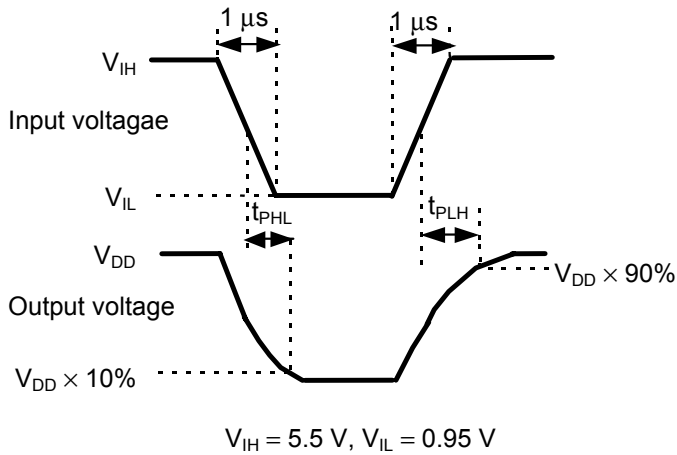
**Remark**  $V_{DDmin}$  is defined by the  $V_{DD}$  voltage at which  $V_{OUT}$  goes below 10% of pull-up voltage when the  $V_{DD}$  increase from 0 V.

**Figure 20**

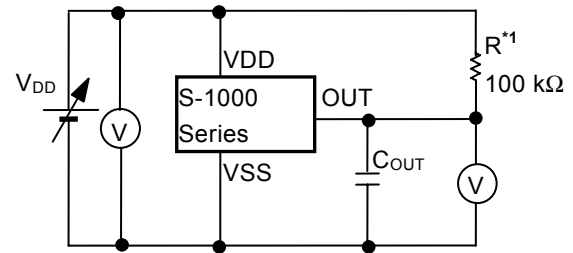


## 10. Dynamic response - $C_{OUT}$





**Figure 21 Measurement condition for response time**



\*1. R is unnecessary for CMOS output products.

**Figure 22 Measurement circuit for response time**

**Caution** The above connection diagram and constants do not guarantee correct operation. Perform sufficient evaluation using the actual application to set the constants.

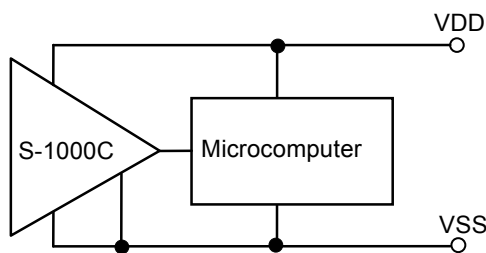
## ■ Application Circuit Examples

### 1. Microcomputer reset circuits

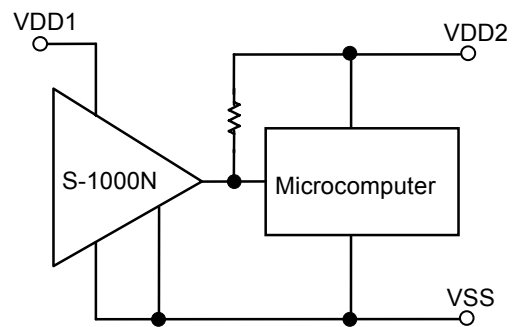
If the power supply voltage to a microcomputer falls below the specified level, an unspecified operation may be performed or the contents of the memory register may be lost. When power supply voltage returns to normal, the microcomputer needs to be initialized before normal operations can be done.

Reset circuits protect microcomputers in the event of current being momentarily switched off or lowered.

Reset circuits shown in **Figures 23, 24** can be easily constructed with the help of the S-1000 series, that has low operating voltage, a high-precision detection voltage and hysteresis.



**Figure 23 Reset circuit example (S-1000C)**



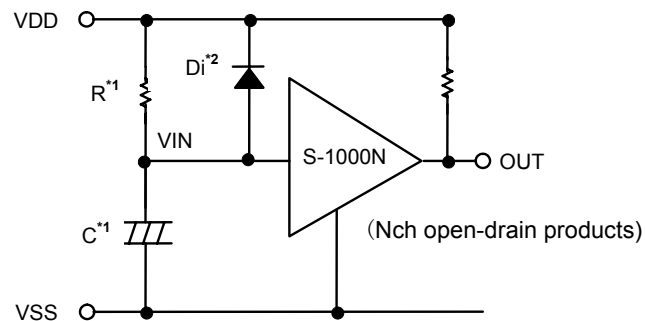
(Only for Nch open-drain products)

**Figure 24 Reset circuit example (S-1000N)**

**Caution** The above connection diagram and constants do not guarantee correct operation. Perform sufficient evaluation using the actual application to set the constants.

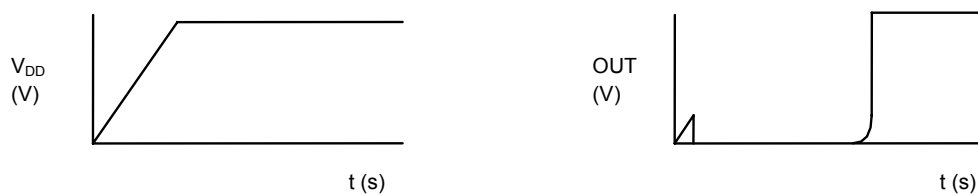
## 2. Power-on reset circuit

A power-on reset circuit can be constructed using Nch open-drain output product of S-1000 Series.



- \*1. R should be 75 k $\Omega$  or less, and C should be 0.01  $\mu$ F or more to prevent oscillation.  
If C is not connected, R should be 800  $\Omega$  or less.
- \*2. Diode Di instantaneously discharges the charge stored in the capacitor (C) at the power falling, Di can be removed when the delay of the falling time is not important.

**Figure 25**



**Figure 26**

**Remark** When the power rises sharply as shown in the **Figure 27** left, the output may go to the high level for an instant in the undefined region where the output voltage is undefined since the power voltage is less than the minimum operation voltage.

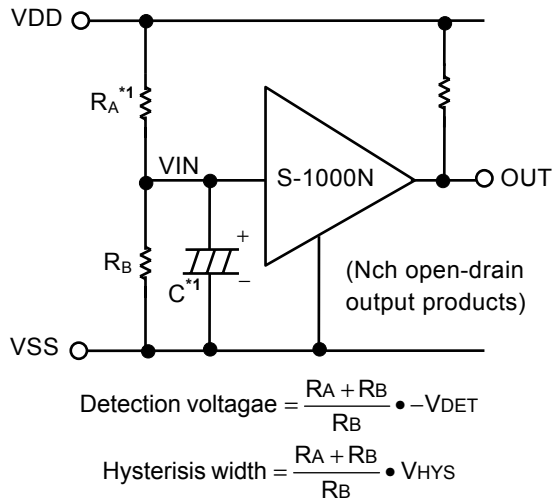


**Figure 27**

**Caution** The above connection diagram and constants do not guarantee correct operation. Perform sufficient evaluation using the actual application to set the constants.

### 3. Change of detection voltage

In Nch open-drain output products of the S-1000 series, detection voltage can be changed using resistance dividers or diodes as shown in **Figures 28 to 29**. In **Figure 28**, hysteresis width also changes.



\*1.  $R_A$  should be 75 k $\Omega$  or less, and C should be 0.01  $\mu$ F or more to prevent oscillation.  
 If C is not connected,  $R_A$  should be 800  $\Omega$  or less.

**Caution** If  $R_A$  and  $R_B$  are large, the hysteresis width may also be larger than the value given by the above equation due to the through-type current (which flows slightly in an Nch open-drain product).

Figure 28

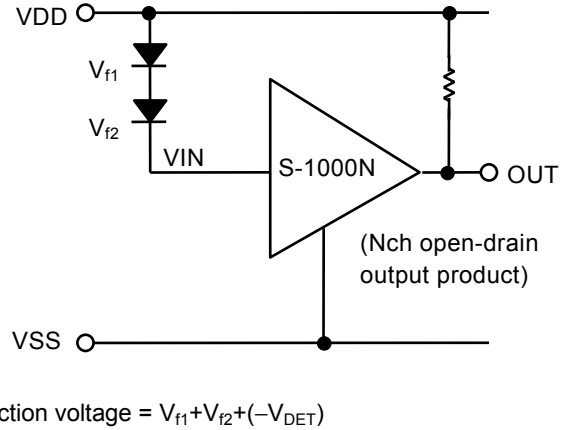


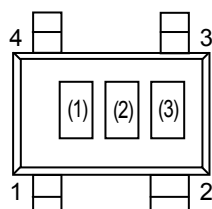
Figure 29

**Caution** The above connection diagram and constants do not guarantee correct operation. Perform sufficient evaluation using the actual application to set the constants.

## ■ Marking Specifications

### (1) SC-82AB

SC-82AB  
Top view



(1) to (3):

Product abbreviation (refer to **List of product names and product abbreviations**)

### List of product names and product abbreviations

#### (a) Nch open-drain output products

| Product Name   | Product Abbreviation |     |     |
|----------------|----------------------|-----|-----|
|                | (1)                  | (2) | (3) |
| S-1000N15-N4T1 | P                    | L   | A   |
| S-1000N16-N4T1 | P                    | L   | B   |
| S-1000N17-N4T1 | P                    | L   | C   |
| S-1000N18-N4T1 | P                    | L   | D   |
| S-1000N19-N4T1 | P                    | L   | E   |
| S-1000N20-N4T1 | P                    | L   | F   |
| S-1000N21-N4T1 | P                    | L   | G   |
| S-1000N22-N4T1 | P                    | L   | H   |
| S-1000N23-N4T1 | P                    | L   | I   |
| S-1000N24-N4T1 | P                    | L   | J   |
| S-1000N25-N4T1 | P                    | L   | K   |
| S-1000N26-N4T1 | P                    | L   | L   |
| S-1000N27-N4T1 | P                    | L   | M   |
| S-1000N28-N4T1 | P                    | L   | N   |
| S-1000N29-N4T1 | P                    | L   | O   |
| S-1000N30-N4T1 | P                    | L   | P   |

| Product Name   | Product Abbreviation |     |     |
|----------------|----------------------|-----|-----|
|                | (1)                  | (2) | (3) |
| S-1000N31-N4T1 | P                    | L   | Q   |
| S-1000N32-N4T1 | P                    | L   | R   |
| S-1000N33-N4T1 | P                    | L   | S   |
| S-1000N34-N4T1 | P                    | L   | T   |
| S-1000N35-N4T1 | P                    | L   | U   |
| S-1000N36-N4T1 | P                    | L   | V   |
| S-1000N37-N4T1 | P                    | L   | W   |
| S-1000N38-N4T1 | P                    | L   | X   |
| S-1000N39-N4T1 | P                    | L   | Y   |
| S-1000N40-N4T1 | P                    | L   | Z   |
| S-1000N41-N4T1 | P                    | L   | 2   |
| S-1000N42-N4T1 | P                    | L   | 3   |
| S-1000N43-N4T1 | P                    | L   | 4   |
| S-1000N44-N4T1 | P                    | L   | 5   |
| S-1000N45-N4T1 | P                    | L   | 6   |
| S-1000N46-N4T1 | P                    | L   | 7   |

#### (b) CMOS output products

| Product Name   | Product Abbreviation |     |     |
|----------------|----------------------|-----|-----|
|                | (1)                  | (2) | (3) |
| S-1000C15-N4T1 | P                    | K   | A   |
| S-1000C16-N4T1 | P                    | K   | B   |
| S-1000C17-N4T1 | P                    | K   | C   |
| S-1000C18-N4T1 | P                    | K   | D   |
| S-1000C19-N4T1 | P                    | K   | E   |
| S-1000C20-N4T1 | P                    | K   | F   |
| S-1000C21-N4T1 | P                    | K   | G   |
| S-1000C22-N4T1 | P                    | K   | H   |
| S-1000C23-N4T1 | P                    | K   | I   |
| S-1000C24-N4T1 | P                    | K   | J   |
| S-1000C25-N4T1 | P                    | K   | K   |
| S-1000C26-N4T1 | P                    | K   | L   |
| S-1000C27-N4T1 | P                    | K   | M   |
| S-1000C28-N4T1 | P                    | K   | N   |
| S-1000C29-N4T1 | P                    | K   | O   |
| S-1000C30-N4T1 | P                    | K   | P   |

| Product Name   | Product Abbreviation |     |     |
|----------------|----------------------|-----|-----|
|                | (1)                  | (2) | (3) |
| S-1000C31-N4T1 | P                    | K   | Q   |
| S-1000C32-N4T1 | P                    | K   | R   |
| S-1000C33-N4T1 | P                    | K   | S   |
| S-1000C34-N4T1 | P                    | K   | T   |
| S-1000C35-N4T1 | P                    | K   | U   |
| S-1000C36-N4T1 | P                    | K   | V   |
| S-1000C37-N4T1 | P                    | K   | W   |
| S-1000C38-N4T1 | P                    | K   | X   |
| S-1000C39-N4T1 | P                    | K   | Y   |
| S-1000C40-N4T1 | P                    | K   | Z   |
| S-1000C41-N4T1 | P                    | K   | 2   |
| S-1000C42-N4T1 | P                    | K   | 3   |
| S-1000C43-N4T1 | P                    | K   | 4   |
| S-1000C44-N4T1 | P                    | K   | 5   |
| S-1000C45-N4T1 | P                    | K   | 6   |
| S-1000C46-N4T1 | P                    | K   | 7   |

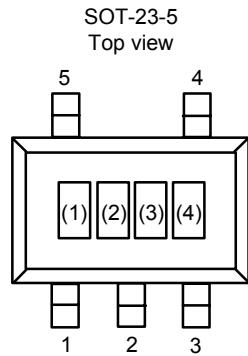


# ULTRA-SMALL PACKAGE HIGH-PRECISION VOLTAGE DETECTOR

## S-1000C Series

Rev.1.0\_00

### (2) SOT-23-5



- (1) to (3) : Product abbreviation (refer to **List of product names and product abbreviations**)  
(4) : Lot number

### List of product names and product abbreviations

#### (a) Nch open-drain output products

| Product Name   | Product Abbreviation |     |     |
|----------------|----------------------|-----|-----|
|                | (1)                  | (2) | (3) |
| S-1000N15-M5T1 | P                    | L   | A   |
| S-1000N16-M5T1 | P                    | L   | B   |
| S-1000N17-M5T1 | P                    | L   | C   |
| S-1000N18-M5T1 | P                    | L   | D   |
| S-1000N19-M5T1 | P                    | L   | E   |
| S-1000N20-M5T1 | P                    | L   | F   |
| S-1000N21-M5T1 | P                    | L   | G   |
| S-1000N22-M5T1 | P                    | L   | H   |
| S-1000N23-M5T1 | P                    | L   | I   |
| S-1000N24-M5T1 | P                    | L   | J   |
| S-1000N25-M5T1 | P                    | L   | K   |
| S-1000N26-M5T1 | P                    | L   | L   |
| S-1000N27-M5T1 | P                    | L   | M   |
| S-1000N28-M5T1 | P                    | L   | N   |
| S-1000N29-M5T1 | P                    | L   | O   |
| S-1000N30-M5T1 | P                    | L   | P   |

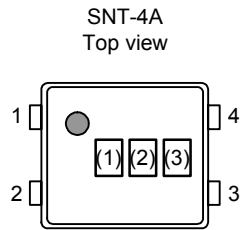
| Product Name   | Product Abbreviation |     |     |
|----------------|----------------------|-----|-----|
|                | (1)                  | (2) | (3) |
| S-1000N31-M5T1 | P                    | L   | Q   |
| S-1000N32-M5T1 | P                    | L   | R   |
| S-1000N33-M5T1 | P                    | L   | S   |
| S-1000N34-M5T1 | P                    | L   | T   |
| S-1000N35-M5T1 | P                    | L   | U   |
| S-1000N36-M5T1 | P                    | L   | V   |
| S-1000N37-M5T1 | P                    | L   | W   |
| S-1000N38-M5T1 | P                    | L   | X   |
| S-1000N39-M5T1 | P                    | L   | Y   |
| S-1000N40-M5T1 | P                    | L   | Z   |
| S-1000N41-M5T1 | P                    | L   | 2   |
| S-1000N42-M5T1 | P                    | L   | 3   |
| S-1000N43-M5T1 | P                    | L   | 4   |
| S-1000N44-M5T1 | P                    | L   | 5   |
| S-1000N45-M5T1 | P                    | L   | 6   |
| S-1000N46-M5T1 | P                    | L   | 7   |

#### (b) CMOS output products

| Product Name   | Product Abbreviation |     |     |
|----------------|----------------------|-----|-----|
|                | (1)                  | (2) | (3) |
| S-1000C15-M5T1 | P                    | K   | A   |
| S-1000C16-M5T1 | P                    | K   | B   |
| S-1000C17-M5T1 | P                    | K   | C   |
| S-1000C18-M5T1 | P                    | K   | D   |
| S-1000C19-M5T1 | P                    | K   | E   |
| S-1000C20-M5T1 | P                    | K   | F   |
| S-1000C21-M5T1 | P                    | K   | G   |
| S-1000C22-M5T1 | P                    | K   | H   |
| S-1000C23-M5T1 | P                    | K   | I   |
| S-1000C24-M5T1 | P                    | K   | J   |
| S-1000C25-M5T1 | P                    | K   | K   |
| S-1000C26-M5T1 | P                    | K   | L   |
| S-1000C27-M5T1 | P                    | K   | M   |
| S-1000C28-M5T1 | P                    | K   | N   |
| S-1000C29-M5T1 | P                    | K   | O   |
| S-1000C30-M5T1 | P                    | K   | P   |

| Product Name   | Product Abbreviation |     |     |
|----------------|----------------------|-----|-----|
|                | (1)                  | (2) | (3) |
| S-1000C31-M5T1 | P                    | K   | Q   |
| S-1000C32-M5T1 | P                    | K   | R   |
| S-1000C33-M5T1 | P                    | K   | S   |
| S-1000C34-M5T1 | P                    | K   | T   |
| S-1000C35-M5T1 | P                    | K   | U   |
| S-1000C36-M5T1 | P                    | K   | V   |
| S-1000C37-M5T1 | P                    | K   | W   |
| S-1000C38-M5T1 | P                    | K   | X   |
| S-1000C39-M5T1 | P                    | K   | Y   |
| S-1000C40-M5T1 | P                    | K   | Z   |
| S-1000C41-M5T1 | P                    | K   | 2   |
| S-1000C42-M5T1 | P                    | K   | 3   |
| S-1000C43-M5T1 | P                    | K   | 4   |
| S-1000C44-M5T1 | P                    | K   | 5   |
| S-1000C45-M5T1 | P                    | K   | 6   |
| S-1000C46-M5T1 | P                    | K   | 7   |

**(3) SNT-4A**



(1) to (3):

Product abbreviation (refer to **List of product names and product abbreviations**)

**List of product names and product abbreviations**

**(a) Nch open-drain output products**

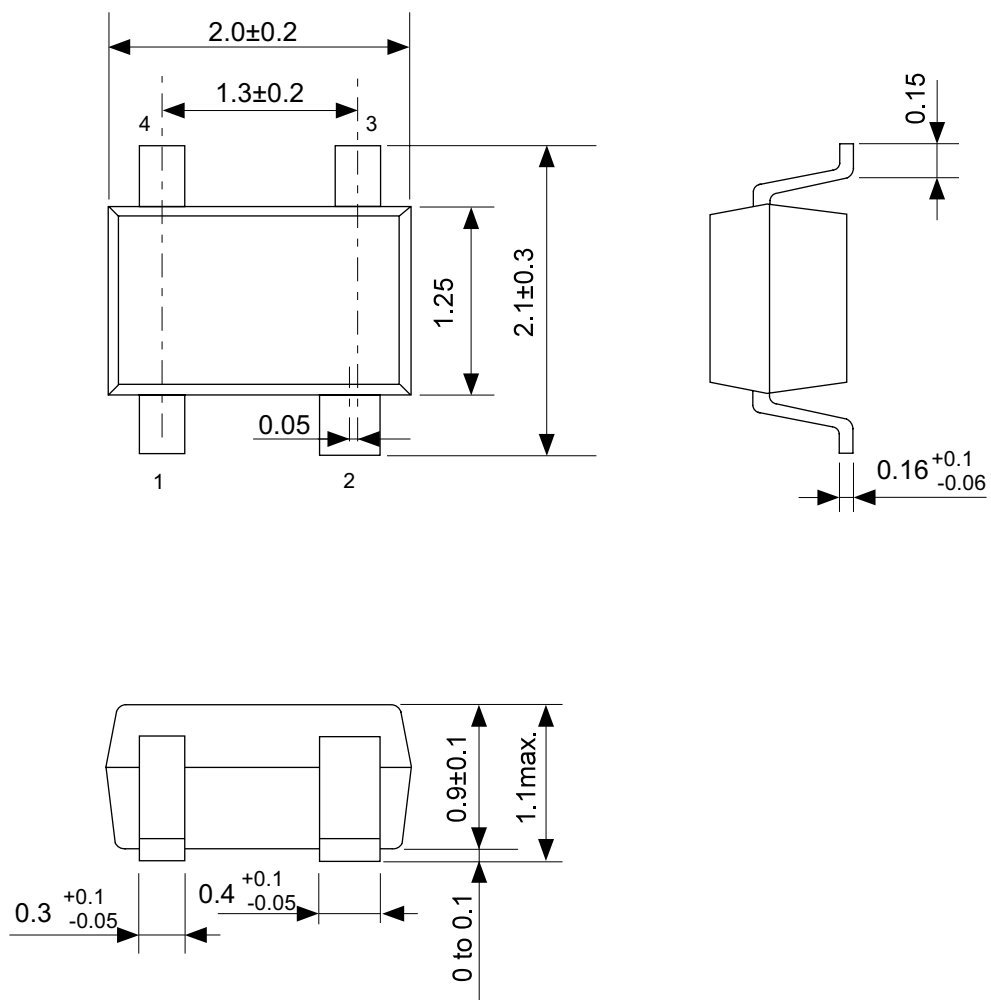
| Product Name    | Product Abbreviation |     |     |
|-----------------|----------------------|-----|-----|
|                 | (1)                  | (2) | (3) |
| S-1000N15-I4T1G | P                    | L   | A   |
| S-1000N16-I4T1G | P                    | L   | B   |
| S-1000N17-I4T1G | P                    | L   | C   |
| S-1000N18-I4T1G | P                    | L   | D   |
| S-1000N19-I4T1G | P                    | L   | E   |
| S-1000N20-I4T1G | P                    | L   | F   |
| S-1000N21-I4T1G | P                    | L   | G   |
| S-1000N22-I4T1G | P                    | L   | H   |
| S-1000N23-I4T1G | P                    | L   | I   |
| S-1000N24-I4T1G | P                    | L   | J   |
| S-1000N25-I4T1G | P                    | L   | K   |
| S-1000N26-I4T1G | P                    | L   | L   |
| S-1000N27-I4T1G | P                    | L   | M   |
| S-1000N28-I4T1G | P                    | L   | N   |
| S-1000N29-I4T1G | P                    | L   | O   |
| S-1000N30-I4T1G | P                    | L   | P   |

| Product Name    | Product Abbreviation |     |     |
|-----------------|----------------------|-----|-----|
|                 | (1)                  | (2) | (3) |
| S-1000N31-I4T1G | P                    | L   | Q   |
| S-1000N32-I4T1G | P                    | L   | R   |
| S-1000N33-I4T1G | P                    | L   | S   |
| S-1000N34-I4T1G | P                    | L   | T   |
| S-1000N35-I4T1G | P                    | L   | U   |
| S-1000N36-I4T1G | P                    | L   | V   |
| S-1000N37-I4T1G | P                    | L   | W   |
| S-1000N38-I4T1G | P                    | L   | X   |
| S-1000N39-I4T1G | P                    | L   | Y   |
| S-1000N40-I4T1G | P                    | L   | Z   |
| S-1000N41-I4T1G | P                    | L   | 2   |
| S-1000N42-I4T1G | P                    | L   | 3   |
| S-1000N43-I4T1G | P                    | L   | 4   |
| S-1000N44-I4T1G | P                    | L   | 5   |
| S-1000N45-I4T1G | P                    | L   | 6   |
| S-1000N46-I4T1G | P                    | L   | 7   |

**(b) CMOS output products**

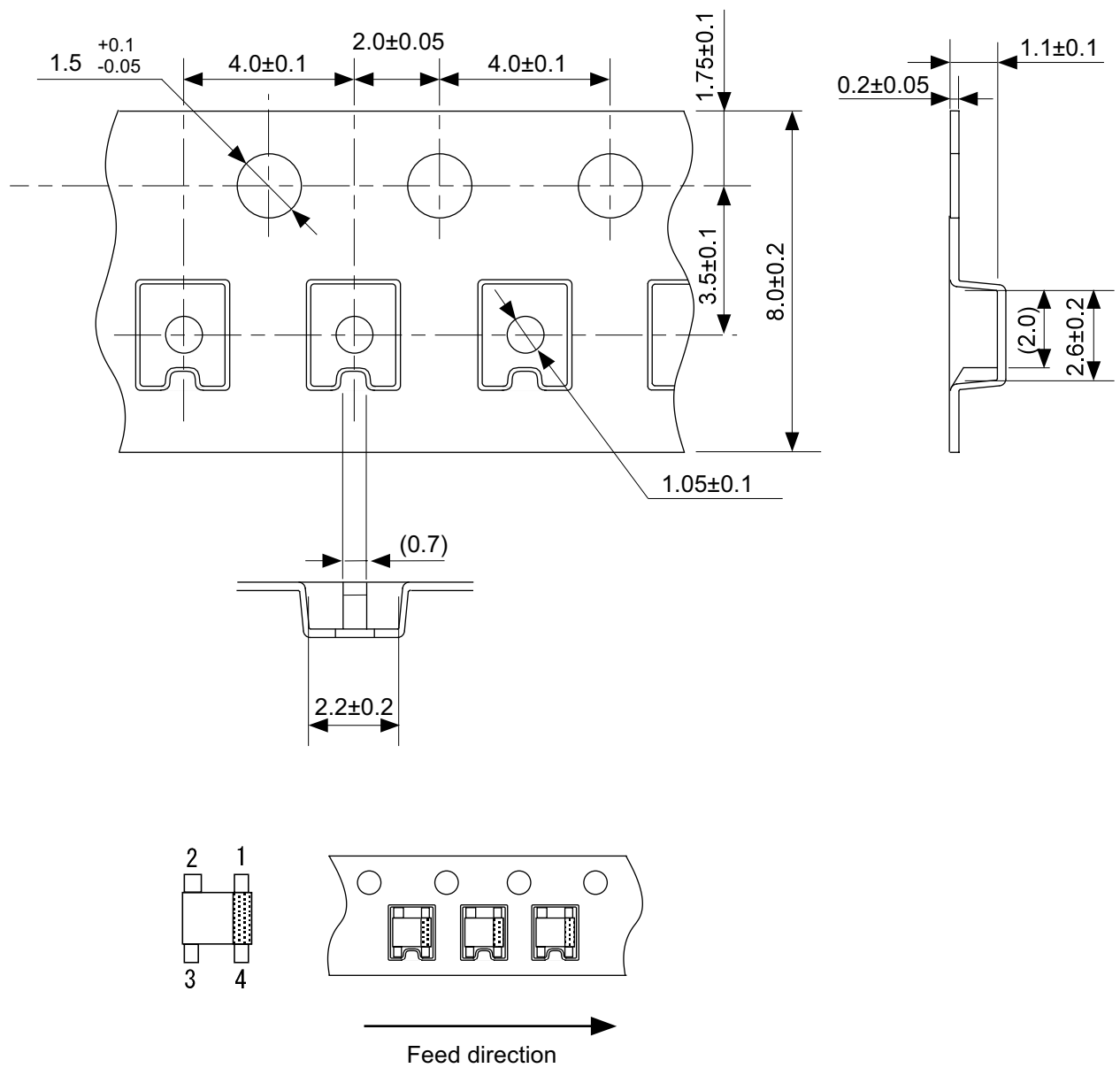
| Product Name    | Product Abbreviation |     |     |
|-----------------|----------------------|-----|-----|
|                 | (1)                  | (2) | (3) |
| S-1000C15-I4T1G | P                    | K   | A   |
| S-1000C16-I4T1G | P                    | K   | B   |
| S-1000C17-I4T1G | P                    | K   | C   |
| S-1000C18-I4T1G | P                    | K   | D   |
| S-1000C19-I4T1G | P                    | K   | E   |
| S-1000C20-I4T1G | P                    | K   | F   |
| S-1000C21-I4T1G | P                    | K   | G   |
| S-1000C22-I4T1G | P                    | K   | H   |
| S-1000C23-I4T1G | P                    | K   | I   |
| S-1000C24-I4T1G | P                    | K   | J   |
| S-1000C25-I4T1G | P                    | K   | K   |
| S-1000C26-I4T1G | P                    | K   | L   |
| S-1000C27-I4T1G | P                    | K   | M   |
| S-1000C28-I4T1G | P                    | K   | N   |
| S-1000C29-I4T1G | P                    | K   | O   |
| S-1000C30-I4T1G | P                    | K   | P   |

| Product Name    | Product Abbreviation |     |     |
|-----------------|----------------------|-----|-----|
|                 | (1)                  | (2) | (3) |
| S-1000C31-I4T1G | P                    | K   | Q   |
| S-1000C32-I4T1G | P                    | K   | R   |
| S-1000C33-I4T1G | P                    | K   | S   |
| S-1000C34-I4T1G | P                    | K   | T   |
| S-1000C35-I4T1G | P                    | K   | U   |
| S-1000C36-I4T1G | P                    | K   | V   |
| S-1000C37-I4T1G | P                    | K   | W   |
| S-1000C38-I4T1G | P                    | K   | X   |
| S-1000C39-I4T1G | P                    | K   | Y   |
| S-1000C40-I4T1G | P                    | K   | Z   |
| S-1000C41-I4T1G | P                    | K   | 2   |
| S-1000C42-I4T1G | P                    | K   | 3   |
| S-1000C43-I4T1G | P                    | K   | 4   |
| S-1000C44-I4T1G | P                    | K   | 5   |
| S-1000C45-I4T1G | P                    | K   | 6   |
| S-1000C46-I4T1G | P                    | K   | 7   |



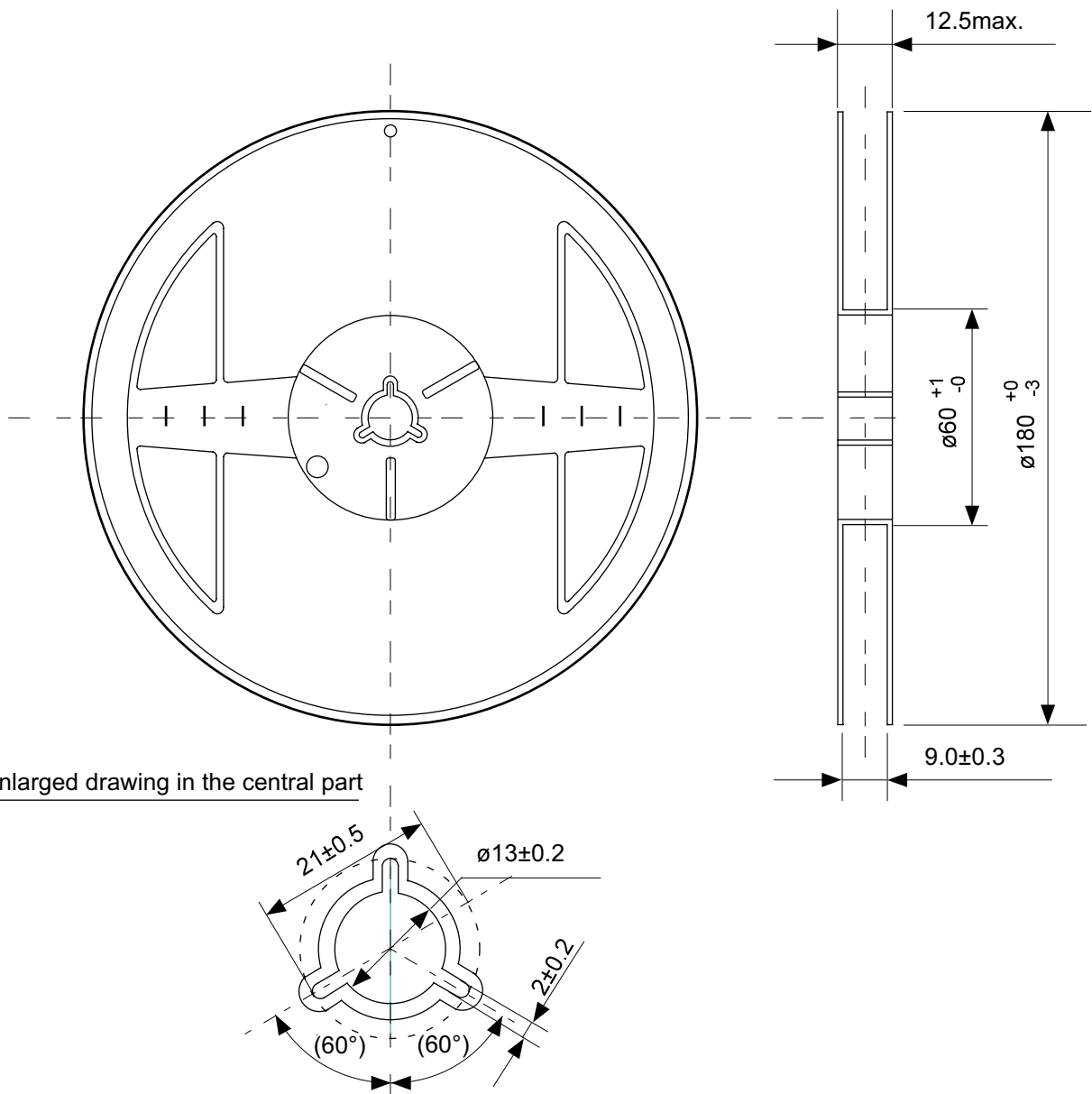
No. NP004-A-P-SD-1.1

|                        |                         |
|------------------------|-------------------------|
| TITLE                  | SC82AB-A-PKG Dimensions |
| No.                    | NP004-A-P-SD-1.1        |
| SCALE                  |                         |
| UNIT                   | mm                      |
|                        |                         |
| Seiko Instruments Inc. |                         |



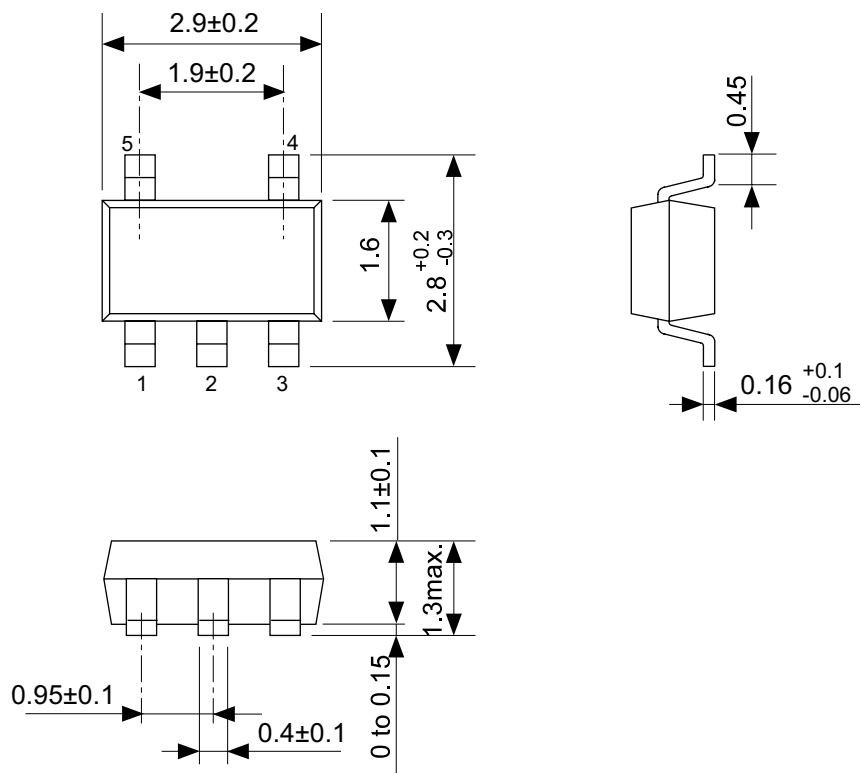
No. NP004-A-C-SD-2.1

|                        |                       |
|------------------------|-----------------------|
| TITLE                  | SC82AB-A-Carrier Tape |
| No.                    | NP004-A-C-SD-2.1      |
| SCALE                  |                       |
| UNIT                   | mm                    |
|                        |                       |
| Seiko Instruments Inc. |                       |



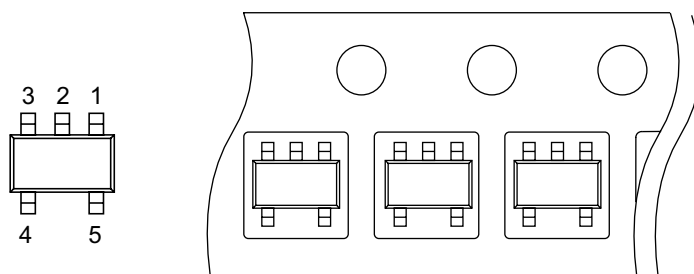
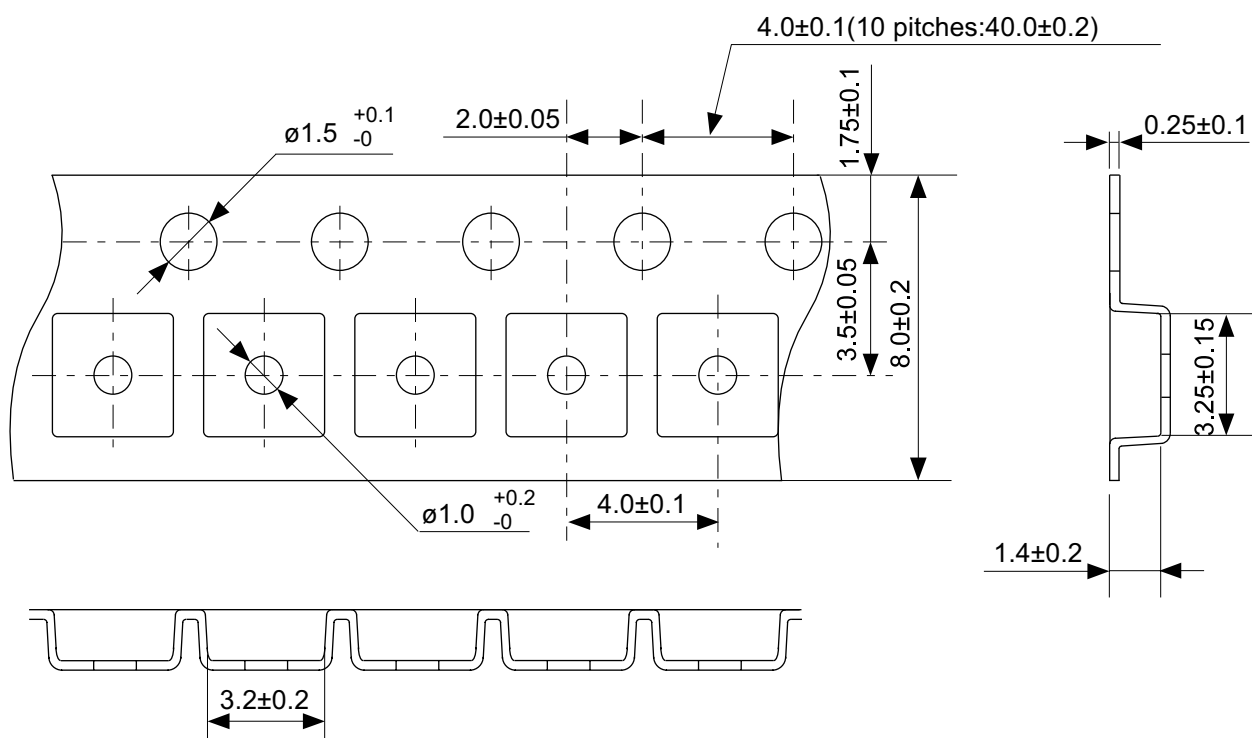
No. NP004-A-R-SD-1.1

|                        |                  |      |       |
|------------------------|------------------|------|-------|
| TITLE                  | SC82AB-A-Reel    |      |       |
| No.                    | NP004-A-R-SD-1.1 |      |       |
| SCALE                  |                  | QTY. | 3,000 |
| UNIT                   | mm               |      |       |
|                        |                  |      |       |
| Seiko Instruments Inc. |                  |      |       |



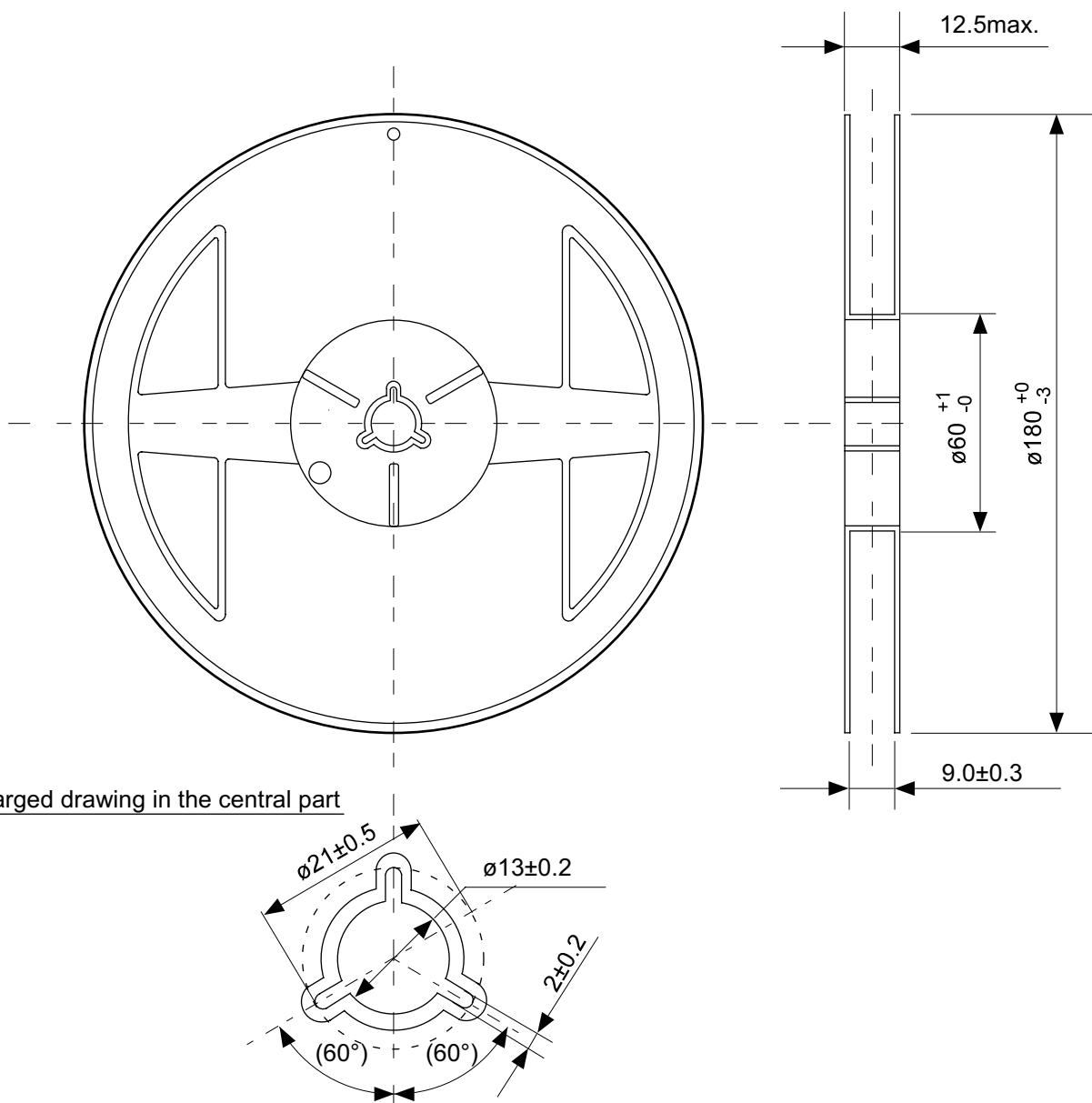
No. MP005-A-P-SD-1.2

|                        |                         |
|------------------------|-------------------------|
| TITLE                  | SOT235-A-PKG Dimensions |
| No.                    | MP005-A-P-SD-1.2        |
| SCALE                  |                         |
| UNIT                   | mm                      |
|                        |                         |
| Seiko Instruments Inc. |                         |



No. MP005-A-C-SD-2.1

|                        |                       |
|------------------------|-----------------------|
| TITLE                  | SOT235-A-Carrier Tape |
| No.                    | MP005-A-C-SD-2.1      |
| SCALE                  |                       |
| UNIT                   | mm                    |
|                        |                       |
| Seiko Instruments Inc. |                       |

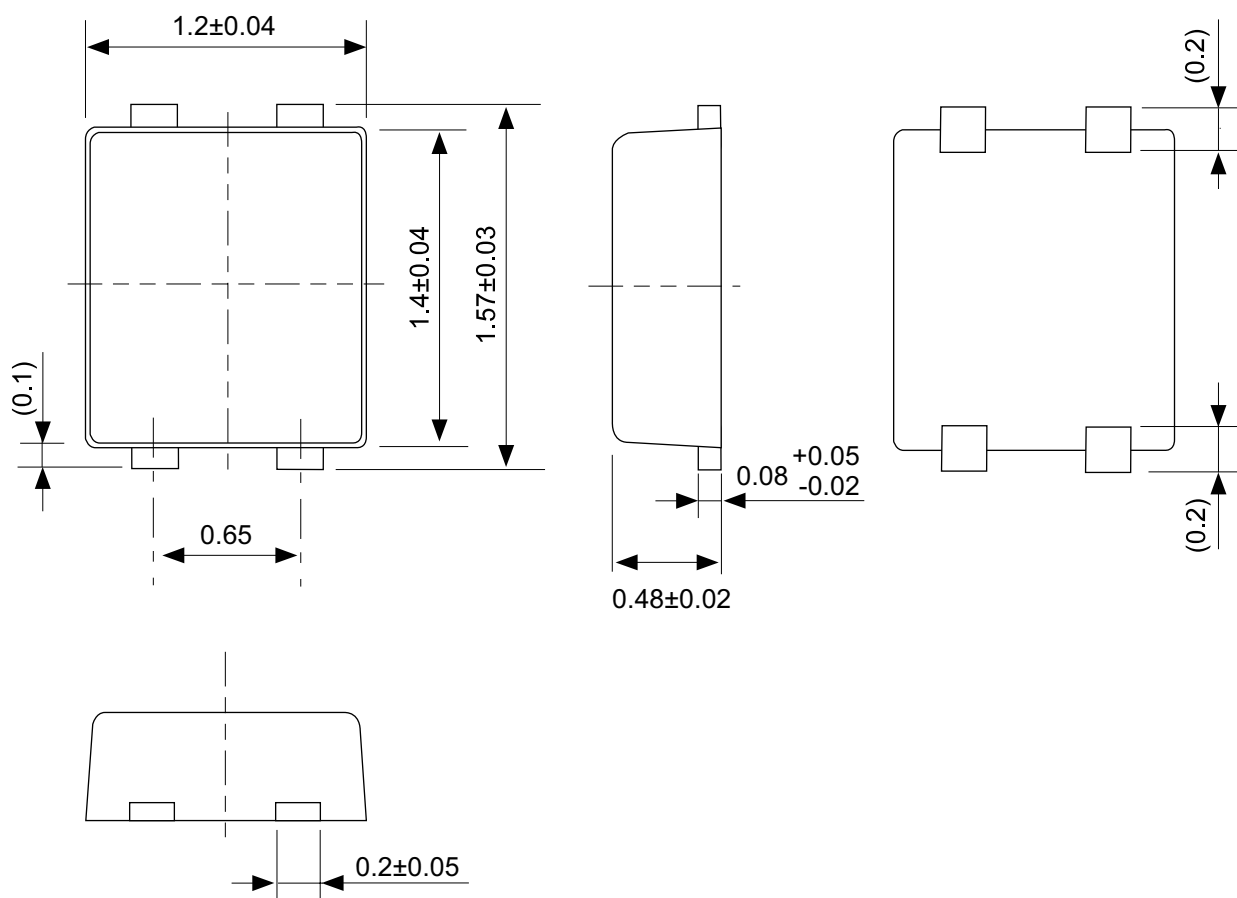


Enlarged drawing in the central part

No. MP005-A-R-SD-1.1

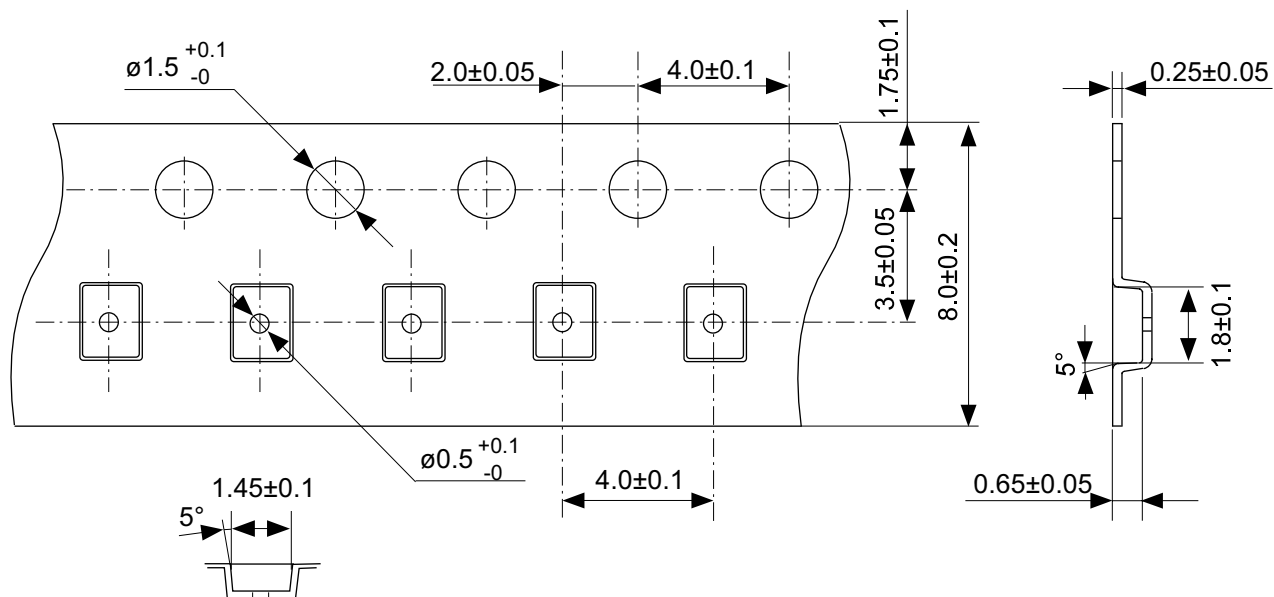
|                        |                  |      |       |
|------------------------|------------------|------|-------|
| TITLE                  | SOT235-A-Reel    |      |       |
| No.                    | MP005-A-R-SD-1.1 |      |       |
| SCALE                  |                  | QTY. | 3,000 |
| UNIT                   | mm               |      |       |
|                        |                  |      |       |
| Seiko Instruments Inc. |                  |      |       |



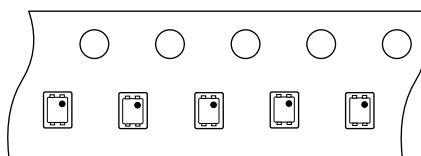
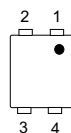


No. PF004-A-P-SD-3.0

|                        |                         |
|------------------------|-------------------------|
| TITLE                  | SNT-4A-A-PKG Dimensions |
| No.                    | PF004-A-P-SD-3.0        |
| SCALE                  |                         |
| UNIT                   | mm                      |
|                        |                         |
| Seiko Instruments Inc. |                         |



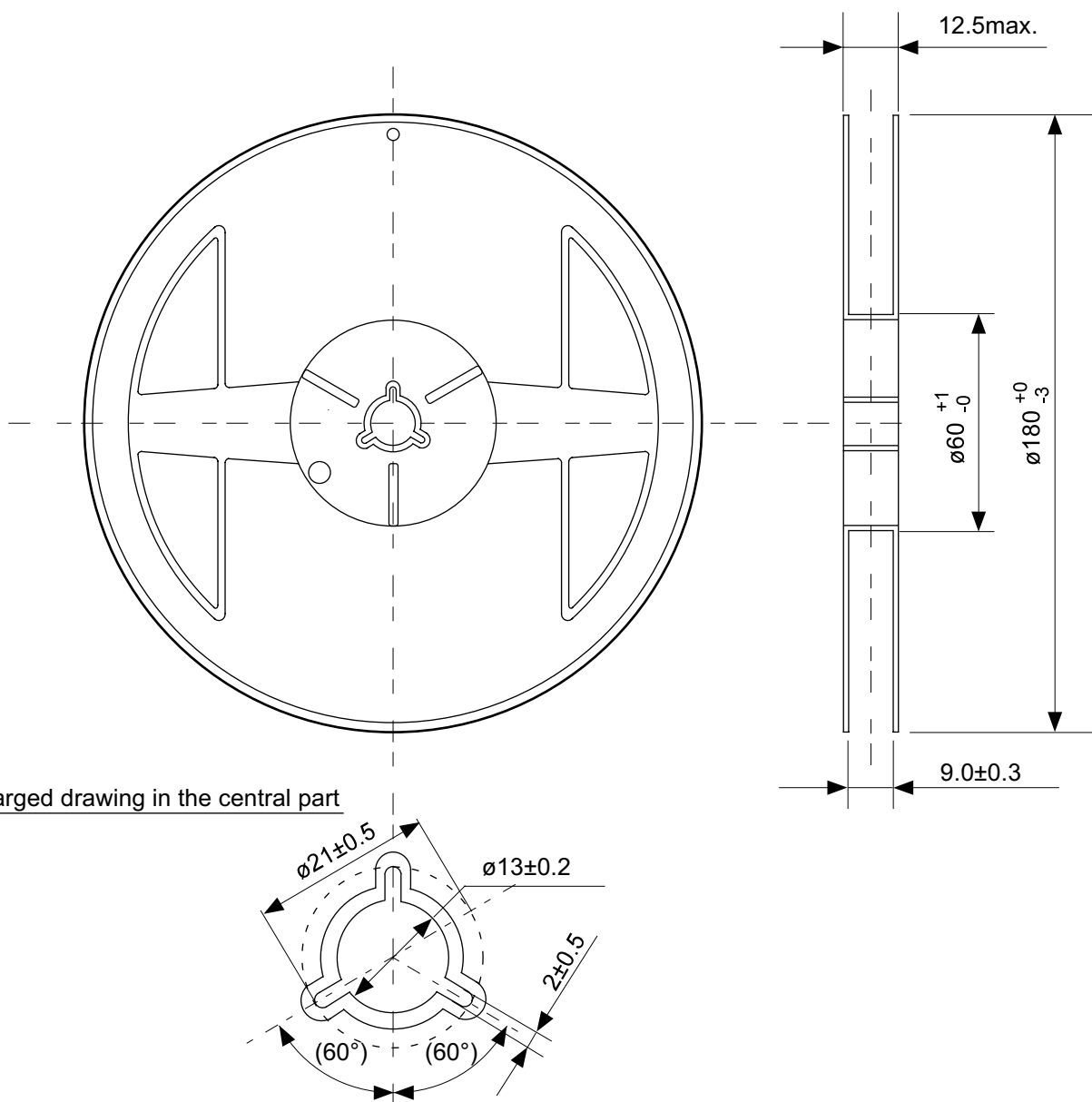
TF type



Feed direction

No. PF004-A-C-SD-1.0

|                        |                       |
|------------------------|-----------------------|
| TITLE                  | SNT-4A-A-Carrier Tape |
| No.                    | PF004-A-C-SD-1.0      |
| SCALE                  |                       |
| UNIT                   | mm                    |
|                        |                       |
| Seiko Instruments Inc. |                       |



No. PF004-A-R-SD-1.0

|                        |                  |      |       |
|------------------------|------------------|------|-------|
| TITLE                  | SNT-4A-A-Reel    |      |       |
| No.                    | PF004-A-R-SD-1.0 |      |       |
| SCALE                  |                  | QTY. | 5,000 |
| UNIT                   | mm               |      |       |
|                        |                  |      |       |
| Seiko Instruments Inc. |                  |      |       |

- The information described herein is subject to change without notice.
- Seiko Instruments Inc. is not responsible for any problems caused by circuits or diagrams described herein whose related industrial properties, patents, or other rights belong to third parties. The application circuit examples explain typical applications of the products, and do not guarantee the success of any specific mass-production design.
- When the products described herein are regulated products subject to the Wassenaar Arrangement or other agreements, they may not be exported without authorization from the appropriate governmental authority.
- Use of the information described herein for other purposes and/or reproduction or copying without the express permission of Seiko Instruments Inc. is strictly prohibited.
- The products described herein cannot be used as part of any device or equipment affecting the human body, such as exercise equipment, medical equipment, security systems, gas equipment, or any apparatus installed in airplanes and other vehicles, without prior written permission of Seiko Instruments Inc.
- Although Seiko Instruments Inc. exerts the greatest possible effort to ensure high quality and reliability, the failure or malfunction of semiconductor products may occur. The user of these products should therefore give thorough consideration to safety design, including redundancy, fire-prevention measures, and malfunction prevention, to prevent any accidents, fires, or community damage that may ensue.