

CMOS TEMPERATURE SENSOR IC

S-5813A/5814A Series

The S-5813A/5814A Series is a family of high-precision temperature sensor ICs on a single chip with a linear output voltage for temperature changes.

Each chip is composed of a temperature sensor, a constant current circuit, and an operational amplifier.

It can be used at temperatures ranging from -40°C to 100°C . These devices have much better linearity than other temperature sensors such as thermistors, and can be used for a wide range of temperature control applications.

■ Features

- Temperature accuracy
 - S-5813A Series : $\pm 5.0^{\circ}\text{C}$ (-30 to 100°C)
 - S-5814A Series : $\pm 2.5^{\circ}\text{C}$ (-30 to 100°C)
- Linear output voltage
 - -11.04 mV/ $^{\circ}\text{C}$ typ.
 - $T_a = -30^{\circ}\text{C}$: 2.582 V typ.
 - $T_a = +30^{\circ}\text{C}$: 1.940 V typ.
 - $T_a = +100^{\circ}\text{C}$: 1.145 V typ.
- Nonlinearity
 - $\pm 0.5\%$ typ. (-20 to 80°C)
- Wide power supply voltage operation
 - $V_{\text{DD}} = 2.4$ to 10.0 V (25°C)
- Low current consumption
 - 4.0 μA typ. (25°C)
- Built-in operational amplifier
- Output voltage referred to V_{SS}
- Small package
 - SNT-4A
- Lead-free products

■ Applications

- Compensation of high-frequency circuits such as cellular phones and radio equipment
- Compensation of oscillation frequency in crystal oscillator
- LCD contrast compensation
- Compensation of amplifier gain
- Compensation of auto focus circuits
- Temperature detection in battery management
- Overheating prevention for charged batteries or halogen lights

■ Package

| Package Name | Drawing Code | | | |
|--------------|--------------|---------|---------|---------|
| | Package | Tape | Reel | Land |
| SNT-4A | PF004-A | PF004-A | PF004-A | PF004-A |

■ Block Diagram

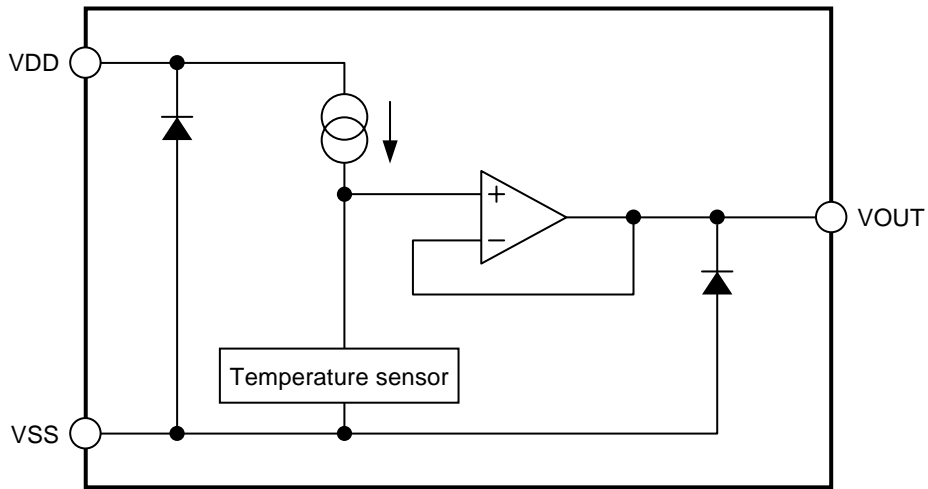
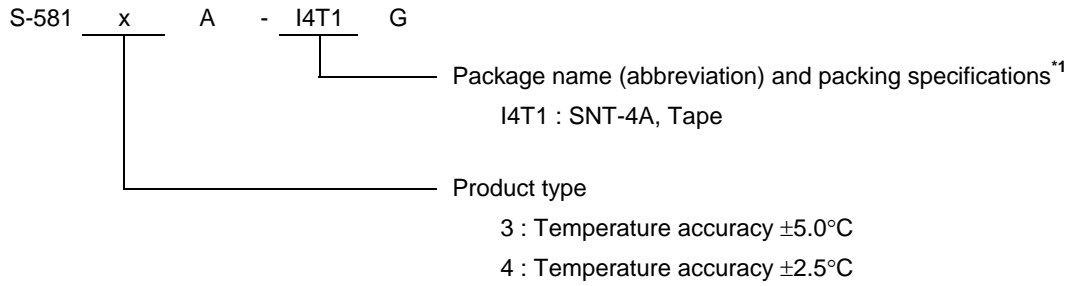


Figure 1

■ **Product Name Structure**

- The product types for the S-5813A/5814A Series can be selected at the user's request. Please refer to "1. **Product name**" for the construction of the product name and "2. **Product name list**" for the full product names.

1. Product name



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

2. Product name list

Table 1

| Product Name | Temperature Accuracy | Package |
|---------------|---------------------------|---------|
| S-5813A-I4T1G | $\pm 5.0^{\circ}\text{C}$ | SNT-4A |
| S-5814A-I4T1G | $\pm 2.5^{\circ}\text{C}$ | SNT-4A |

■ Pin Configuration

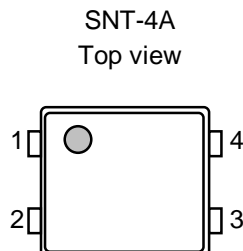


Figure 2

Table 2

| Pin No. | Pin Name | Pin Description |
|---------|------------------|--------------------|
| 1 | VSS | GND pin |
| 2 | VDD | Power supply pin |
| 3 | VOUT | Output voltage pin |
| 4 | NC ^{*1} | No connection |

*1. The NC pin is electrically open.
The NC pin can be connected to VDD or VSS.

■ Absolute Maximum Ratings

Table 3

(Ta = 25°C unless otherwise specified)

| Item | Symbol | Absolute Maximum Rating | Unit |
|-------------------------------|-----------|-----------------------------------|------|
| Power supply pin voltage | V_{DD} | $V_{SS} - 0.3$ to $V_{SS} + 12.0$ | V |
| Output voltage | V_{OUT} | $V_{SS} - 0.3$ to $V_{DD} + 0.3$ | V |
| Power dissipation | P_D | 140 (When not mounted on board) | mW |
| | | 300 ^{*1} | mW |
| Operating ambient temperature | T_{opr} | -40 to +100 | °C |
| Storage temperature | T_{stg} | -40 to +125 | °C |

*1. When mounted on board
[Mounted board]

- (1) Board size : 114.3 mm × 76.2 mm × t1.6 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.

■ Electrical Characteristics

1. S-5813A Series

Table 4

($T_a = 25^\circ\text{C}$, $V_{DD} = 5.0\text{ V}$, $I_{OUT} = 0\text{ A}$ unless otherwise specified)

| Item | Symbol | Conditions | Min. | Typ. | Max. | Unit | Test Circuit |
|-----------------------------|-------------------|--|--------|-----------|--------|---------------|--------------|
| Power supply voltage | V_{DD} | – | 2.40 | – | 10.00 | V | 1 |
| | | $T_a = -20\text{ to }100^\circ\text{C}$ | 2.65 | – | 10.00 | V | 1 |
| | | $T_a = -30\text{ to }100^\circ\text{C}$ | 2.90 | – | 10.00 | V | 1 |
| Output voltage | V_{OUT} | $T_a = -30^\circ\text{C}$ | 2.528 | 2.582 | 2.636 | V | 1 |
| | | $T_a = 30^\circ\text{C}$ | 1.886 | 1.940 | 1.994 | V | 1 |
| | | $T_a = 100^\circ\text{C}$ | 1.091 | 1.145 | 1.199 | V | 1 |
| Temperature sensitivity | V_{SE} | $T_a = -30\text{ to }100^\circ\text{C}$ | -11.31 | -11.04 | -10.77 | mV/°C | – |
| Nonlinearity | ΔN_L | $T_a = -20\text{ to }80^\circ\text{C}$ | – | ± 0.5 | – | % | – |
| Operating temperature range | T_{opr} | – | -40 | – | 100 | °C | – |
| Current consumption | I_{DD} | – | – | 4.0 | 8.0 | μA | 1 |
| Line regulation | ΔV_{OUT1} | $V_{DD} = 2.4\text{ to }10.0\text{ V}$ | – | – | 0.05 | %/V | 2 |
| Load regulation*1 | ΔV_{OUT2} | $I_{OUT} = 0\text{ to }200\ \mu\text{A}$ | – | – | 1.0 | mV | 2 |

*1. Do not flow current into the output voltage pin.

2. S-5814A Series

Table 5

($T_a = 25^\circ\text{C}$, $V_{DD} = 5.0\text{ V}$, $I_{OUT} = 0\text{ A}$ unless otherwise specified)

| Item | Symbol | Conditions | Min. | Typ. | Max. | Unit | Test Circuit |
|-----------------------------|-------------------|--|--------|-----------|--------|---------------|--------------|
| Power supply voltage | V_{DD} | – | 2.40 | – | 10.00 | V | 1 |
| | | $T_a = -20\text{ to }100^\circ\text{C}$ | 2.65 | – | 10.00 | V | 1 |
| | | $T_a = -30\text{ to }100^\circ\text{C}$ | 2.90 | – | 10.00 | V | 1 |
| Output voltage | V_{OUT} | $T_a = -30^\circ\text{C}$ | 2.555 | 2.582 | 2.609 | V | 1 |
| | | $T_a = 30^\circ\text{C}$ | 1.913 | 1.940 | 1.967 | V | 1 |
| | | $T_a = 100^\circ\text{C}$ | 1.118 | 1.145 | 1.172 | V | 1 |
| Temperature sensitivity | V_{SE} | $T_a = -30\text{ to }100^\circ\text{C}$ | -11.31 | -11.04 | -10.77 | mV/°C | – |
| Nonlinearity | ΔN_L | $T_a = -20\text{ to }80^\circ\text{C}$ | – | ± 0.5 | – | % | – |
| Operating temperature range | T_{opr} | – | -40 | – | 100 | °C | – |
| Current consumption | I_{DD} | – | – | 4.0 | 8.0 | μA | 1 |
| Line regulation | ΔV_{OUT1} | $V_{DD} = 2.4\text{ to }10.0\text{ V}$ | – | – | 0.05 | %/V | 2 |
| Load regulation*1 | ΔV_{OUT2} | $I_{OUT} = 0\text{ to }200\ \mu\text{A}$ | – | – | 1.0 | mV | 2 |

*1. Do not flow current into the output voltage pin.

■ Test Circuits

1.

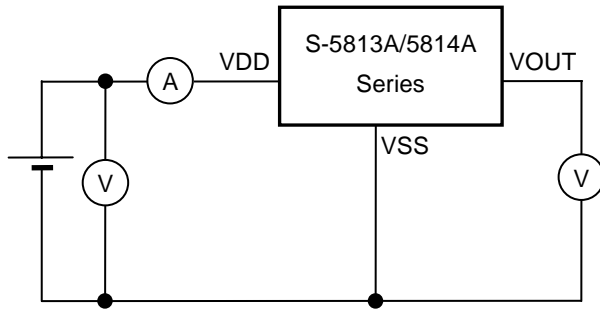


Figure 3

2.

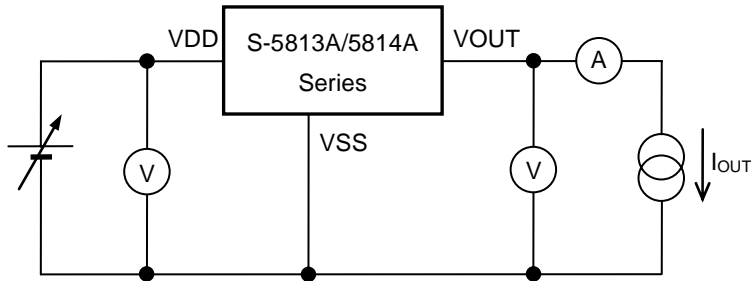


Figure 4

■ Explanation of Terms

1. Output voltage (V_{OUT})

V_{OUT} indicates the output voltage at $T_a = -30^\circ\text{C}$, $T_a = 30^\circ\text{C}$, and $T_a = 100^\circ\text{C}$.

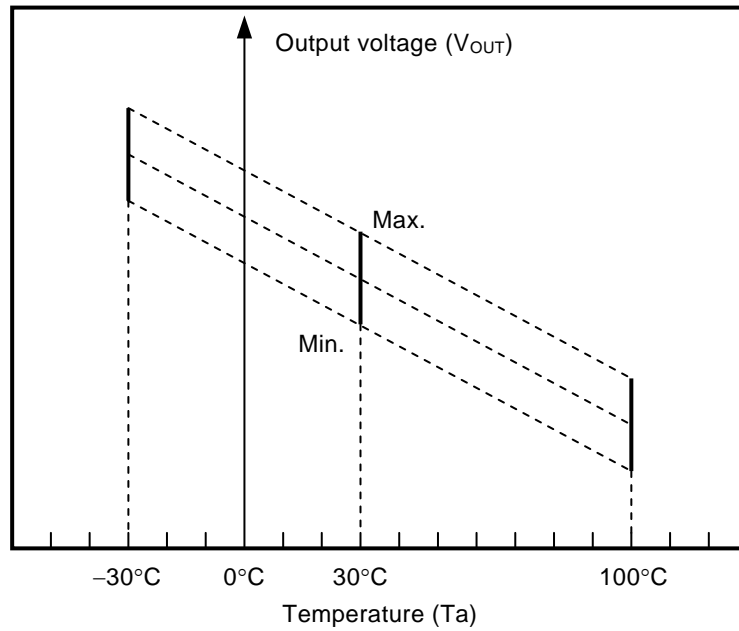


Figure 5

2. Temperature sensitivity (V_{SE})

V_{SE} indicates the temperature coefficient of the output voltage calculated using the output voltage at $T_a = -30^\circ\text{C}$ and $T_a = 100^\circ\text{C}$.

V_{SE} is calculated using the following formula.

$$V_{SE} = \frac{V_{OUT}^{*1} - V_{OUT}^{*2}}{130^{*3}}$$

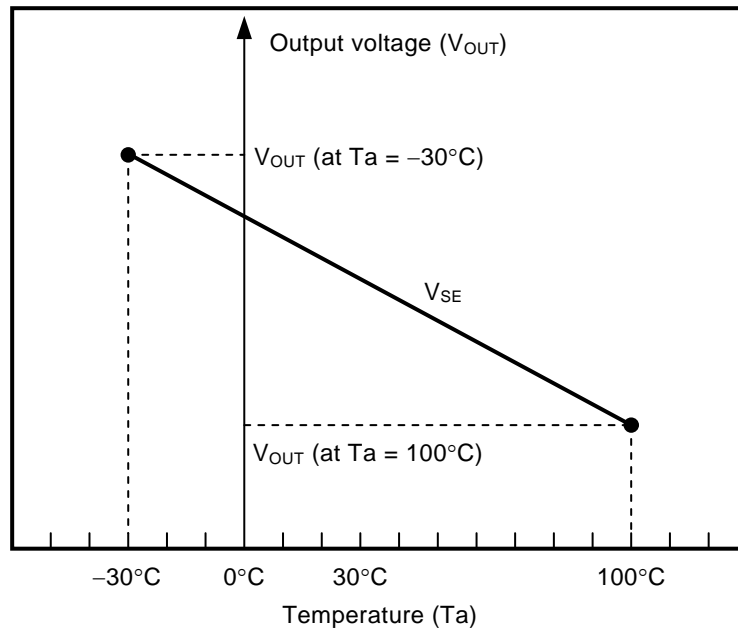


Figure 6

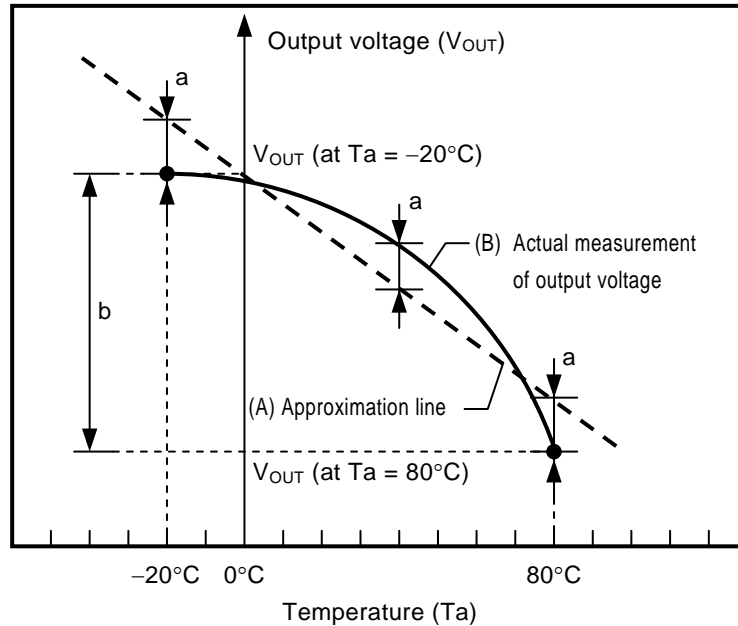
- *1. V_{OUT} value at $T_a = 100^\circ\text{C}$ [V] .
- *2. V_{OUT} value at $T_a = -30^\circ\text{C}$ [V] .
- *3. The difference of the temperature from $T_a = 100^\circ\text{C}$ to $T_a = -30^\circ\text{C}$ [$^\circ\text{C}$] .

3. Nonlinearity (ΔN_L)

ΔN_L indicates the nonlinearity of the output voltage and is defined as the difference of the characteristic curve of the output voltage and the approximation line shown below.

ΔN_L is calculated using the following formula.

$$\Delta N_L = \frac{a^{*1}}{b^{*2}} \times 100$$



- *1. The maximum deviation of the actual measurement of output voltage (B) and an approximation line (A) in temperature within -20°C to 80°C . The approximation line is the line drawn so that "a" should be the minimum value.
- *2. The difference of the output voltage within -20°C to 80°C .

Figure 7

4. Line regulation (ΔV_{OUT1})

ΔV_{OUT1} indicates the output voltage dependency of the input voltage. That is, the values express how the output voltage changes, when input voltage is changed under the condition that output current is fixed.

5. Load regulation (ΔV_{OUT2})

ΔV_{OUT2} indicates the output voltage dependency of the output current. That is, the values express how the output voltage changes, when output current is changed under the condition that input voltage is fixed.

■ Precautions

- Wiring patterns for the VDD pin, VOUT pin, and VSS pin should be designed to hold low impedance.
- In this IC, if load capacitance of the VOUT pin is large, VOUT pin voltage may oscillate. It is recommended not to use the external capacitor between the VOUT and VSS pins. When using an external capacitor, mount it near the VOUT pin. When connecting an A/D converter etc. to the VOUT pin, the input pin capacitance of the A/D converter and the parasitic capacitance component between wires are included as load capacitance. To prevent oscillation, it is recommended to use the following output load condition.

Load capacitance of VOUT pin (C_L) : 2.2 μ F or less

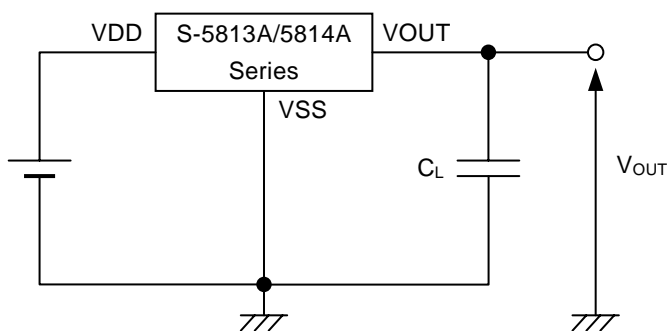


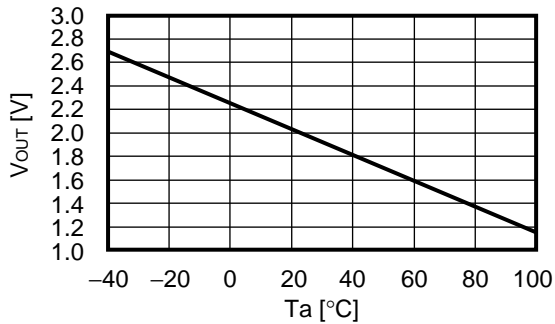
Figure 8

Caution The above connection diagram and constant will not guarantee successful operation. Perform through evaluation using the actual application to set the constant.

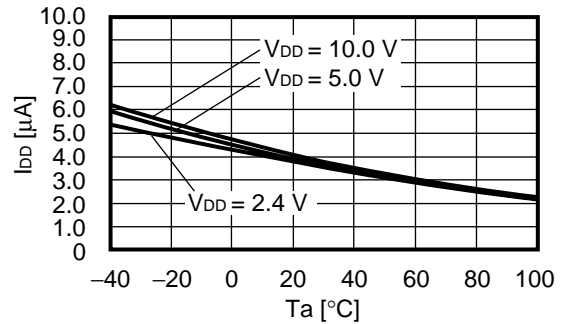
- Please do not connect a pull-up resistor to the output voltage pin.
- The application condition for input voltage, output voltage and load voltage must not exceed the package power dissipation.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.
- SII claims no responsibility for any 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)

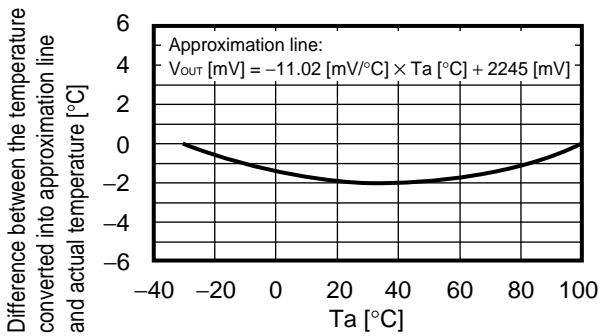
1. Output voltage (V_{OUT}) vs. Temperature (T_a)



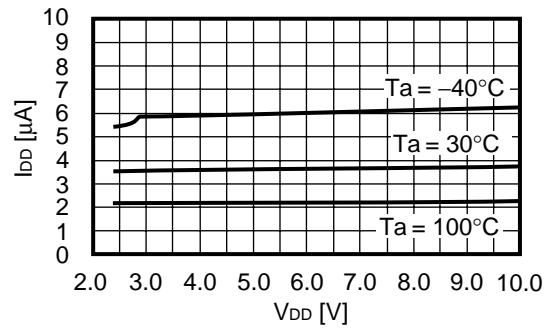
2. Current consumption (I_{DD}) vs. Temperature (T_a)



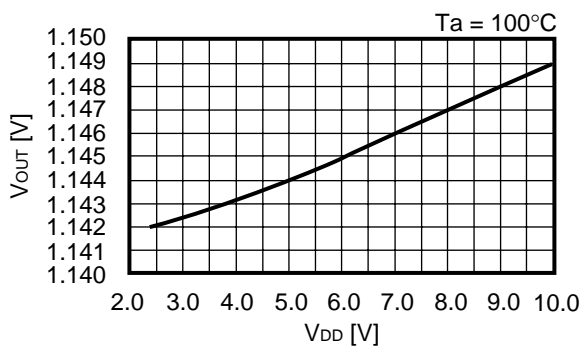
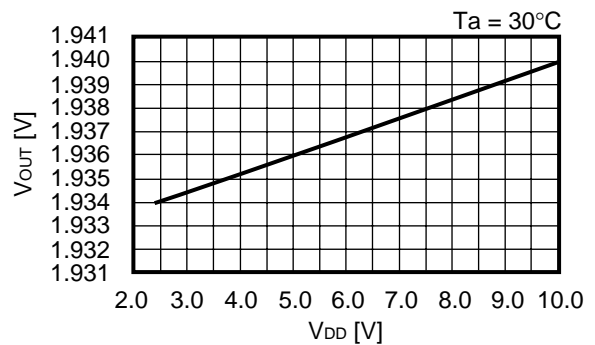
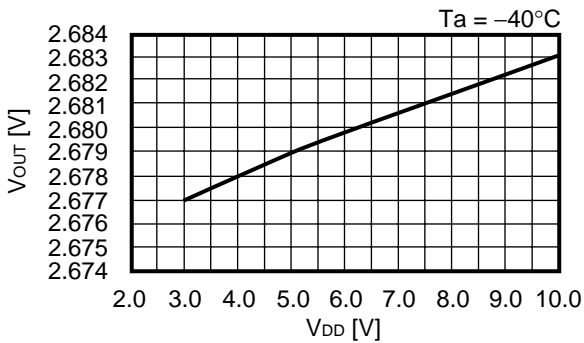
3. Error range of each temperature



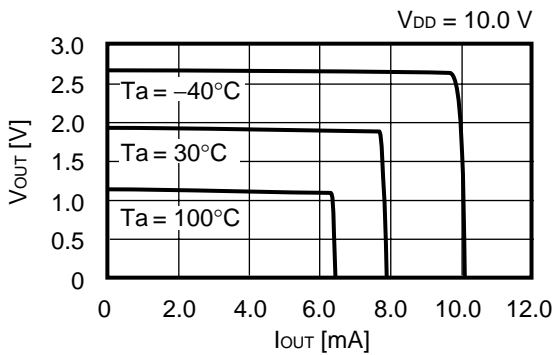
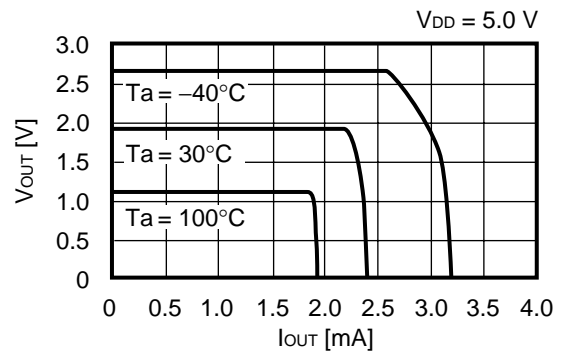
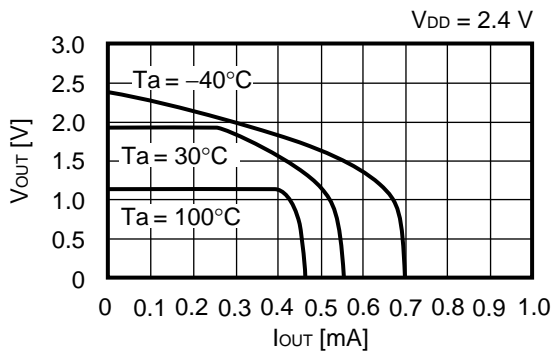
4. Current consumption (I_{DD}) vs. Power supply voltage (V_{DD})



5. Output voltage (V_{OUT}) vs. Power supply voltage (V_{DD})

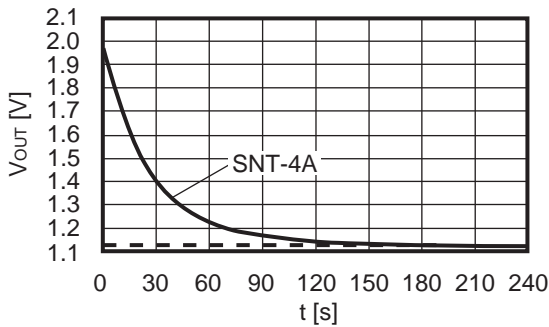


6. Output voltage (V_{OUT}) vs. Load current (I_{OUT})

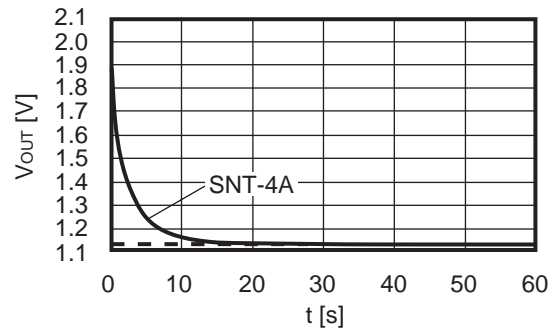


7. Heat response Output voltage (V_{OUT}) vs. Time (t)

When packages are put into the air of 100°C from the air of 25°C

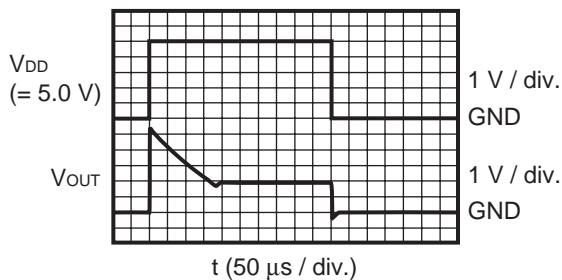


When packages are put into the liquid of 100°C from the air of 25°C

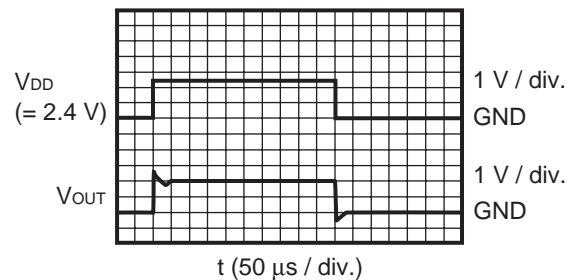


8. Start up response

$T_a = 25^\circ\text{C}$, $C_L = 100 \text{ pF}$, $R_L = 10 \text{ M}\Omega$



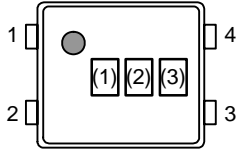
$T_a = 25^\circ\text{C}$, $C_L = 100 \text{ pF}$, $R_L = 10 \text{ M}\Omega$



■ **Marking Specification**

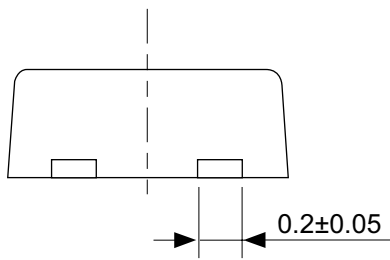
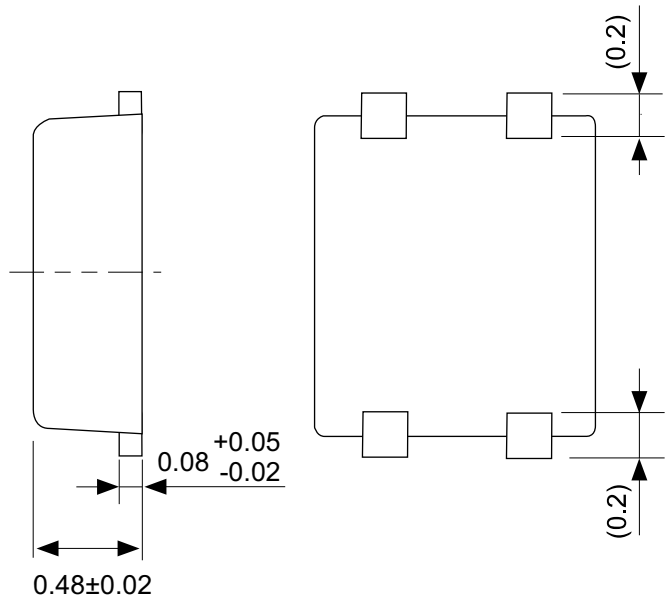
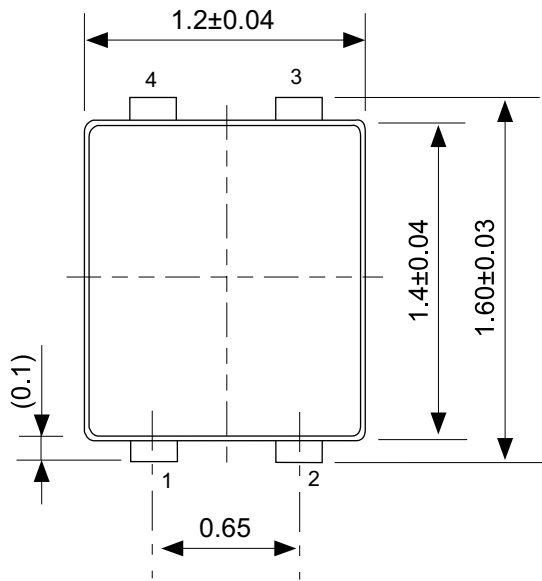
SNT-4A
 Top view

(1) to (3) : Product code (refer to **Product name vs. Product code**)



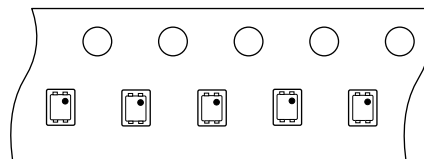
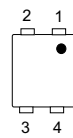
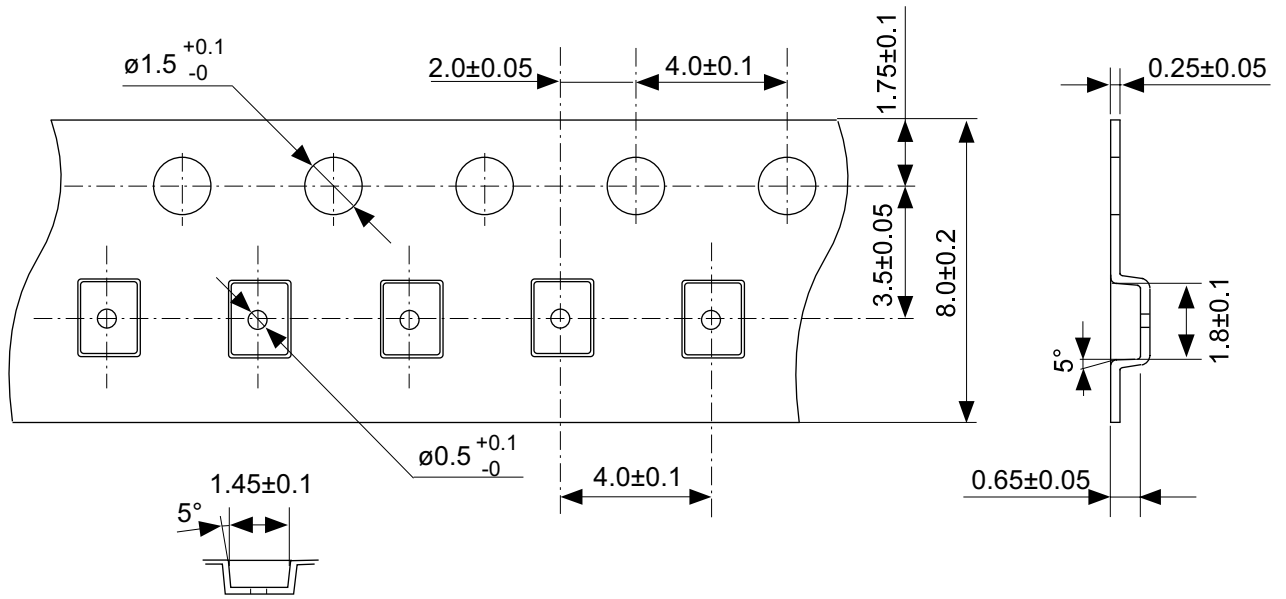
Product name vs. Product code

| Product Name | Product Code | | |
|---------------|--------------|-----|-----|
| | (1) | (2) | (3) |
| S-5813A-I4T1G | D | R | C |
| S-5814A-I4T1G | D | R | D |



No. PF004-A-P-SD-4.0

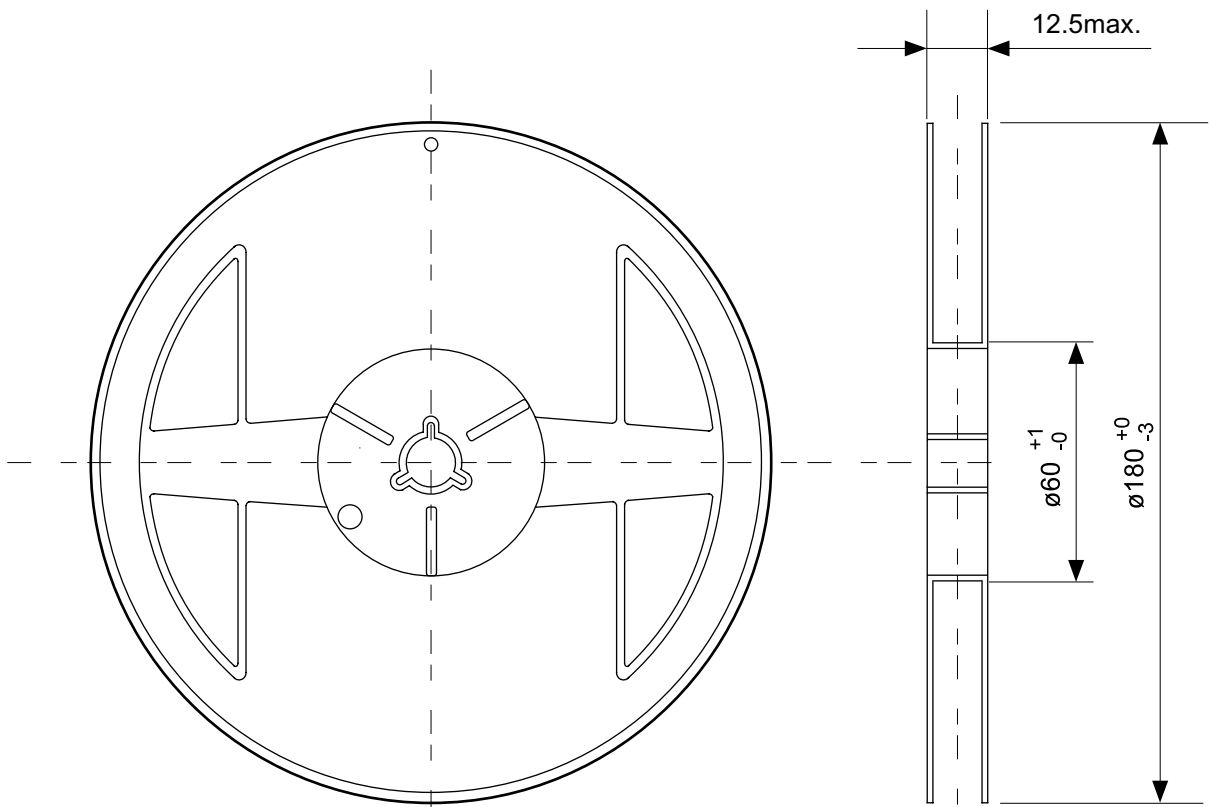
| | |
|------------------------|-------------------------|
| TITLE | SNT-4A-A-PKG Dimensions |
| No. | PF004-A-P-SD-4.0 |
| SCALE | |
| UNIT | mm |
| | |
| Seiko Instruments Inc. | |



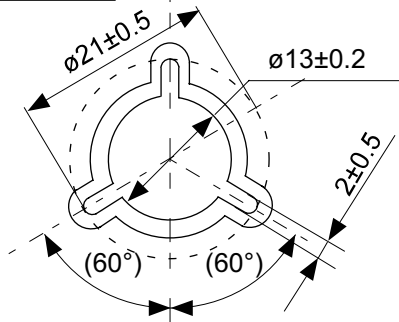
Feed direction

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. | |

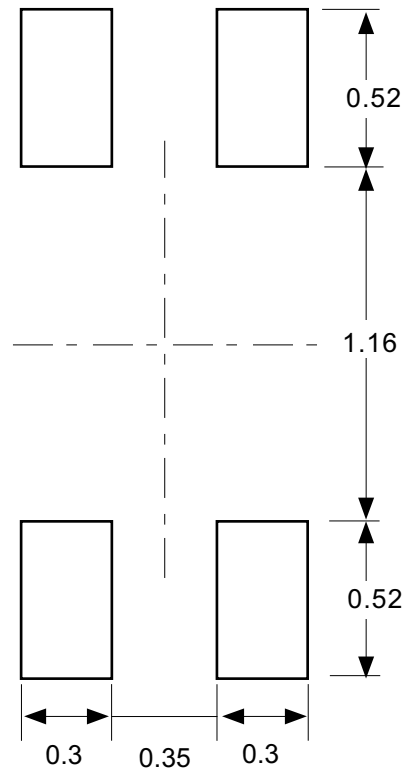


Enlarged drawing in the central part



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. | | | |



Caution Making the wire pattern under the package is possible. However, note that the package may be upraised due to the thickness made by the silk screen printing and of a solder resist on the pattern because this package does not have the standoff.

注意 パッケージ下への配線パターン形成は可能ですが、本パッケージはスタンドオフが無いので、パターン上のレジスト厚み、シルク印刷の厚みによってパッケージが持ち上がる場合がありますのでご配慮ください。

No. PF004-A-L-SD-3.0

| | |
|------------------------|------------------------------|
| TITLE | SNT-4A-A-Land Recommendation |
| No. | PF004-A-L-SD-3.0 |
| SCALE | |
| UNIT | mm |
| | |
| Seiko Instruments Inc. | |

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