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 : ±5.0°C (−30 to 100°C)
                                S-5814A Series : ±2.5°C (−30 to 100°C)
- Linear output voltage   −11.04 mV/°C typ.
                                Ta = −30°C :   2.582 V typ.
                                Ta = +30°C :   1.940 V typ.
                                Ta = +100°C :   1.145 V typ.
- Nonlinearity   ±0.5% typ. (−20 to 80°C)
- Wide power supply voltage operation V_{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

CMOS TEMPERATURE SENSOR IC
S-5813A/5814A Series

Rev.1.2_00

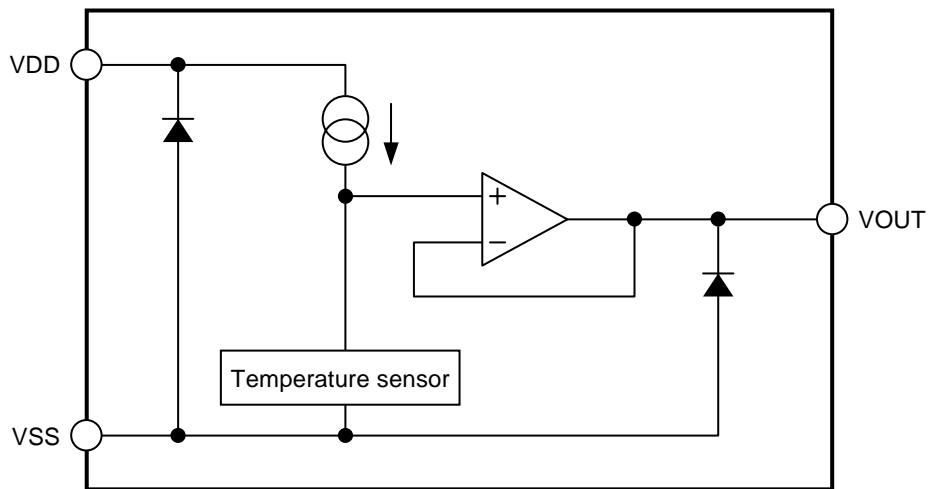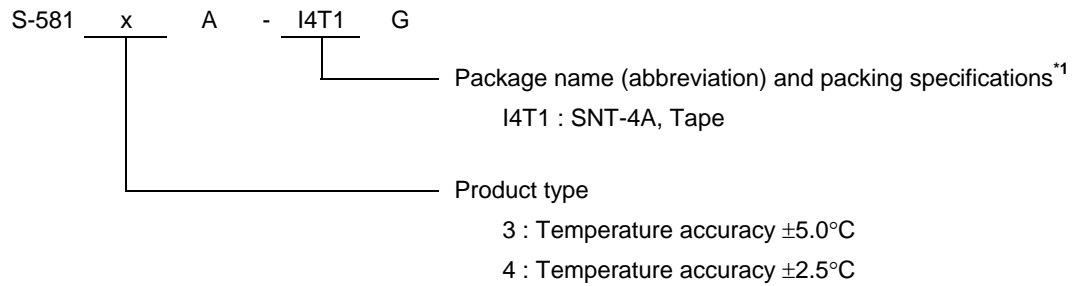■ **Block Diagram**

Figure 1

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■ 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

S-581 __x__ A - __I4T1__ G

Package name (abbreviation) and packing specifications[*1]

I4T1 : SNT-4A, Tape

Product type

3 : Temperature accuracy ±5.0°C

4 : Temperature accuracy ±2.5°C

*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	±5.0°C	SNT-4A
S-5814A-I4T1G	±2.5°C	SNT-4A

■ **Pin Configuration**

SNT-4A
Top view

1 □ ⚪   □ 4

2 □   □ 3
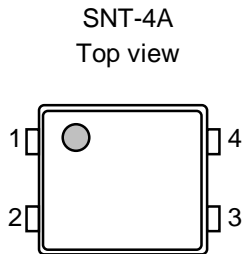
Figure 2

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

(Ta = 25°C, V_{DD} = 5.0 V, I_{OUT} = 0 A unless otherwise specified)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test Circuit
Power supply voltage	V_{DD}	–	2.40	–	10.00	V	1
		Ta = −20 to 100°C	2.65	–	10.00	V	1
		Ta = −30 to 100°C	2.90	–	10.00	V	1
Output voltage	V_{OUT}	Ta = −30°C	2.528	2.582	2.636	V	1
		Ta = 30°C	1.886	1.940	1.994	V	1
		Ta = 100°C	1.091	1.145	1.199	V	1
Temperature sensitivity	V_{SE}	Ta = −30 to 100°C	−11.31	−11.04	−10.77	mV/°C	–
Nonlinearity	ΔN_L	Ta = −20 to 80°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 to 10.0 V	–	–	0.05	%/V	2
Load regulation[1]	ΔV_{OUT2}	I_{OUT} = 0 to 200 μA	–	–	1.0	mV	2

[1]. Do not flow current into the output voltage pin.

2. S-5814A Series

Table 5

(Ta = 25°C, V_{DD} = 5.0 V, I_{OUT} = 0 A unless otherwise specified)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test Circuit
Power supply voltage	V_{DD}	–	2.40	–	10.00	V	1
		Ta = −20 to 100°C	2.65	–	10.00	V	1
		Ta = −30 to 100°C	2.90	–	10.00	V	1
Output voltage	V_{OUT}	Ta = −30°C	2.555	2.582	2.609	V	1
		Ta = 30°C	1.913	1.940	1.967	V	1
		Ta = 100°C	1.118	1.145	1.172	V	1
Temperature sensitivity	V_{SE}	Ta = −30 to 100°C	−11.31	−11.04	−10.77	mV/°C	–
Nonlinearity	ΔN_L	Ta = −20 to 80°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 to 10.0 V	–	–	0.05	%/V	2
Load regulation[1]	ΔV_{OUT2}	I_{OUT} = 0 to 200 μA	–	–	1.0	mV	2

[1]. Do not flow current into the output voltage pin.

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■ **Test Circuits**

1.

Figure 3

2.

Figure 4

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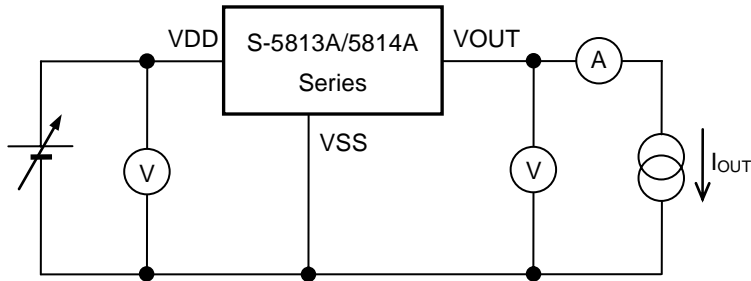
■ Explanation of Terms

1. Output voltage (V$_{OUT}$)

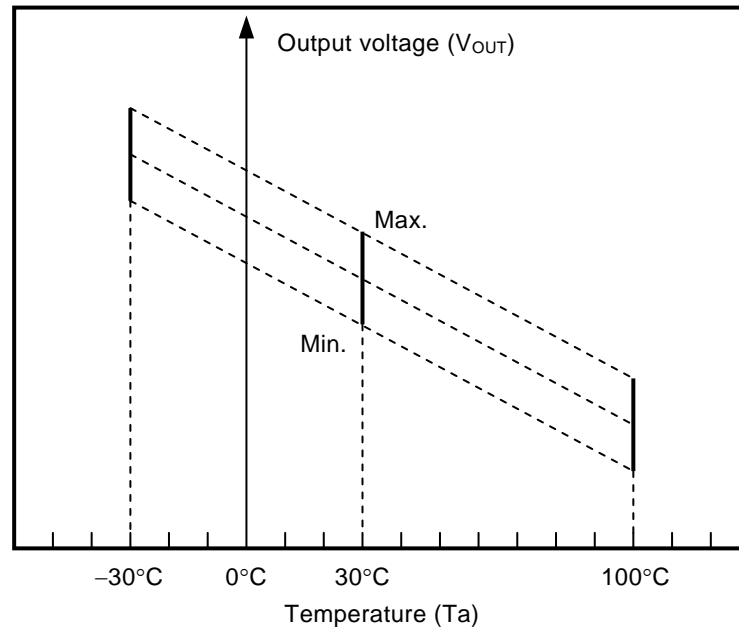V$_{OUT}$ indicates the output voltage at Ta = –30°C, Ta = 30°C, and Ta = 100°C.

Figure 5

2. Temperature sensitivity (V_SE)

V_{SE} indicates the temperature coefficient of the output voltage calculated using the output voltage at Ta = −30°C and Ta = 100°C.

V_{SE} is calculated using the following formula.

$$V_{SE} = \frac{\left[V_{OUT}{}^{*1} - V_{OUT}{}^{*2}\right]}{130^{*3}}$$
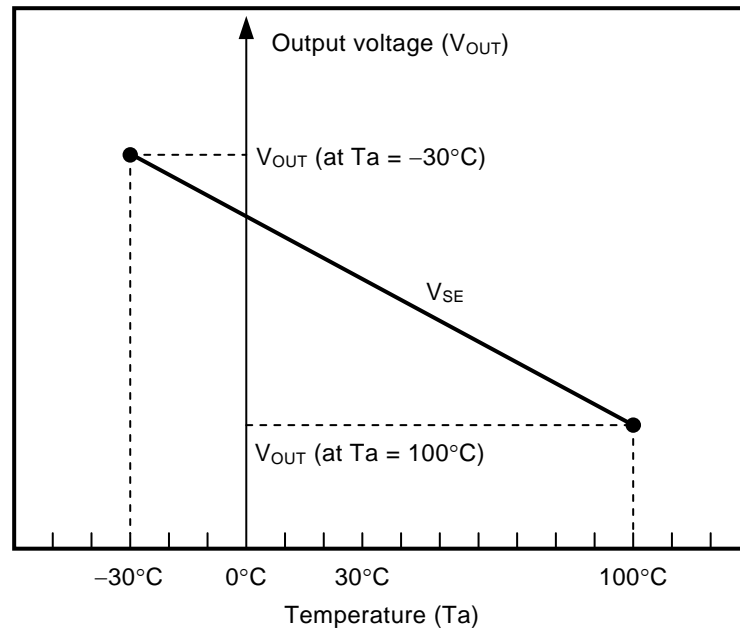
Figure 6

*1. V_{OUT} value at Ta = 100°C [V] .
*2. V_{OUT} value at Ta = −30°C [V] .
*3. The difference of the temperature from Ta = 100°C to Ta = −30°C [°C] .

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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.

$$\Delta N_L = \frac{a^{*1}}{b^{*2}} \times 100$$
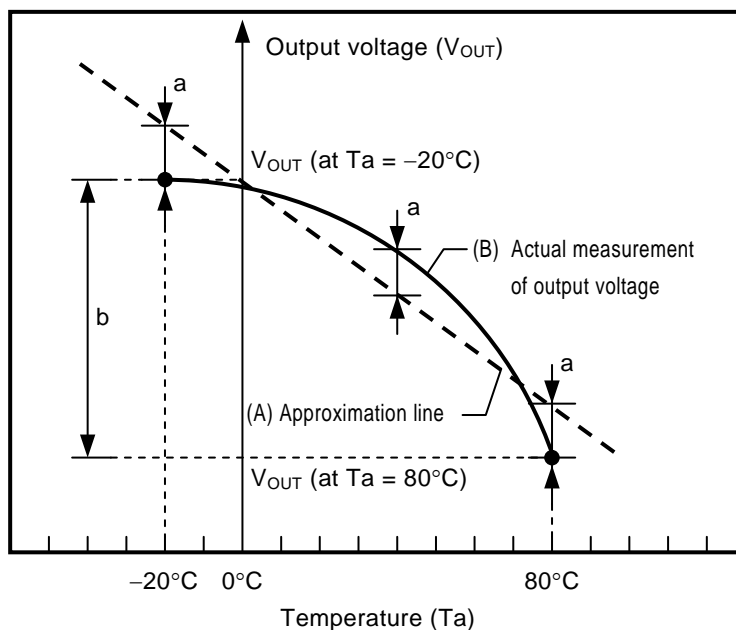
*1. The maximum deviation of the actual measurement of output voltage (B) and an approximation line (A) in temperature within −20°C to 80°C. The approximation line is the line drawn so that "a" should be the minimum value.

*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 μF or less
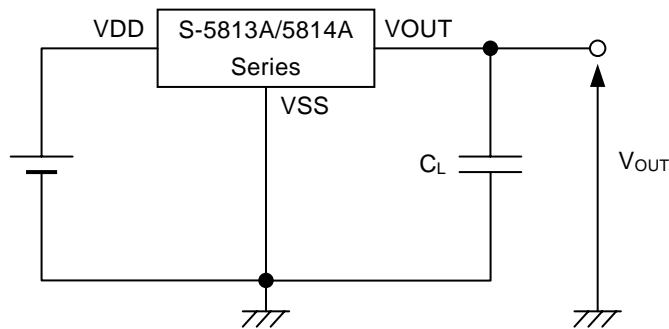
Figure 8

> **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.

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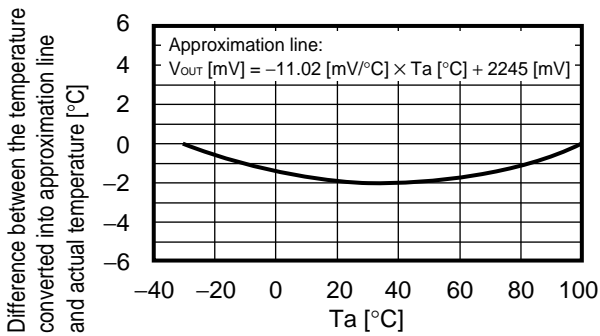# ■ Characteristics (Typical Data)

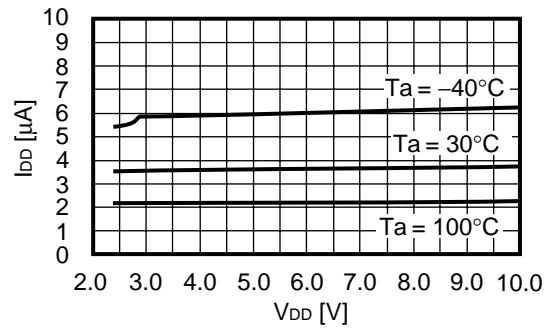### 1. Output voltage (V_{OUT}) vs. Temperature (Ta)
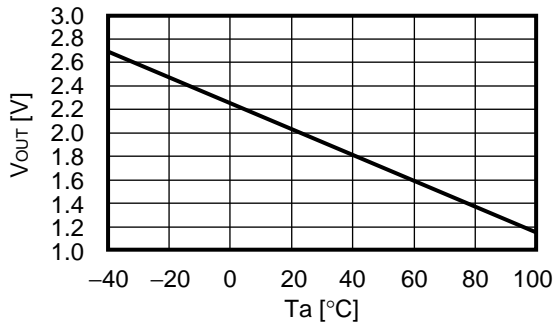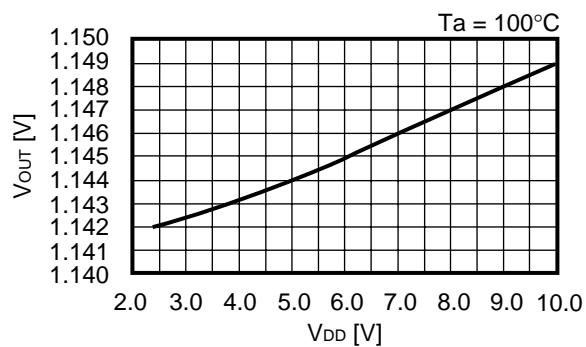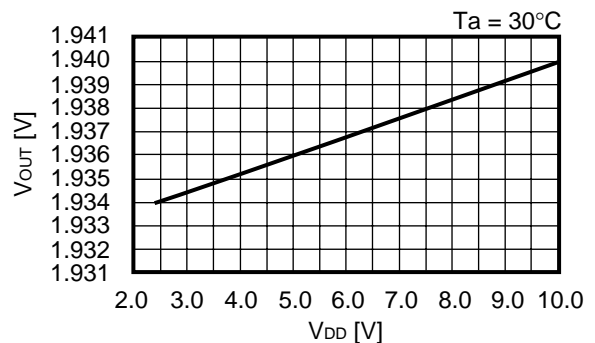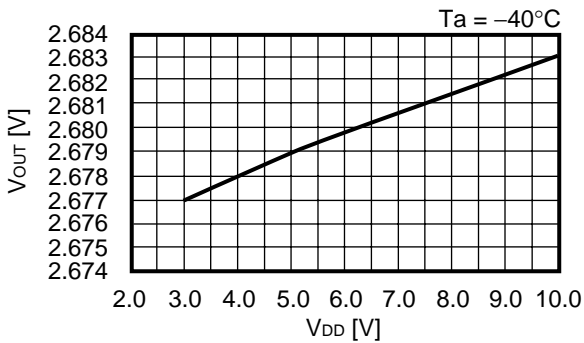

2. Current consumption (I_{DD}) vs. Temperature (Ta)
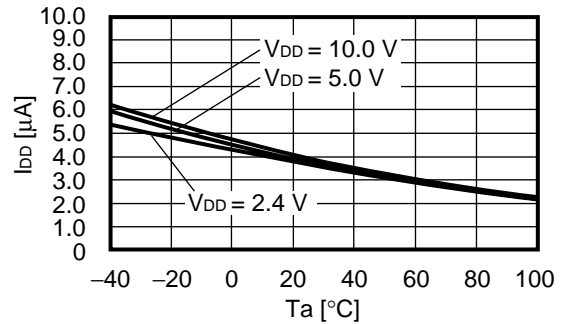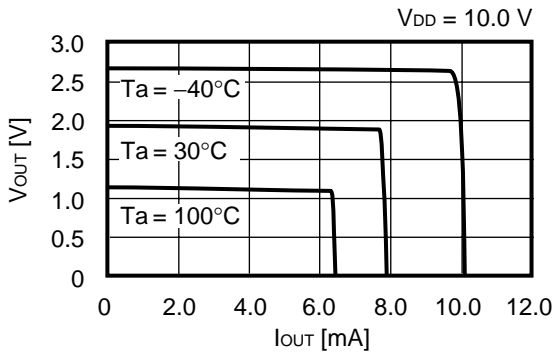

3. Error range of each temperature

Approximation line:
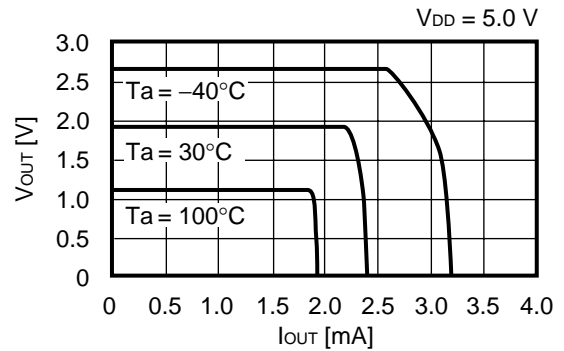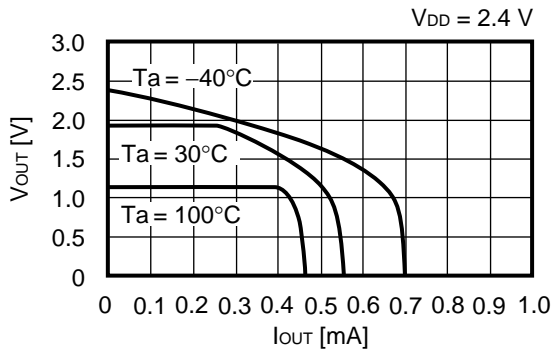V_{OUT} [mV] = −11.02 [mV/°C] × Ta [°C] + 2245 [mV]

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

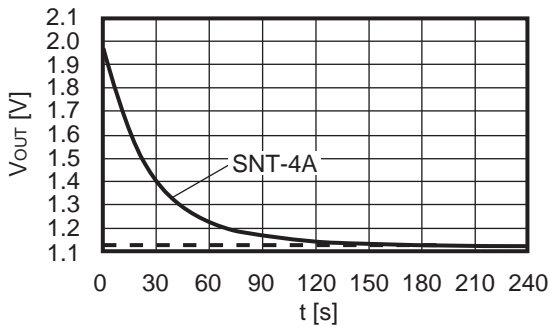### 5. Output voltage (V_{OUT}) vs. Power supply voltage (V_{DD})

Ta = −40°C

Ta = 30°C

Ta = 100°C

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

V_{DD} = 2.4 V

Ta = −40°C
Ta = 30°C
Ta = 100°C

V_{OUT} [V]
I_{OUT} [mA]

V_{DD} = 5.0 V

Ta = −40°C
Ta = 30°C
Ta = 100°C

V_{OUT} [V]
I_{OUT} [mA]

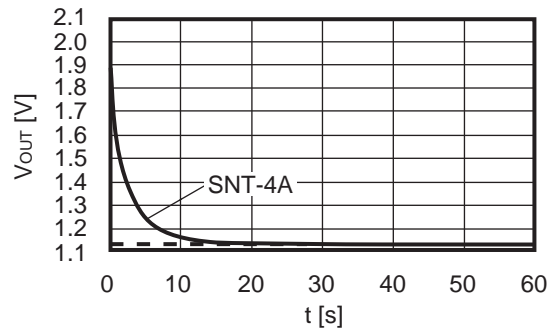V_{DD} = 10.0 V

Ta = −40°C
Ta = 30°C
Ta = 100°C

V_{OUT} [V]
I_{OUT} [mA]

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

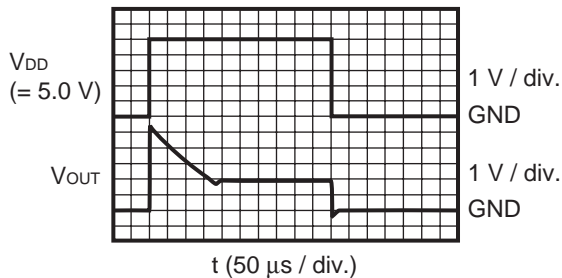**When packages are put into the air of 100°C from the air of 25°C**

V_{OUT} [V]
SNT-4A
t [s]

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

V_{OUT} [V]
SNT-4A
t [s]

8. Start up response

Ta = 25°C, C_L = 100 pF, R_L = 10 MΩ

V_{DD}
(= 5.0 V)
V_{OUT}
1 V / div.
GND
1 V / div.
GND
t (50 μs / div.)

Ta = 25°C, C_L = 100 pF, R_L = 10 MΩ

V_{DD}
(= 2.4 V)
V_{OUT}
1 V / div.
GND
1 V / div.
GND
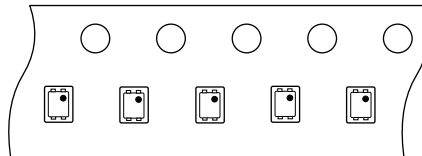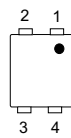t (50 μs / div.)
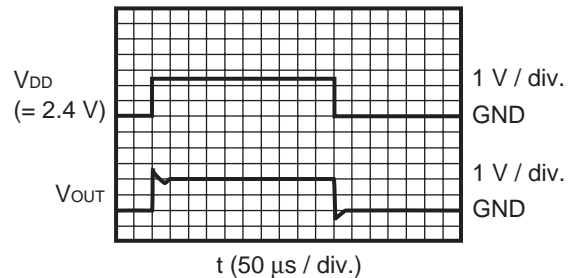
■ Marking Specification

SNT-4A
Top view

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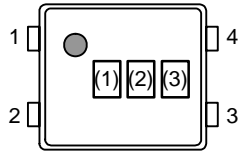
Product name vs. Product code

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

1.2±0.04

4   3

1.4±0.04

1.60±0.03

(0.1)

1   2

0.65

(0.2)

(0.2)

0.08 +0.05 -0.02

0.48±0.02

0.2±0.05

No. PF004-A-P-SD-4.0

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

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ø1.5 $^{+0.1}_{-0}$

2.0±0.05

4.0±0.1

1.75±0.1

0.25±0.05

3.5±0.05

8.0±0.2

1.8±0.1

5°

ø0.5 $^{+0.1}_{-0}$

4.0±0.1

0.65±0.05

1.45±0.1

5°

2   1

3   4
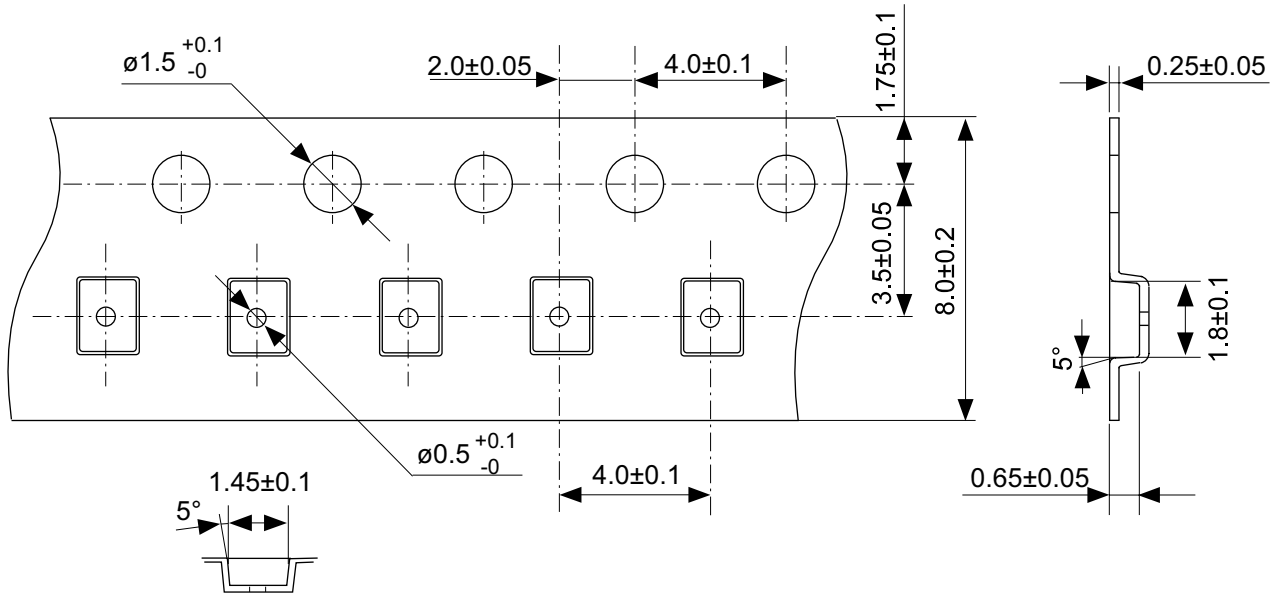
Feed direction

No. PF004-A-C-SD-1.0

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

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12.5max.

$\phi 60^{+1}_{-0}$

$\phi 180^{+0}_{-3}$

9.0±0.3
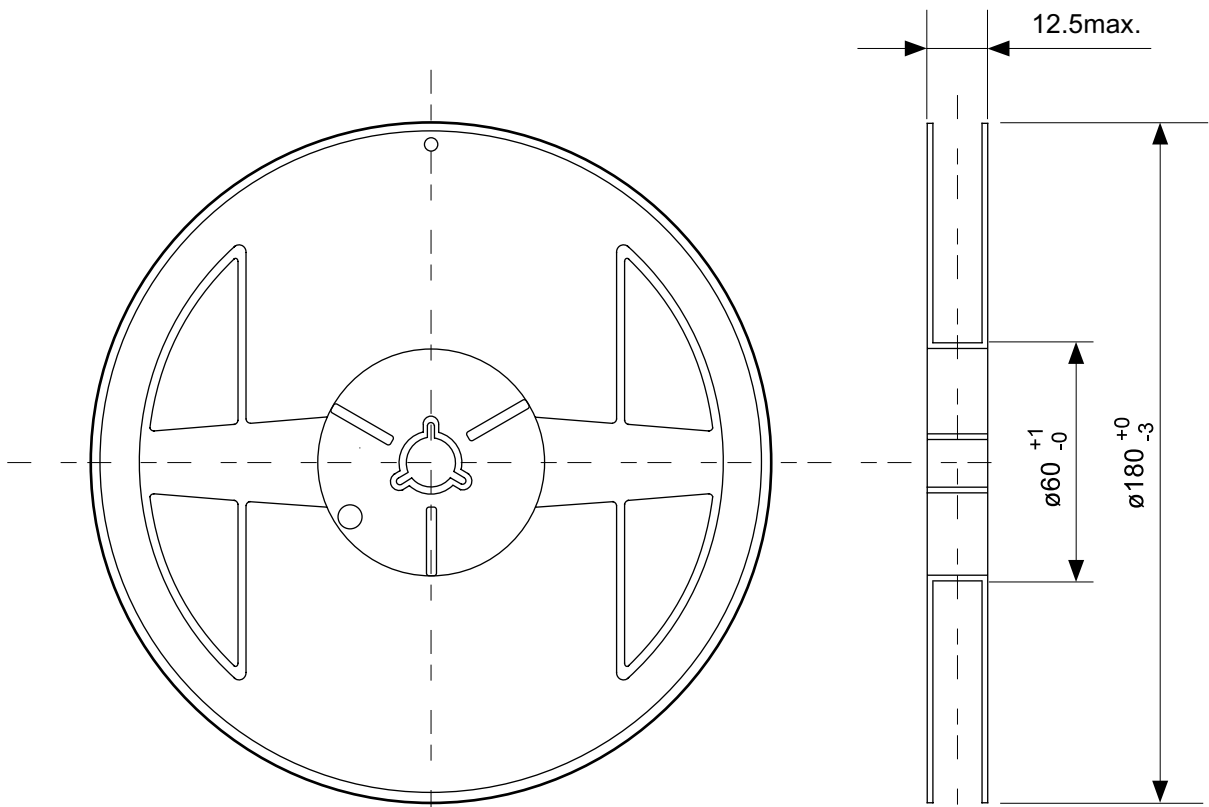
Enlarged drawing in the central part

$\phi 21\pm0.5$

$\phi 13\pm0.2$

2±0.5

(60°) (60°)
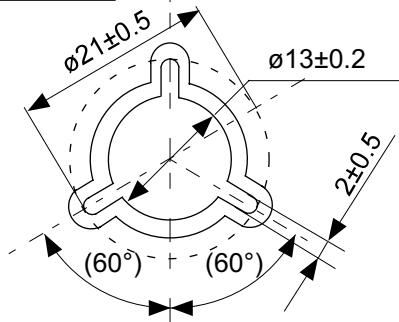
No. PF004-A-R-SD-1.0

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

Seiko Instruments

0.52

1.16

0.52

0.3   0.35   0.3
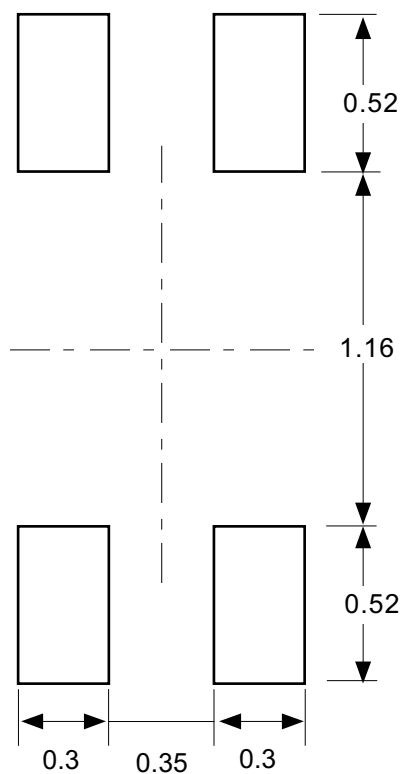
Caution   Making the wire pattern under the package is possible. However, note that the package
may be upraised due to the thickness made by the silk screen printing and of a solder
resist on the pattern because this package does not have the standoff.

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
が持ち上がること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 Instrum

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