CMOS TEMPERATURE SENSOR IC S-8110C/8120C Series

The S-8110C/8120C 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-8110C Series: ±5.0 °C (–30 to 100 °C); S-8120C Series: ±2.5 °C (–30 to 100 °C)
- Linear output voltage: –8.20 mV/ °C Typ.
  Ta=–30 °C: 1.951 V Typ.
  Ta=+30 °C: 1.474 V Typ.
  Ta=+100 °C: 0.882 V Typ.
- Nonlinearity: ±0.5 % typ. (–20 to 80 °C)
- Wide power supply voltage operation: V_{DD}=2.4 to 10.0 V
- Low current consumption: 4.5 μA typ. (25 °C)
- Built-in operational amplifier
- V_{SS} standard output
- Ultra-small plastic package: SC-82AB, SNT-4A

■ Applications

- 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
- Overheatinig prevention for charged batteries or halogen lights

■ Packages

Package name	Drawing code		
	Package	Tape	Reel
SC-82AB	NP004-A	NP004-A	NP004-A
SNT-4A	PF004-A	PF004-A	PF004-A

■ Block Diagram

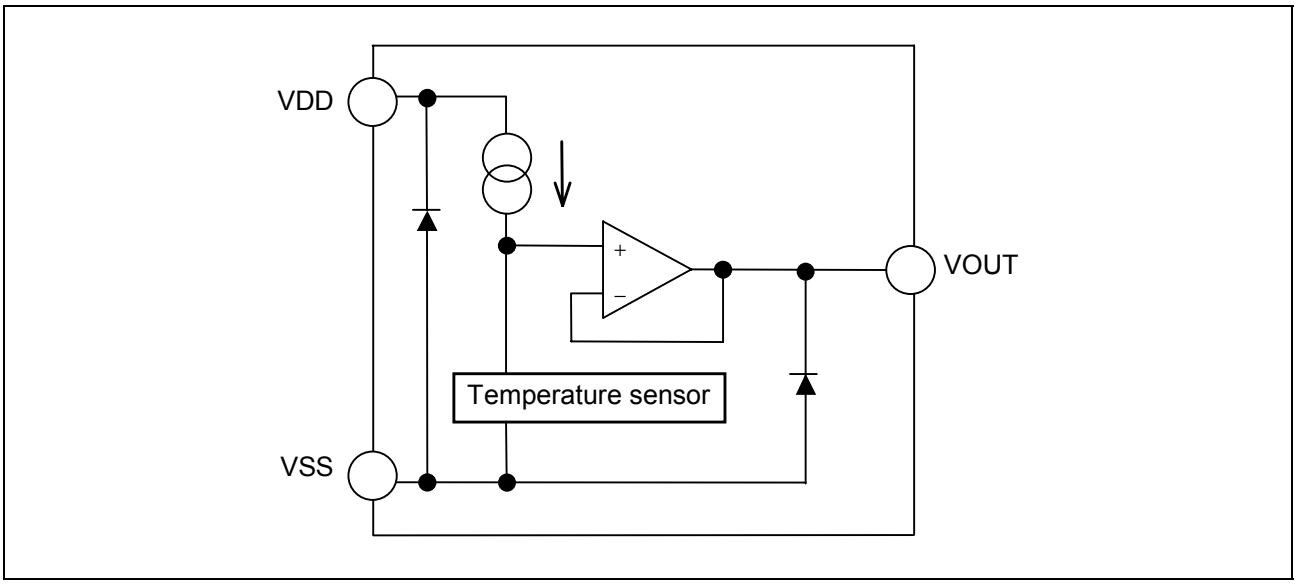


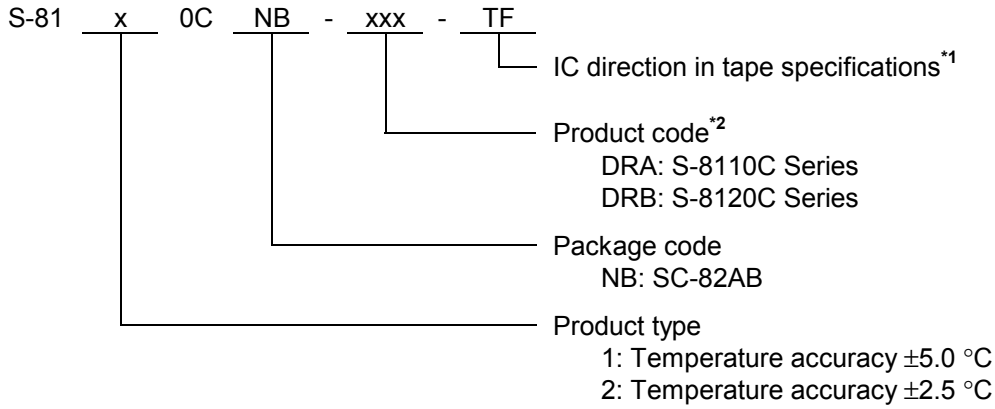
Figure 1

■ Product Name Structure

- The product types and package types for S-8110C/8120C Series can be selected at the user's request. Please refer to the "**1. Product Name**" for the construction of the product name and "**2. Product Name List**" for the full product names.

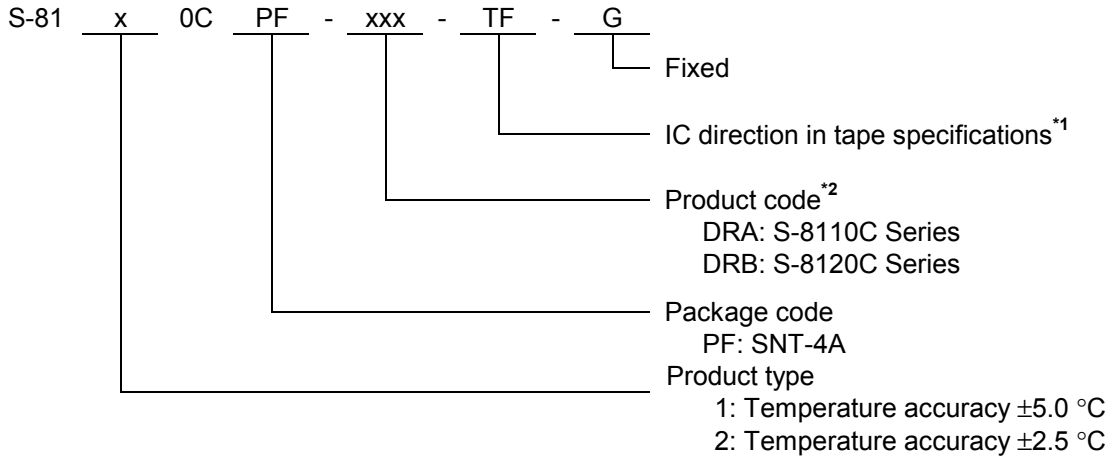
1. Product Name

1-1. SC-82AB package



***1.** Refer to the taping specifications at the end of this book.
***2.** Refer to the **Table 1** in the "**2. Product Name List**".

1-2. SNT-4A package



***1.** Refer to the taping specifications at the end of this book.
***2.** Refer to the **Table 1** in the "**2. Product Name List**".

2. Product Name List

Table 1

	SC-82AB	SNT-4A
S-8110C Series	S-8110CNB-DRA-TF	S-8110CPF-DRA-TF-G
S-8120C Series	S-8120CNB-DRB-TF	S-8120CPF-DRB-TF-G

■ Pin Configurations

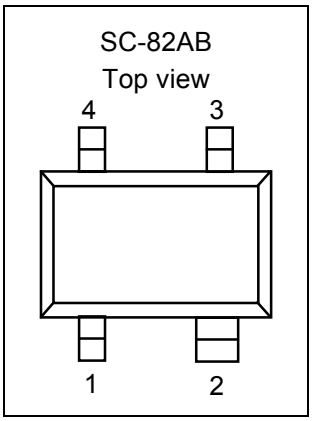


Figure 2

Table 2

Pin No.	Pin name	Pin description
1	VDD	Power supply pin
2	VSS	GND pin
3	NC*1	No connection
4	VOUT	Output voltage pin

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

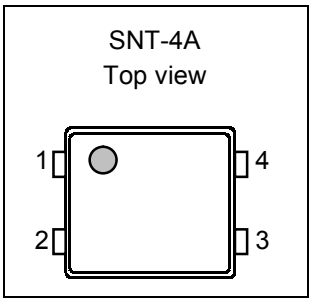


Figure 3

Table 3

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 4

(Ta=25 °C unless otherwise specified)

Item	Symbol	Absolute maximum ratings		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		
Power dissipation	P_D	SC-82AB	150	mW
		SNT-4A	140	
Operating ambient temperature	Topr	–40 to 100		°C
Storage temperature	Tstg	–40 to 125		

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-8110C Series

Table 5

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

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test circuit
Power supply voltage	V_{DD}	—	2.4	—	10.0	V	1
Output voltage	V_{OUT}	Ta=−30 °C	1.911	1.951	1.991		
		Ta=30 °C	1.434	1.474	1.514		
		Ta=100 °C	0.842	0.882	0.922		
Temperature sensitivity	V_{SE}	−30 °C≤Ta≤100 °C	−8.40	−8.20	−8.00	mV/ °C	—
Nonlinearity	ΔN_L	−20 °C≤Ta≤80 °C	—	±0.5	—	%	
Operating temperature range	Topr	—	−40	—	100	°C	
Current consumption	I_{DD}	—	—	4.5	8.0	μA	1
Line regulation	ΔV_{OUT1}	V_{DD}=2.4 V to 10.0 V	—	—	0.05	%/ V	2
Load regulation*1	ΔV_{OUT2}	I_{OUT}=0 μA to 200 μA	—	—	1.0	mV	

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

2. S-8120C Series

Table 6

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

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Power supply voltage	V_{DD}	—	2.4	—	10.0	V	1
Output voltage	V_{OUT}	Ta=−30 °C	1.931	1.951	1.971		
		Ta=30 °C	1.454	1.474	1.494		
		Ta=100 °C	0.862	0.882	0.902		
Temperature sensitivity	V_{SE}	−30 °C≤Ta ≤100 °C	−8.40	−8.20	−8.00	mV/ °C	—
Nonlinearity	ΔN_L	−20 °C≤Ta ≤80 °C	—	±0.5	—	%	
Operating temperature range	Topr	—	−40	—	100	°C	
Current consumption	I_{DD}	—	—	4.5	8.0	μA	1
Line regulation	ΔV_{OUT1}	V_{DD}=2.4 V to 10.0 V	—	—	0.05	%/ V	2
Load regulation*1	ΔV_{OUT2}	I_{OUT}=0 μA to 200 μA	—	—	1.0	mV	

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

■ Test Circuits

1.

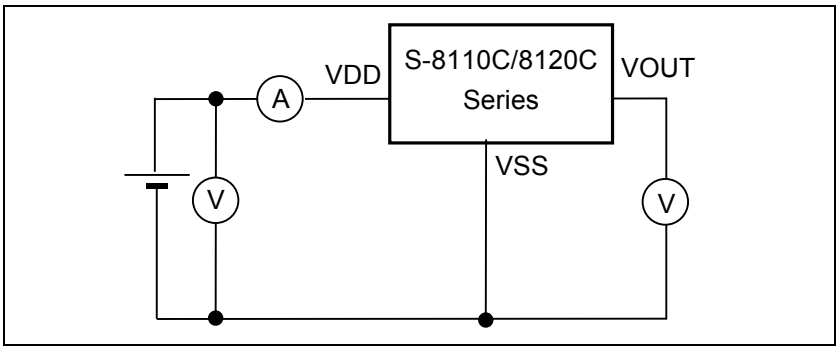


Figure 4

2.

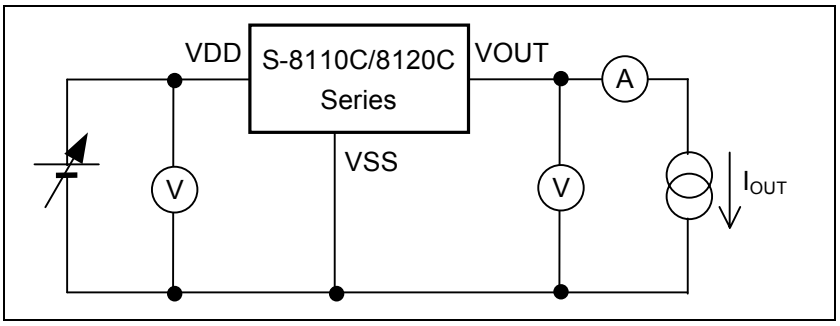


Figure 5

■ Technical Terms

1. Output Voltage (V_{OUT})

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

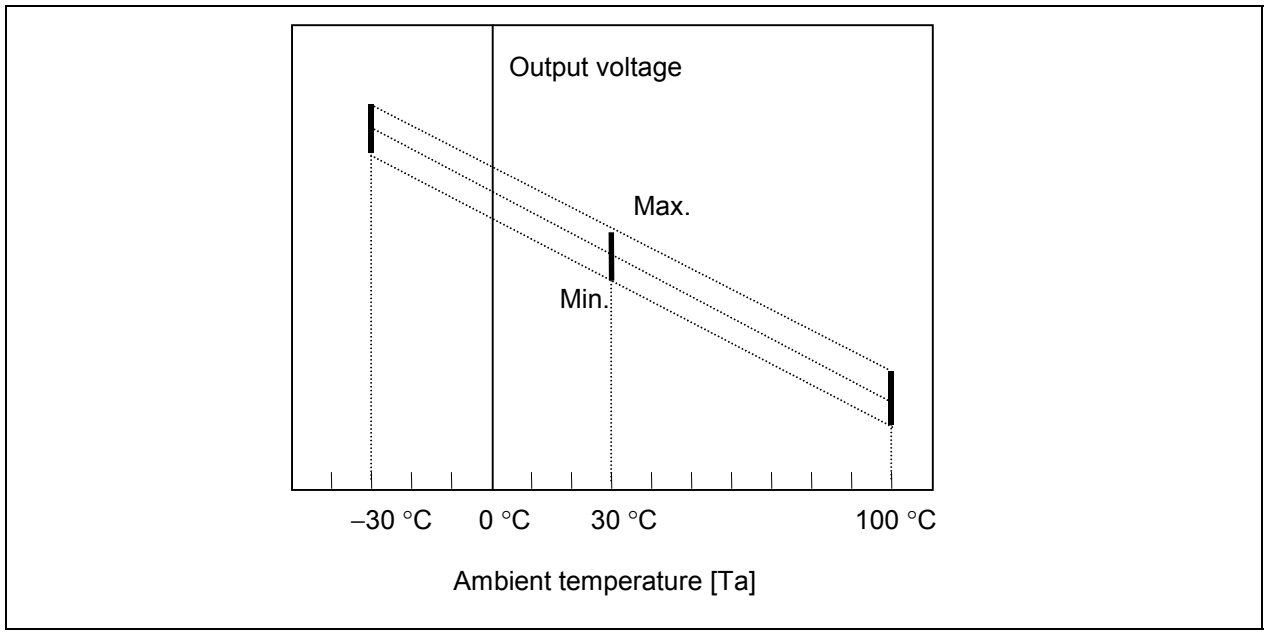


Figure 6

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.

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

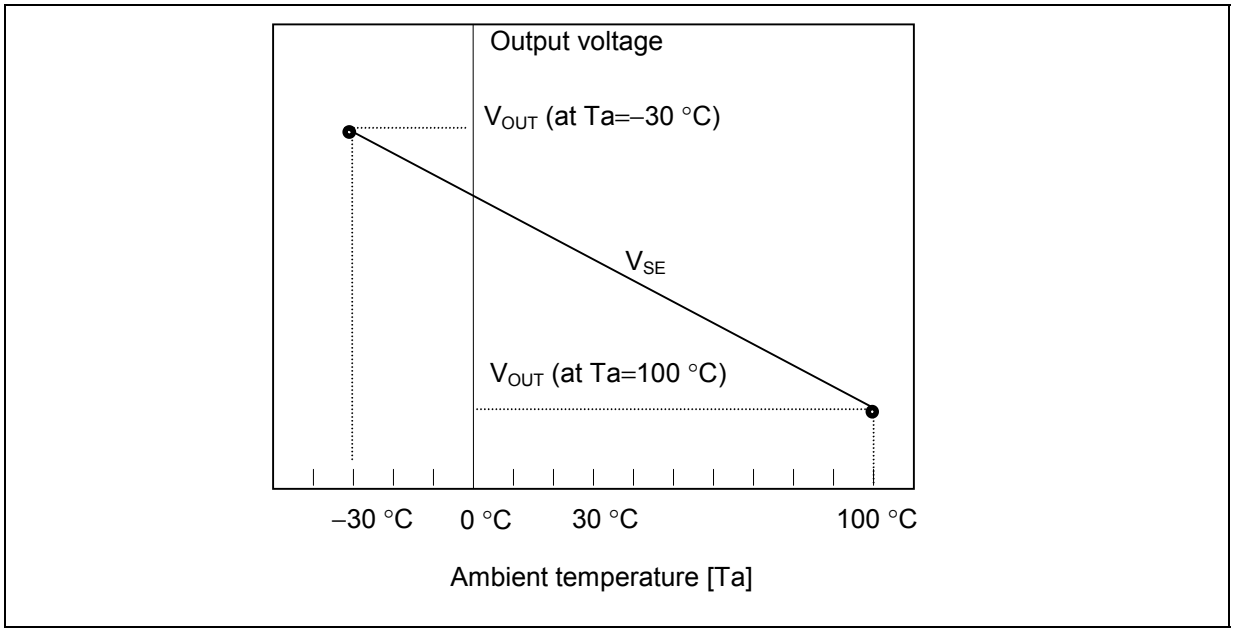


Figure 7

***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]

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 approximated straight line shown below.
ΔN_L is calculated using the following formula.

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

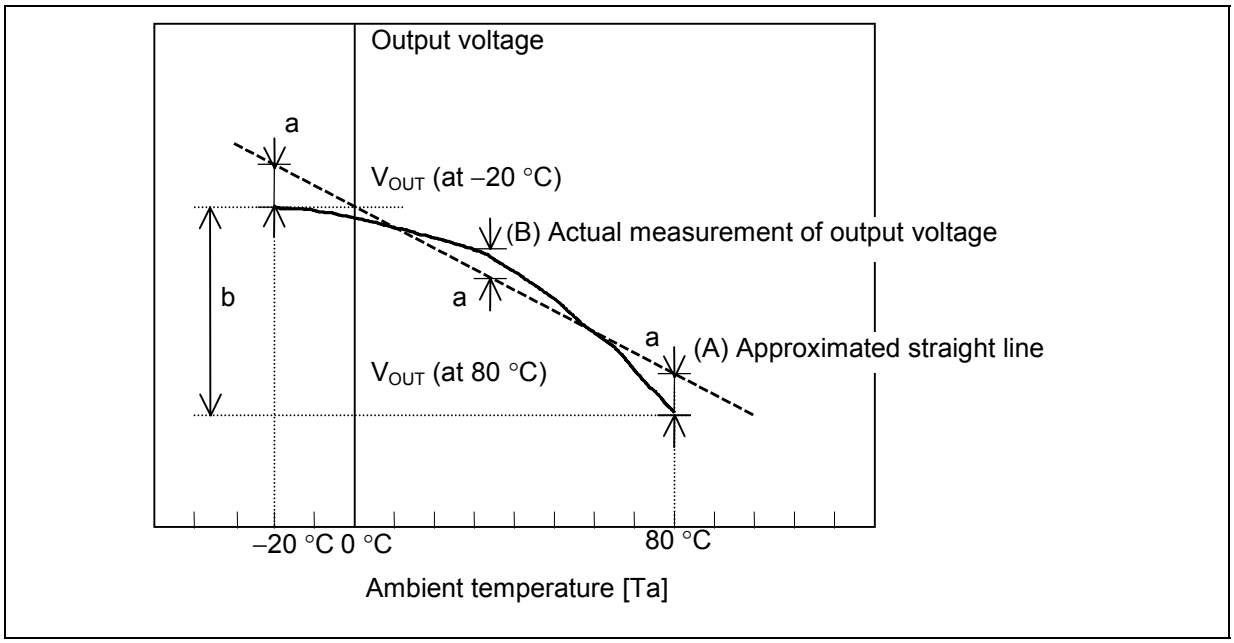


Figure 8

***1.** The maximum deviation of the actual measurement of output voltage (B) and an approximated straight line (A) in temperature within –20 °C to 80 °C. (An approximated straight line is taken as the straight line from which the "a" becomes the minimum.)
***2.** The difference of the output voltage within –20 °C to 80 °C.

4. Line Regulation (ΔV_{OUT1})

ΔV_{OUT1} indicates the output voltage dependence on 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 dependence on 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 VDD pin, VOUT pin and VSS pin should be designed to hold low impedance. When mounting an output capacitor, the distance from the capacitor to the VOUT pin and to the VSS pin should be as short as possible.
- To prevent oscillation, it is recommended to use the external components under the following conditions.
  Output capacitor (C_L): 100 pF or less
  Output resistor (R_L): 500k Ω or more

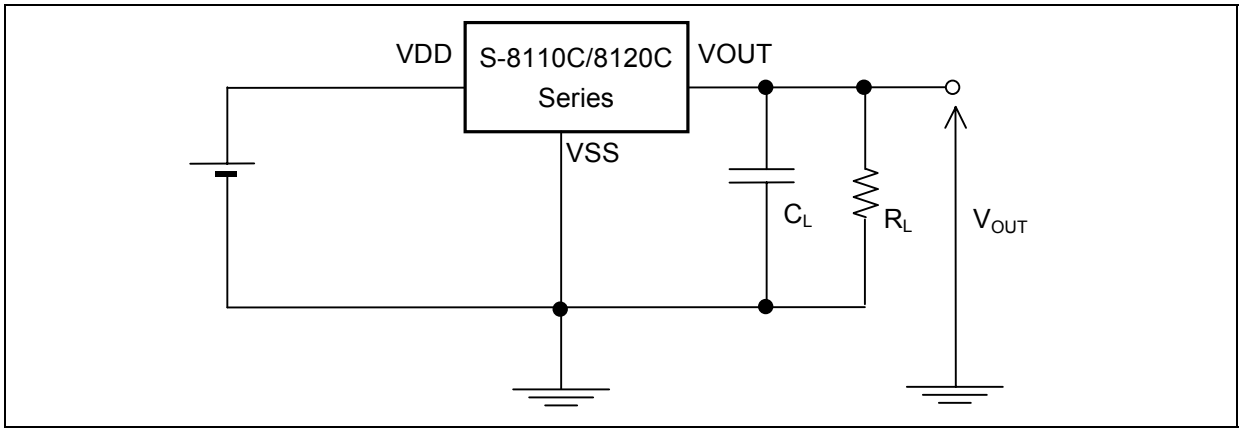


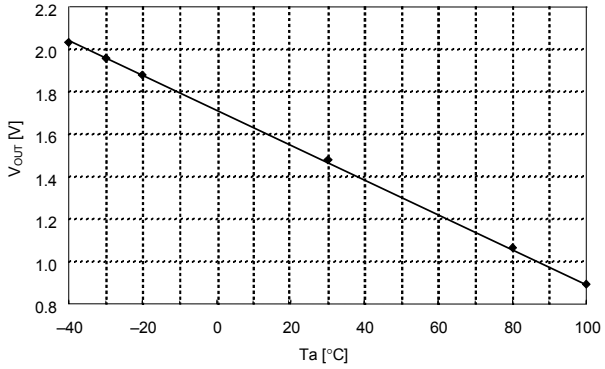
Figure 9

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

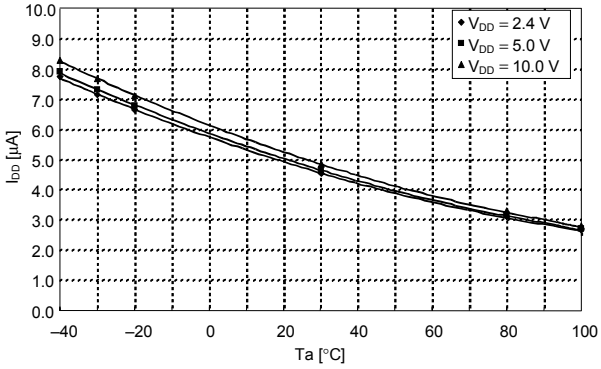
- Please do not connect a pull-up resistor to the output voltage pin.
- The application condition for input voltage, output voltage and load current must not exceed the package power dissipation.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.
- In determining output current, attention should be paid to the output current value specified in the **Table 5** to **Table 6** for electrical characteristics and the **footnote *1** of the **Table 5** to **Table 6**.
- 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

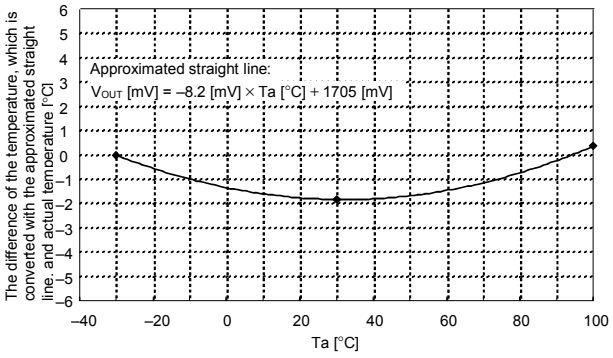
Temperature (Ta) vs. Output voltage (V_{OUT})



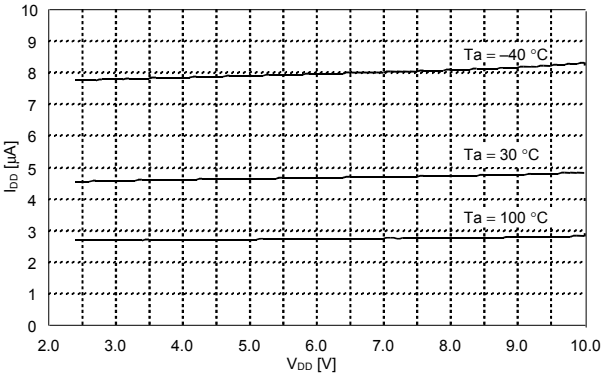
Temperature (Ta) vs. Current consumption (I_{DD})



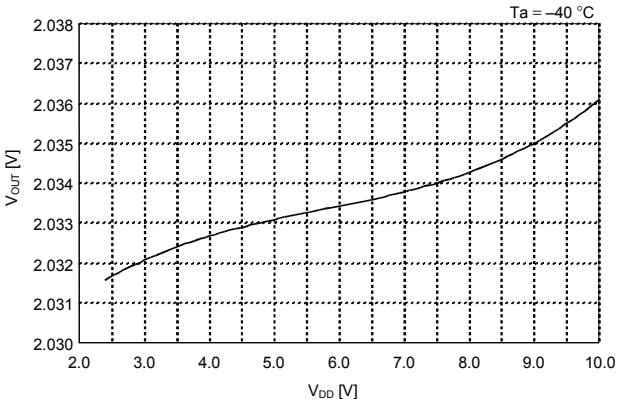
Error range of each temperature

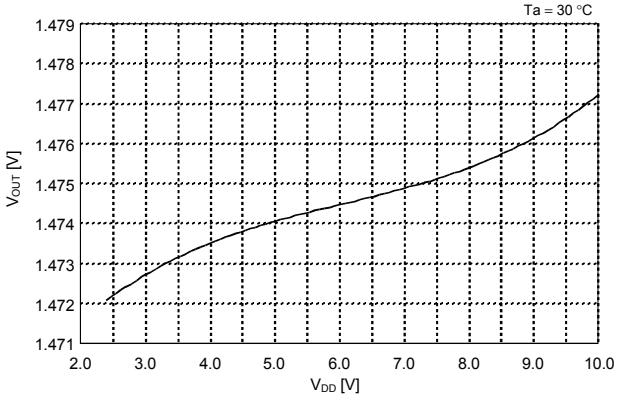


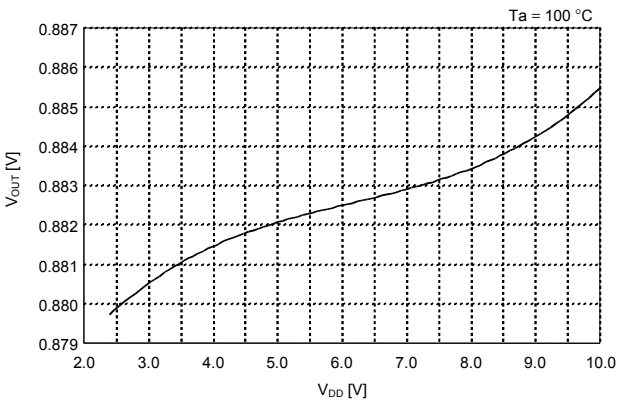
Power supply voltage (V_{DD}) vs. Current consumption (I_{DD})



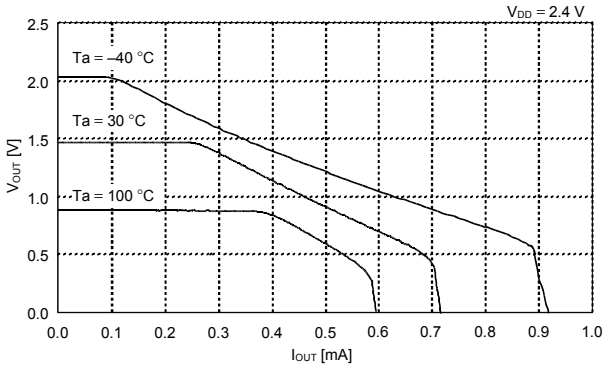
Power supply voltage (V_{DD}) vs. Output voltage (V_{OUT})

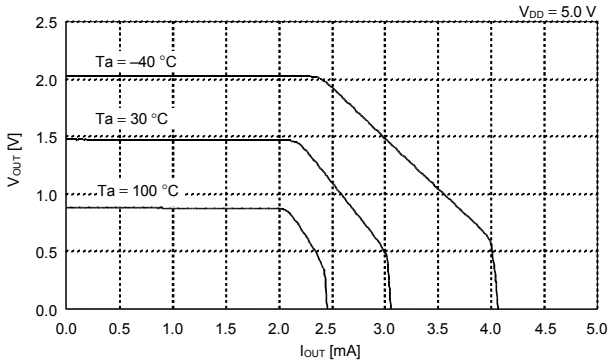


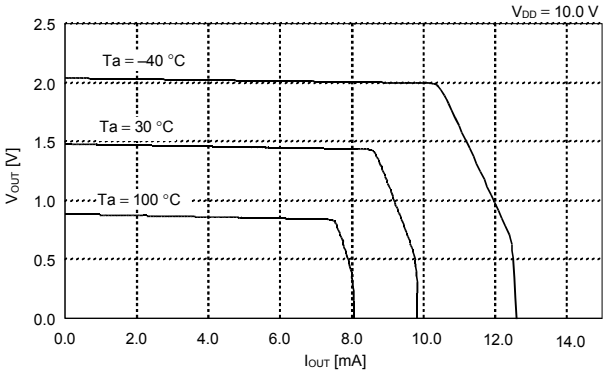




Load current (I_{OUT}) vs. Output voltage (V_{OUT})

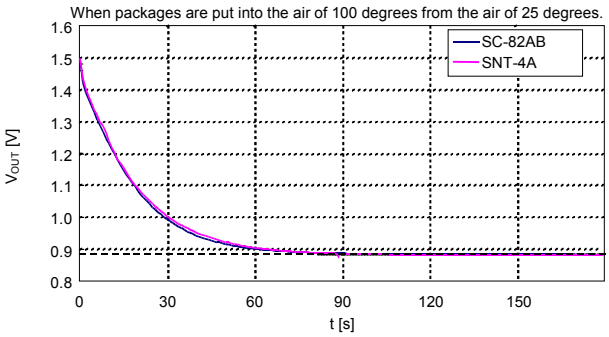


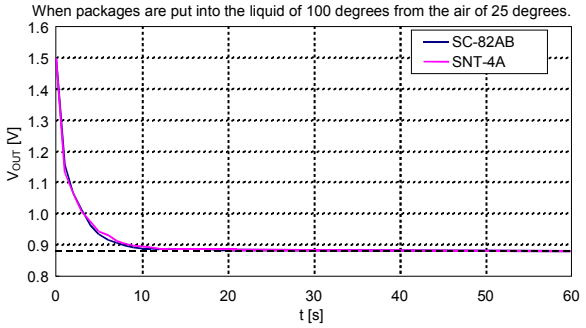




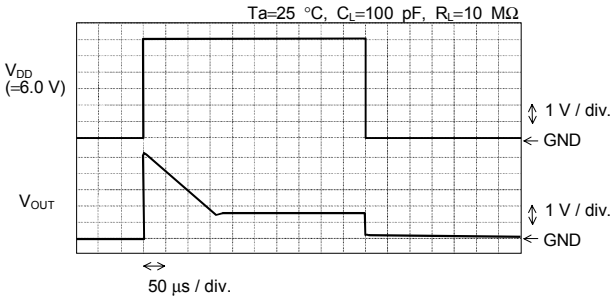
Heat response

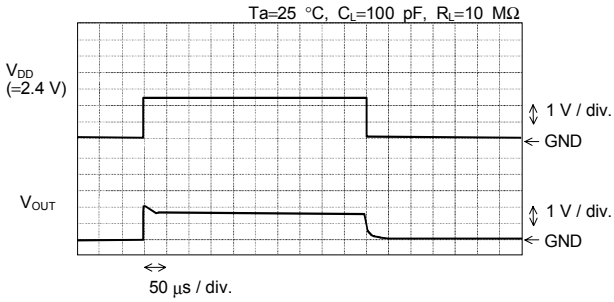
Time (t) vs. Output voltage (V_{OUT})

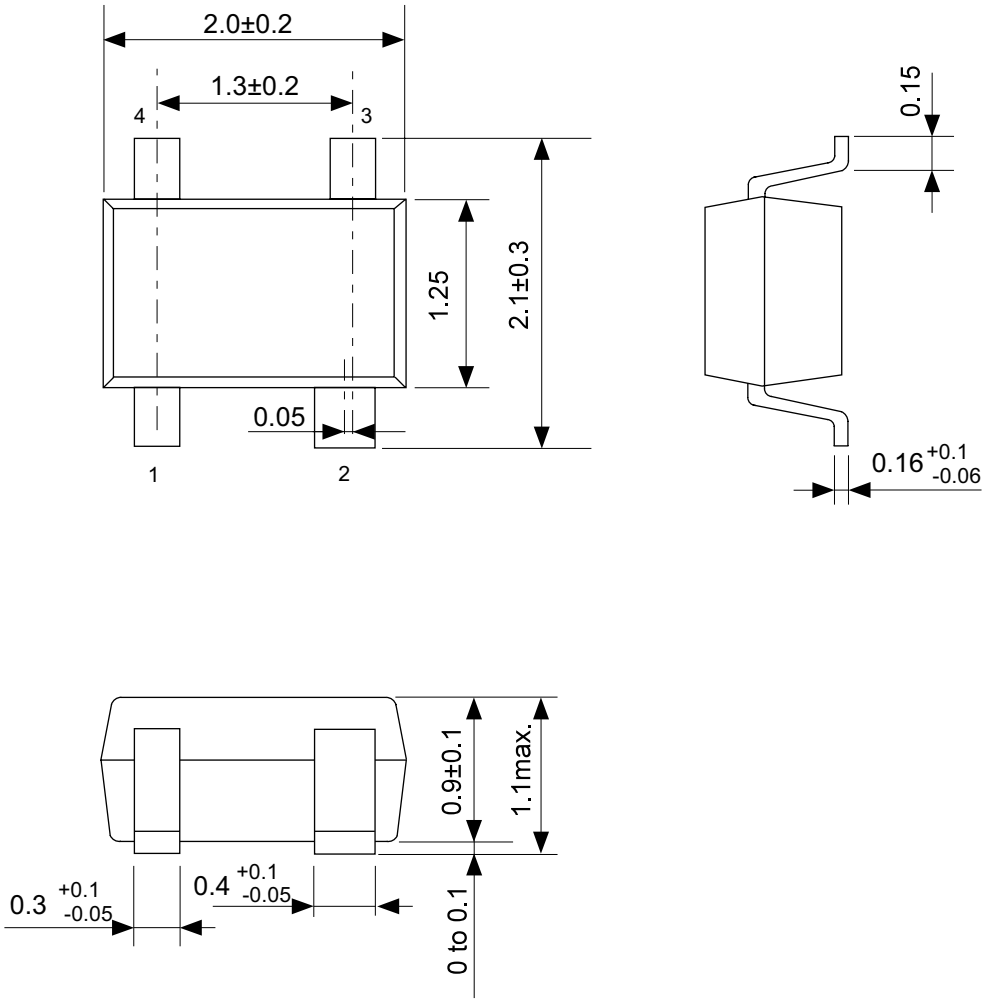




Start up response

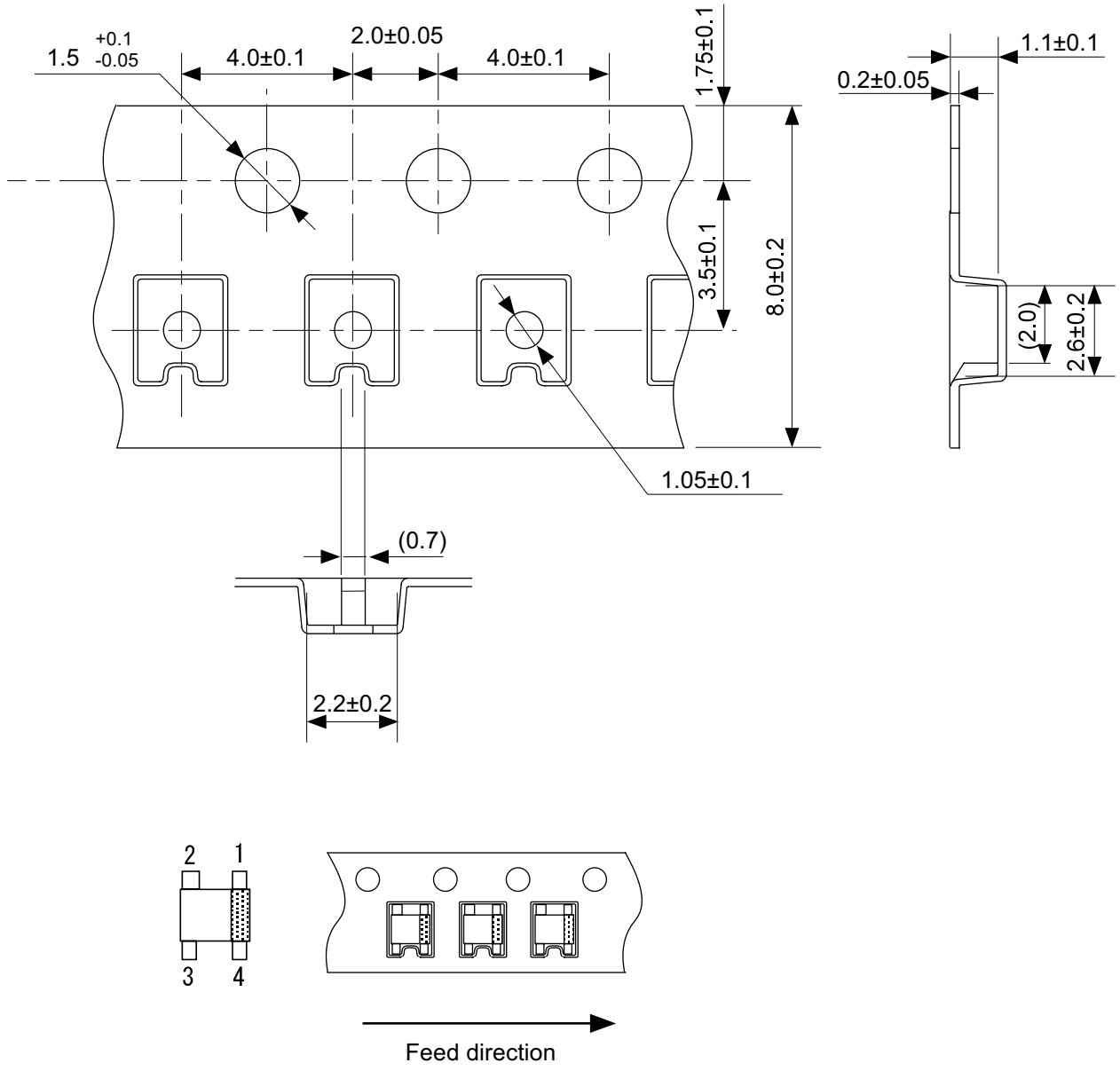






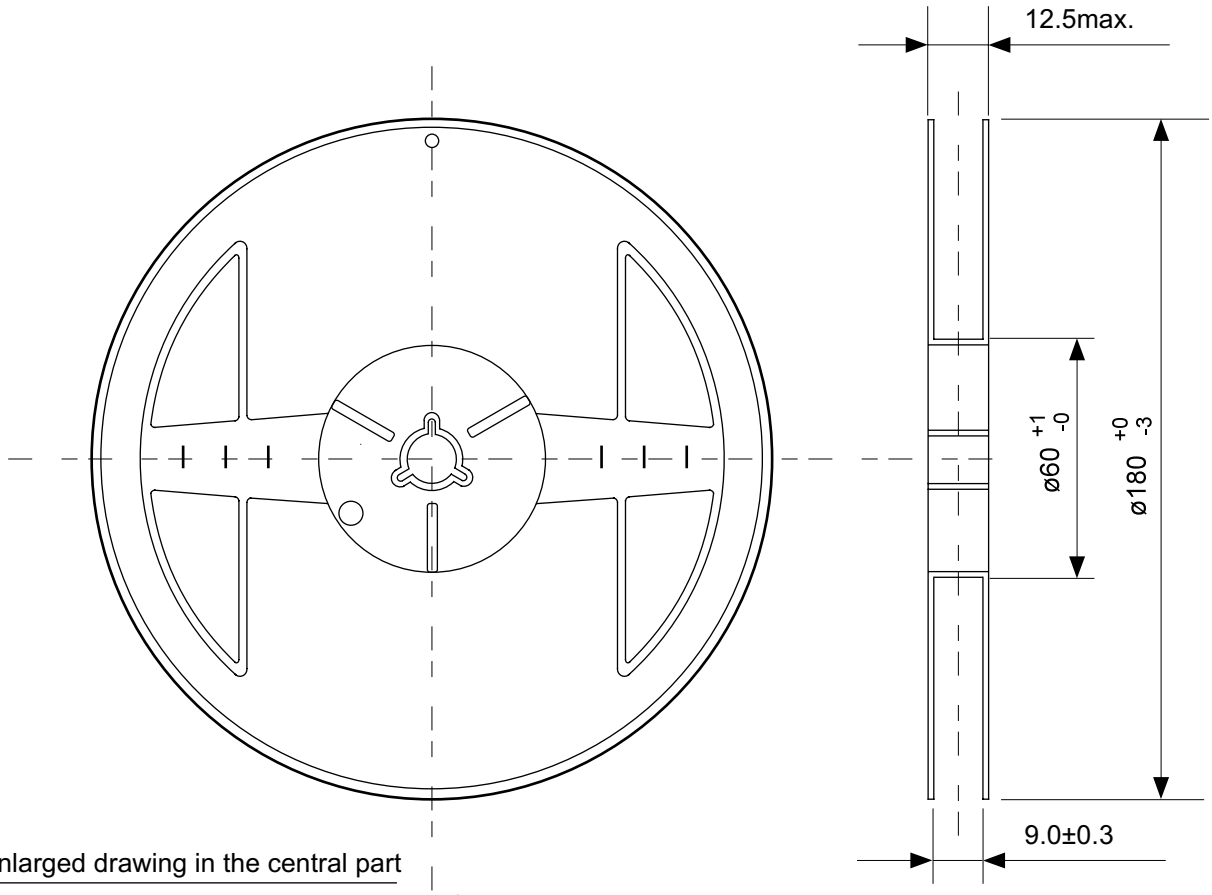
No. NP004-A-P-SD-1.1

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

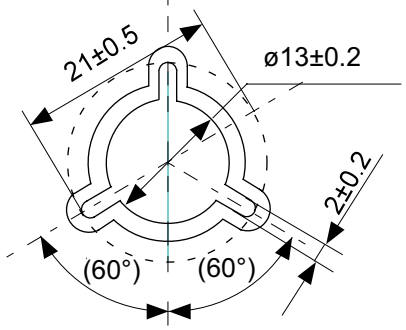


No. NP004-A-C-SD-2.1

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

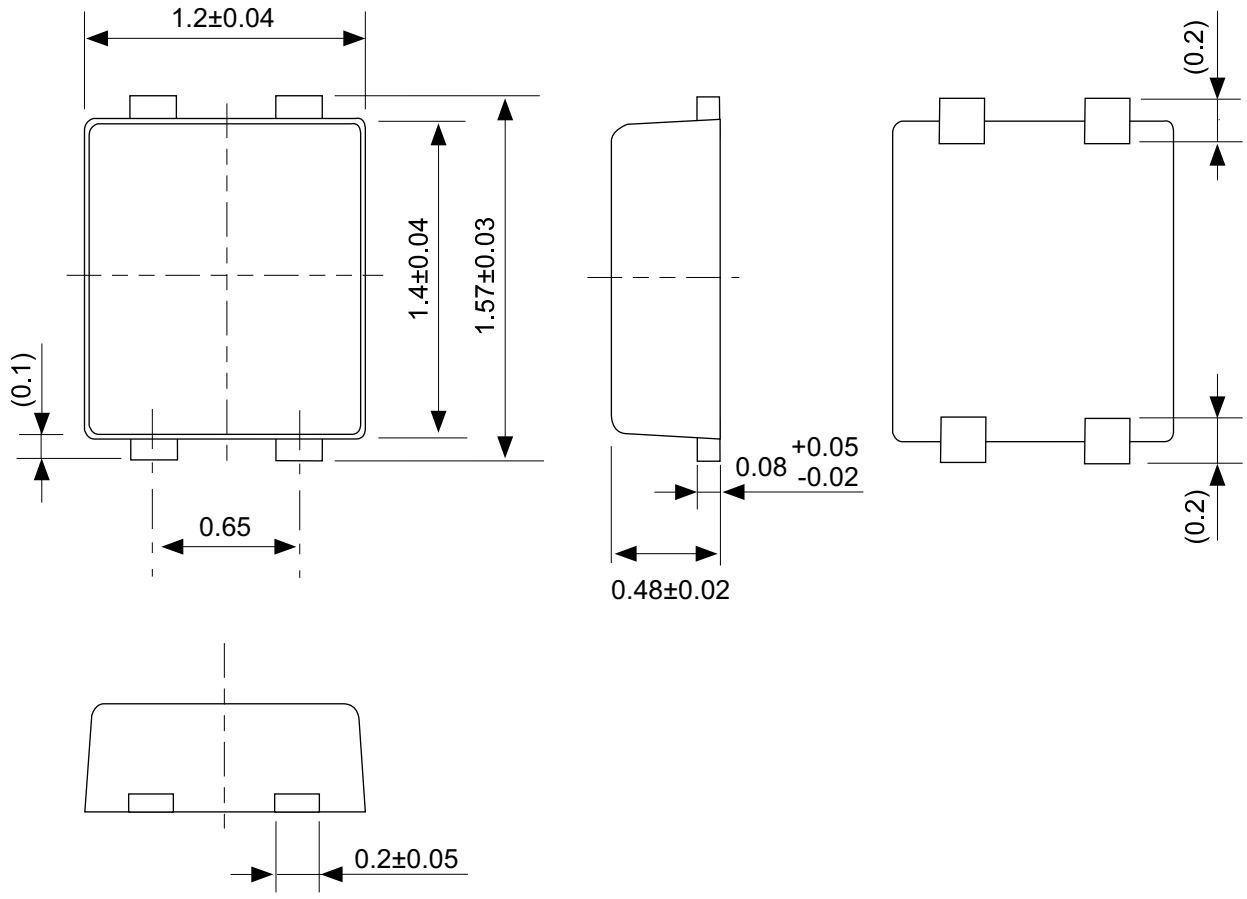


Enlarged drawing in the central part



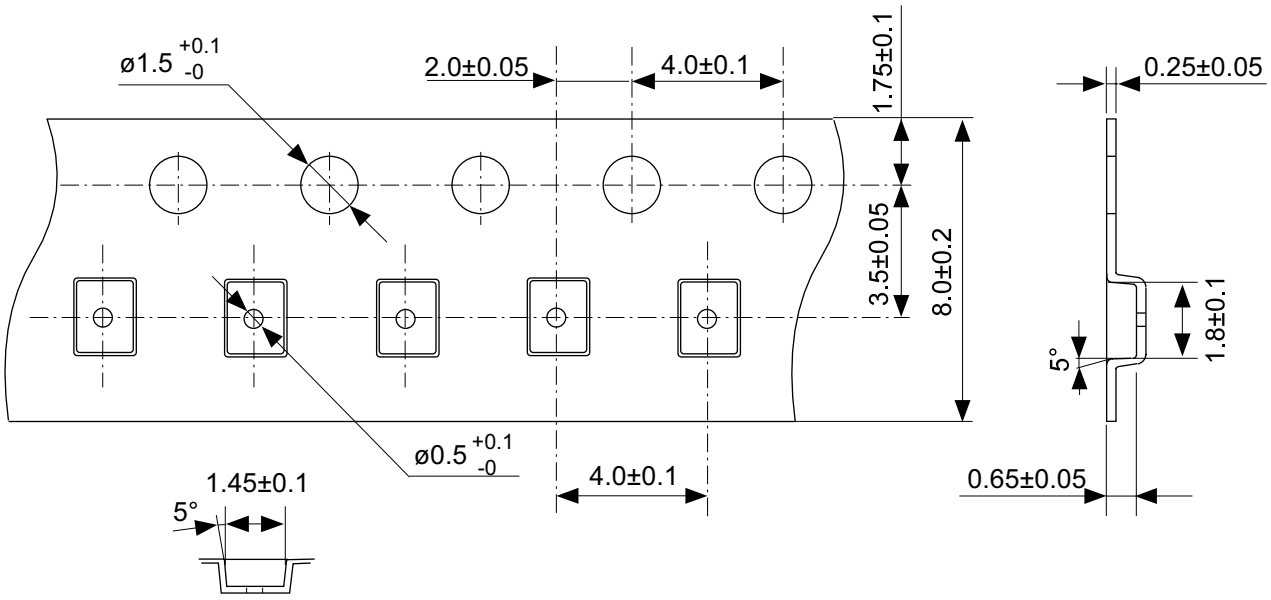
No. NP004-A-R-SD-1.1

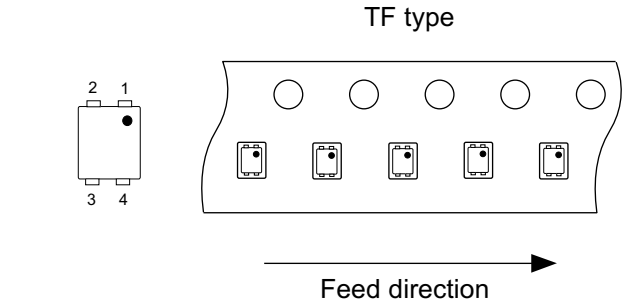
TITLE	SC82AB-A-Reel		
No.	NP004-A-R-SD-1.1		
SCALE		QTY.	3,000
UNIT	mm		
Seiko Instruments Inc.			



No. PF004-A-P-SD-3.0

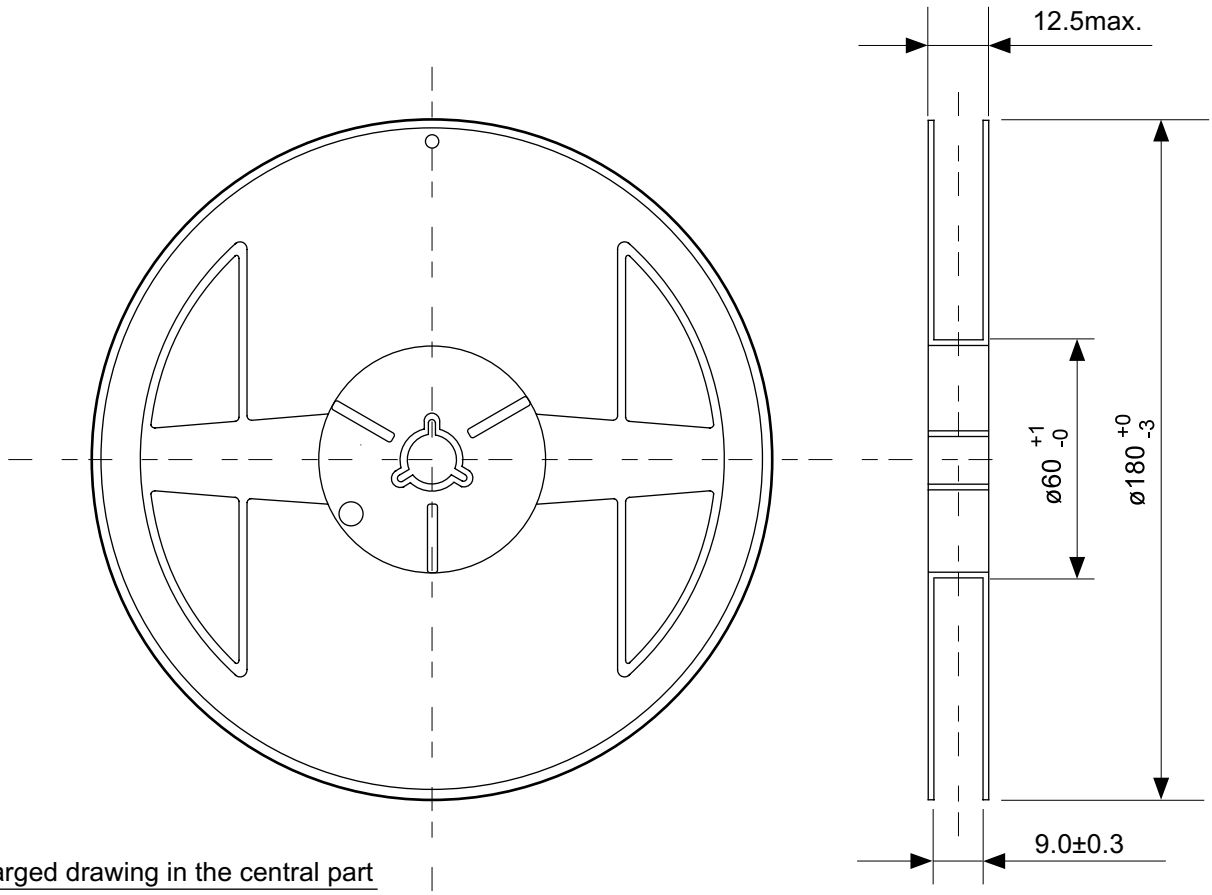
TITLE	SNT-4A-A-PKG Dimensions
No.	PF004-A-P-SD-3.0
SCALE	
UNIT	mm
Seiko Instruments Inc.	



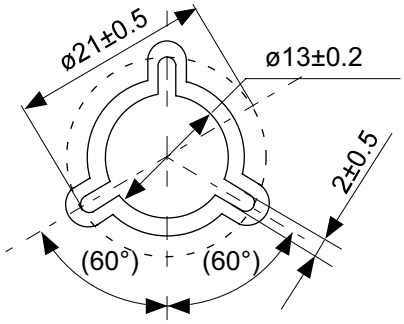


No. PF004-A-C-SD-1.0

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.			

- 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.