

## CMOS TEMPERATURE SENSOR IC

## S-5815A/5816A Series

The S-5815A/5816A 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  $-40^{\circ}\text{C}$  to  $100^{\circ}\text{C}$ . 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-5815A Series :  $\pm 5.0^{\circ}\text{C}$  ( $-30$  to  $100^{\circ}\text{C}$ )
  - S-5816A Series :  $\pm 2.5^{\circ}\text{C}$  ( $-30$  to  $100^{\circ}\text{C}$ )
- Linear output voltage
  - $-11.04\text{ mV}/^{\circ}\text{C}$  typ.
  - $T_a = -30^{\circ}\text{C}$  :  $2.582\text{ V}$  typ.
  - $T_a = +30^{\circ}\text{C}$  :  $1.940\text{ V}$  typ.
  - $T_a = +100^{\circ}\text{C}$  :  $1.145\text{ V}$  typ.
- Nonlinearity
  - $\pm 0.5\%$  typ. ( $-20$  to  $80^{\circ}\text{C}$ )
- Wide power supply voltage operation
  - $V_{\text{DD}} = 2.4$  to  $10.0\text{ V}$  ( $25^{\circ}\text{C}$ )
- Low current consumption
  - $4.0\text{ }\mu\text{A}$  typ. ( $25^{\circ}\text{C}$ )
- Built-in operational amplifier
- Output voltage referred to  $V_{\text{SS}}$
- Small package
  - WLP-4B
- 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
WLP-4B	HB004-B	HB004-B	HB004-B

■ Block Diagram

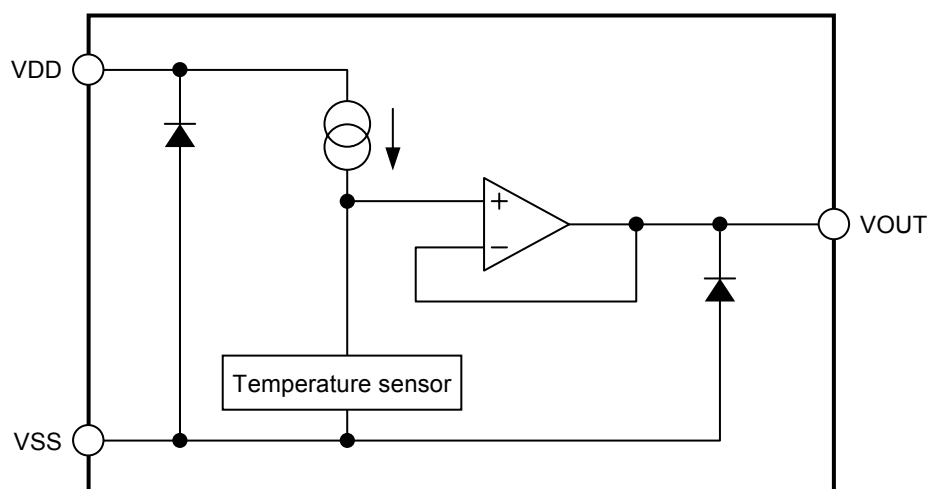
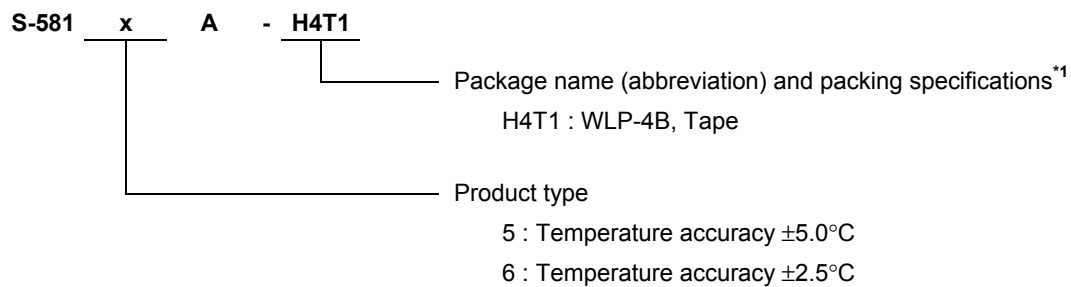


Figure 1

## ■ Product Name Structure

- The product types for the S-5815A/5816A 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

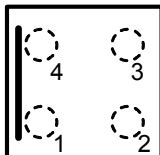
Table 1

Product Name	Temperature Accuracy	Package
S-5815A-H4T1	$\pm 5.0^{\circ}\text{C}$	WLP-4B
S-5816A-H4T1	$\pm 2.5^{\circ}\text{C}$	WLP-4B

## ■ Pin Configuration

WLP-4B

Top view

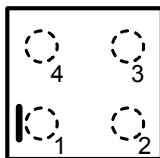


S-5815A

Figure 2

WLP-4B

Top view

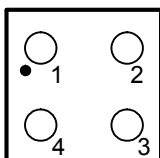


S-5816A

Figure 3

WLP-4B

Bottom view



S-5815A/S-5816A

Figure 4

Table 2

Pin No.	Pin Name	Pin Description
1	VDD	Power supply pin
2	VSS <sup>*1</sup>	GND pin
3	VSS <sup>*1</sup>	GND pin
4	VOUT	Output voltage pin

\*1. Connect both VSS pins to GND.

## ■ Absolute Maximum Ratings

Table 3

(Ta = 25°C unless otherwise specified)

Item	Symbol	Absolute Maximum Rating	Unit
Power supply pin voltage	V <sub>DD</sub>	V <sub>SS</sub> – 0.3 to V <sub>SS</sub> + 12.0	V
Output voltage	V <sub>OUT</sub>	V <sub>SS</sub> – 0.3 to V <sub>DD</sub> + 0.3	V
Power dissipation	P <sub>D</sub>	290 <sup>*1</sup>	mW
Operating ambient temperature	T <sub>opr</sub>	–40 to +100	°C
Storage temperature	T <sub>stg</sub>	–40 to +125	°C

\*1. At mounted on printed circuit 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-5815A Series

Table 4

(Ta = 25°C, V<sub>DD</sub> = 5.0 V, I<sub>OUT</sub> = 0 A unless otherwise specified)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test Circuit
Power supply voltage	V <sub>DD</sub>	—	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 <sub>OUT</sub>	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 <sub>SE</sub>	Ta = -30 to 100°C	-11.31	-11.04	-10.77	mV/°C	—
Nonlinearity	ΔN <sub>L</sub>	Ta = -20 to 80°C	—	±0.5	—	%	—
Operating temperature range	T <sub>opr</sub>	—	-40	—	100	°C	—
Current consumption	I <sub>DD</sub>	—	—	4.0	8.0	μA	1
Line regulation	ΔV <sub>OUT1</sub>	V <sub>DD</sub> = 2.4 to 10.0 V	—	—	0.05	%/V	2
Load regulation <sup>*1</sup>	ΔV <sub>OUT2</sub>	I <sub>OUT</sub> = 0 to 200 μA	—	—	1.0	mV	2

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

### 2. S-5816A Series

Table 5

(Ta = 25°C, V<sub>DD</sub> = 5.0 V, I<sub>OUT</sub> = 0 A unless otherwise specified)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test Circuit
Power supply voltage	V <sub>DD</sub>	—	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 <sub>OUT</sub>	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 <sub>SE</sub>	Ta = -30 to 100°C	-11.31	-11.04	-10.77	mV/°C	—
Nonlinearity	ΔN <sub>L</sub>	Ta = -20 to 80°C	—	±0.5	—	%	—
Operating temperature range	T <sub>opr</sub>	—	-40	—	100	°C	—
Current consumption	I <sub>DD</sub>	—	—	4.0	8.0	μA	1
Line regulation	ΔV <sub>OUT1</sub>	V <sub>DD</sub> = 2.4 to 10.0 V	—	—	0.05	%/V	2
Load regulation <sup>*1</sup>	ΔV <sub>OUT2</sub>	I <sub>OUT</sub> = 0 to 200 μA	—	—	1.0	mV	2

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

■ Test Circuits

1.

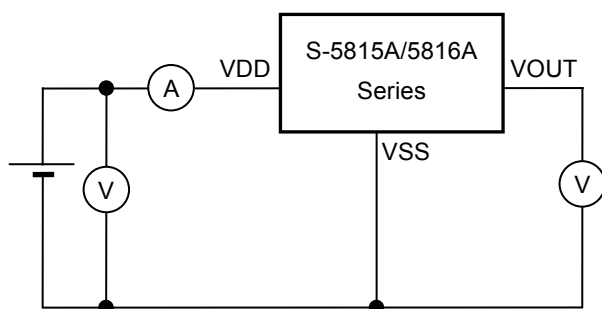


Figure 5

2.

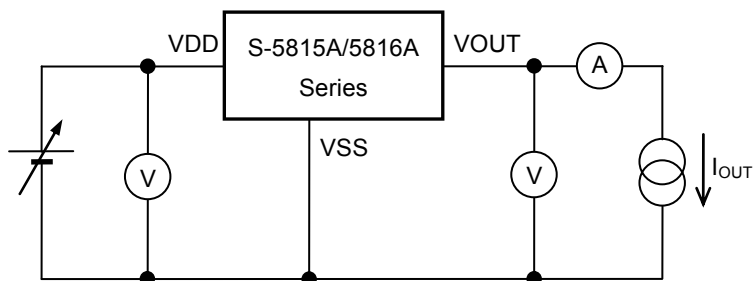


Figure 6

## ■ 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  $T_a = 100^\circ\text{C}$ .

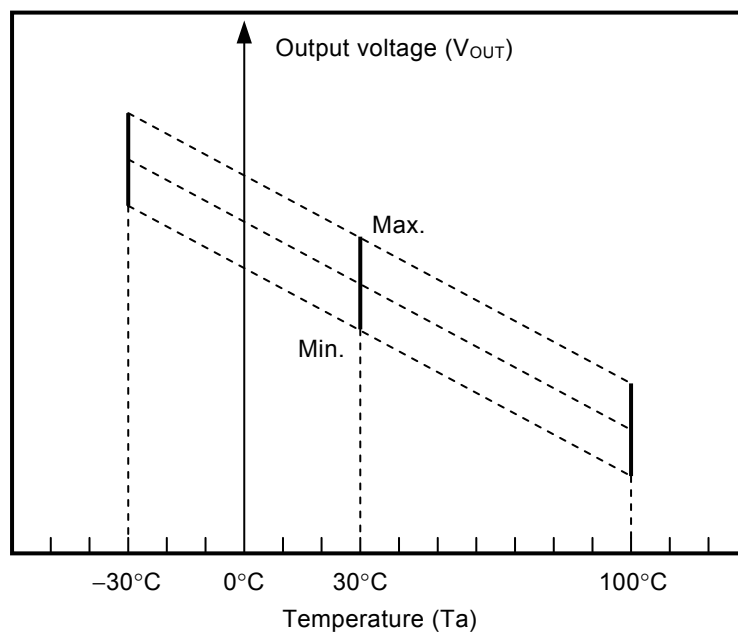


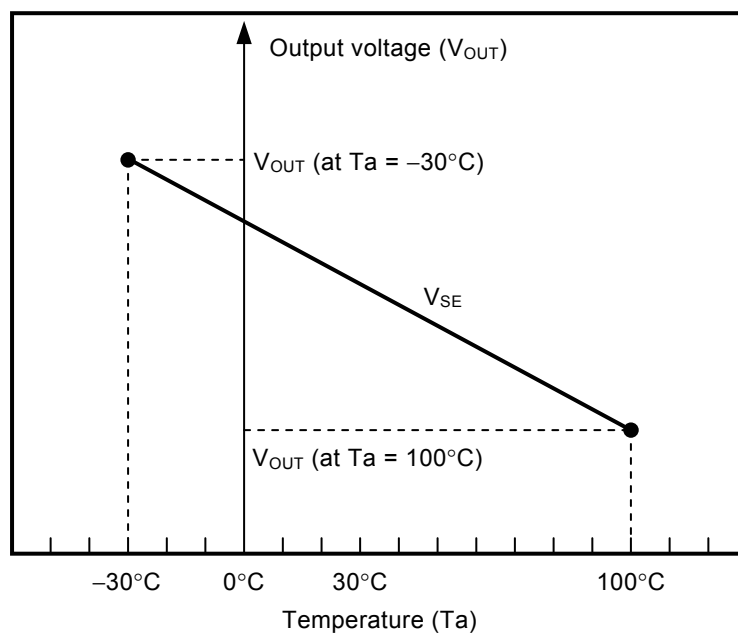
Figure 7

## 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 8**

\*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  $T_a = -30^{\circ}\text{C}$  [ $^{\circ}\text{C}$ ] .

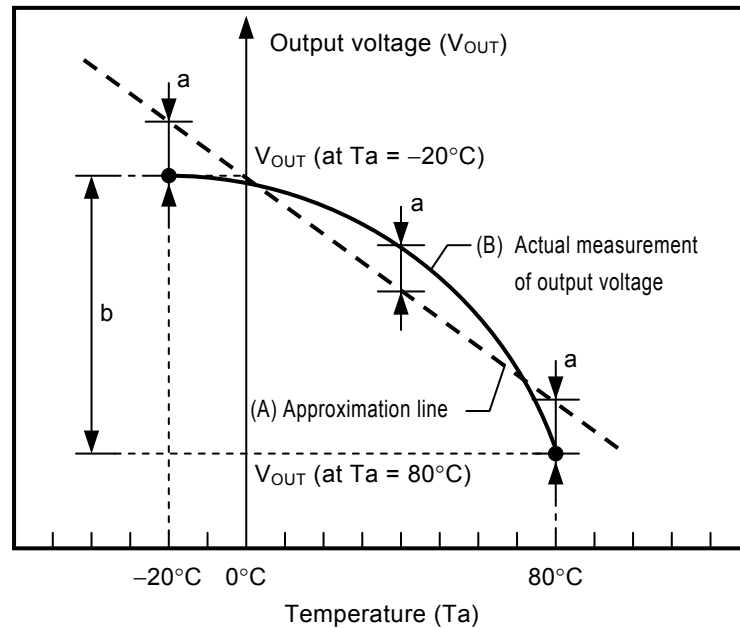


### 3. Nonlinearity ( $\Delta N_L$ )

$\Delta N_L$  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.

$\Delta N_L$  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  $-20^{\circ}\text{C}$  to  $80^{\circ}\text{C}$ . The approximation line is the line drawn so that "a" should be the minimum value.
- \*2. The difference of the output voltage within  $-20^{\circ}\text{C}$  to  $80^{\circ}\text{C}$ .

Figure 9

### 4. Line regulation ( $\Delta V_{OUT1}$ )

$\Delta V_{OUT1}$  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 ( $\Delta V_{OUT2}$ )

$\Delta V_{OUT2}$  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  $\mu$ F or less

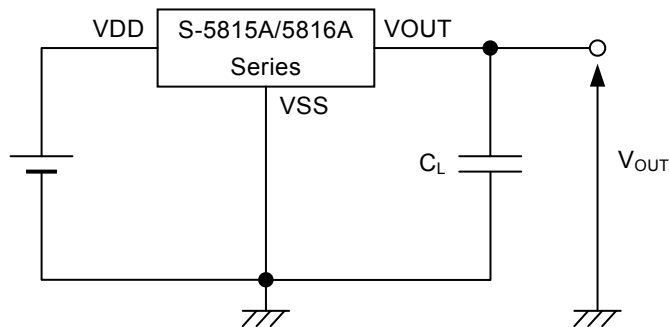


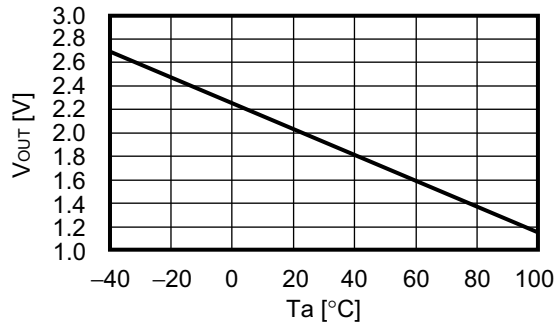
Figure 10

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

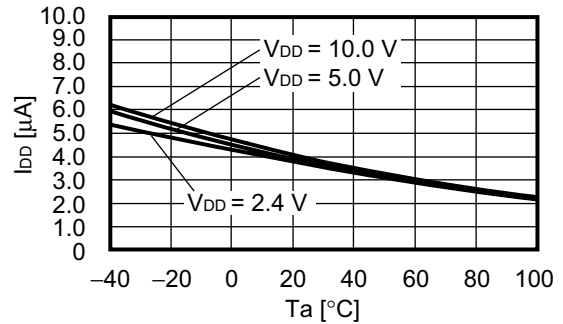
- Please do not connect a pull-up resistor to the output voltage pin.
- The application condition for input voltage, output voltage and load voltage must not exceed the package power dissipation.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in 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)

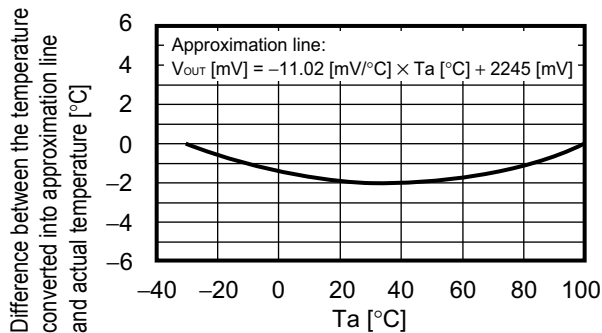
1. Output voltage ( $V_{OUT}$ ) vs. Temperature ( $T_a$ )



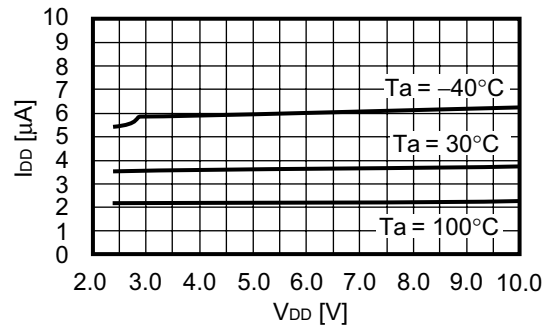
2. Current consumption ( $I_{DD}$ ) vs. Temperature ( $T_a$ )



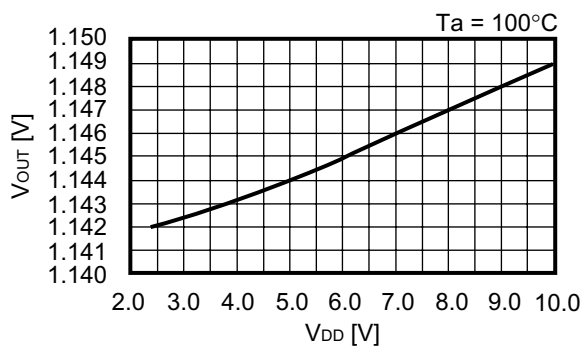
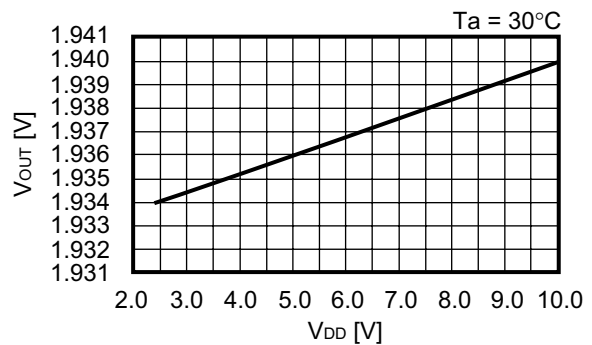
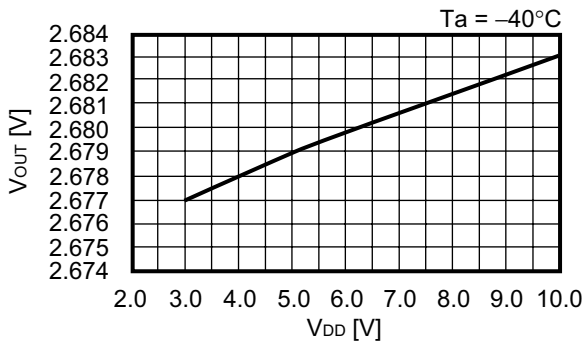
3. Error range of each temperature



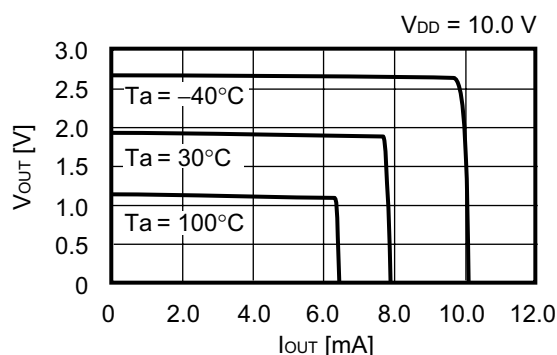
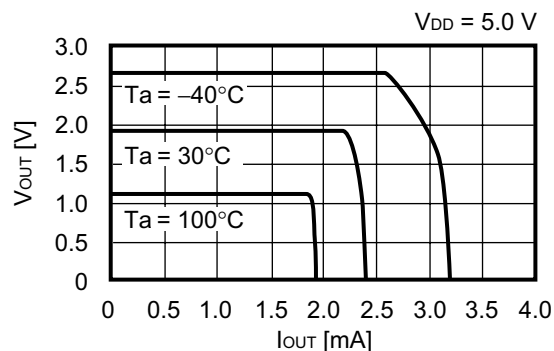
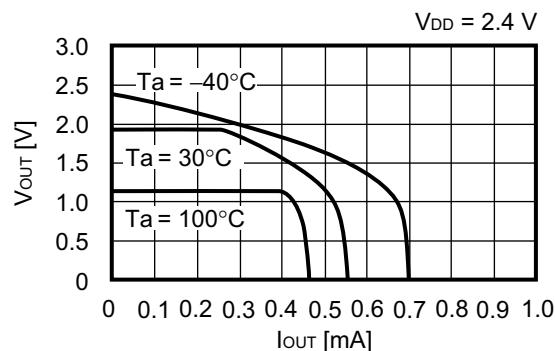
4. Current consumption ( $I_{DD}$ ) vs. Power supply voltage ( $V_{DD}$ )



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

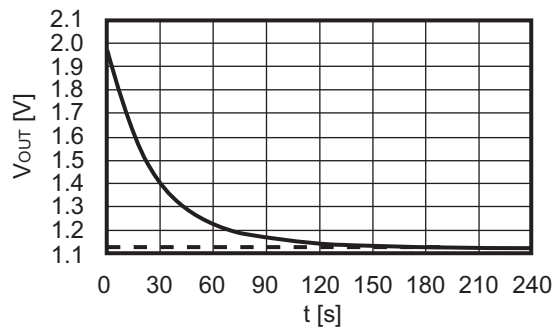


**6. Output voltage ( $V_{OUT}$ ) vs. Load current ( $I_{OUT}$ )**

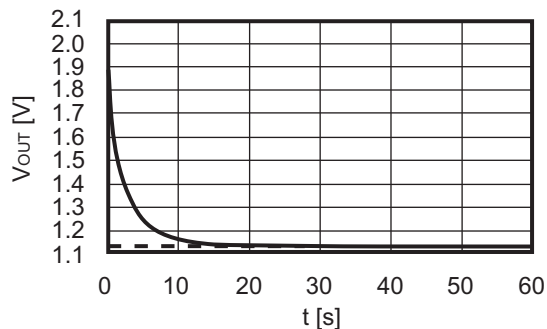


**7. Heat response Output voltage ( $V_{OUT}$ ) vs. Time (t)**

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

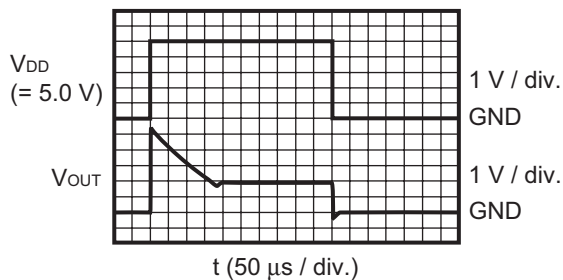


When packages are put into the liquid of 100°C from the air of 25°C

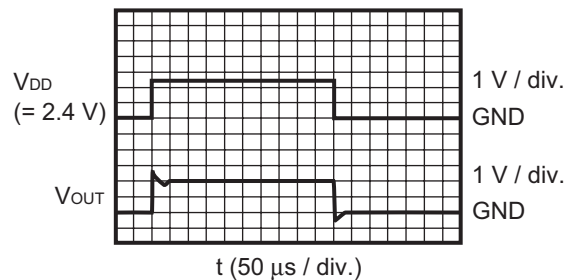


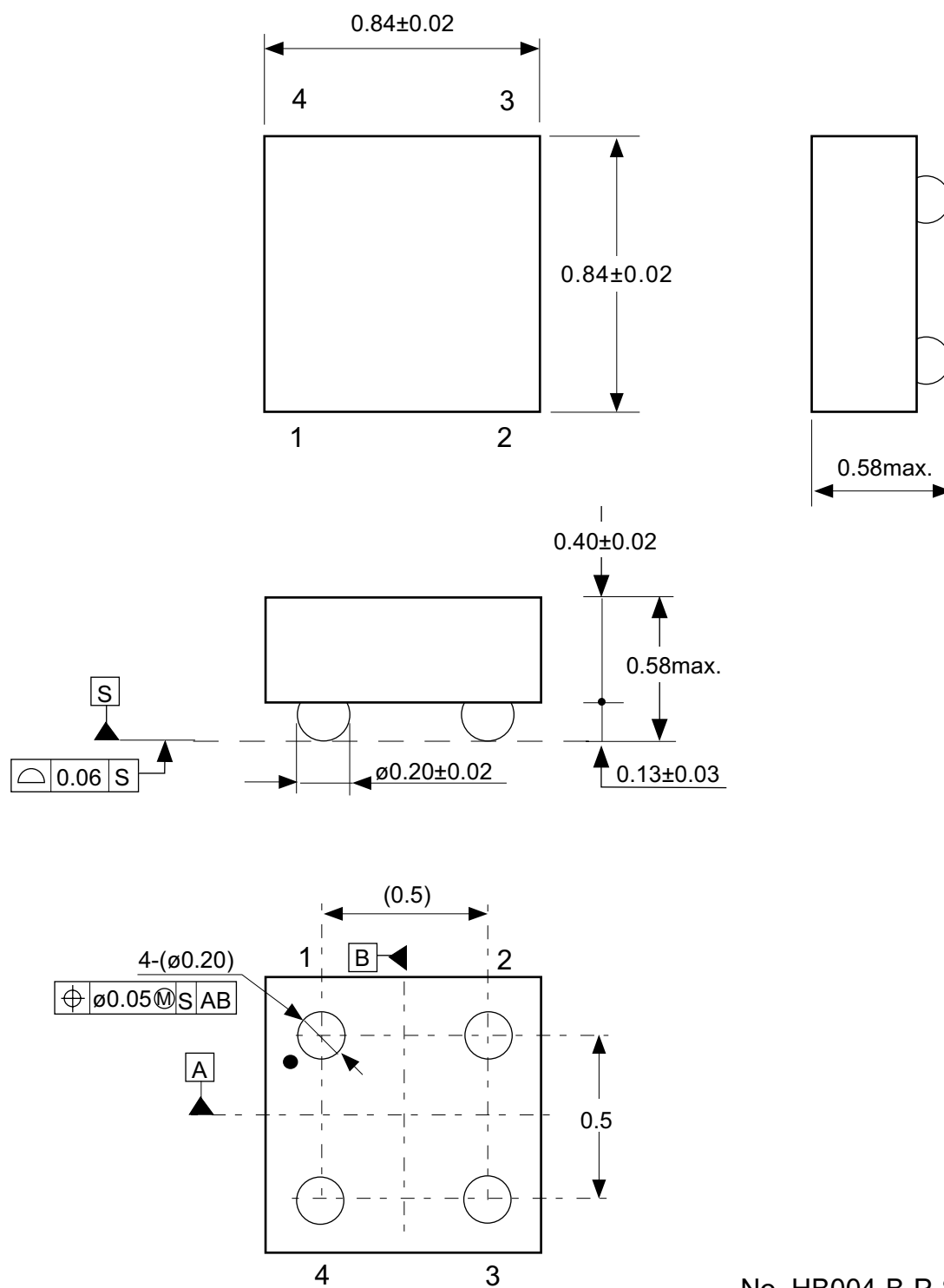
**8. Start up response**

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



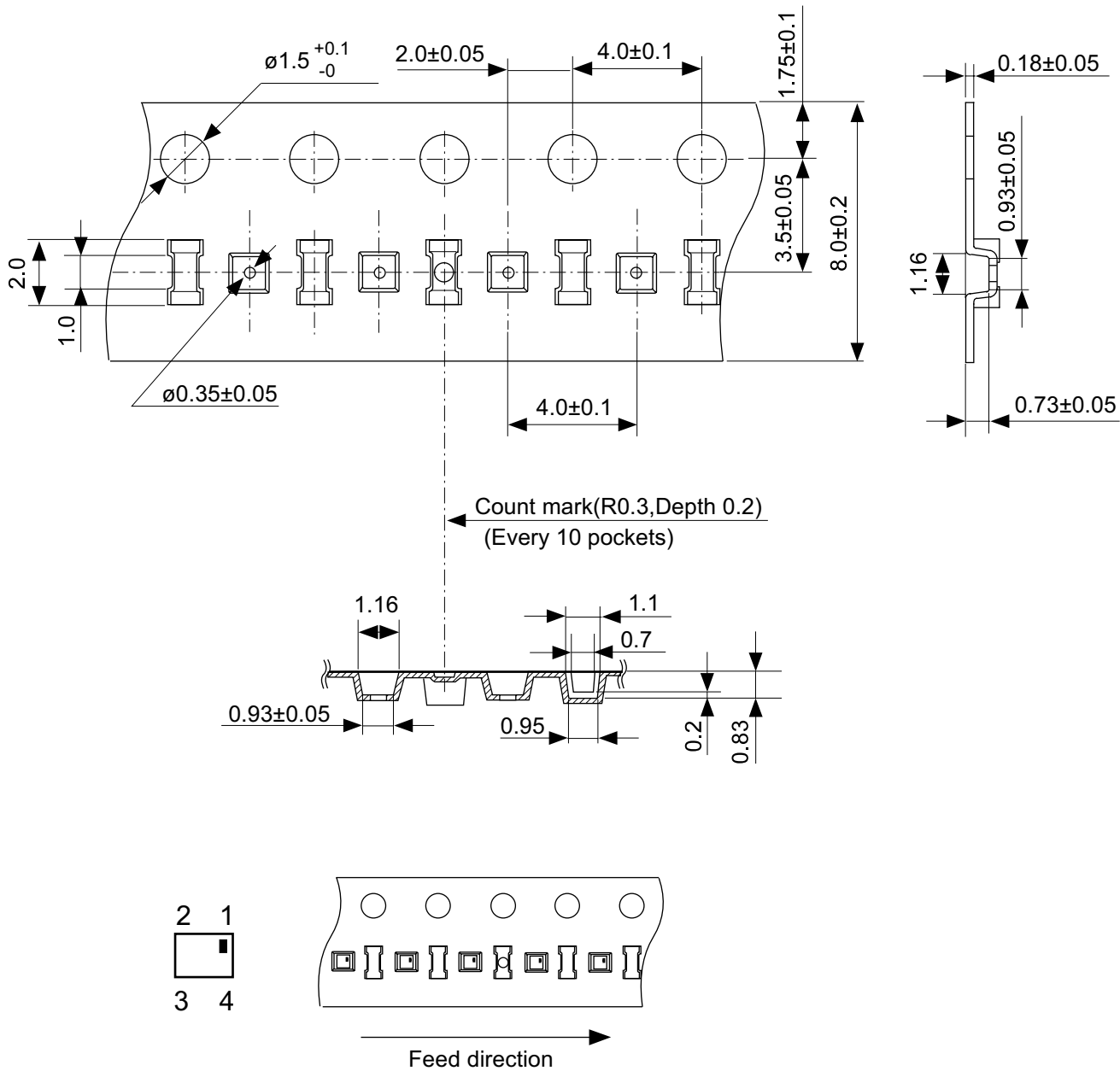
$T_a = 25^\circ\text{C}$ ,  $C_L = 100 \text{ pF}$ ,  $R_L = 10 \text{ M}\Omega$





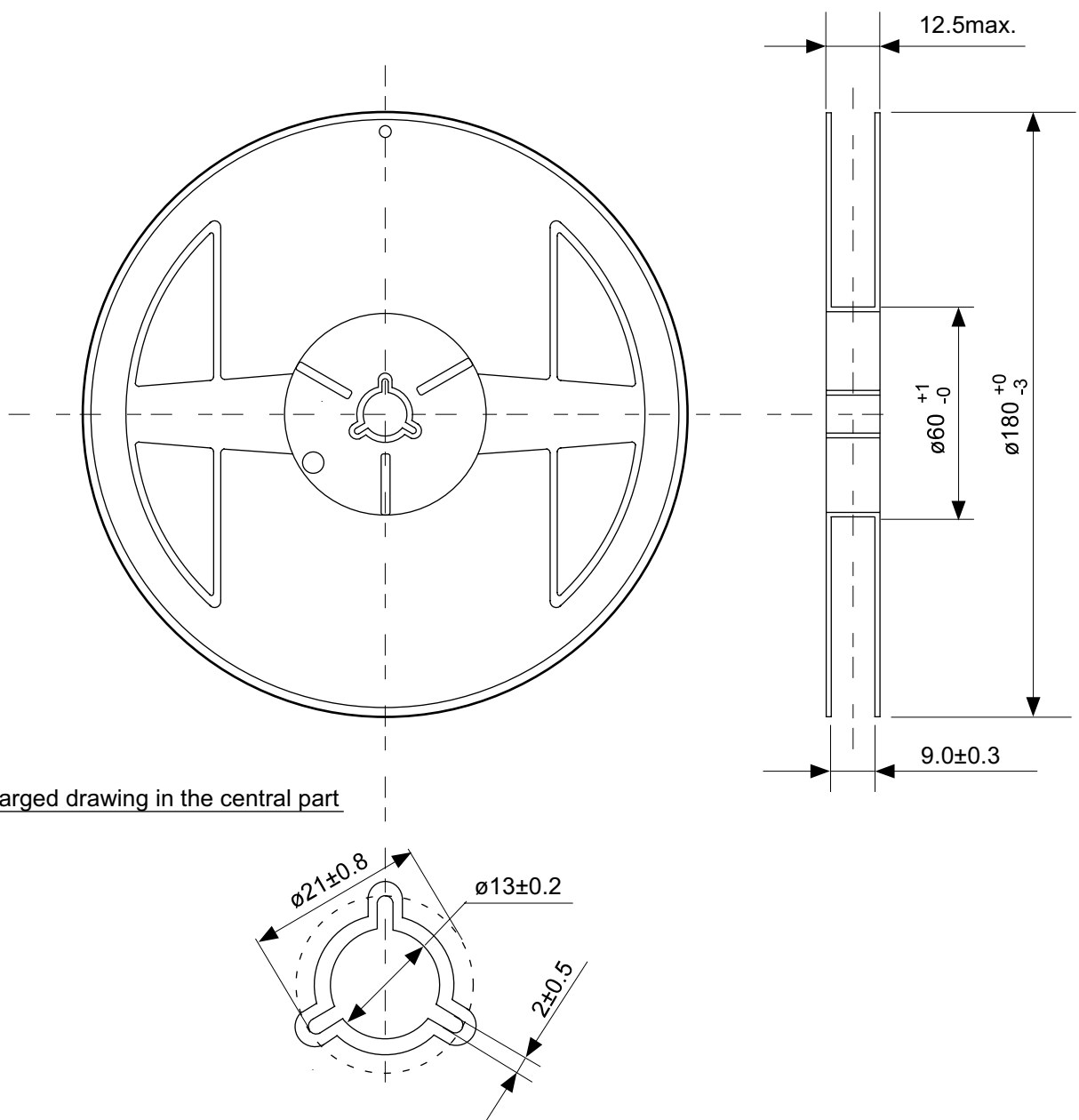
No. HB004-B-P-SD-1.0

TITLE	WLP-4B-B-PKG Dimensions
No.	HB004-B-P-SD-1.0
SCALE	
UNIT	mm
Seiko Instruments Inc.	



No. HB004-B-C-SD-1.0

TITLE	WLP-4B-B-Carrier Tape
No.	HB004-B-C-SD-1.0
SCALE	
UNIT	mm
Seiko Instruments Inc.	



Enlarged drawing in the central part

No. HB004-B-R-SD-1.0

TITLE	WLP-4B-B-Reel		
No.	HB004-B-R-SD-1.0		
SCALE		QTY.	3,000
UNIT	mm		
Seiko Instruments Inc.			

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