S-5855A Series

PWM OUTPUT TEMPERATURE SENSOR IC

www.sii-ic.com

The S-5855A Series, developed by CMOS technology, is a 1-wire PWM output temperature sensor IC of low current consumption that itself changes the duty according to temperature.
The duty decreases from 100% if exceeding the temperature set by user, and this decrease is linear against the temperature rise.
CMOS and Nch open drain are available for its output form.
Its small packages SNT-4A and SOT-23-5 enable high-density mounting.

■ Features

- PWM output : 1-wire PWM interface
- Temperature accuracy : ±3.0°C
- Duty change-start temperature : Selectable from +40°C to +80°C in 10°C step
- Duty temperature sensitivity : Selectable from −1 %/°C to −4 %/°C in 1 %/°C step
- Low current consumption : 50 μA (Typ.), Ta = +25°C
- Low power supply voltage : 1.65 V to 5.5 V
- Wide range of temperature : −40°C to +125°C
- Lead-free (Sn 100%), halogen-free*1

***1.** Refer to "■ **Product Name Structure**" for details.

■ Application

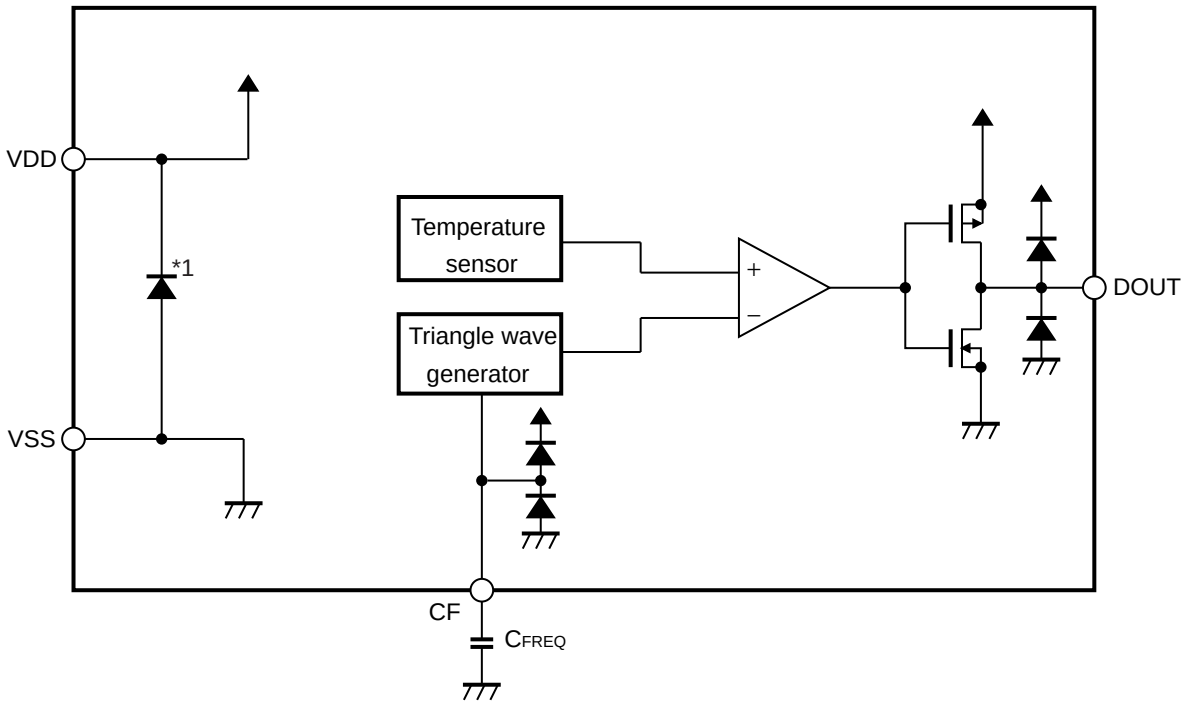
- Temperature compensation for LED instruments

■ Packages

- SNT-4A
- SOT-23-5

■ Block Diagrams

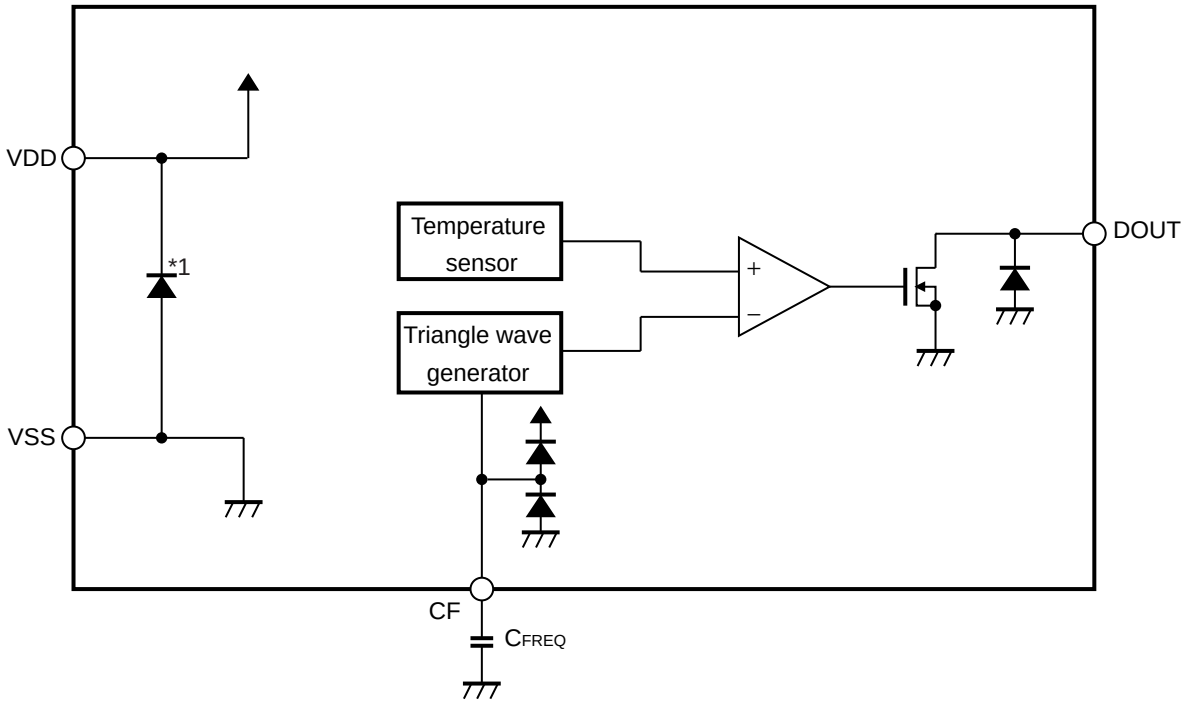
1. CMOS output



***1.** Parasitic diode

Figure 1

2. Nch open drain output

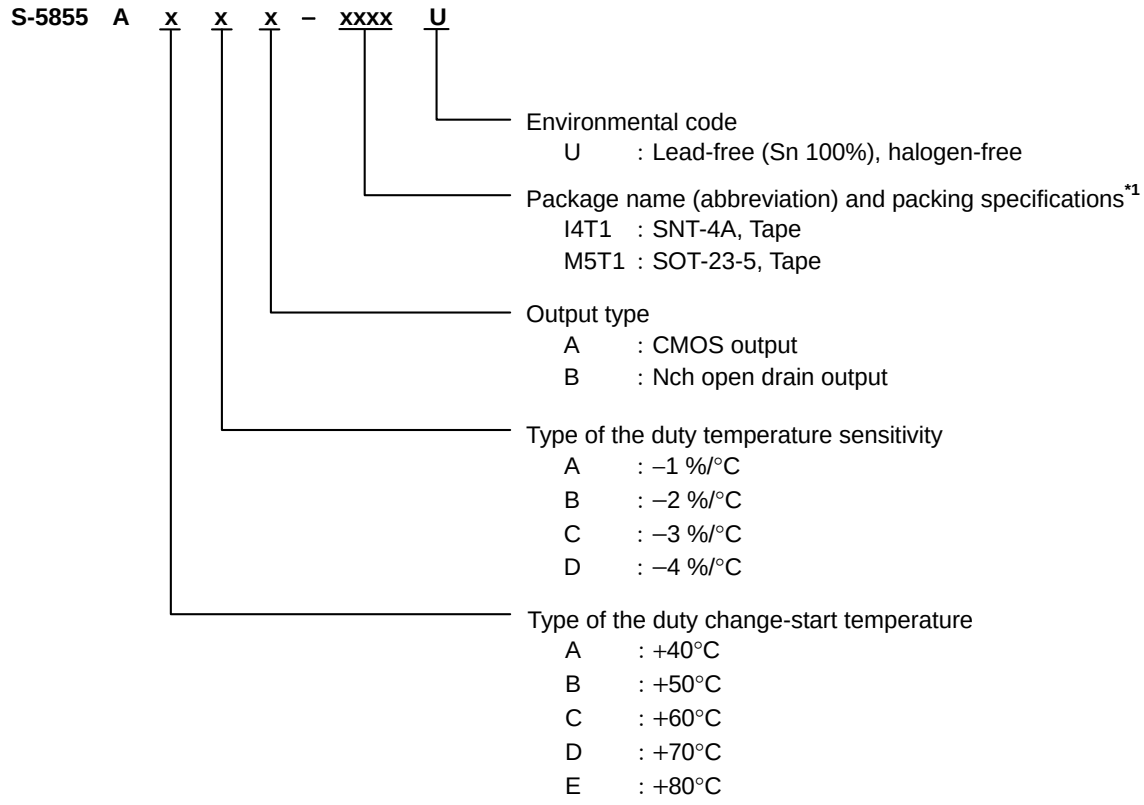


***1.** Parasitic diode

Figure 2

■ Product Name Structure

1. Product name



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

2. Packages

Package Name	Drawing Code			
	Package	Tape	Reel	Land
SNT-4A	PF004-A-P-SD	PF004-A-C-SD	PF004-A-R-SD	PF004-A-L-SD
SOT-23-5	MP005-A-P-SD	MP005-A-C-SD	MP005-A-R-SD	–

3. Product name list

(1) SNT-4A

Table 1

Product name	Type of duty change-start temperature T_S [°C]*1	Type pf duty temperature sensitivity Ddt(s) [%/°C]*2	Output type	T_{SP5}*3	T_{EM5}*4
S-5855AACA-I4T1U	40	–3	CMOS	45	60
S-5855AEAA-I4T1U	80	–1	CMOS	85	125
S-5855AECA-I4T1U	80	–3	CMOS	85	100

***1.** T_S : Duty change-start temperature set by user
***2.** Ddt(s) : Duty temperature sensitivity set by user
***3.** T_{SP5} : Temperature 5°C higher than duty change-start temperature T_S (Refer to **Table 12** for details)
***4.** T_{EM5} : : Higher temperature when measuring duty temperature sensitivity (Refer to **Table 12** for details)

Remark Please contact our sales office for products other than those specified above.

(2) SOT-23-5

Table 2

Product name	Type of duty change-start temperature T_S [°C]*1	Type pf duty temperature sensitivity Ddt(s) [%/°C]*2	Output type	T_{SP5}*3	T_{EM5}*4
S-5855AAAA-M5T1U	40	–1	CMOS	45	115
S-5855AAAB-M5T1U	40	–1	Nch open drain	45	115
S-5855AADA-M5T1U	40	–4	CMOS	45	55

***1.** T_S : Duty change-start temperature set by user
***2.** Ddt(s) : Duty temperature sensitivity set by user
***3.** T_{SP5} : Temperature 5°C higher than duty change-start temperature T_S (Refer to **Table 12** for details)
***4.** T_{EM5} : : Higher temperature when measuring duty temperature sensitivity (Refer to **Table 12** for details)

Remark Please contact our sales office for products other than those specified above

■ Pin Configurations

SNT-4A
Top view

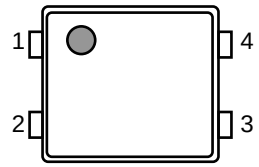


Figure 3

Table 3

Pin No.	Symbol	Pin Description
1	VSS	GND pin
2	CF	Connection pin for frequency control capacitor
3	VDD	Power supply pin
4	DOUT	Output pin

SOT-23-5
Top view

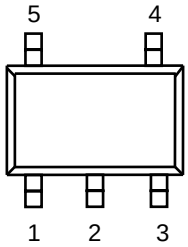


Figure 4

Table 4

Pin No.	Symbol	Pin Description
1	CF	Connection pin for frequency control capacitor
2	VSS	GND pin
3	NC*1	Open
4	DOUT	Output pin
5	VDD	Power supply pin

***1.** The NC pin is electrically open.
Please connect NC to VDD or GND.

■ Absolute Maximum Ratings

Table 5

(Ta = +25°C, V_{SS} = 0 V, unless otherwise specified)

Item		Symbol	Absolute Maximum Rating	Unit
Power supply voltage		V_{DD}	V_{SS} −0.3 to V_{SS} +7.0	V
Output voltage	CMOS output product	V_{OUT}	V_{SS} −0.3 to V_{DD} +0.3	V
	Nch open drain output product		V_{SS} −0.3 to V_{SS} +7.0	V
CF voltage		V_{CF}	V_{SS} −0.3 to V_{DD} +0.3	V
Output current		I_{OUT}	−13 to +13	mA
Power dissipation	SNT-4A	P_D	300[*1]	mW
	SOT-23-5		600[*1]	mW
Operating ambient temperature		T_{opr}	−40 to +125	°C
Storage temperature		T_{stg}	−65 to +150	°C

***1.** When mounted on board
[Mounted board]
(1) Board size: 114.3 mm × 76.2 mm × t1.6 mm
(2) 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. Common items

Table 6

($Ta = T_{SP5}$, V_{DD} = 3.0 V, V_{SS} = 0 V, unless otherwise specified)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
Power supply voltage	V_{DD}	–		1.65	–	5.5	V	1
Current consumption	I_{DD}	No load at output pin	$Ta = T_{SP5}$	–	–	200	μA	1
			Ta = +25°C (at 100% duty)	–	50	–	μA	1
Output leakage current	I_{LEAK}	Nch open drain output V_{OUT} = 5.5 V, Ta = +25°C		–	–	1	μA	3
Output source current	I_{SOURCE}	$V_{OUT} = V_{DD} - 0.3$ V		0.8	–	–	mA	3
Output sink current	I_{SINK}	$V_{OUT} = V_{SS} + 0.3$ V		3	–	–	mA	3
Fall time	t_F	C_L = 100 pF, R_L = 10 kΩ $V_{OUT} = 0.8 \times V_{DD}$ to $0.2 \times V_{DD}$		–	20	–	ns	4
Rise time	t_R	Nch open drain output C_L = 15 pF, R_L = 10 kΩ $V_{OUT} = 0.2 \times V_{DD}$ to $0.8 \times V_{DD}$		–	300	–	ns	5
		CMOS output C_L = 100 pF, R_L = 10 kΩ $V_{OUT} = 0.2 \times V_{DD}$ to $0.8 \times V_{DD}$		–	50	–	ns	4

2. Electrical characteristics: product with duty temperature sensitivity Ddt(s) = –1 %/°C

Table 7

($Ta = T_{SP5}$, V_{DD} = 3.0 V , V_{SS} = 0 V, C_{FREQ} = 2.2 nF, unless otherwise specified)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
Duty accuracy	Dsp5	V_{DD} = 3.0 V		92.0	95.0	98.0	%	2
		V_{DD} = 1.65 V to 5.5 V		91.0	95.0	99.0	%	2
Duty temperature sensitivity	Ddt(E)*1	$Ta = T_{SP5}$*2, T_{EM5}*3	V_{DD} = 3.0 V	–1.2	–1.0	–0.8	%/°C	2
			V_{DD} = 1.65 V to 5.5 V	–1.26	–1.0	–0.76	%/°C	2
Oscillation frequency	f_{OSC}	$Ta = T_{SP5}$	V_{DD} = 3.0 V	1950	2300	2650	Hz	2
			V_{DD} = 1.65 V to 5.5 V	1860	2300	2780	Hz	2
		$Ta = T_{EM5}$	V_{DD} = 3.0 V	1670	2300	3040	Hz	2

***1.** Ddt(E): Actual duty temperature sensitivity
***2.** T_{SP5}: Temperature 5°C higher than duty change-start temperature T_S (Refer to **Table 12** for details)
***3.** T_{EM5}: Higher temperature when measuring duty temperature sensitivity (Refer to **Table 12** for details)

3. Electrical characteristics: product with duty temperature sensitivity Ddt(s) = –2 %/°C

Table 8

($Ta = T_{SP5}$, V_{DD} = 3.0 V , V_{SS} = 0 V, C_{FREQ} = 4.7 nF, unless otherwise specified)

Item	Symbol	Conditions		Min.	Typ.	Max.	Unit	Test circuit
Duty accuracy	Dsp5	V_{DD} = 3.0 V		84.0	90.0	96.0	%	2
		V_{DD} = 1.65 V to 5.5 V		82.0	90.0	98.0	%	2
Duty temperature sensitivity	Ddt(E)*1	$Ta = T_{SP5}$*2, T_{EM5}*3	V_{DD} = 3.0 V	–2.4	–2.0	–1.6	%/°C	2
			V_{DD} = 1.65 V to 5.5 V	–2.52	–2.0	–1.52	%/°C	2
Oscillation frequency	f_{OSC}	$Ta = T_{SP5}$	V_{DD} = 3.0 V	1840	2160	2740	Hz	2
			V_{DD} = 1.65 V to 5.5 V	1750	2160	2600	Hz	2
		$Ta = T_{EM5}$	V_{DD} = 3.0 V	1560	2160	2850	Hz	2

***1.** Ddt(E): Actual duty temperature sensitivity
***2.** T_{SP5}: Temperature 5°C higher than duty change-start temperature T_S (Refer to **Table 12** for details)
***3.** T_{EM5}: Higher temperature when measuring duty temperature sensitivity (Refer to **Table 12** for details)

4. Electrical characteristics: product with duty temperature sensitivity Ddt(s) = –3 %/°C

Table 9

($Ta = T_{SP5}$, V_{DD} = 3.0 V , V_{SS} = 0 V, C_{FREQ} = 6.8 nF, unless otherwise specified)

Items	Symbol	Conditions		Min.	Typ.	Max.	Unit	Test circuit
Duty accuracy	Dsp5	V_{DD} = 3.0 V		76.0	85.0	94.0	%	2
		V_{DD} = 1.65 V to 5.5 V		73.0	85.0	97.0	%	2
Duty temperature sensitivity	Ddt(E)*1	$Ta = T_{SP5}$*2, T_{EM5}*3	V_{DD} = 3.0 V	–3.6	–3.0	–2.4	%/°C	2
			V_{DD} = 1.65 V to 5.5 V	–3.78	–3.0	–2.28	%/°C	2
Oscillation frequency	f_{OSC}	$Ta = T_{SP5}$	V_{DD} = 3.0 V	1900	2240	2570	Hz	2
			V_{DD} = 1.65 V to 5.5 V	1810	2240	2700	Hz	2
		$Ta = T_{EM5}$	V_{DD} = 3.0 V	1620	2240	2950	Hz	2

***1.** Ddt($E_{)}$: Actual duty temperature sensitivity
***2.** T_{SP5}: Temperature 5°C higher than duty change-start temperature T_S (Refer to **Table 12** for details)
***3.** T_{Em5}: Higher temperature when measuring duty temperature sensitivity (Refer to **Table 12** for details)

5. Electrical characteristics: product with duty temperature sensitivity Ddt(s) = –4 %/°C

Table 10

($Ta = T_{SP5}$, V_{DD} = 3.0 V , V_{SS} = 0 V, C_{FREQ} = 10 nF, unless otherwise specified)

Items	Symbol	Conditions		Min.	Typ.	Max.	Unit	Test circuit
Duty accuracy	Dsp5	V_{DD} = 3.0 V		68.0	80.0	92.0	%	2
		V_{DD} = 1.65 V to 5.5 V		64.0	80.0	96.0	%	2
Duty temperature sensitivity	Ddt(E)*1	$Ta = T_{SP5}$*2, T_{EM5}*3	V_{DD} = 3.0 V	–4.8	–4.0	–3.2	%/°C	2
			V_{DD} = 1.65 V to 5.5 V	–5.05	–4.0	–3.04	%/°C	2
Oscillation frequency	f_{OSC}	$Ta = T_{SP5}$	V_{DD} = 3.0 V	1730	2030	2330	Hz	2
			V_{DD} = 1.65 V to 5.5 V	1640	2030	2440	Hz	2
		$Ta = T_{EM5}$	V_{DD} = 3.0 V	1470	2030	2680	Hz	2

***1.** Ddt(E): Actual duty temperature sensitivity
***2.** T_{SP5}: Temperature 5°C higher than duty change-start temperature T_S (Refer to **Table 12** for details)
***3.** T_{EM5}: Higher temperature when measuring duty temperature sensitivity (Refer to **Table 12** for details)

■ Test Circuits

1.

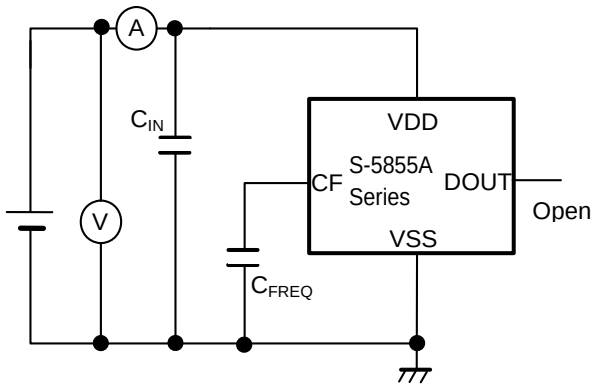
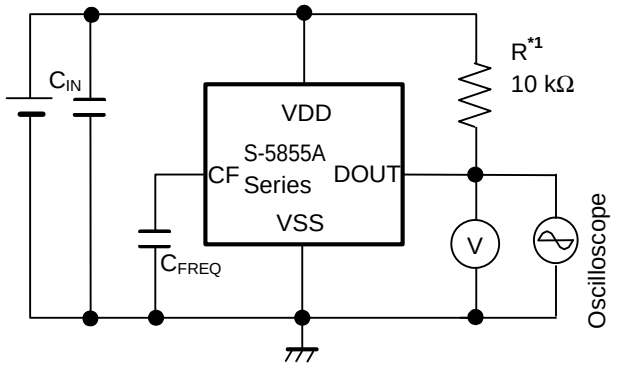


Figure 5

2.



***1.** Resistor (R) is unnecessary for the CMOS output product.

Figure 6

3.

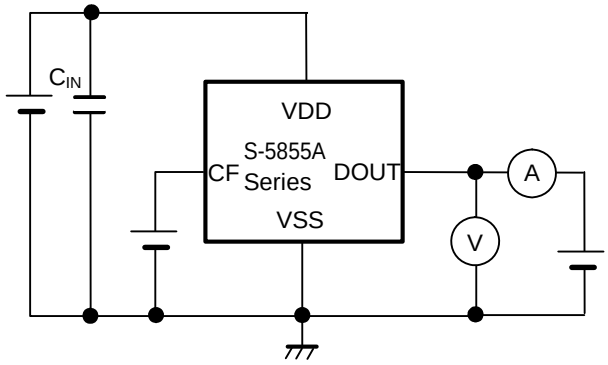


Figure 7

4.

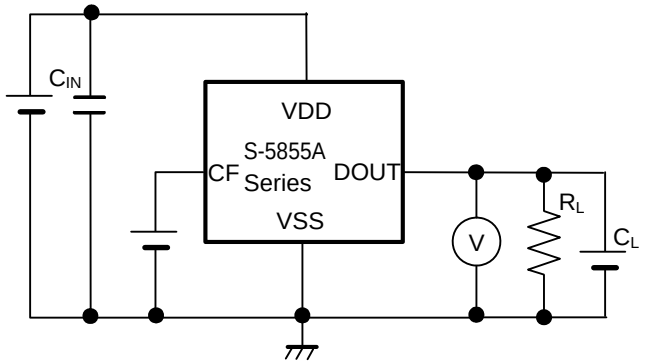


Figure 8

5.

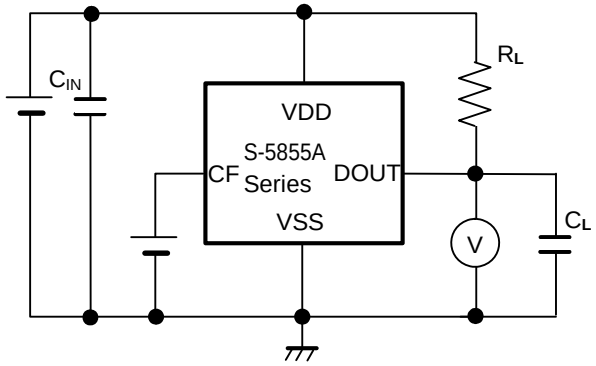
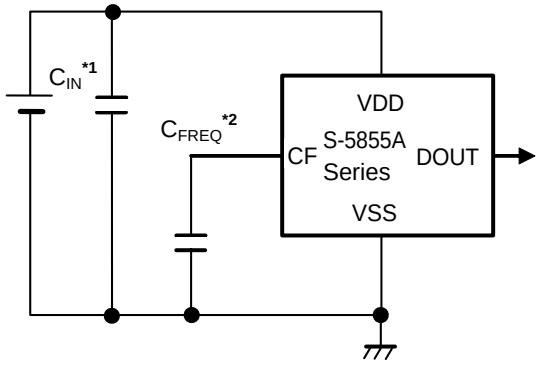


Figure 9

■ Standard Circuit



***1.** C_{IN} is a capacitor for stabilization.
***2.** C_{FREQ} is a capacitor for oscillation frequency.

Figure 10

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

■ Operation

1. Duty

The following equation is the definition of duty.
Duty = PW / T × 100 [%]
The definitions of PW and T are shown in **Figure 11**.

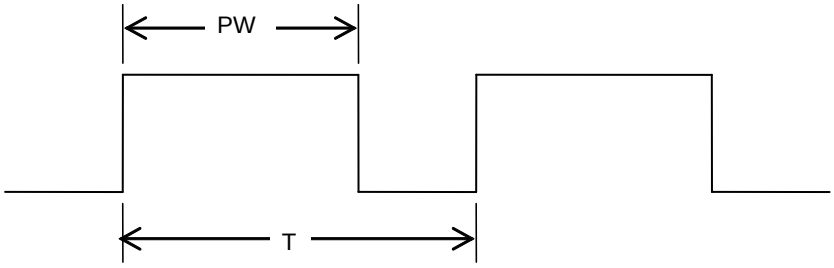


Figure 11

2. Oscillation frequency

The oscillation frequency is set by the capacitance value of the capacitor C_{FREQ} for the oscillation frequency.
The relationship between the C_{FREQ} capacitance value every type of duty temperature sensitivity and the center value of the oscillation frequency are shown in **Table 11**.

Table 11

Type of duty temperature sensitivity	C_{FREQ} capacitance value [nF]	Center value of oscillation frequency [Hz]
Ddt(s) = –1 %/°C	2.2	2300
Ddt(s) = –2 %/°C	4.7	2160
Ddt(s) = –3 %/°C	6.8	2240
Ddt(s) = –4 %/°C	10.0	2030

■ Term

1. Duty accuracy (Dsp5)

Dsp5 shows duty in temperature T_{SP5}, 5°C higher than duty change-start temperature T_S.

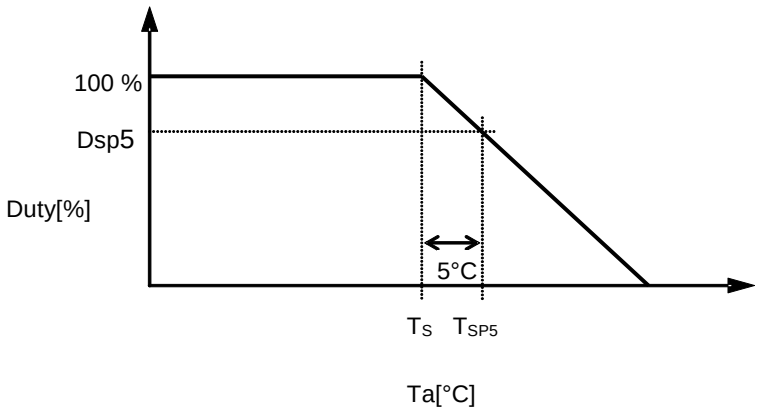
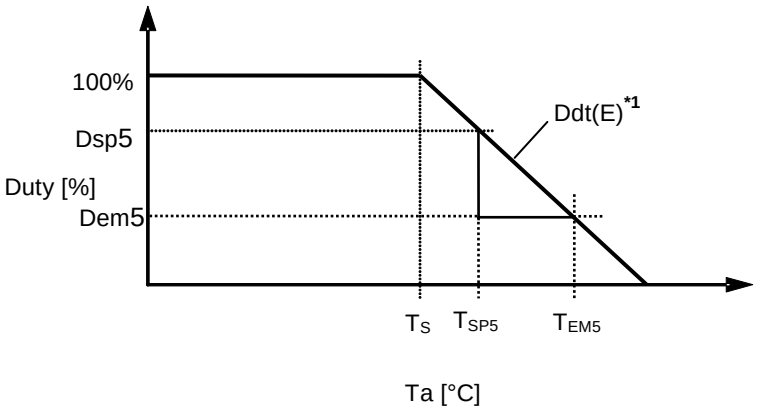


Figure 12

2. Duty temperature sensitivity (Ddt(E))

Duty temperature sensitivity (Ddt(E)) is the temperature coefficient of duty calculated from the output duty at Ta = T_{SP5} and Ta = T_{EM5}. T_{EM5} is the temperature decided for every product type shown in **Table 11**, and Dem5 is the output duty at Ta = T_{EM5}. Ddt(E) is calculated using the following formula.

Ddt(E) = (Dem5 – Dsp5) / (T_{EM5} – T_{SP5}) [%/°C]



***1.** Selectable from –1 %/°C to –4 %/°C in 1 %/°C step

Figure 13

Table 12 T_{SP5} and T_{EM5} in Each Product Type

Type of duty change-start temperature T_S [°C]	Type of duty temperature sensitivity Ddt(s) [%/°C]	T_{SP5} [°C]	T_{EM5} [°C]
+40	–1	+45	+115
+40	–2	+45	+75
+40	–3	+45	+60
+40	–4	+45	+55
+50	–1	+55	+125
+50	–2	+55	+85
+50	–3	+55	+70
+50	–4	+55	+65
+60	–1	+65	+125
+60	–2	+65	+95
+60	–3	+65	+80
+60	–4	+65	+75
+70	–1	+75	+125
+70	–2	+75	+105
+70	–3	+75	+90
+70	–4	+75	+85
+80	–1	+85	+125
+80	–2	+85	+115
+80	–3	+85	+100
+80	–4	+85	+95

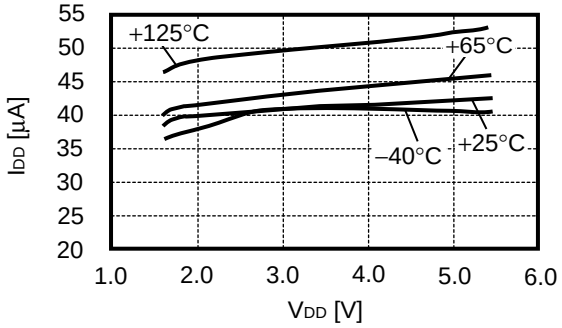
■ Precaution

- Note that this IC may itself heat depending on a connected load to the output pin, resulting in error in measuring temperature.
- Set a capacitor (C_{IN}) of approx. 0.1 μF between the VDD and VSS pins for stabilization as close to IC as possible.
- Connect a capacitor C_{FREQ} for oscillation frequency as close to IC as possible.
- Leakage current applied on the CF pin may cause error in the output duty. Do not connect other components than C_{FREQ}.
- Since the error of the output duty may become

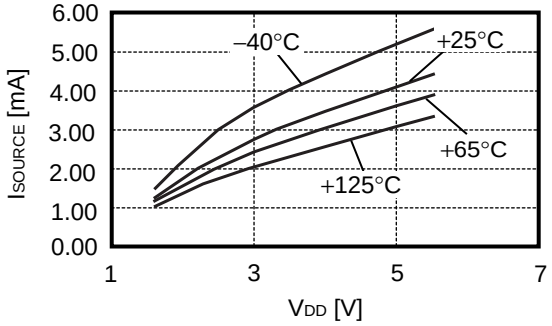
  large depending on an application circuit or the design of a board pattern on this IC, perform thorough evaluation with the actually mounted model in the case of use.
- The application conditions for the input voltage, output voltage, and load current should not exceed the package power dissipation.
- 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)

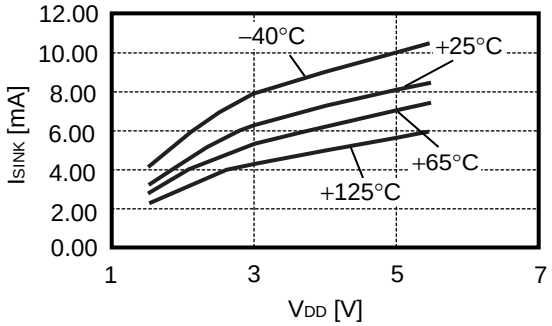
1. Current consumption (I_{DD}) vs. Power supply voltage (V_{DD})



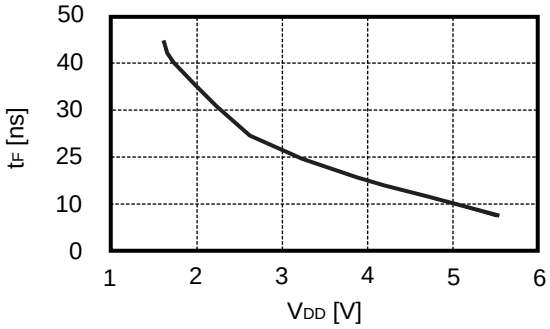
2. Output source current (I_{SOURCE}) vs. Power supply voltage (V_{DD})



3. Output sink current (I_{SINK}) vs. Power supply voltage (V_{DD})

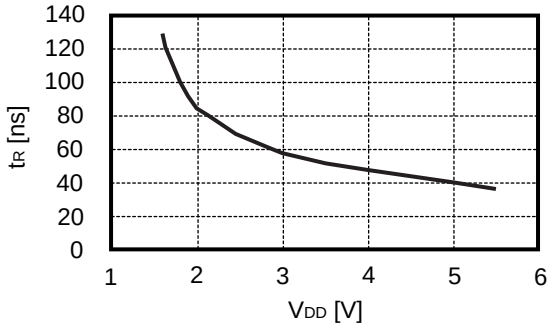


4. Fall time (t_F) vs. Power supply voltage (V_{DD}) dependency

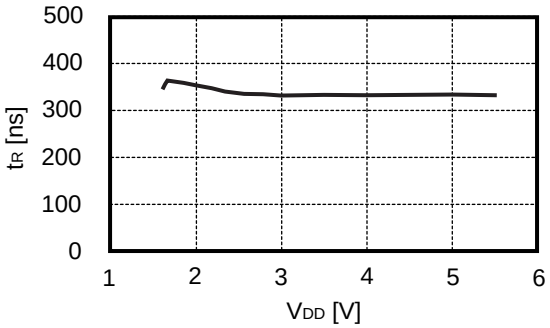


5. Rise time (t_R) vs.Power supply voltage (V_{DD}) dependency

5.1 CMOS output

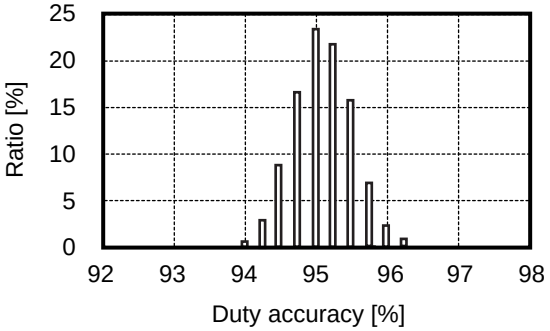


5.2 Nch open drain output

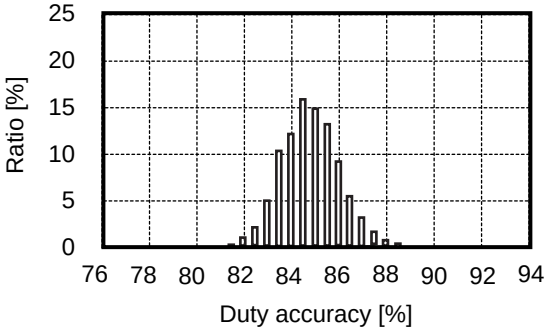


6. Duty accuracy

6.1 Ta = T_{SP5}, Ddt(s) = –1 %/°C

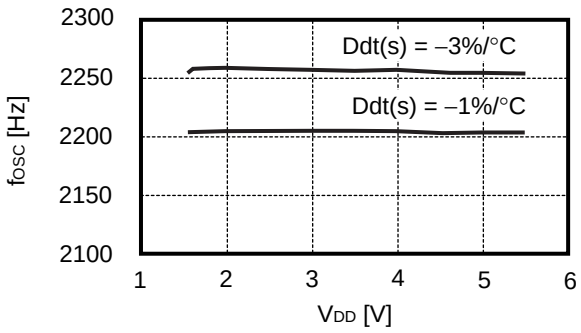


6.2 Ta = T_{SP5}, Ddt(s) = –3 %/°C

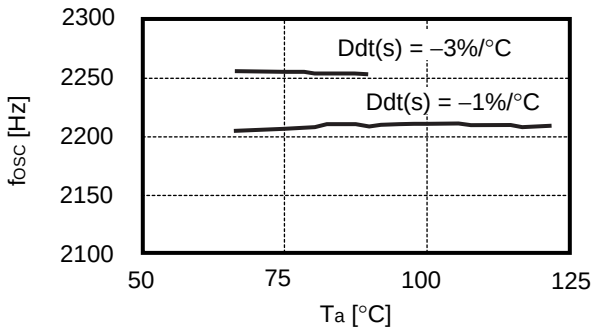


7. Oscillation frequency

7.1 Oscillation frequency (f_{OSC}) vs. Power supply voltage (V_{DD})



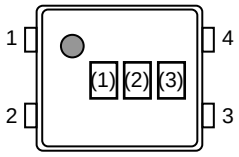
7.2 Oscillation frequency (f_{OSC}) vs. Temperature(Ta)



■ Marking Specifications

(1) SNT-4A

SNT-4A
Top view



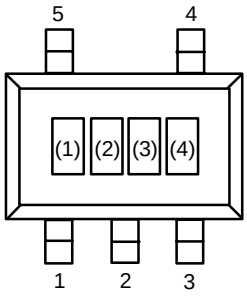
(1) to (3) : Product code (Refer to **Product name vs. Product code**.)

Product name vs. Product code

Product Name	Product Code		
	(1)	(2)	(3)
S-5855AACA-I4T1U	V	Q	C
S-5855AEAA-I4T1U	V	Q	Y
S-5855AECA-I4T1U	V	Q	3

(2) SOT-23-5

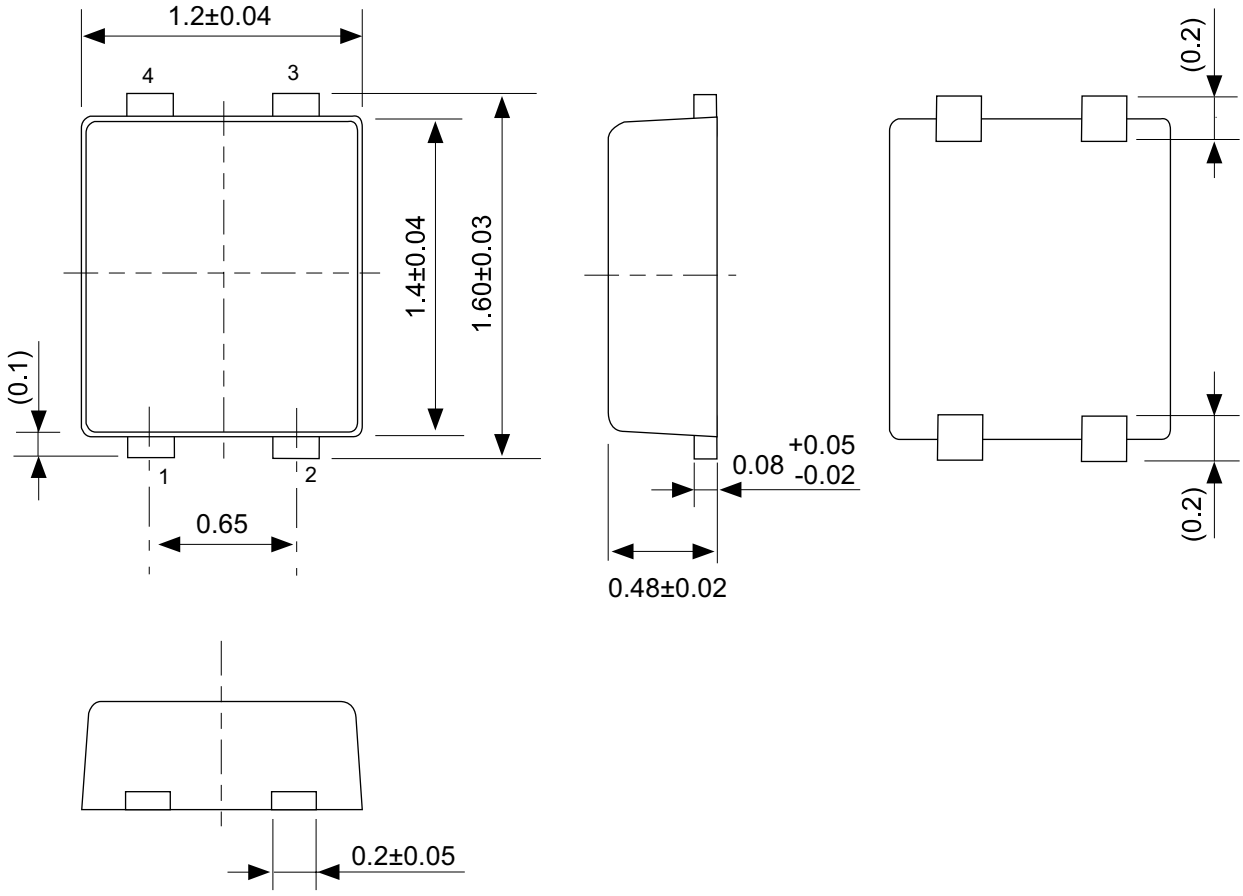
SOT-23-5
Top view



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

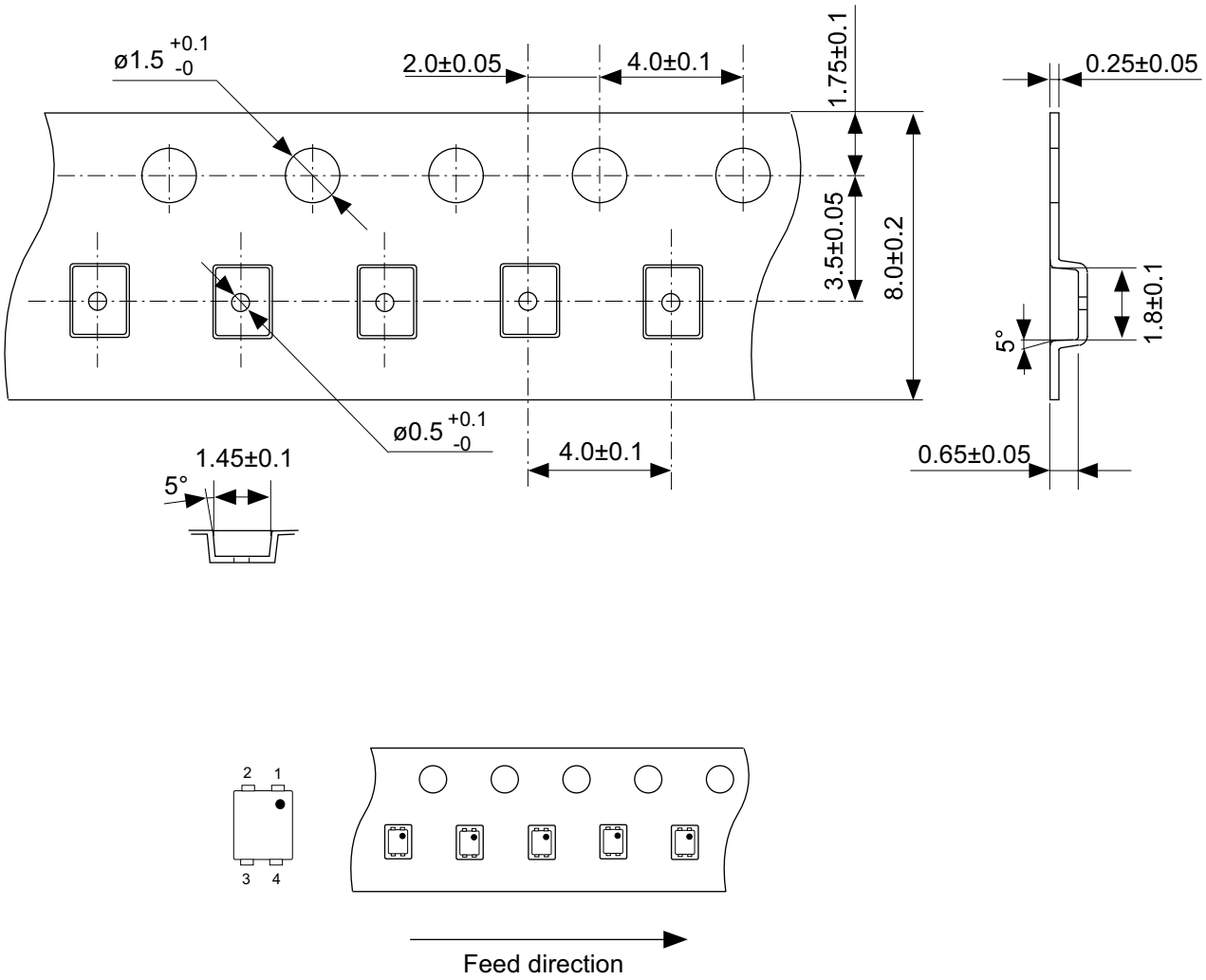
Product name vs. Product code

Product Name	Product Code		
	(1)	(2)	(3)
S-5855AAAA-M5T1U	V	Q	A
S-5855AAAB-M5T1U	V	R	A
S-5855AADA-M5T1U	V	Q	D



No. PF004-A-P-SD-4.0

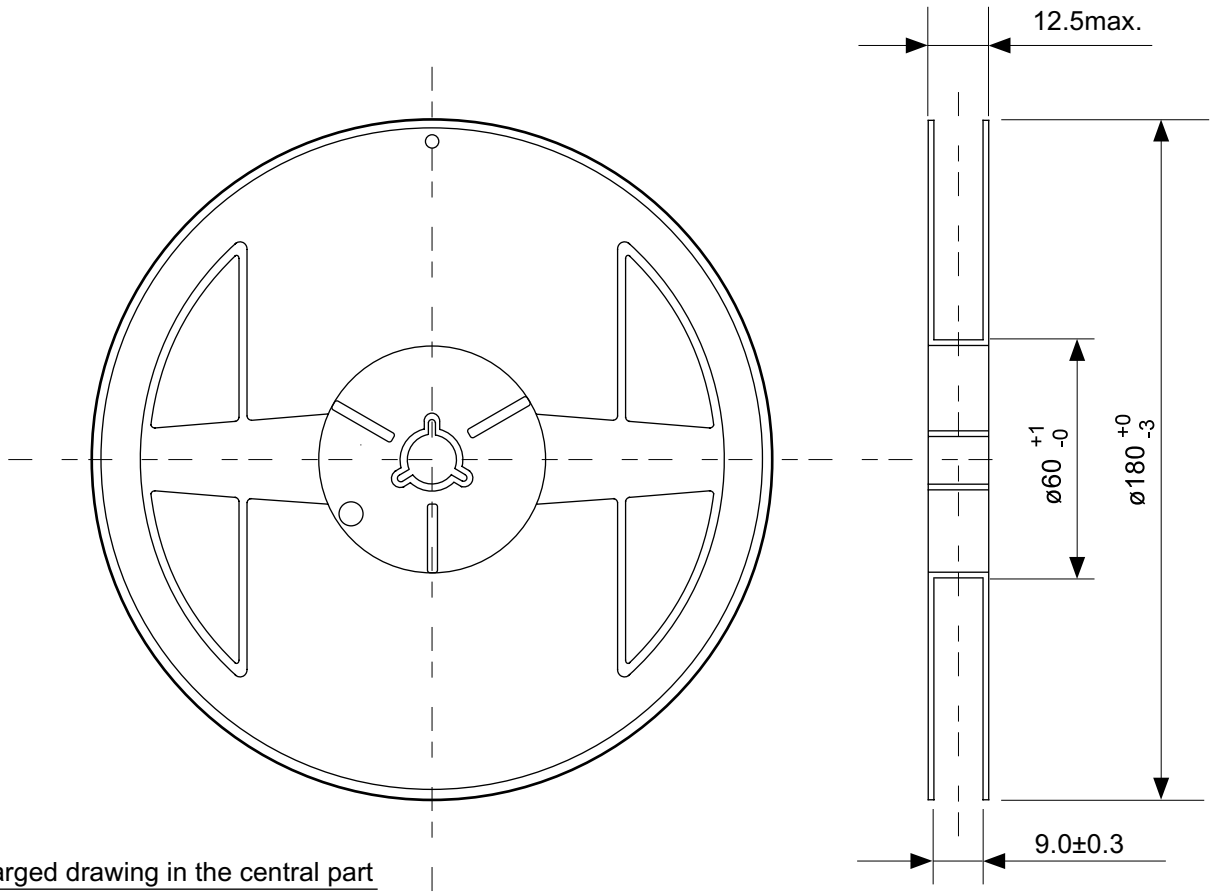
TITLE	SNT-4A-A-PKG Dimensions
No.	PF004-A-P-SD-4.0
SCALE	
UNIT	mm
Seiko Instruments Inc.	



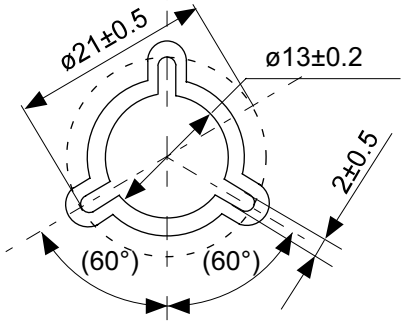
Feed direction

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.	

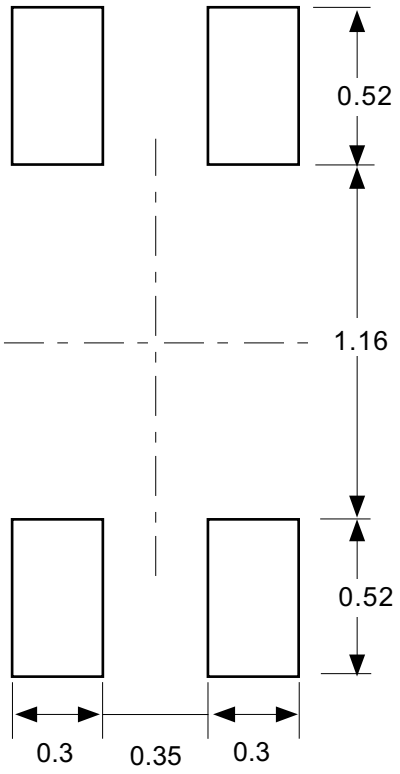


Enlarged drawing in the central part



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.			

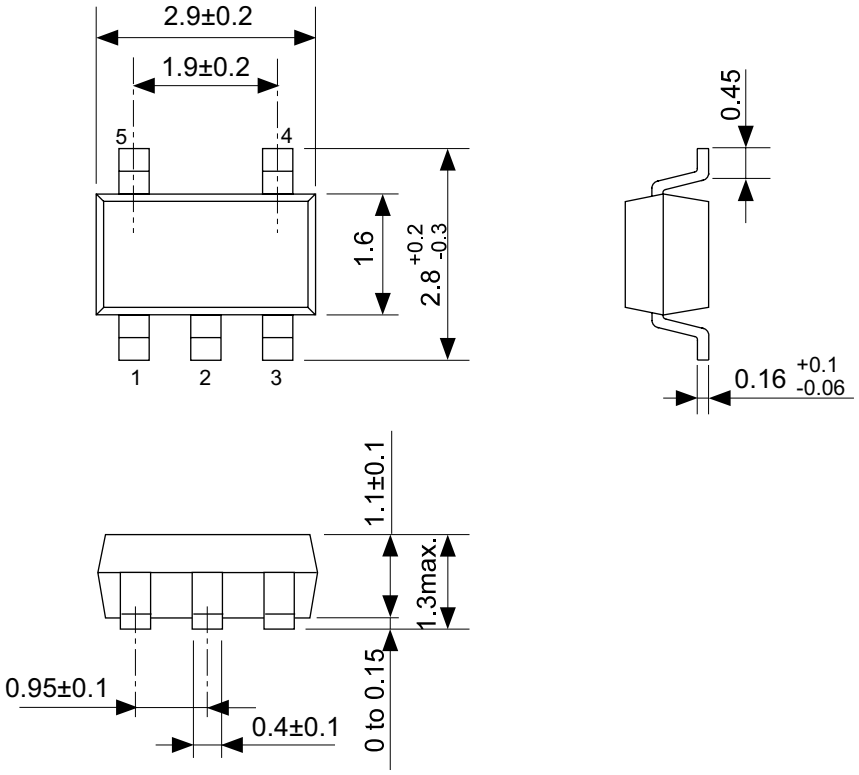


Caution Making the wire pattern under the package is possible. However, note that the package may be upraised due to the thickness made by the silk screen printing and of a solder resist on the pattern because this package does not have the standoff.

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。

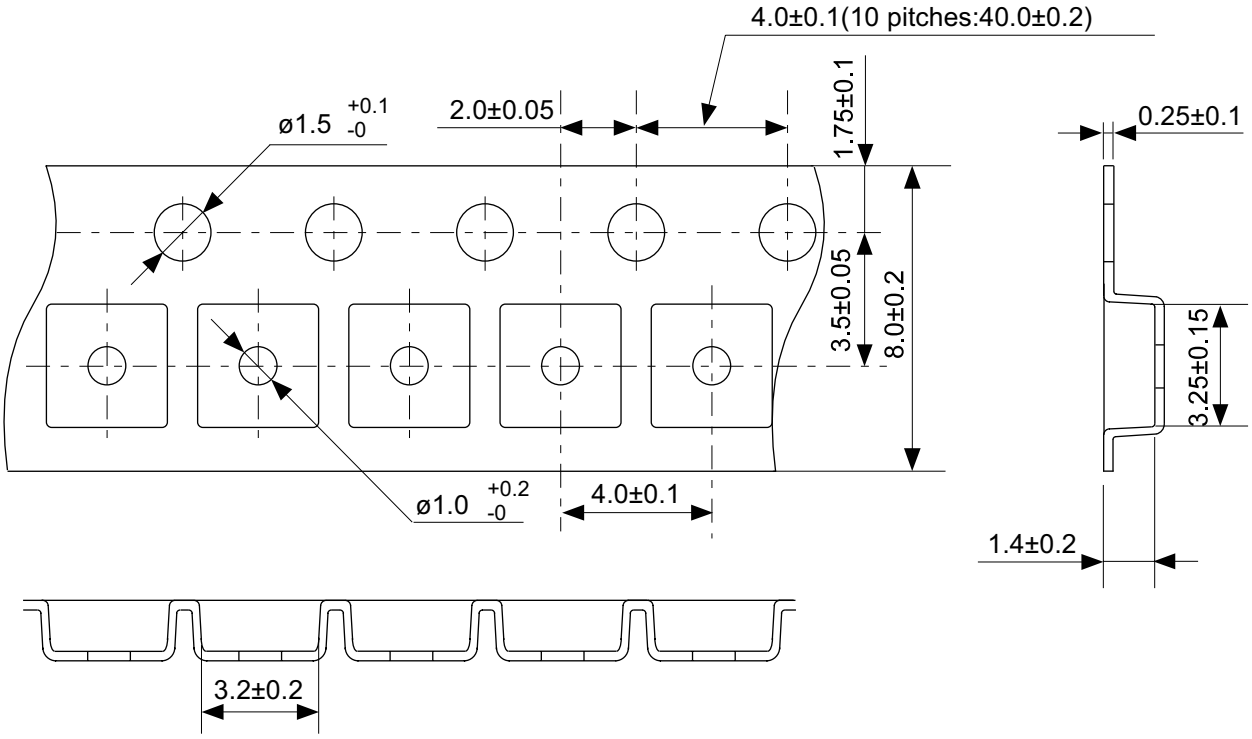
No. PF004-A-L-SD-3.0

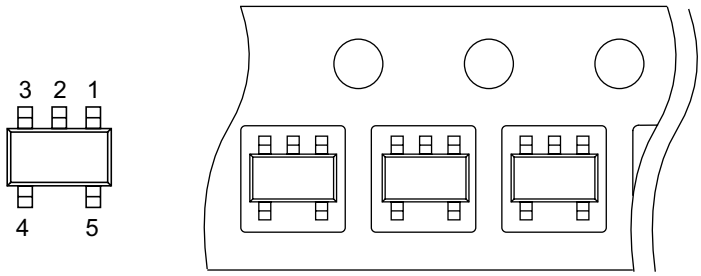
TITLE	SNT-4A-A-Land Recommendation
No.	PF004-A-L-SD-3.0
SCALE	
UNIT	mm
Seiko Instruments Inc.	



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.	

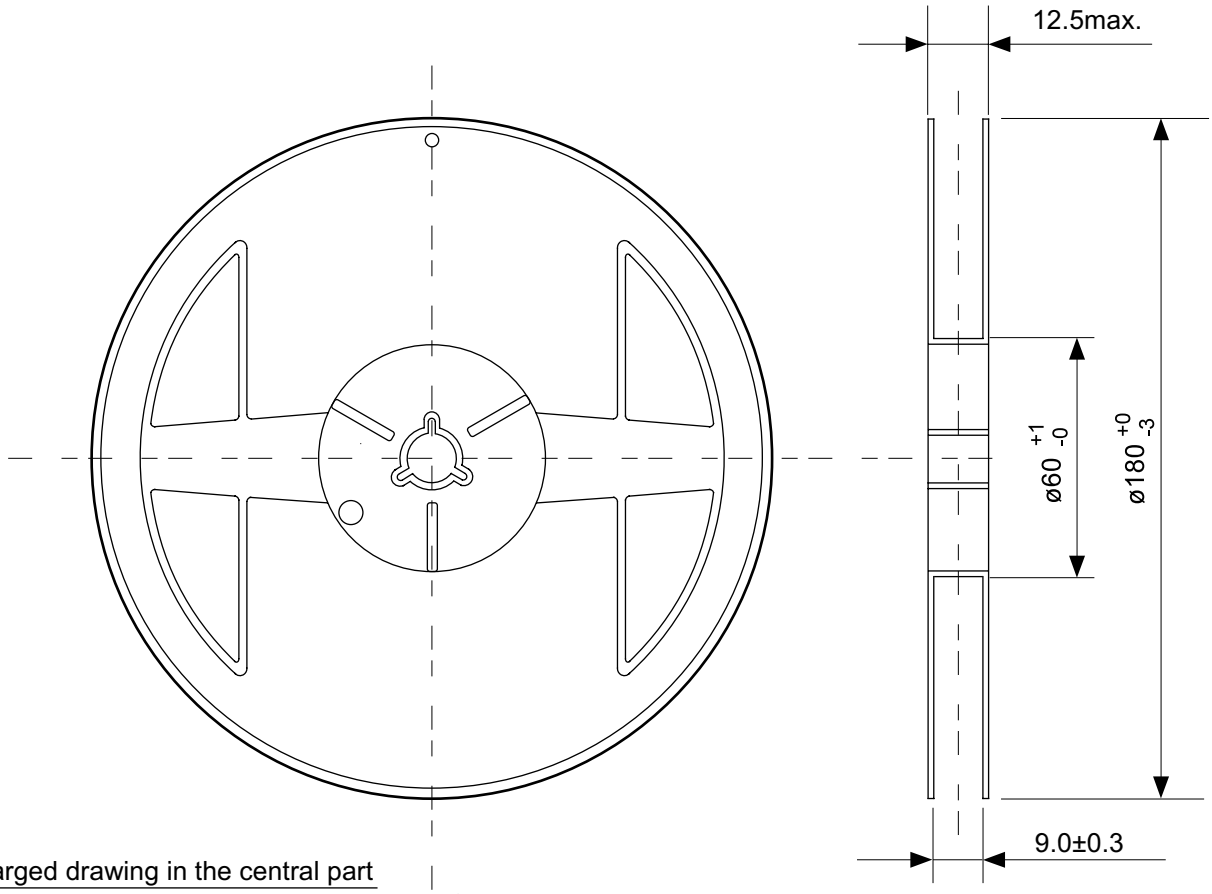




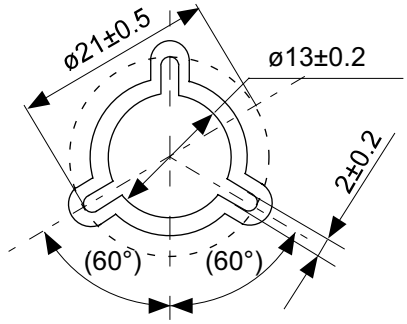
Feed direction

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.			

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