Rev.2.0_00

The mini-analog series is a group of ICs that incorporate a general purpose analog circuit in a small package.
The S-89110/89120 Series is a CMOS type operational amplifier that has a phase compensation circuit, and operates at a low voltage with low current consumption. These features make this product the ideal solution for small battery-powered portable equipment.
The S-89110A/120A Series is a single operational amplifier (one circuit).
The S-89110B/120B Series is a dual operational amplifier (two circuits).

■ Features

- Lower operating voltage than the conventional general-purpose: V_{DD} = 1.8 V to 5.5 V
- Low current consumption (per circuit): I_{DD} = 50 μA (S-89110 Series)
  I_{DD} = 10 μA (S-89120 Series)
- Low input offset voltage: 4.0 mV max.
- No external capacitors required for internal phase compensation
- Output full swing
- Lead-free, Sn 100%, halogen-free*1

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

■ Application

- Mobile phones
- Notebook PCs
- Digital cameras
- Digital video cameras

■ Package

- SC-88A
- SNT-8A
- TMSOP-8

■ Block Diagram

1. S-89110A/89120A Series single operational amplifier (one circuit)

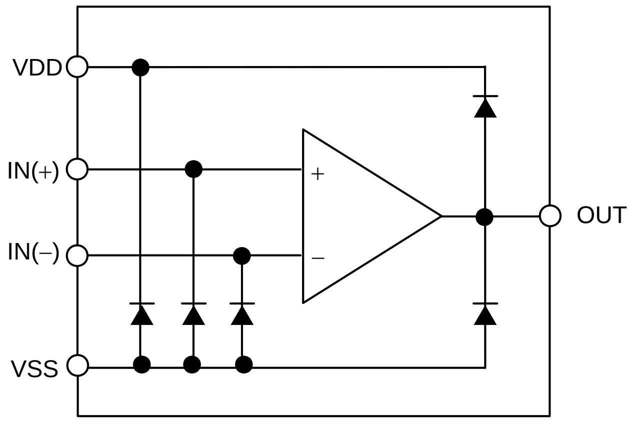


Figure 1

2. S-89110B/89120B Series dual operational amplifier (two circuits)

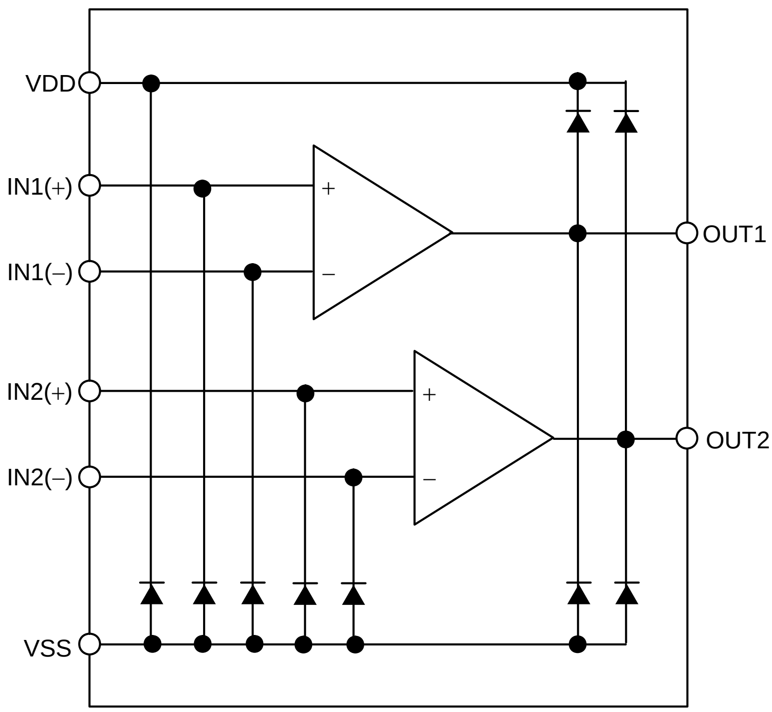


Figure 2

■ Product Name Structure

Users can select the product type for the S-89110/89120 Series. Refer to "**1. Product name**" regarding the contents of product name, "**2. Package**" regarding the package drawings and "**3. Product name list**" regarding the product type.

1. Product name

(1) SC-88A

S-891 x 0 A NC – xxx TF x

- x — Environmental code
  - S : Lead-free, halogen-free
  - G : Lead-free (for details, please contact our sales office)
- TF — IC direction in tape specifications*1
- xxx — Product code (abbreviation)*2
- NC — Package name (abbreviation)
  - NC : SC-88A
- A — Number of circuits
  - A : 1
- x — Current consumption (per circuit)
  - 1 : I_{DD} = 50 μA
  - 2 : I_{DD} = 10 μA

***1.** Refer to the tape specifications.
***2.** Refer to "**3. Product name list**"

(2) SNT-8A

S-891 x 0 B PH – xxx TF x

- x — Environmental code
  - U : Lead-free (Sn 100%), halogen-free
  - G : Lead-free (for details, please contact our sales office)
- TF — IC direction in tape specifications*1
- xxx — Product code (abbreviation)*2
- PH — Package name (abbreviation)
  - PH : SNT-8A
- B — Number of circuits
  - B : 2
- x — Current consumption (per circuit)
  - 1 : I_{DD} = 50 μA
  - 2 : I_{DD} = 10 μA

***1.** Refer to the tape specifications.
***2.** Refer to "**3. Product name list**"

(3) TMSOP-8

S-891 x 0 B FM – xxx TF U

- U: Environmental code
  - U : Lead-free (Sn 100%), halogen-free
- TF: IC direction in tape specifications*1
- xxx: Product code (abbreviation)*2
- FM: Package name (abbreviation)
  - FM : TMSOP-8
- B: Number of circuits
  - B : 2
- x: Current consumption (per circuit)
  - 1 : I_{DD} = 50 µA
  - 2 : I_{DD} = 10 µA

***1.** Refer to the tape specifications.
***2.** Refer to "**3. Product name list**"

2. Package

Package Name	Drawing Code			
	Package	Tape	Reel	Land
SC-88A	NP005-B-P-SD	NP005-B-C-SD	NP005-B-R-SD	—
SNT-8A	PH008-A-P-SD	PH008-A-C-SD	PH008-A-R-SD	PH008-A-L-SD
TMSOP-8	FM008-A-P-SD	FM008-A-C-SD	FM008-A-R-SD	—

3. Product name list

Table 1

Product name	Current consumption (per circuit)	Gain-bandwidth*1	Number of circuits	Package
S-89110ANC-1A1-TFz	50 µA	175 kHz	1	SC-88A
S-89110BPH-H4A-TFx	50 µA	175 kHz	2	SNT-8A
S-89110BFM-H4A-TFU	50 µA	175 kHz	2	TMSOP-8
S-89120ANC-1A2-TFz	10 µA	35 kHz	1	SC-88A
S-89120BPH-H4B-TFx	10 µA	35 kHz	2	SNT-8A
S-89120BFM-H4B-TFU	10 µA	35 kHz	2	TMSOP-8

***1.** The value when V_{DD} = 3.0 V

Remark 1. x: G or U
2. z: G or S
3. Please select products of environmental code = U for Sn 100%, halogen-free products.

■ Pin Configuration

SC-88A
Top view

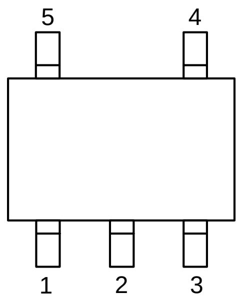


Figure 3

Table 2

(Product with 1 circuit)

Pin No.	Symbol	Description
1	IN(+)	Non-inverted input pin
2	VSS	GND pin
3	IN(−)	Inverted input pin
4	OUT	Output pin
5	VDD	Positive power supply pin

SNT-8A
Top view

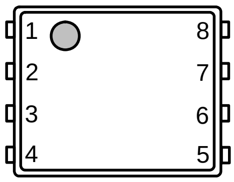


Figure 4

Table 3

(Product with 2 circuits)

Pin No.	Symbol	Description
1	OUT1	Output pin 1
2	IN1(−)	Inverted input pin 1
3	IN1(+)	Non-inverted input pin 1
4	VSS	GND pin
5	IN2(+)	Non-inverted input pin 2
6	IN2(−)	Inverted input pin 2
7	OUT2	Output pin 2
8	VDD	Positive power supply pin

TMSOP-8
Top view

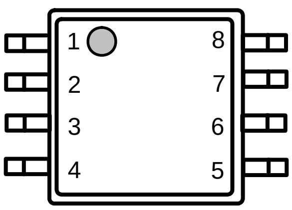


Figure 5

Table 4

(Product with 2 circuits)

Pin No.	Symbol	Description
1	OUT1	Output pin 1
2	IN1(−)	Inverted input pin 1
3	IN1(+)	Non-inverted input pin 1
4	VSS	GND pin
5	IN2(+)	Non-inverted input pin 2
6	IN2(−)	Inverted input pin 2
7	OUT2	Output pin 2
8	VDD	Positive power supply pin

■ Absolute Maximum Ratings

Table 5

(Ta = +25°C unless otherwise specified)

Parameter		Symbol	Absolute Maximum Rating	Unit
Power supply voltage		V_{DD}	V_{SS}−0.3 to V_{SS}+10.0	V
Input voltage		V_{IN}	V_{SS}−0.3 to V_{SS}+7.0 (7.0 max.)	V
Output voltage		V_{OUT}	V_{SS}−0.3 to V_{DD}+0.3 (7.0 max.)	V
Differential input voltage		V_{IND}	±7.0	V
Power dissipation	SC-88A	P_D	350*1	mW
	SNT-8A		450*1	mW
	TMSOP-8		650*1	mW
Operating ambient temperature		T_{opr}	−40 to +85	°C
Storage temperature		T_{stg}	−55 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.

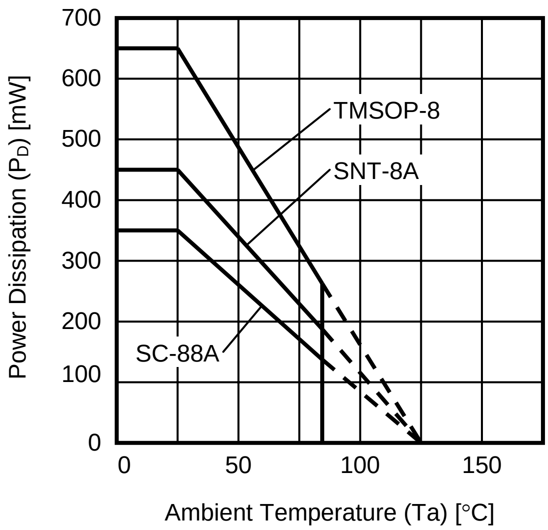


Figure 6 Power Dissipation of Package (When Mounted on Board)

■ Electrical Characteristics

Table 6

(Ta = +25°C unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test Circuit
Range of operating power supply voltage	V_{DD}	–	1.8	–	5.5	V	–

1. V_{DD} = 5.0 V

Table 7

DC Electrical Characteristics (V_{DD} = 5.0 V) (Ta = +25°C unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit	Test Circuit
Current consumption (per circuit)	I_{DD}	S-89110 Series		–	50	120	μA	5
		S-89120 Series		–	10	30	μA	5
Input offset voltage	V_{IO}	–		–4	±3	+4	mV	1
Input offset voltage drift	$\frac{\Delta V_{IO}}{\Delta Ta}$	Ta = –40°C to +85°C		–	±10	–	μV/°C	1
Input offset current	I_{IO}	–		–	1	–	pA	–
Input bias current	I_{BIAS}	–		–	1	–	pA	–
Common-mode input voltage range	V_{CMR}	–		0	–	4.3	V	2
Voltage gain (open loop)	A_{VOL}	V_{SS}+0.5 V ≤ V_{OUT} ≤ V_{DD}–0.5 V, V_{CMR} = 2.5 V		70	80	–	dB	8
Maximum output swing voltage	V_{OH}	R_L = 1.0 MΩ		4.9	–	–	V	3
	V_{OL}	R_L = 1.0 MΩ		–	–	0.1	V	4
Common-mode input signal rejection ratio	CMRR	–		60	70	–	dB	2
Power supply voltage rejection ratio	PSRR	–		60	70	–	dB	1
Source current	I_{SOURCE}	V_{OUT} = 0 V	S-89110 Series	120	–	–	μA	6
			S-89120 Series	25	–	–	μA	6
Sink current	I_{SINK}	V_{OUT} = V_{DD}		20	–	–	mA	7

Table 8

AC Electrical Characteristics (V_{DD} = 5.0 V) (Ta = +25°C unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Slew rate	SR	R_L = 1.0 MΩ, C_L = 15 pF (Refer to **Figure 15**)	S-89110 Series	–	0.07	–	V/μs
			S-89120 Series	–	0.015	–	V/μs
Gain-bandwidth product	GBP	S-89110 Series		–	180	–	kHz
		S-89120 Series		–	40	–	kHz

2. V_{DD} = 3.0 V

Table 9

DC Electrical Characteristics (V_{DD} = 3.0 V) (Ta = +25°C unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test Circuit
Current consumption (per circuit)	I_{DD}	S-89110 Series	–	50	120	µA	5
		S-89120 Series	–	10	30	µA	5
Input offset voltage	V_{IO}	–	–4	±3	+4	mV	1
Input offset voltage drift	$\frac{\Delta V_{IO}}{\Delta Ta}$	Ta = –40°C to +85°C	–	±10	–	µV/°C	1
Input offset current	I_{IO}	–	–	1	–	pA	–
Input bias current	I_{BIAS}	–	–	1	–	pA	–
Common-mode input voltage range	V_{CMR}	–	0	–	2.3	V	2
Voltage gain (open loop)	A_{VOL}	V_{SS}+0.5 V ≤ V_{OUT} ≤ V_{DD}–0.5 V, V_{CMR} = 1.5 V	70	80	–	dB	8
Maximum output swing voltage	V_{OH}	R_L = 1.0 MΩ	2.9	–	–	V	3
	V_{OL}	R_L = 1.0 MΩ	–	–	0.1	V	4
Common-mode input signal rejection ratio	CMRR	–	60	70	–	dB	2
Power supply voltage rejection ratio	PSRR	–	60	70	–	dB	1
Source current	I_{SOURCE}	V_{OUT} = 0 V, S-89110 Series	120	–	–	µA	6
		V_{OUT} = 0 V, S-89120 Series	25	–	–	µA	6
Sink current	I_{SINK}	V_{OUT} = V_{DD}	15	–	–	mA	7

Table 10

AC Electrical Characteristics (V_{DD} = 3.0 V) (Ta = +25°C unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Slew rate	SR	R_L = 1.0 MΩ, C_L = 15 pF (Refer to **Figure 15**), S-89110 Series	–	0.07	–	V/µs
		R_L = 1.0 MΩ, C_L = 15 pF (Refer to **Figure 15**), S-89120 Series	–	0.015	–	V/µs
Gain-bandwidth product	GBP	S-89110 Series	–	175	–	kHz
		S-89120 Series	–	35	–	kHz

3. V_{DD} = 1.8 V

Table 11

DC Electrical Characteristics (V_{DD} = 1.8 V) (Ta = +25°C unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit	Test Circuit
Current consumption (per circuit)	I_{DD}	S-89110 Series		–	50	120	μA	5
		S-89120 Series		–	10	30	μA	5
Input offset voltage	V_{IO}	–		–4	±3	+4	mV	1
Input offset voltage drift	$\frac{\Delta V_{IO}}{\Delta Ta}$	Ta = –40°C to +85°C		–	±10	–	μV/°C	1
Input offset current	I_{IO}	–		–	1	–	pA	–
Input bias current	I_{BIAS}	–		–	1	–	pA	–
Common-mode input voltage range	V_{CMR}	–		0	–	1.1	V	2
Voltage gain (open loop)	A_{VOL}	V_{SS}+0.5 V ≤ V_{OUT} ≤ V_{DD}–0.5 V, V_{CMR} = 0.9 V		70	80	–	dB	8
Maximum output swing voltage	V_{OH}	R_L = 1.0 MΩ		1.7	–	–	V	3
	V_{OL}	R_L = 1.0 MΩ		–	–	0.1	V	4
Common-mode input signal rejection ratio	CMRR	–		60	70	–	dB	2
Power supply voltage rejection ratio	PSRR	–		60	70	–	dB	1
Source current	I_{SOURCE}	V_{OUT} = 0 V	S-89110 Series	100	–	–	μA	6
			S-89120 Series	20	–	–	μA	6
Sink current	I_{SINK}	V_{OUT} = V_{DD}		5	–	–	mA	7

Table 12

AC Electrical Characteristics (V_{DD} = 1.8 V) (Ta = +25°C unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Slew rate	SR	R_L = 1.0 MΩ, C_L = 15 pF (Refer to **Figure 15**)	S-89110 Series	–	0.07	–	V/μs
			S-89120 Series	–	0.015	–	V/μs
Gain-bandwidth product	GBP	S-89110 Series		–	160	–	kHz
		S-89120 Series		–	30	–	kHz

■ Test Circuit (Per Circuit)

1. Power supply voltage rejection ratio, input offset voltage

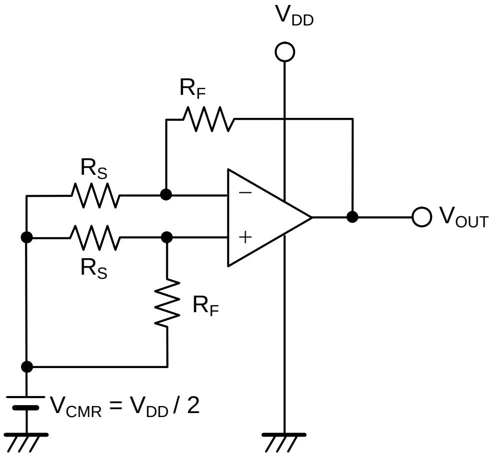


Figure 7

- **Power supply voltage rejection ratio (PSRR)**
  The power supply voltage rejection ratio (PSRR) can be calculated by the following expression, with V_{OUT} measured at each V_{DD}.

  Test conditions:
  When V_{DD} = 1.8 V: $V_{DD} = V_{DD1}$, $V_{OUT} = V_{OUT1}$,
  When V_{DD} = 5.0 V: $V_{DD} = V_{DD2}$, $V_{OUT} = V_{OUT2}$

$$\mathrm{PSRR} = 20 \log \left(\left| \frac{V_{DD1} - V_{DD2}}{\left(V_{OUT1} - \frac{V_{DD1}}{2}\right) - \left(V_{OUT2} - \frac{V_{DD2}}{2}\right)} \right| \times \frac{R_F + R_S}{R_S} \right)$$

- **Input offset voltage (V_{IO})**

$$V_{IO} = \left(V_{OUT} - \frac{V_{DD}}{2}\right) \times \frac{R_S}{R_F + R_S}$$

2. Common-mode input signal rejection ratio, common-mode input voltage range

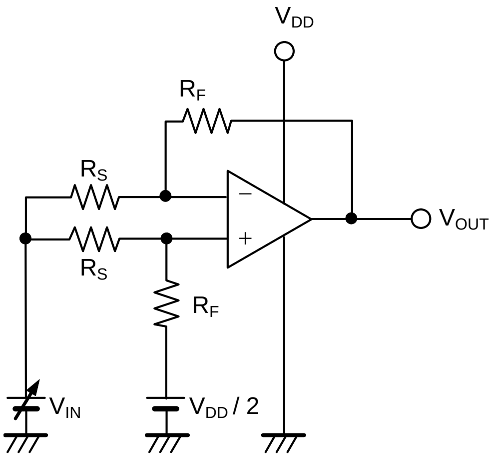


Figure 8

- **Common-mode input signal rejection ratio (CMRR)**
  The common-mode input signal rejection ratio (CMRR) can be calculated by the following expression, with V_{OUT} measured at each V_{IN}.

  Test conditions:
  When $V_{IN} = V_{CMR\ Max.}$: $V_{IN} = V_{IN1}$, $V_{OUT} = V_{OUT1}$,
  When $V_{IN} = V_{DD}$ / 2: $V_{IN} = V_{IN2}$, $V_{OUT} = V_{OUT2}$

$$\mathrm{CMRR} = 20 \log \left(\left| \frac{V_{IN1} - V_{IN2}}{V_{OUT1} - V_{OUT2}} \right| \times \frac{R_F + R_S}{R_S} \right)$$

- **Common-mode input voltage range (V_{CMR})**
  The common-mode input voltage range is the range of V_{IN} in which V_{OUT} satisfies the common-mode input signal rejection ratio specifications.

3. Maximum output swing voltage (V_{OH})

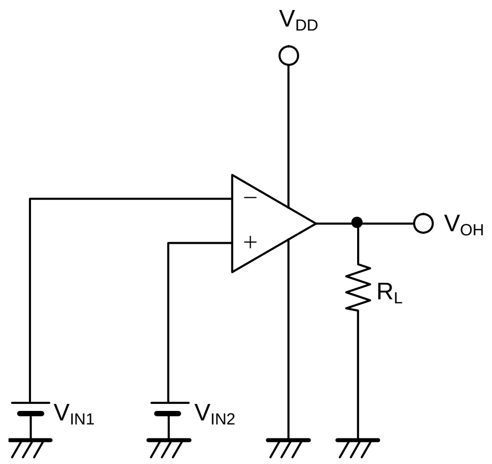


Figure 9

- **Maximum output swing voltage (V_{OH})**

Test conditions:

$V_{IN1} = \frac{V_{DD}}{2} - 0.1\ V$

$V_{IN2} = \frac{V_{DD}}{2} + 0.1\ V$

$R_L = 1\ M\Omega$

4. Maximum output swing voltage (V_{OL})

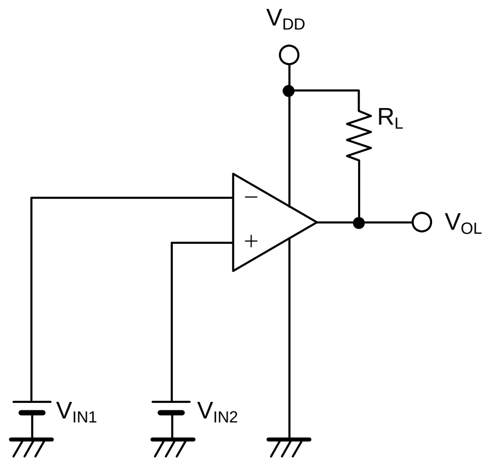


Figure 10

- **Maximum output swing voltage (V_{OL})**

Test conditions:

$V_{IN1} = \frac{V_{DD}}{2} + 0.1\ V$

$V_{IN2} = \frac{V_{DD}}{2} - 0.1\ V$

$R_L = 1\ M\Omega$

5. Current consumption

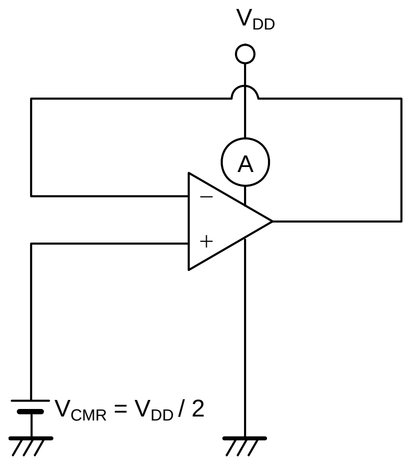


Figure 11

- **Current consumption (I_{DD})**

6. Source current

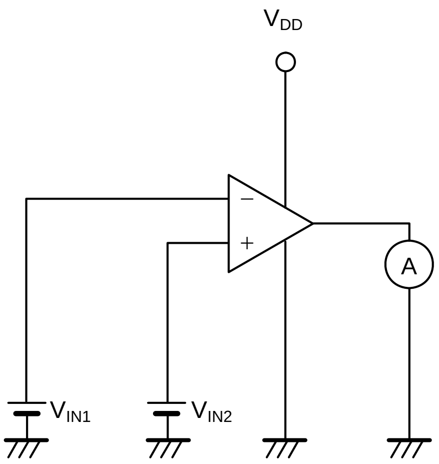


Figure 12

- **Source current (I_{SOURCE})**

Test conditions:

$V_{IN1} = \frac{V_{DD}}{2} - 0.5\ V$

$V_{IN2} = \frac{V_{DD}}{2} + 0.5\ V$

7. Sink current

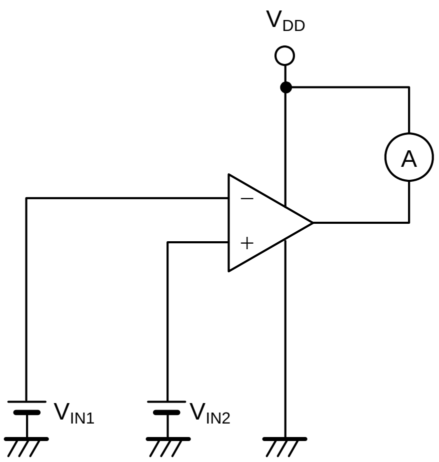


Figure 13

- **Sink current (I_{SINK})**

Test conditions:

$V_{IN1} = \frac{V_{DD}}{2} + 0.5\ V$

$V_{IN2} = \frac{V_{DD}}{2} - 0.5\ V$

8. Voltage gain (open loop)

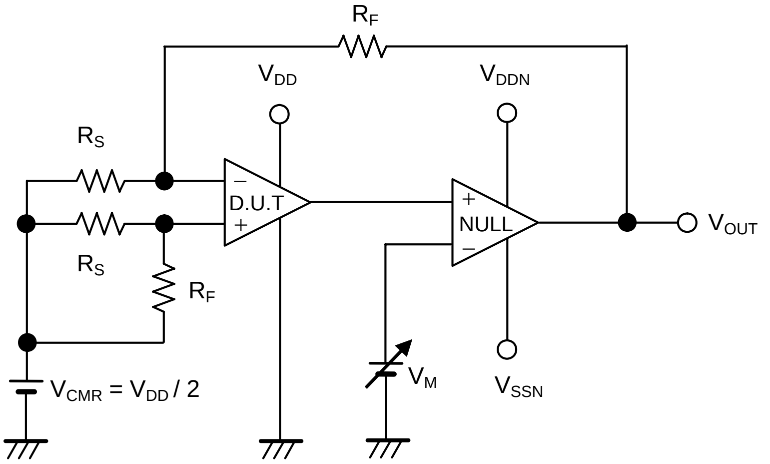


Figure 14

- **Voltage-gain (open loop) (A_{VOL})**

  The voltage gain (A_{VOL}) can be calculated by the following expression, with measured V_{OUT} at each V_M.

  Test conditions:
  When $V_M = V_{DD} - 0.5$ V: $V_M = V_{M1}$, $V_{OUT} = V_{OUT1}$,
  When $V_M = V_{SS} + 0.5$ V: $V_M = V_{M2}$, $V_{OUT} = V_{OUT2}$

$$A_{VOL} = 20 \log \left(\left| \frac{V_{M1} - V_{M2}}{V_{OUT1} - V_{OUT2}} \right| \times \frac{R_F + R_S}{R_S} \right)$$

9. Slew rate (SR)

Measured by the voltage follower circuit.

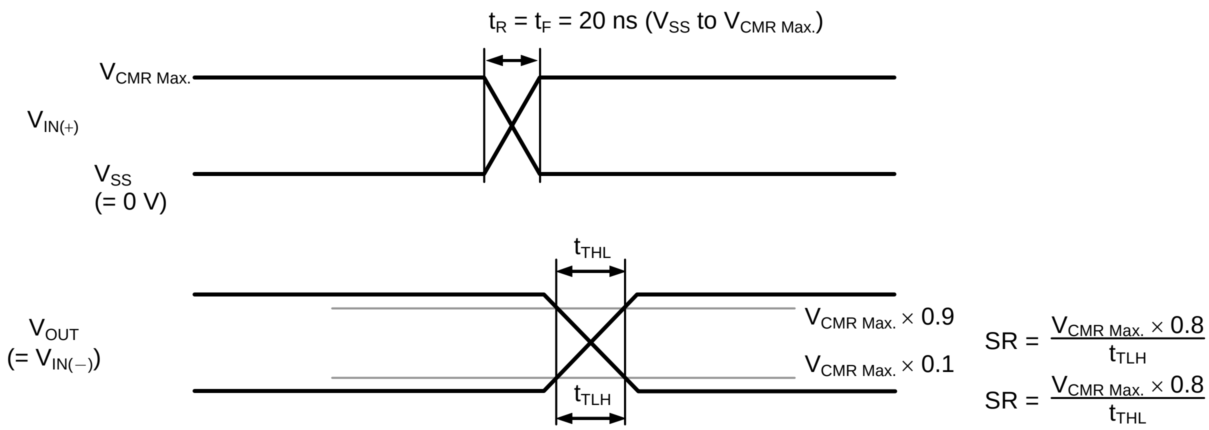


Figure 15

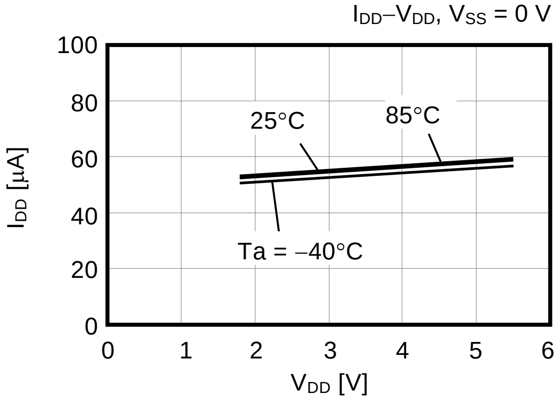
■ Precautions

- Do not apply an electrostatic discharge to this IC that exceeds 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.

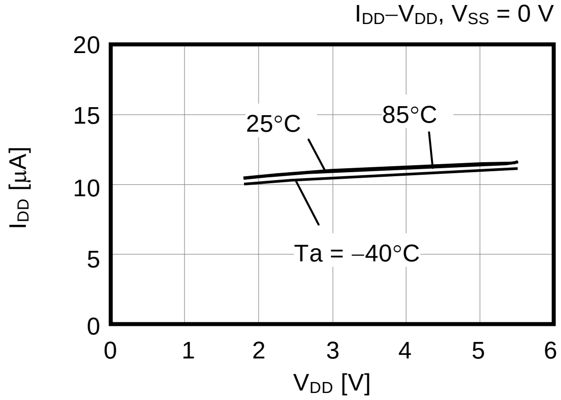
■ Characteristics (Typical Data)

1. Current consumption (per circuit) vs. Power supply voltage

(1) S-89110 Series

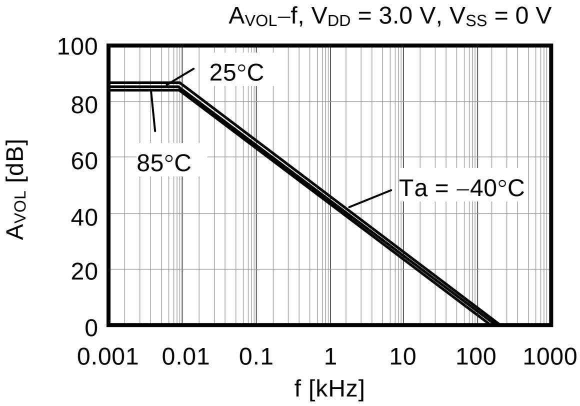


(2) S-89120 Series

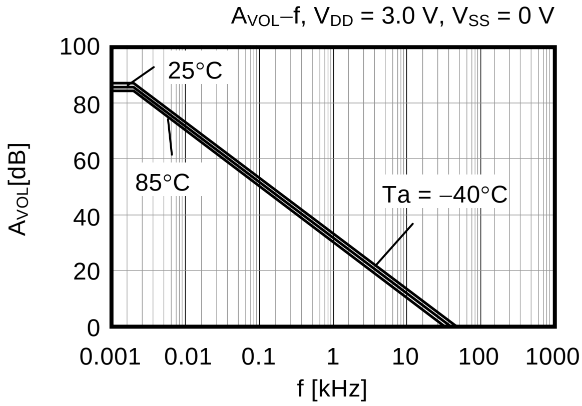


2. Voltage gain vs. Frequency

(1) S-89110 Series



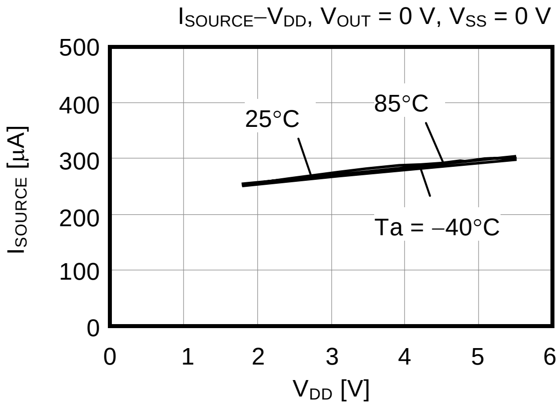
(2) S-89120 Series



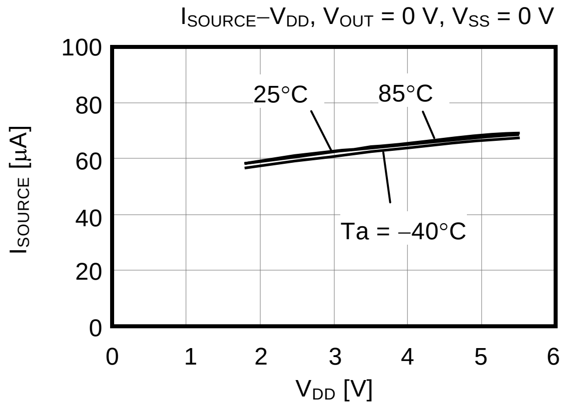
3. Output current

3. 1 I_{SOURCE} vs. Power supply voltage

(1) S-89110 Series

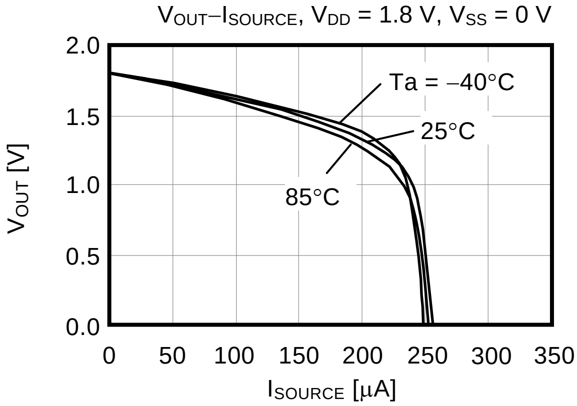


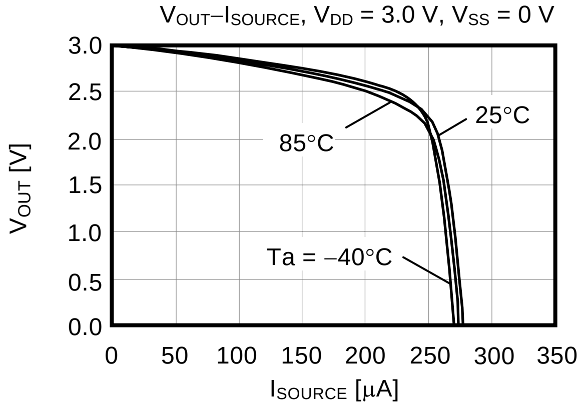
(2) S-89120 Series

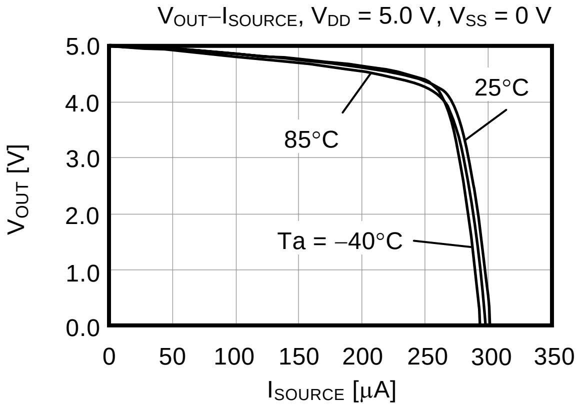


3. 2 Output voltage (V_{OUT}) vs. I_{SOURCE}

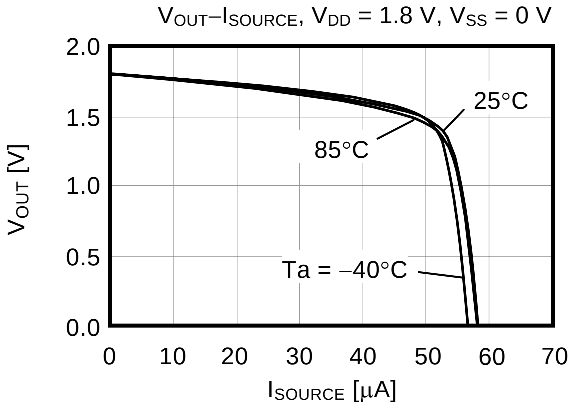
(1) S-89110 Series

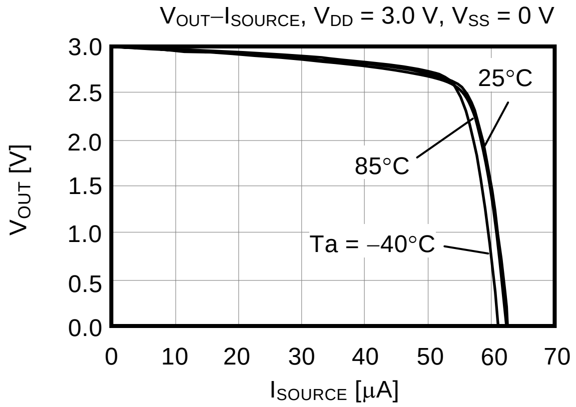


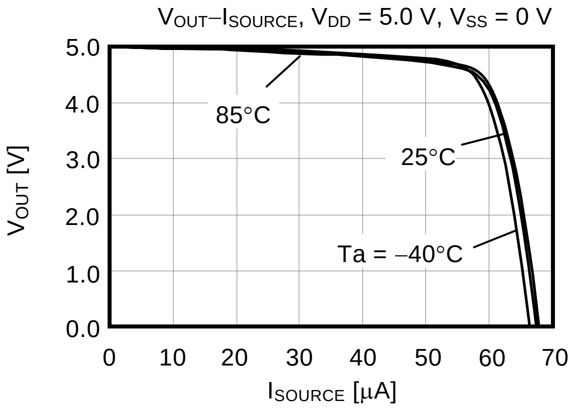




(2) S-89120 Series

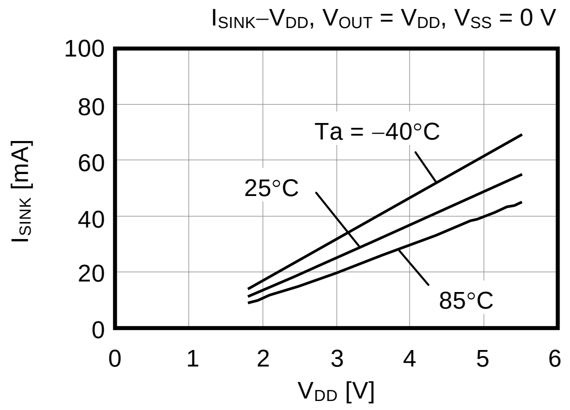




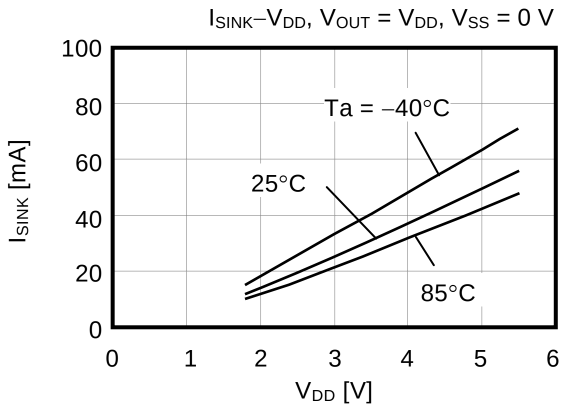


3. 3 I_{SINK} vs. Power supply voltage

(1) S-89110 Series



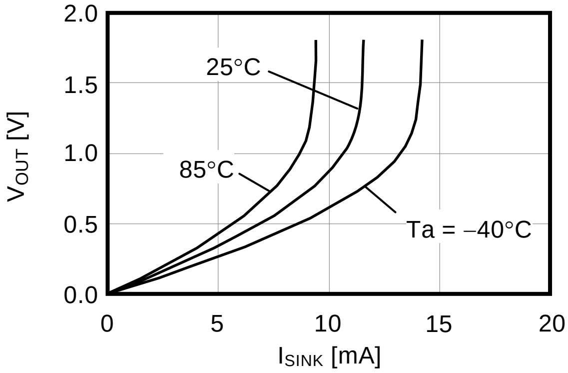
(2) S-89120 Series



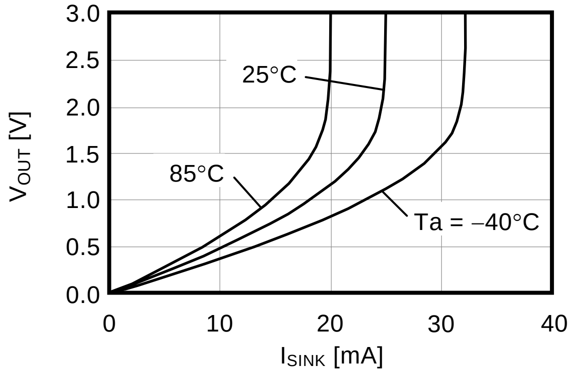
3. 4 Output voltage (V_{OUT}) vs. I_{SINK}

(1) S-89110 Series

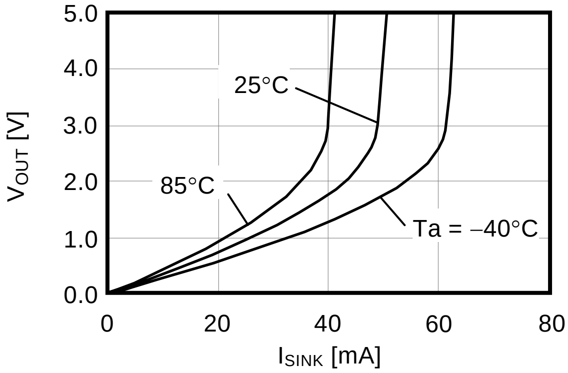
V_{OUT}–I_{SINK}, V_{DD} = 1.8 V, V_{SS} = 0 V



V_{OUT}–I_{SINK}, V_{DD} = 3.0 V, V_{SS} = 0 V

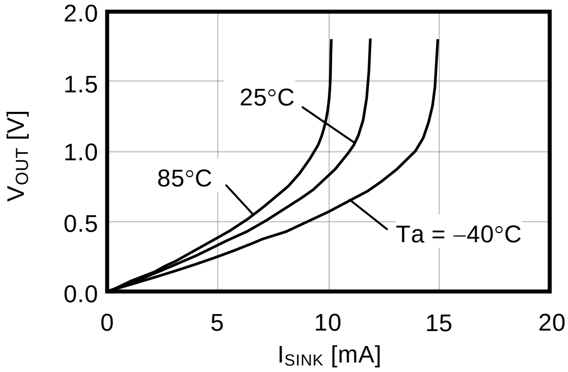


V_{OUT}–I_{SINK}, V_{DD} = 5.0 V, V_{SS} = 0 V

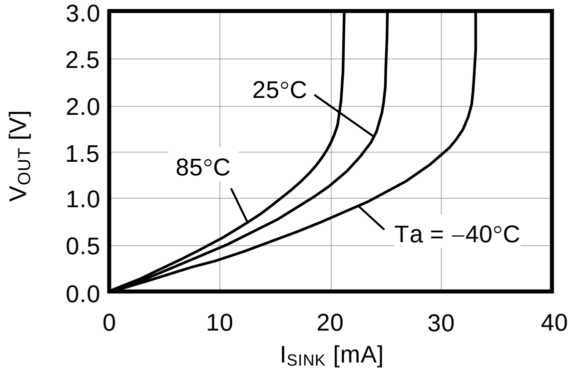


(2) S-89120 Series

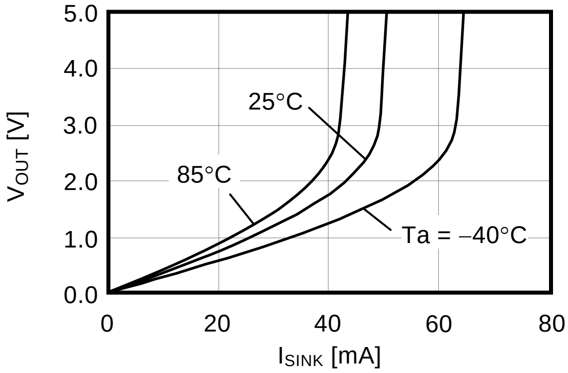
V_{OUT}–I_{SINK}, V_{DD} = 1.8 V, V_{SS} = 0 V

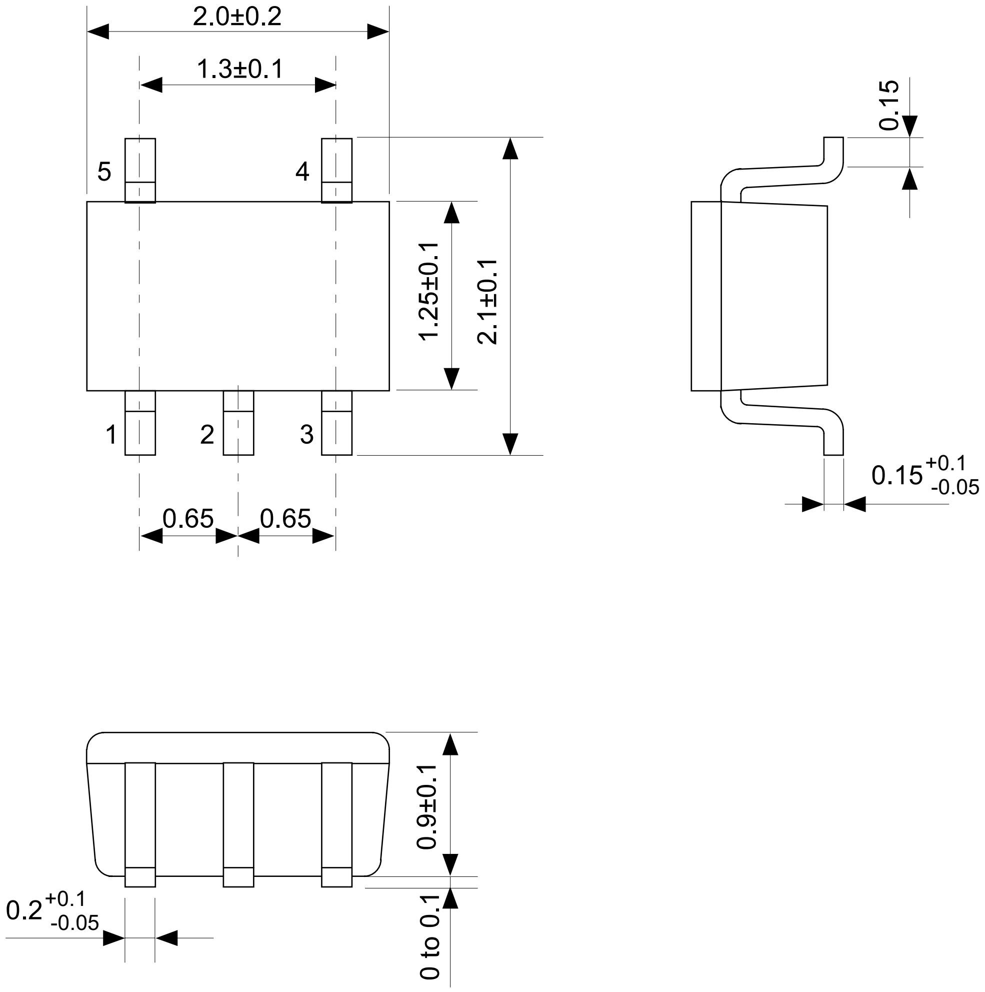


V_{OUT}–I_{SINK}, V_{DD} = 3.0 V, V_{SS} = 0 V



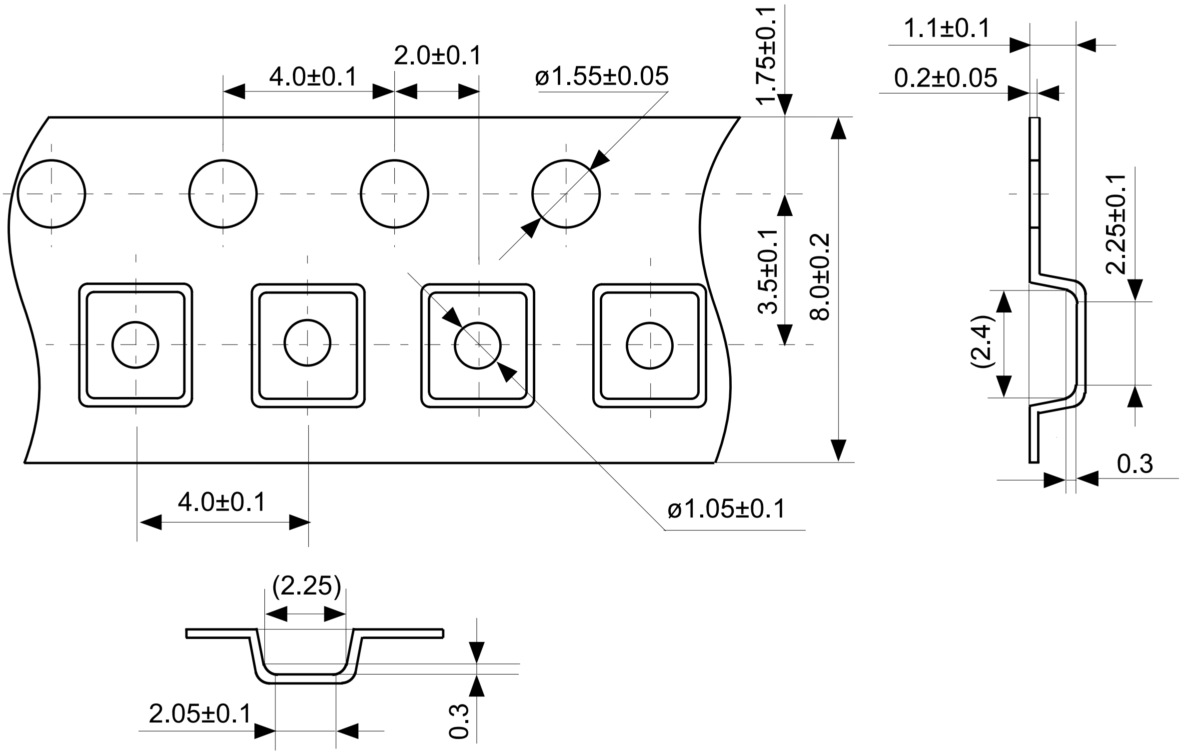
V_{OUT}–I_{SINK}, V_{DD} = 5.0 V, V_{SS} = 0 V

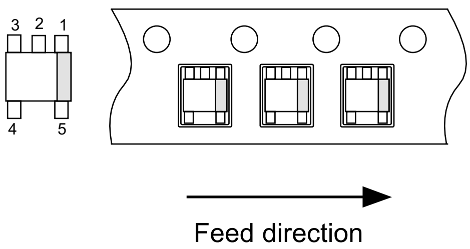




No. NP005-B-P-SD-1.1

TITLE	SC88A-B-PKG Dimensions
No.	NP005-B-P-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	

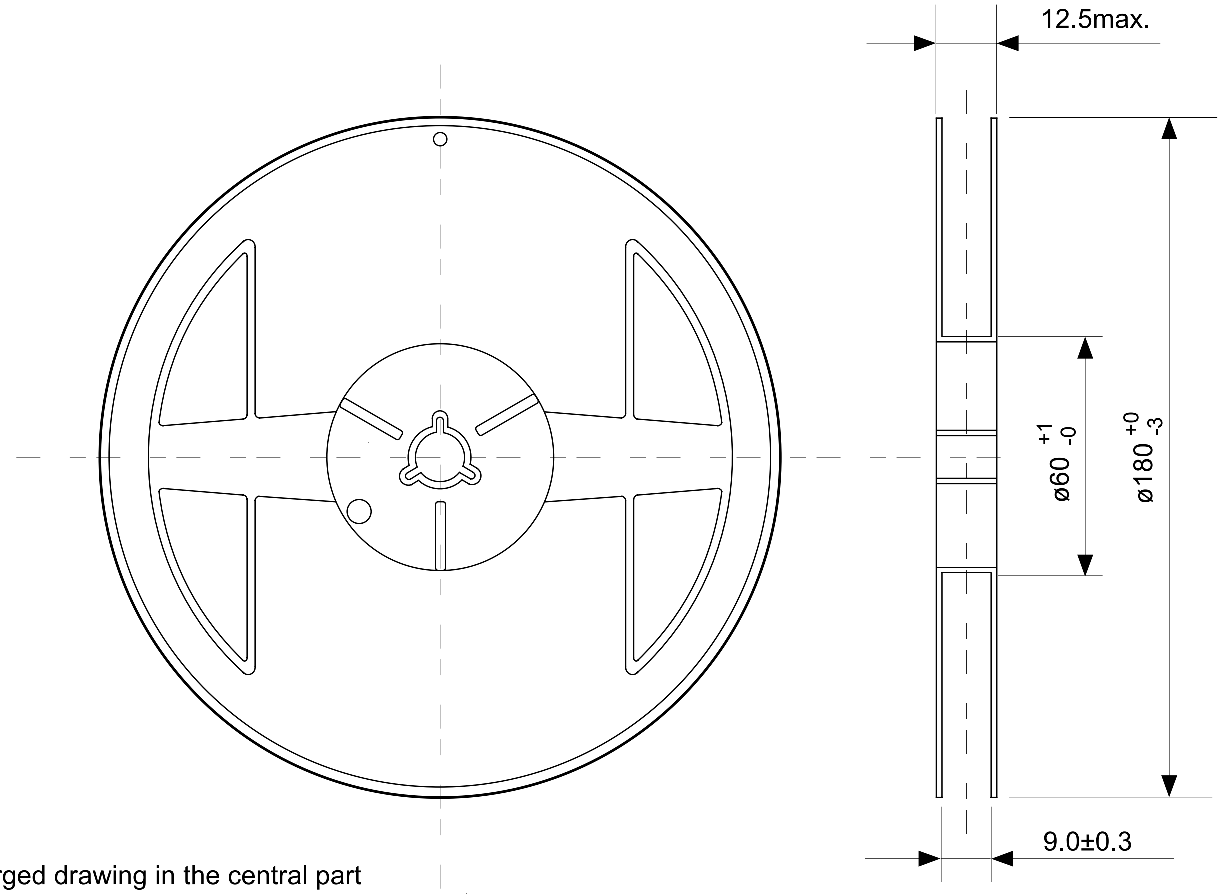




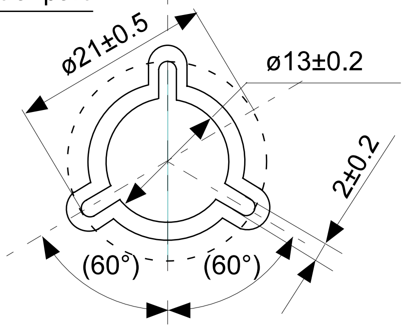
No. NP005-B-C-SD-2.0

TITLE	SC88A-B-Carrier Tape
No.	NP005-B-C-SD-2.0
SCALE	
UNIT	mm

Seiko Instruments Inc.

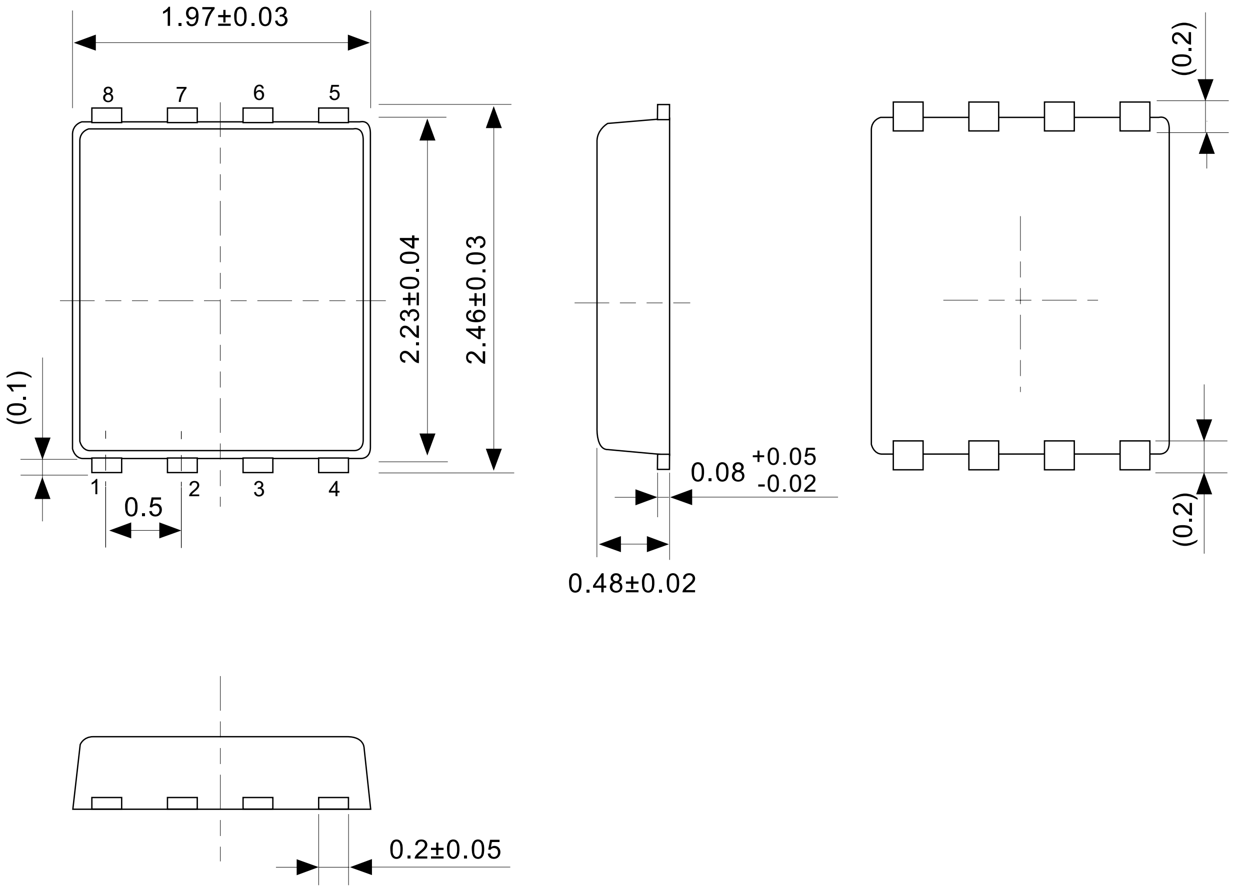


Enlarged drawing in the central part



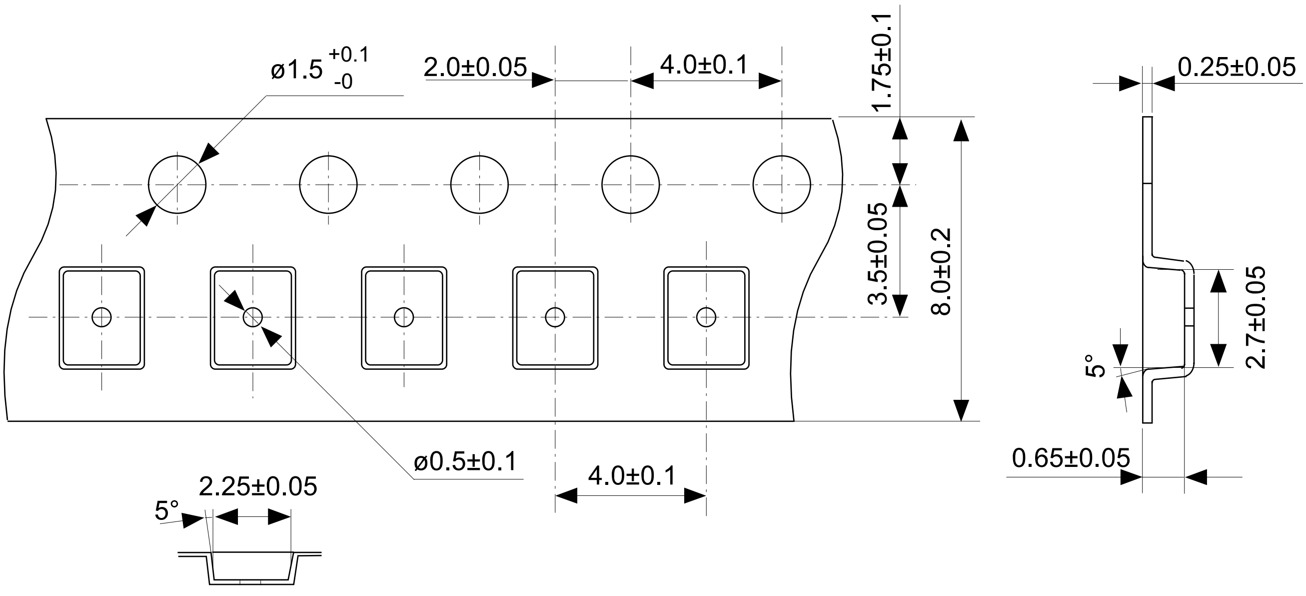
No. NP005-B-R-SD-2.1

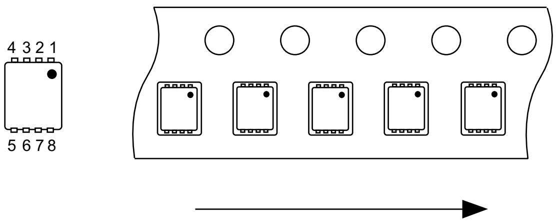
TITLE	SC88A-B-Reel		
No.	NP005-B-R-SD-2.1		
SCALE		QTY.	3000
UNIT	mm		
Seiko Instruments Inc.			



No. PH008-A-P-SD-2.0

TITLE	SNT-8A-A-PKG Dimensions
No.	PH008-A-P-SD-2.0
SCALE	
UNIT	mm
Seiko Instruments Inc.	

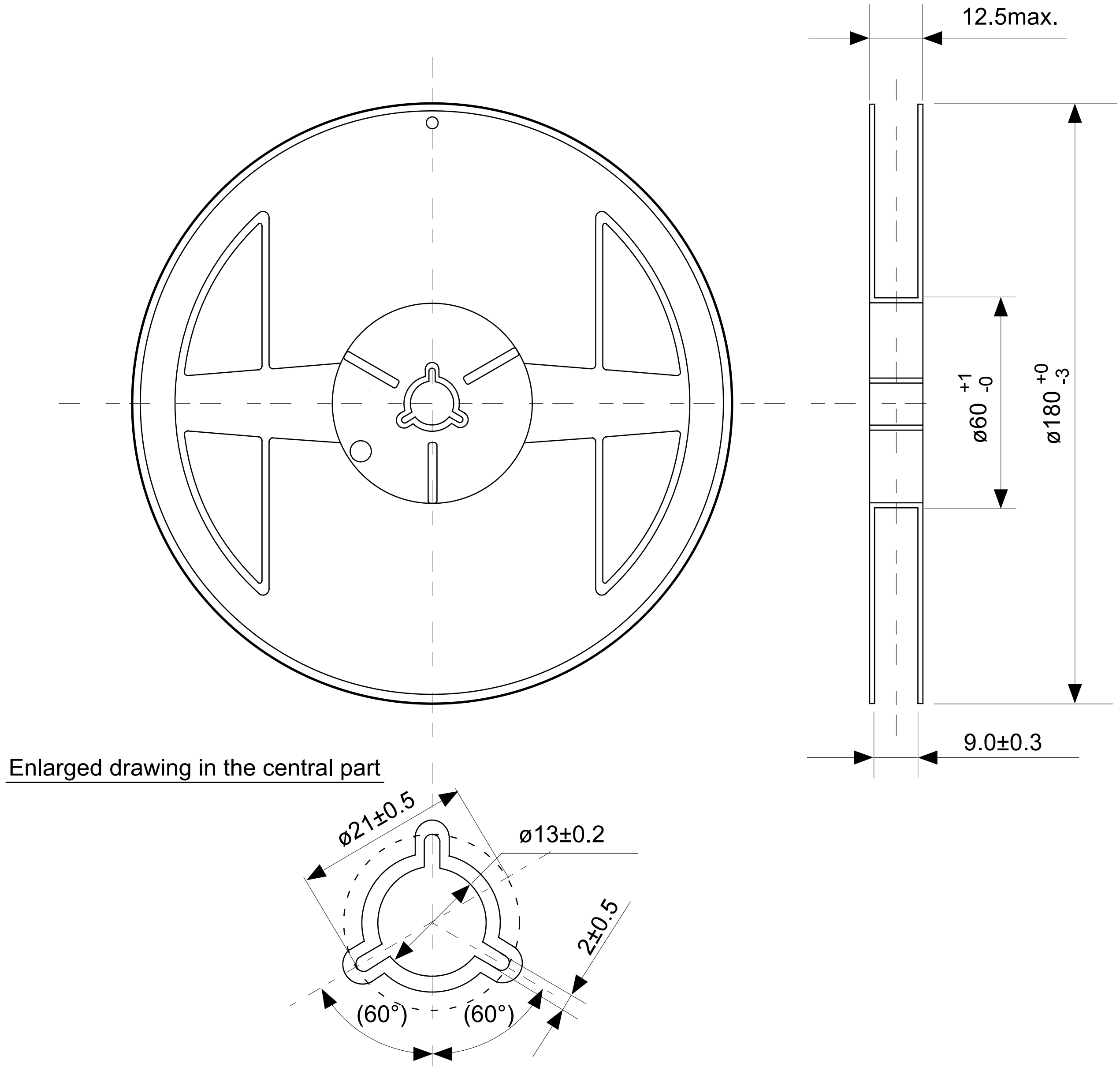




Feed direction

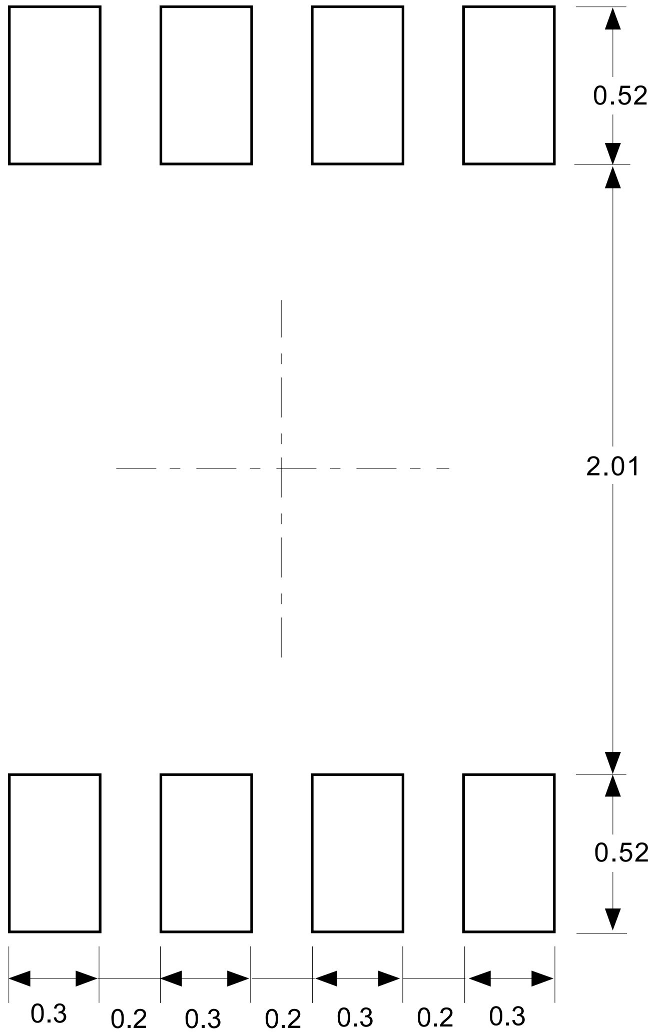
No. PH008-A-C-SD-1.0

TITLE	SNT-8A-A-Carrier Tape
No.	PH008-A-C-SD-1.0
SCALE	
UNIT	mm
Seiko Instruments Inc.	



No. PH008-A-R-SD-1.0

TITLE	SNT-8A-A-Reel		
No.	PH008-A-R-SD-1.0		
SCALE		QTY.	5,000
UNIT	mm		
Seiko Instruments Inc.			

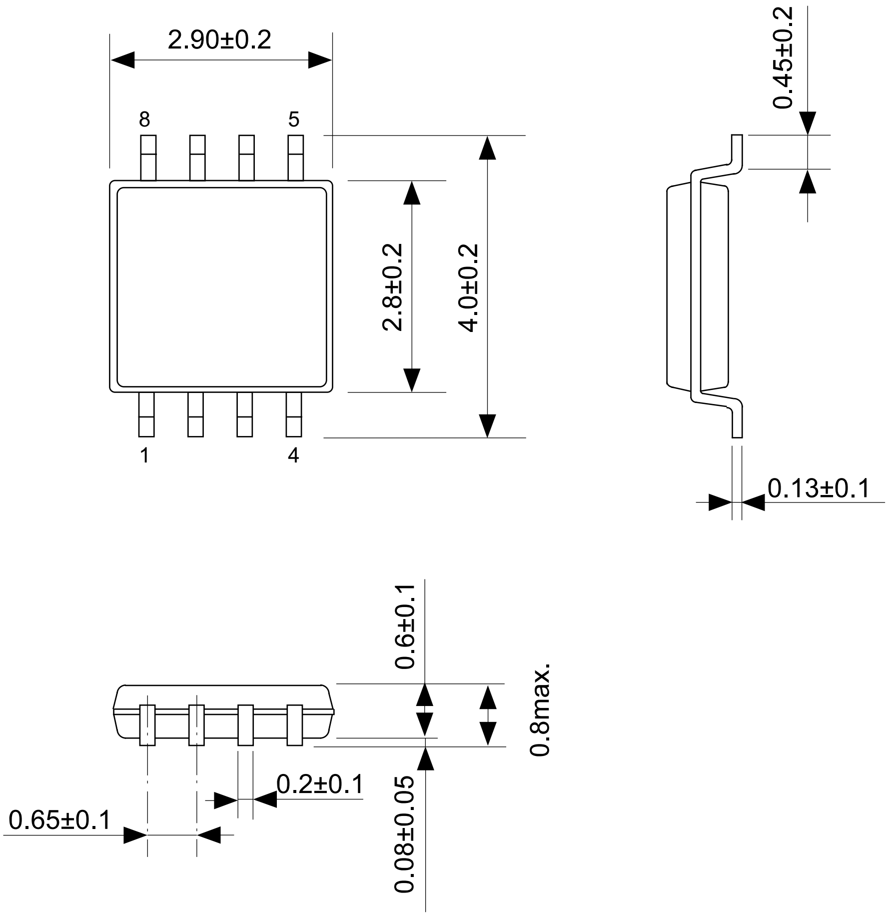


Caution Making the wire pattern under the package is possible. However, note that the package may be upraised due to the thickness made by the silk screen printing and of a solder resist on the pattern because this package does not have the standoff.

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. PH008-A-L-SD-3.0

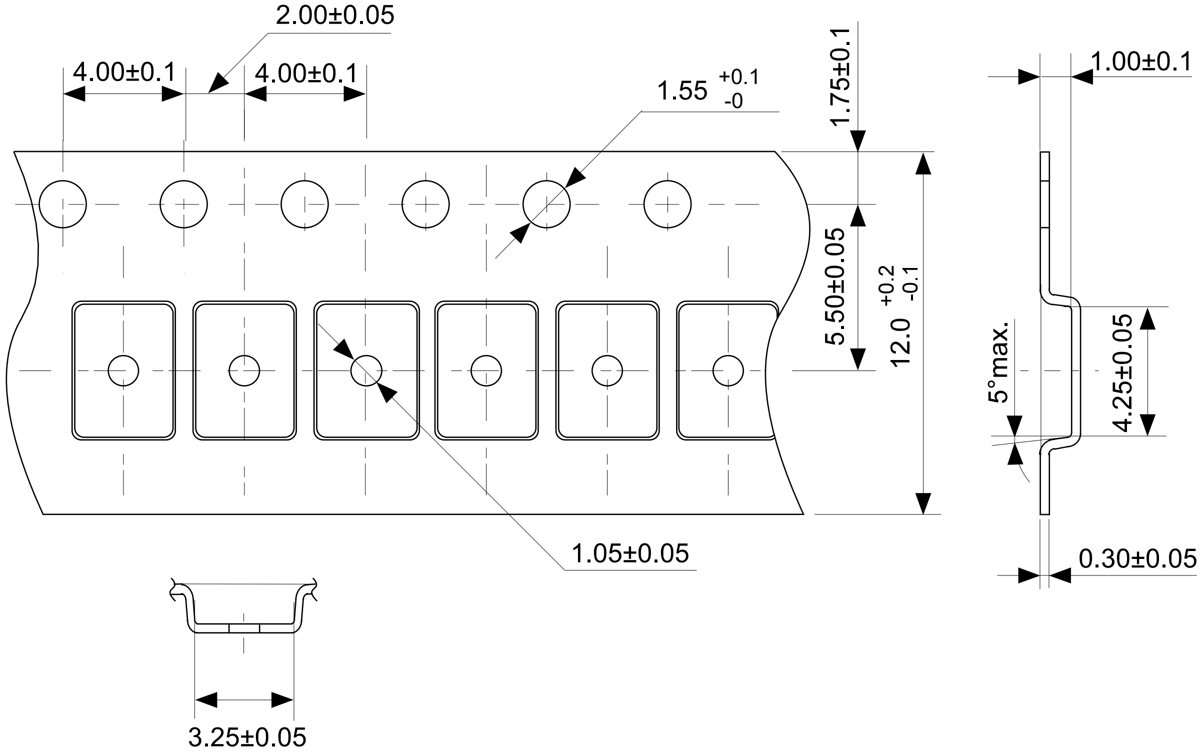
TITLE	SNT-8A-A-Land Recommendation
No.	PH008-A-L-SD-3.0
SCALE	
UNIT	mm
Seiko Instruments Inc.	

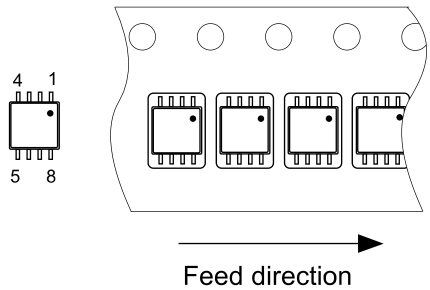


No. FM008-A-P-SD-1.0

TITLE	TMSOP8-A-PKG Dimensions
No.	FM008-A-P-SD-1.0
SCALE	
UNIT	mm

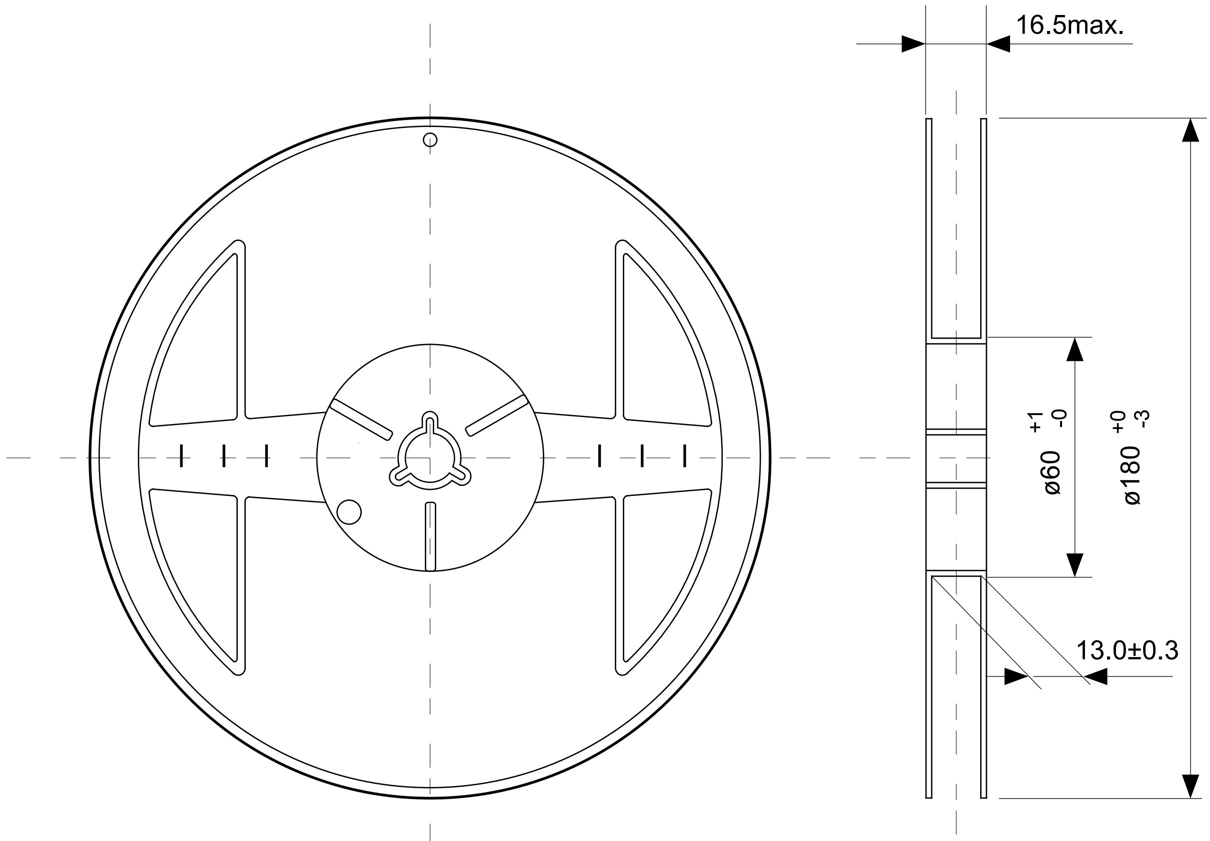
Seiko Instruments Inc.



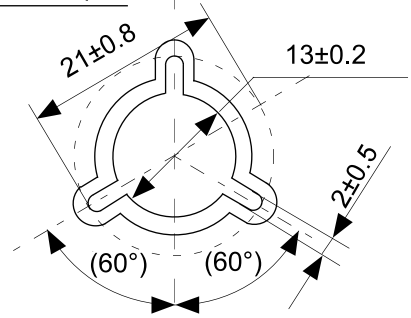


No. FM008-A-C-SD-1.0

TITLE	TMSOP8-A-Carrier Tape
No.	FM008-A-C-SD-1.0
SCALE	
UNIT	mm
Seiko Instruments Inc.	



Enlarged drawing in the central part



No. FM008-A-R-SD-1.0

TITLE	TMSOP8-A-Reel		
No.	FM008-A-R-SD-1.0		
SCALE		QTY.	4,000
UNIT	mm		
Seiko Instruments Inc.			