

## MINI ANALOG SERIES CMOS OPERATIONAL AMPLIFIER

## S-89110A/89120A

The mini-analog series is a group of ICs that incorporate a general purpose analog circuit in a small package.

The S-89110A/89120A is a CMOS type single operational amplifier that has a phase compensation circuit, and that can be driven at a lower voltage with lower current consumption than existing bipolar operational amplifiers. These features make this product the ideal solution for small battery-powered portable equipment.

The S-89110A/89120A is a single operational amplifier.

### ■ Features

- Lower operating voltage than the conventional general-purpose operational amplifiers:  $V_{DD} = 1.8$  to  $5.5$  V
- Low current consumption:  $I_{DD} = 50$   $\mu$ A (S-89110A)  
 $I_{DD} = 10$   $\mu$ A (S-89120A)
- Low input offset voltage:  $4.0$  mV (max.)
- No external capacitors required for internal phase compensation
- Output full swing
- Lead-free products

### ■ Application

- Cellular phones
- PDAs
- Notebook PCs
- Digital cameras
- Digital video cameras

### ■ Package

Package Name	Drawing Code		
	Package	Tape	Reel
SC-88A	NP005-B	NP005-B	NP005-B

### ■ Product Name List

Table 1

Current consumption	SC-88A
$I_{DD} = 50$ $\mu$ A	S-89110ANC-1A1-TFG
$I_{DD} = 10$ $\mu$ A	S-89120ANC-1A2-TFG

**Remark** Delivery form : Taping only

■ Pin Configuration

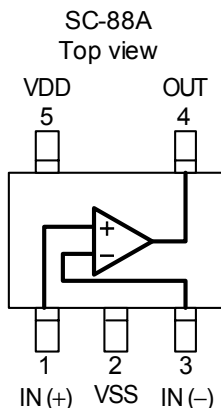


Figure 1

Table 2

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

■ Internal Equivalent Circuit

<1> Output pin

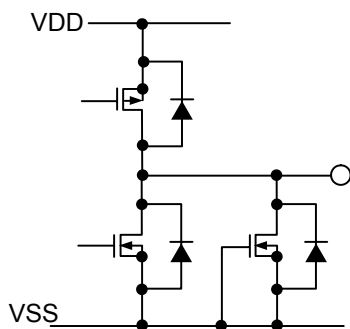


Figure 2

<2> Input pin

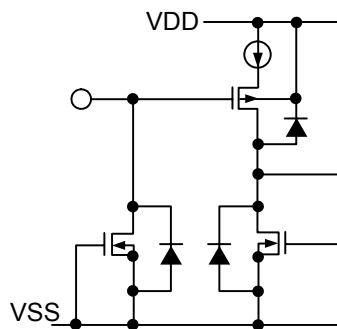


Figure 3

<3> VDD pin

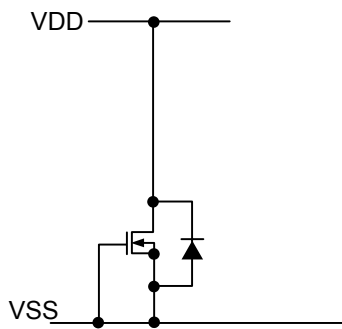


Figure 4

■ Absolute Maximum Ratings

Table 3

Parameter	Symbol	Ratings	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	$V_{IND}$	$\pm 7.0$	V
Power dissipation	$P_D$	200 (When not mounted on board)	mW
		350*1	mW
Operating temperature range	$T_{opr}$	-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.

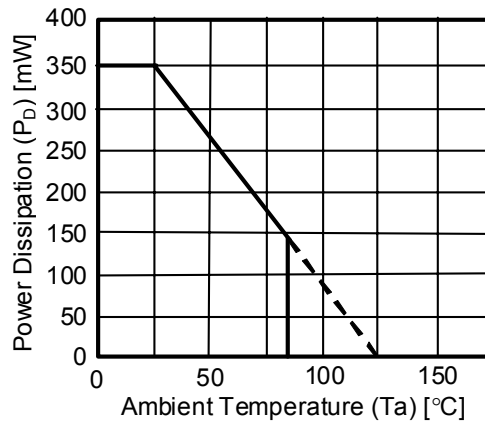


Figure 5 Power Dissipation of Package (When Mounted on Board)

■ Recommended Operating Power Supply Voltage Range

Table 4

Parameter	Symbol	Range	Unit
Operating power supply voltage range	$V_{DD}$	1.8 to 5.5	V

■ **Electrical Characteristics**

1.  $V_{DD} = 5.0\text{ V}$

**Table 5**

DC Characteristics ( $V_{DD} = 5.0\text{ V}$ ) (Ta = 25°C unless otherwise specified)

Parameter	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	Measurement Circuit	
Current consumption	$I_{DD}$	S-89110A	—	50	120	$\mu\text{A}$	<b>Figure 10</b>	
		S-89120A	—	10	30	$\mu\text{A}$		
Input offset voltage	$V_{IO}$	—	-4	$\pm 3$	+4	mV	<b>Figure 6</b>	
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	<b>Figure 7</b>	
Voltage gain (open loop)	$G_V$	—	70	80	—	dB	—	
Maximum output swing voltage	$V_{OH}$	$R_L = 1.0\text{ M}\Omega$	4.9	—	—	V	<b>Figure 8</b>	
	$V_{OL}$	$R_L = 1.0\text{ M}\Omega$	—	—	0.1		<b>Figure 9</b>	
Common-mode input signal rejection ratio	CMRR	—	60	70	—	dB	<b>Figure 7</b>	
Power supply voltage rejection ratio	PSRR	—	60	70	—	dB	<b>Figure 6</b>	
Source current	$I_{SOURCE}$	S-89110A	$V_{OH} = 0\text{ V}$	120	—	—	$\mu\text{A}$	<b>Figure 11</b>
		S-89120A		25	—	—		
Sink current	$I_{SINK}$	$V_{OL} = V_{DD}$	20	—	—	mA	<b>Figure 12</b>	

**Table 6**

AC Characteristics ( $V_{DD} = 5.0\text{ V}$ ) (Ta = 25°C unless otherwise specified)

Parameter	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	
Slew rate	SR	S-89110A	$R_L = 1.0\text{ M}\Omega, C_L = 15\text{ pF}$ (Refer to <b>Figure 13.</b> )	—	0.07	—	V/ $\mu\text{s}$
		S-89120A		—	0.015	—	
Gain-bandwidth product	GBP	S-89110A	—	—	180	—	kHz
		S-89120A		—	40	—	

**MINI ANALOG SERIES CMOS OPERATIONAL AMPLIFIER**  
**S-89110A/89120A**

Rev.2.2\_00

**2.  $V_{DD} = 3.0\text{ V}$**

**Table 7**

DC Characteristics ( $V_{DD} = 3.0\text{ V}$ ) ( $T_a = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	Measurement Circuit	
Current consumption	$I_{DD}$	S-89110A	—	50	120	$\mu\text{A}$	<b>Figure 10</b>	
		S-89120A	—	10	30	$\mu\text{A}$		
Input offset voltage	$V_{IO}$	—	-4	$\pm 3$	+4	mV	<b>Figure 6</b>	
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	<b>Figure 7</b>	
Voltage gain (open loop)	$G_V$	—	70	80	—	dB	—	
Maximum output swing voltage	$V_{OH}$	$R_L = 1.0\text{ M}\Omega$	2.9	—	—	V	<b>Figure 8</b>	
	$V_{OL}$	$R_L = 1.0\text{ M}\Omega$	—	—	0.1	V	<b>Figure 9</b>	
Common-mode input signal rejection ratio	CMRR	—	60	70	—	dB	<b>Figure 7</b>	
Power supply voltage rejection ratio	PSRR	—	60	70	—	dB	<b>Figure 6</b>	
Source current	$I_{SOURCE}$	S-89110A	$V_{OH} = 0\text{ V}$	120	—	—	$\mu\text{A}$	<b>Figure 11</b>
	$I_{SOURCE}$	S-89120A		25	—	—		
Sink current	$I_{SINK}$	$V_{OL} = V_{DD}$	15	—	—	mA	<b>Figure 12</b>	

**Table 8**

AC Characteristics ( $V_{DD} = 3.0\text{ V}$ ) ( $T_a = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	
Slew rate	SR	S-89110A	$R_L = 1.0\text{ M}\Omega$ , $C_L = 15\text{ pF}$ (Refer to <b>Figure 13.</b> )	—	0.07	—	$\text{V}/\mu\text{s}$
		S-89120A		—	0.015	—	
Gain-bandwidth product	GBP	S-89110A	—	—	175	—	kHz
		S-89120A		—	35	—	

3.  $V_{DD} = 1.8\text{ V}$

**Table 9**

DC Characteristics ( $V_{DD} = 1.8\text{ V}$ ) (Ta = 25°C unless otherwise specified)

Parameter	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	Measurement Circuit	
Current consumption	$I_{DD}$	S-89110A	—	50	120	$\mu\text{A}$	<b>Figure 10</b>	
		S-89120A	—	10	30	$\mu\text{A}$		
Input offset voltage	$V_{IO}$	—	-4	$\pm 3$	+4	mV	<b>Figure 6</b>	
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	<b>Figure 7</b>	
Voltage gain (open loop)	$G_V$	—	70	80	—	dB	—	
Maximum output swing voltage	$V_{OH}$	$R_L = 1.0\text{ M}\Omega$	1.7	—	—	V	<b>Figure 8</b>	
	$V_{OL}$	$R_L = 1.0\text{ M}\Omega$	—	—	0.1	V	<b>Figure 9</b>	
Common-mode input signal rejection ratio	CMRR	—	60	70	—	dB	<b>Figure 7</b>	
Power supply voltage rejection ratio	PSRR	—	60	70	—	dB	<b>Figure 6</b>	
Source current	$I_{SOURCE}$	S-89110A	$V_{OH} = 0\text{ V}$	100	—	—	$\mu\text{A}$	<b>Figure 11</b>
	$I_{SOURCE}$	S-89120A		20	—	—		
Sink current	$I_{SINK}$	$V_{OL} = V_{DD}$	5	—	—	mA	<b>Figure 12</b>	

**Table 10**

AC Characteristics ( $V_{DD} = 1.8\text{ V}$ ) (Ta = 25°C unless otherwise specified)

Parameter	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	
Slew rate	SR	S-89110A	$R_L = 1.0\text{ M}\Omega$ , $C_L = 15\text{ pF}$ (Refer to <b>Figure 13.</b> )	—	0.07	—	V/ $\mu\text{s}$
		S-89120A		—	0.015	—	
Gain-bandwidth product	GBP	S-89110A	—	—	160	—	kHz
		S-89120A		—	30	—	

■ Measurement Circuit

1. Power supply voltage rejection ratio, input offset voltage

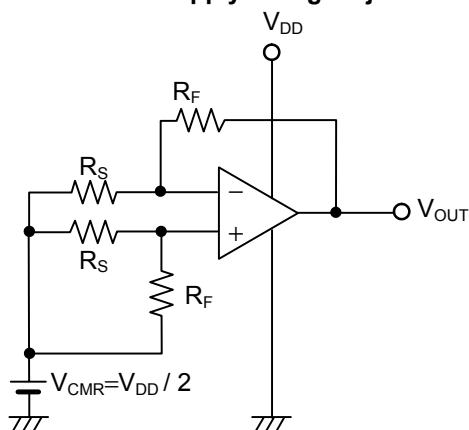


Figure 6

• 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  $V_{DD}$ .

Measurement conditions:

When  $V_{DD} = 1.8\text{ V}$ :  $V_{DD} = V_{DD1}$ ,  $V_{OUT} = V_{OUT1}$

When  $V_{DD} = 5.0\text{ V}$ :  $V_{DD} = V_{DD2}$ ,  $V_{OUT} = V_{OUT2}$

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

• 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

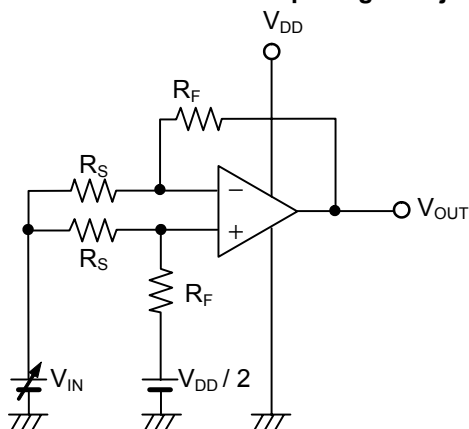


Figure 7

• 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  $V_{IN}$ .

Measurement conditions:

When  $V_{IN} = V_{CMR} (\text{max.})$ :  $V_{IN} = V_{IN1}$ ,  $V_{OUT} = V_{OUT1}$

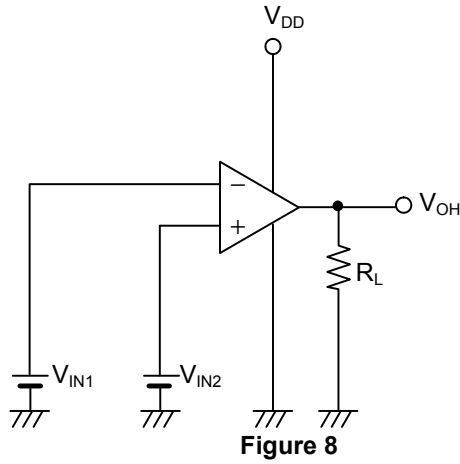
When  $V_{IN} = V_{DD}/2$ :  $V_{IN} = V_{IN2}$ ,  $V_{OUT} = V_{OUT2}$

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

• 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

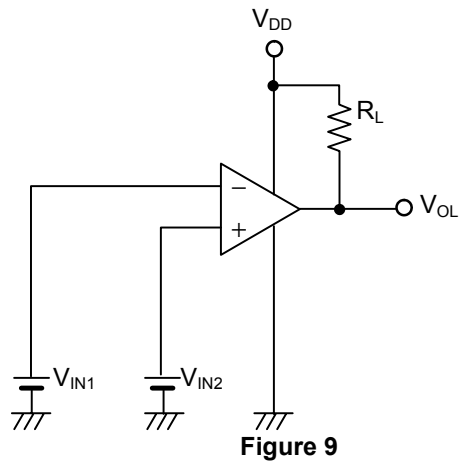


• Maximum output swing voltage ( $V_{OH}$ )

Measurement conditions:  $V_{IN1} = \frac{V_{DD}}{2} - 0.5 \text{ V}$

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

$R_L = 1 \text{ M}\Omega$



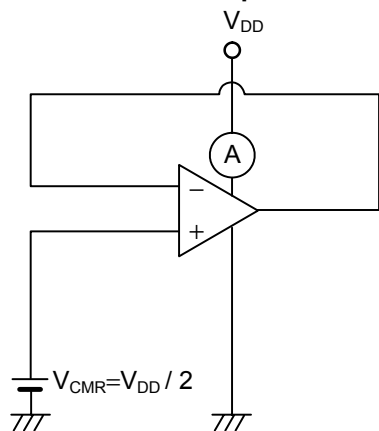
• Maximum output swing voltage ( $V_{OL}$ )

Measurement conditions:  $V_{IN1} = \frac{V_{DD}}{2} + 0.5 \text{ V}$

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

$R_L = 1 \text{ M}\Omega$

4. Current consumption



• Current consumption ( $I_{D}$ )



**5. Source current**

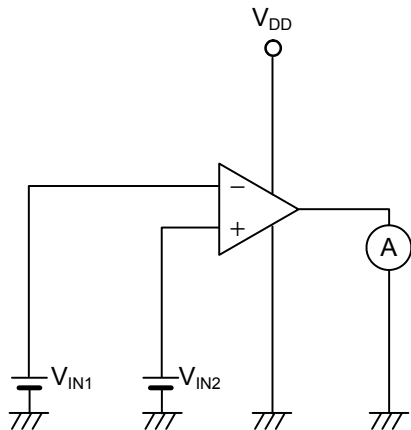


Figure 11

• **Source current ( $I_{SOURCE}$ )**

Measurement conditions:  $V_{IN1} = \frac{V_{DD}}{2} - 0.5\text{ V}$

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

**6. Sink current**

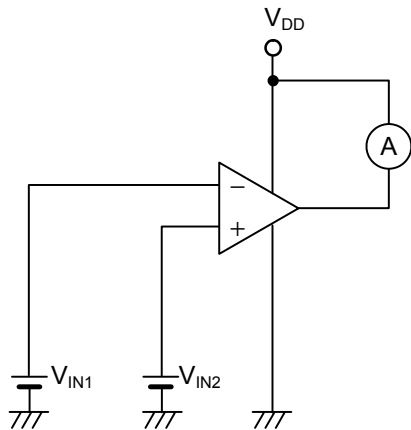


Figure 12

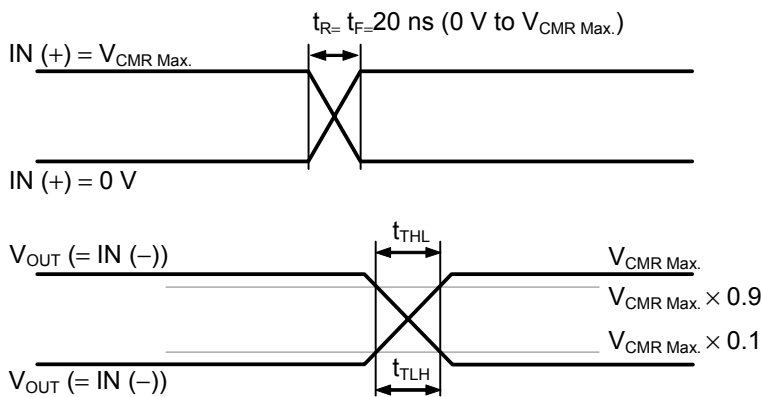
• **Sink current ( $I_{SINK}$ )**

Measurement conditions:  $V_{IN1} = \frac{V_{DD}}{2} + 0.5\text{ V}$

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

**7. Slew rate (SR):**

Measured by the voltage follower circuit



$$SR = \frac{V_{CMR\ Max.} \times 0.8}{t_{TLH}}$$

$$SR = \frac{V_{CMR\ Max.} \times 0.8}{t_{THL}}$$

Figure 13

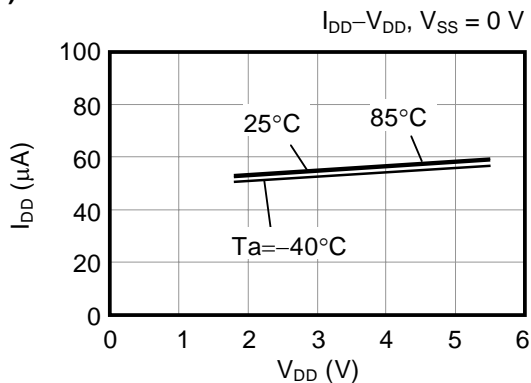
■ **Precaution**

- 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.

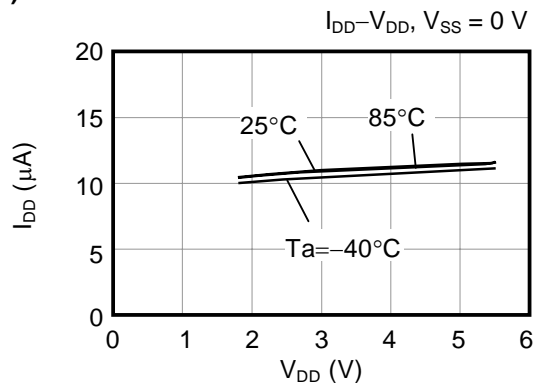
■ Characteristics (Reference Data)

1. Current consumption vs. Power supply voltage

(a) S-89110A

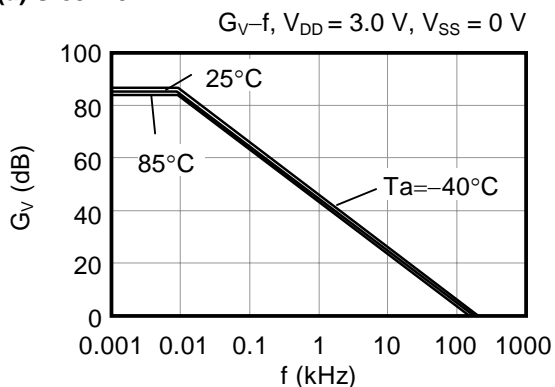


(b) S-89120A

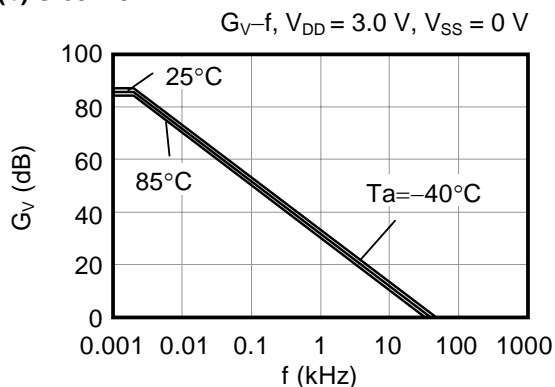


2. Voltage gain vs. Frequency

(a) S-89110A



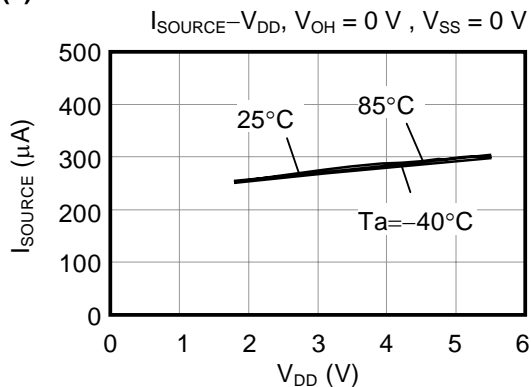
(b) S-89120A



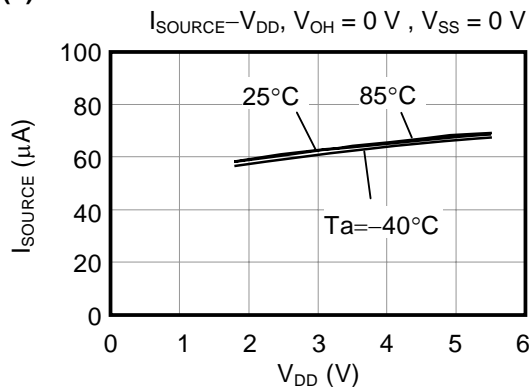
3. Output current

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

(a) S-89110A

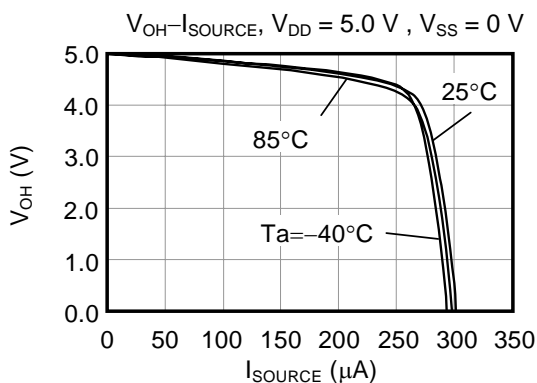
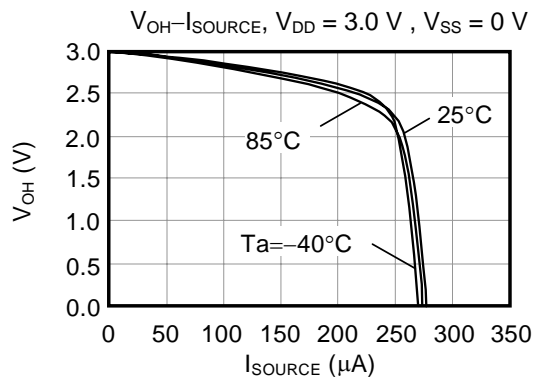
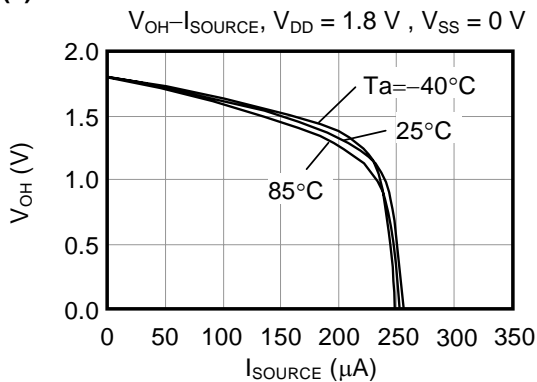


(b) S-89120A

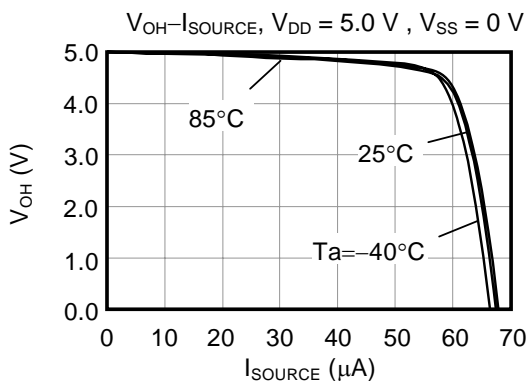
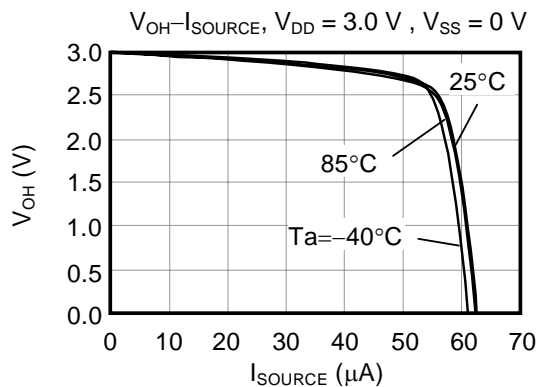
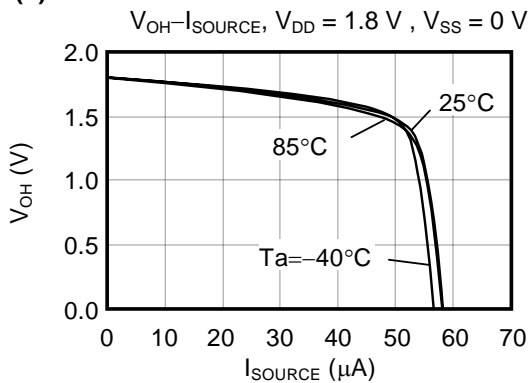


**3-2. Output voltage ( $V_{OH}$ ) vs.  $I_{SOURCE}$**

**(a) S-89110A**

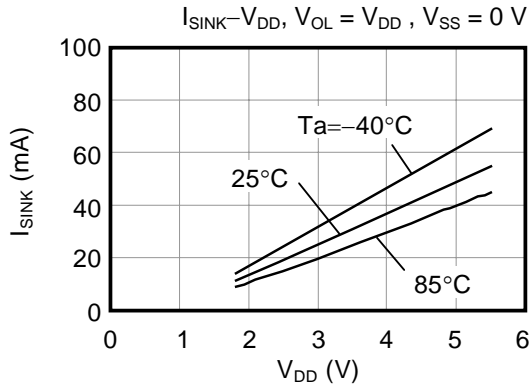


**(b) S-89120A**

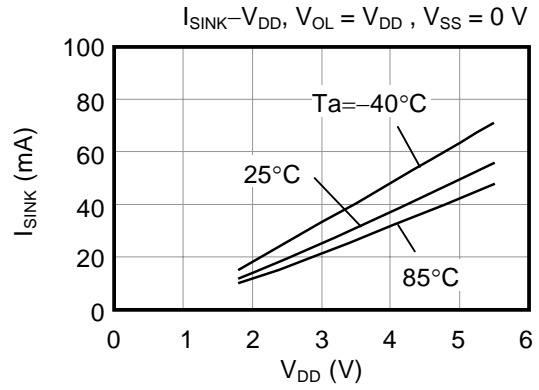


3-3.  $I_{SINK}$  vs. Power supply voltage

(a) S-89110A

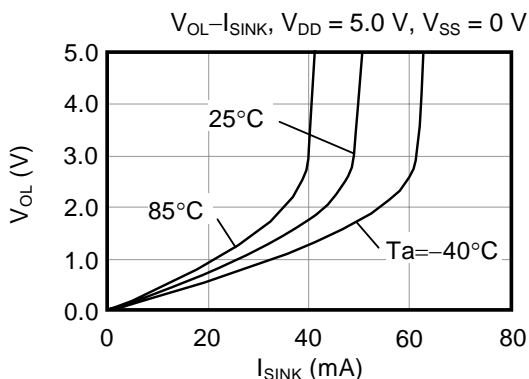
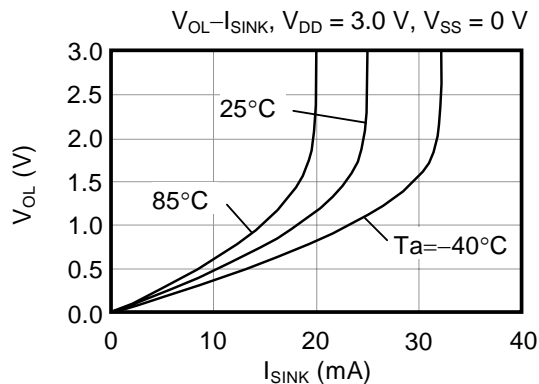
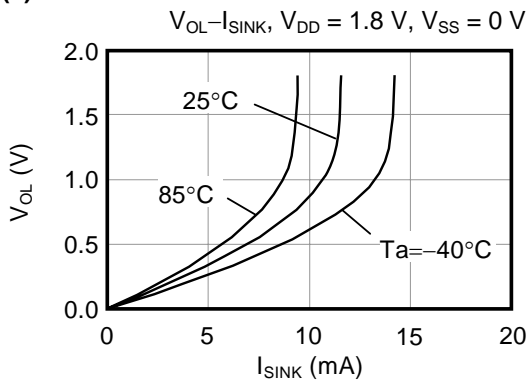


(b) S-89120A

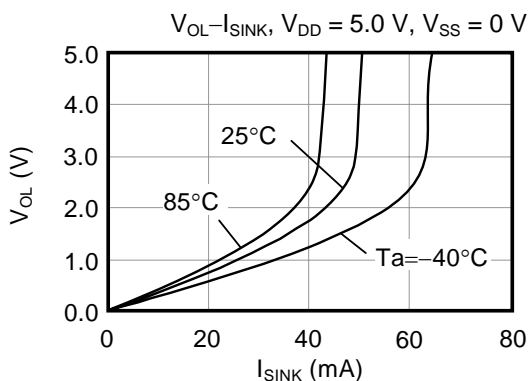
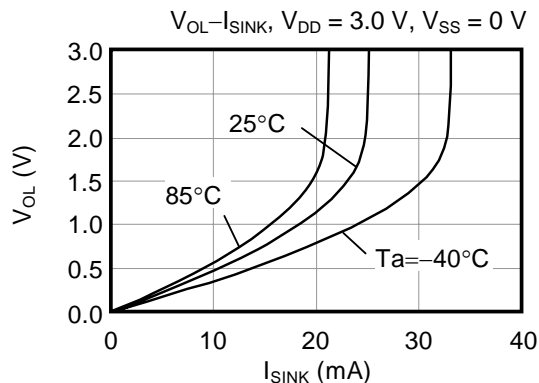
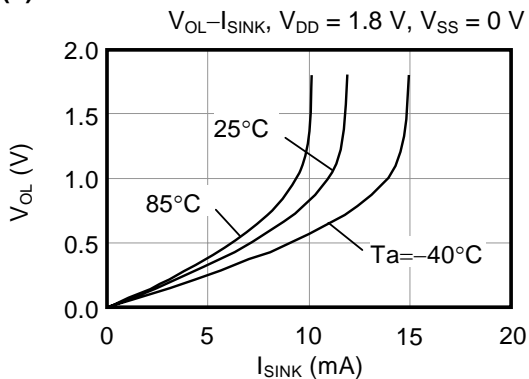


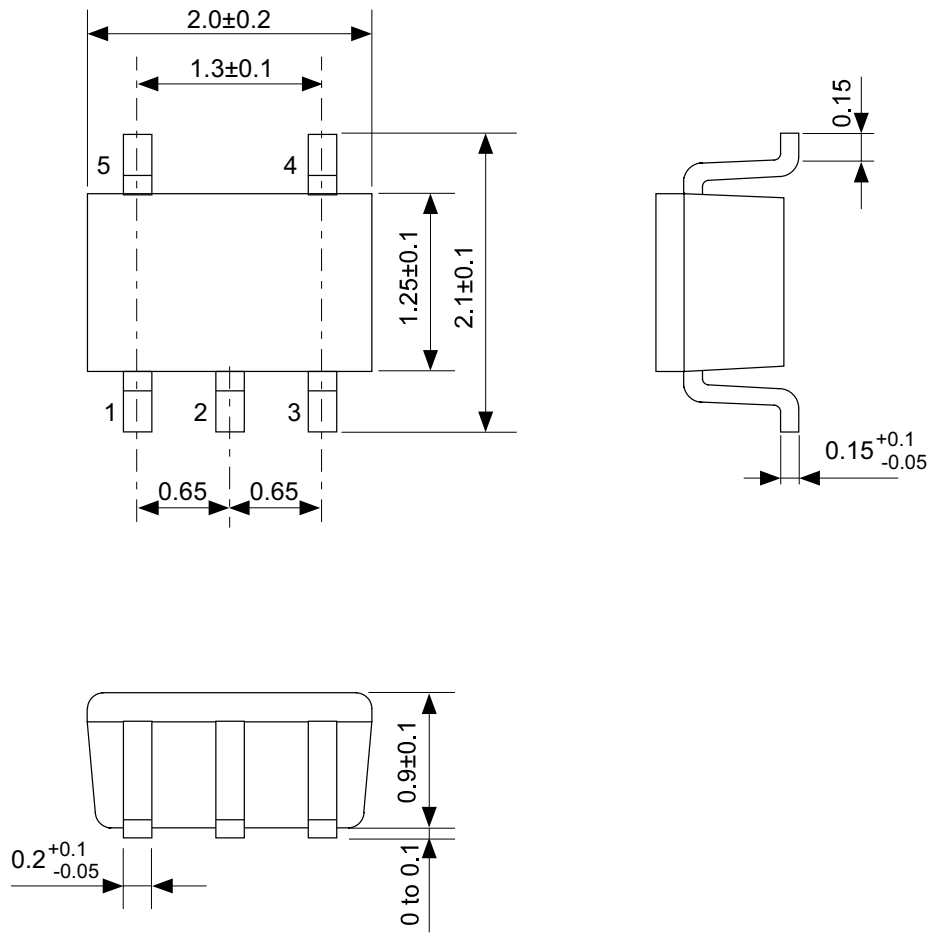
**3-4. Output voltage ( $V_{OL}$ ) vs.  $I_{SINK}$**

**(a) S-89110A**



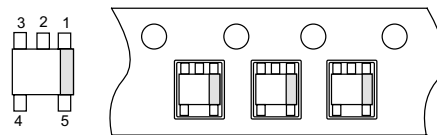
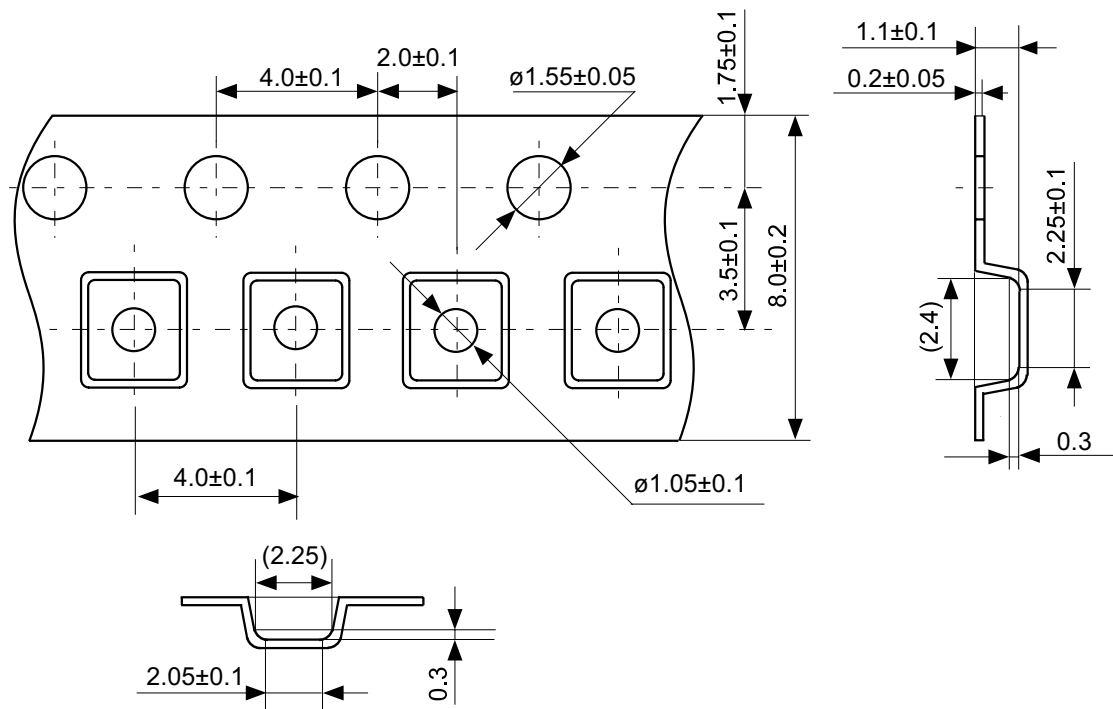
**(b) S-89120A**





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.	

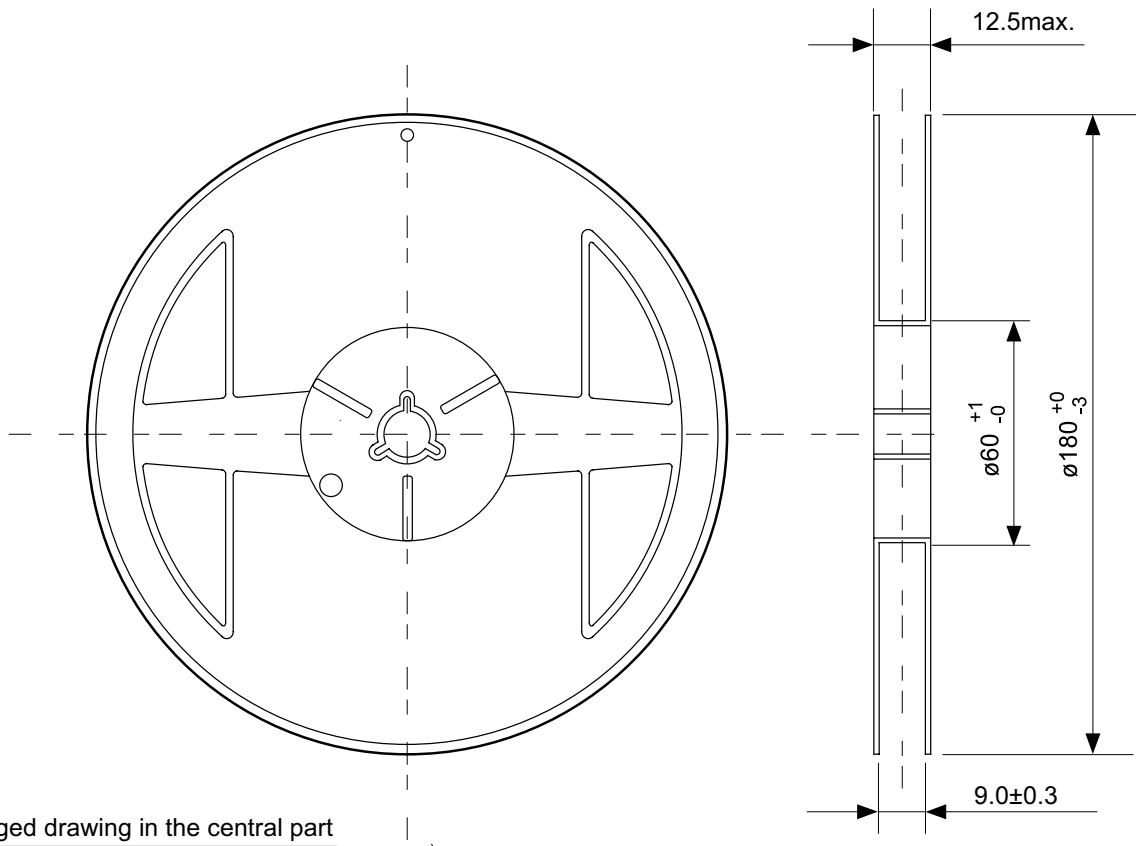


→  
Feed direction

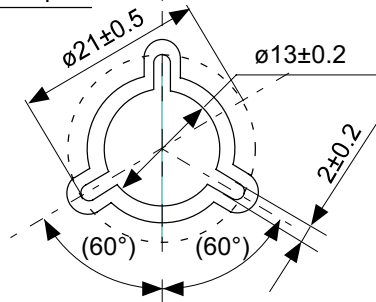
No. NP005-B-C-SD-2.0

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.			

- 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.