

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: $I_{DD} = 50$ μ A (S-89110A)
 $I_{DD} = 10$ μ 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
$I_{DD} = 50$ μ A	S-89110ANC-1A1-TFG
$I_{DD} = 10$ μ A	S-89120ANC-1A2-TFG

Remark Delivery form : Taping only

■ Pin Configuration

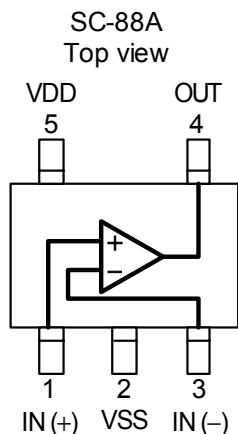


Figure 1

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

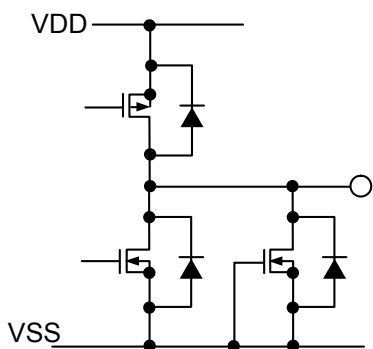


Figure 2

<2> Input pin

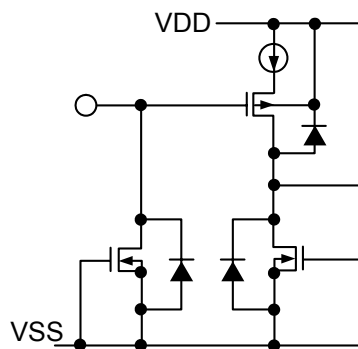


Figure 3

<3> VDD pin

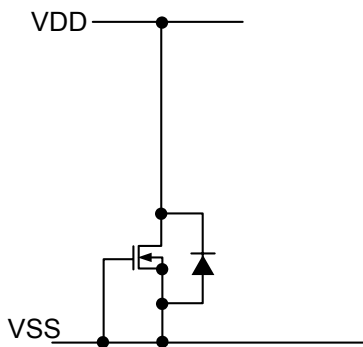


Figure 4

■ **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}	± 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.

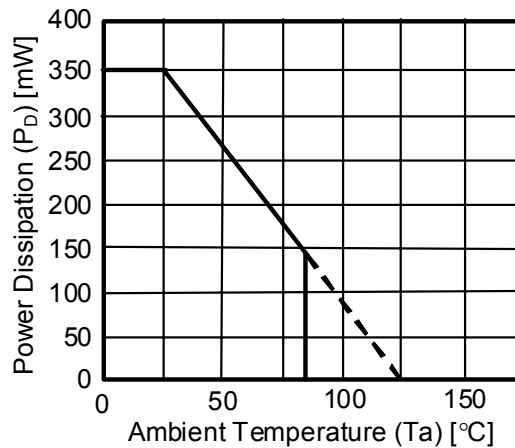


Figure 5 Power Dissipation of Package (When Mounted on Board)

■ **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 ($V_{DD} = 5.0\text{ V}$)

($T_a = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	Measurement Circuit	
Current consumption	I_{DD}	S-89110A	—	50	120	μA	Figure 10	
		S-89120A	—	10	30	μA		
Input offset voltage	V_{IO}	—	-4	± 3	+4	mV	Figure 6	
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	Figure 7	
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	Figure 8	
	V_{OL}	$R_L = 1.0\text{ M}\Omega$	—	—	0.1		Figure 9	
Common-mode input signal rejection ratio	CMRR	—	60	70	—	dB	Figure 7	
Power supply voltage rejection ratio	PSRR	—	60	70	—	dB	Figure 6	
Source current	I_{SOURCE}	S-89110A	$V_{OH} = 0\text{ V}$	120	—	—	μA	Figure 11
		S-89120A		25	—	—		
Sink current	I_{SINK}	$V_{OL} = V_{DD}$	20	—	—	mA	Figure 12	

Table 6

AC Characteristics ($V_{DD} = 5.0\text{ V}$)

($T_a = 25^\circ\text{C}$ 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 Figure 13.)	—	0.07	—	V/ μs
		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	μA	Figure 10	
		S-89120A	—	10	30	μA		
Input offset voltage	V_{IO}	—	-4	± 3	+4	mV	Figure 6	
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	Figure 7	
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	Figure 8	
	V_{OL}	$R_L = 1.0\text{ M}\Omega$	—	—	0.1	V	Figure 9	
Common-mode input signal rejection ratio	CMRR	—	60	70	—	dB	Figure 7	
Power supply voltage rejection ratio	PSRR	—	60	70	—	dB	Figure 6	
Source current	I_{SOURCE}	S-89110A	$V_{OH} = 0\text{ V}$	120	—	—	μA	Figure 11
	I_{SOURCE}	S-89120A		25	—	—		
Sink current	I_{SINK}	$V_{OL} = V_{DD}$	15	—	—	mA	Figure 12	

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 Figure 13.)	—	0.07	—	V/ μs
		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	μA	Figure 10	
		S-89120A	—	10	30	μA		
Input offset voltage	V_{IO}	—	-4	± 3	+4	mV	Figure 6	
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	Figure 7	
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	Figure 8	
	V_{OL}	$R_L = 1.0\text{ M}\Omega$	—	—	0.1	V	Figure 9	
Common-mode input signal rejection ratio	CMRR	—	60	70	—	dB	Figure 7	
Power supply voltage rejection ratio	PSRR	—	60	70	—	dB	Figure 6	
Source current	I_{SOURCE}	S-89110A	$V_{OH} = 0\text{ V}$	100	—	—	μA	Figure 11
	I_{SOURCE}	S-89120A		20	—	—		
Sink current	I_{SINK}	$V_{OL} = V_{DD}$	5	—	—	mA	Figure 12	

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 Figure 13.)	—	0.07	—	V/ μs
		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

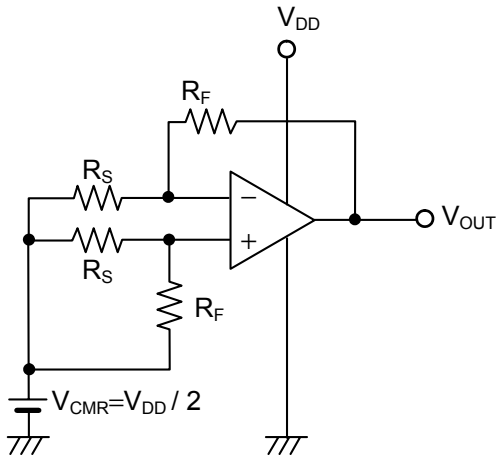


Figure 6

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

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

• 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

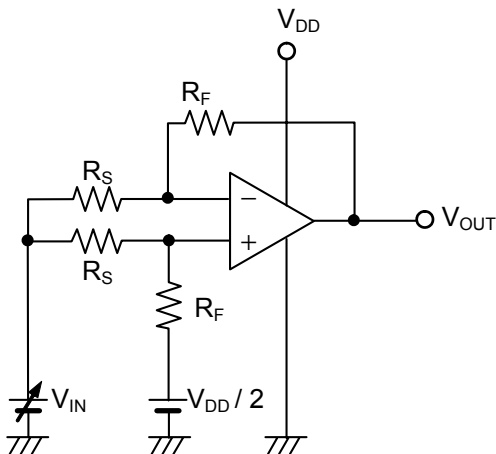


Figure 7

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

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

• 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

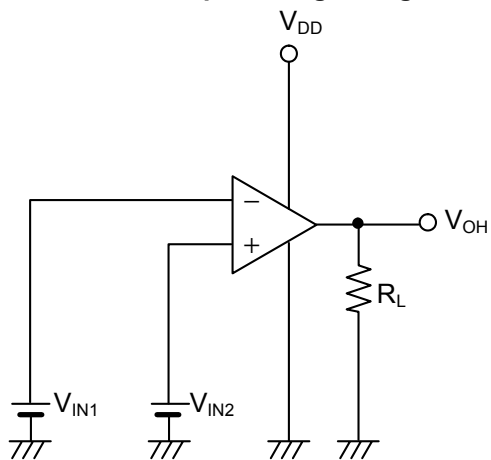


Figure 8

• Maximum output swing voltage (V_{OH})

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

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

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

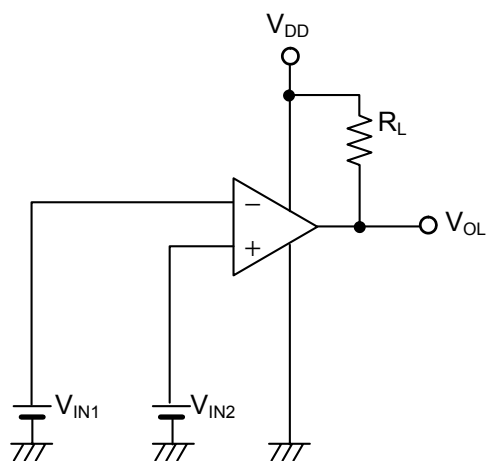


Figure 9

• 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

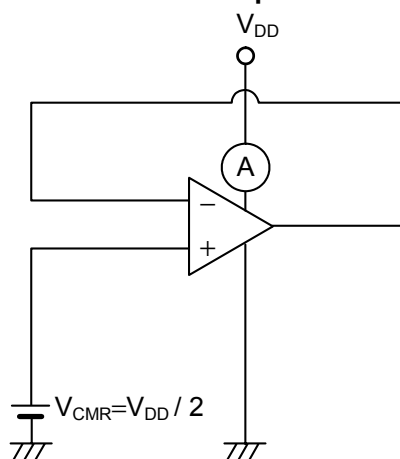


Figure 10

• Current consumption (I_{DD})

5. Source current

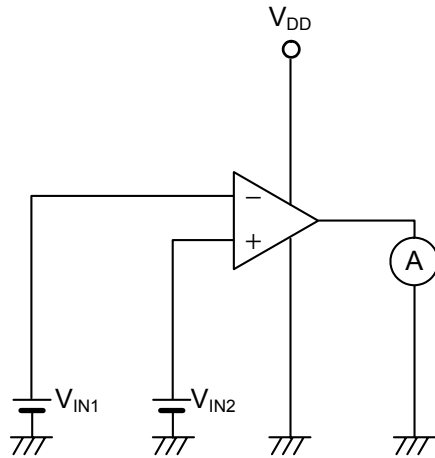


Figure 11

• 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

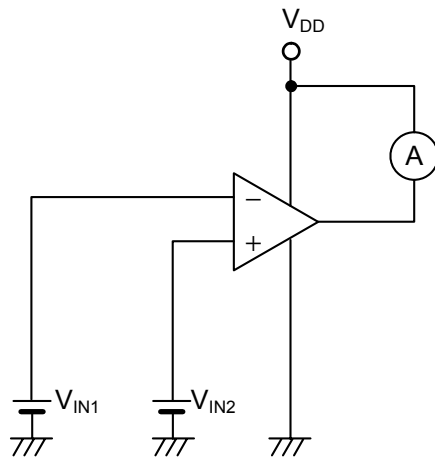


Figure 12

• 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

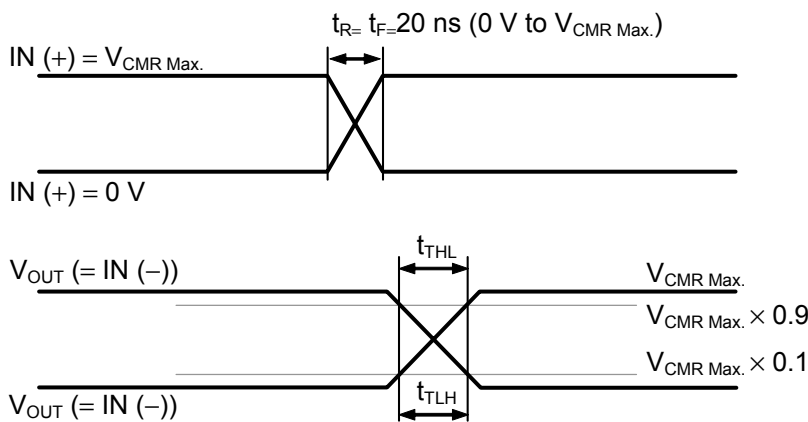


Figure 13

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

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

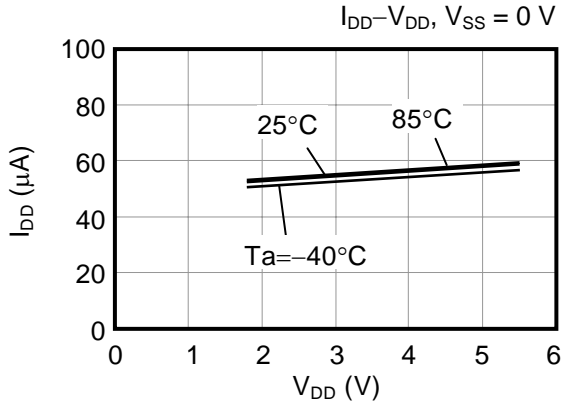
■ **Precaution**

- 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.

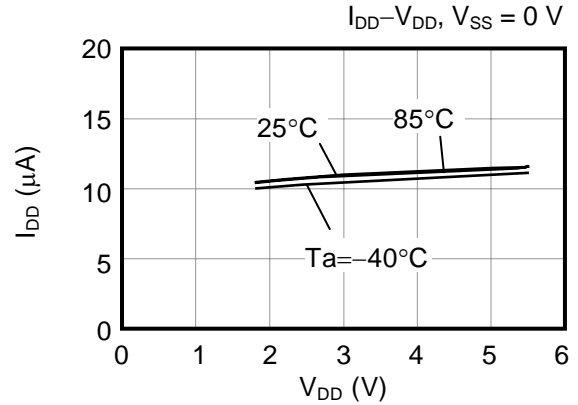
■ Characteristics (Reference Data)

1. Current consumption vs. Power supply voltage

(a) S-89110A

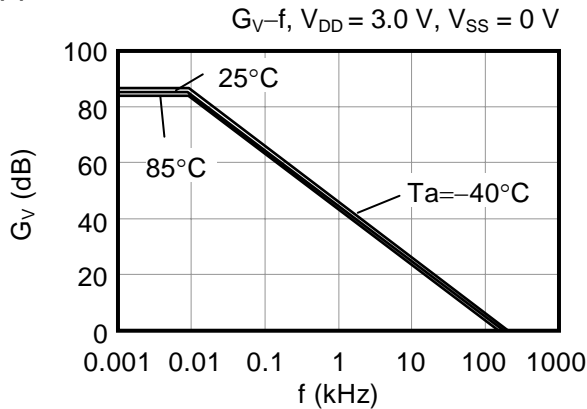


(b) S-89120A

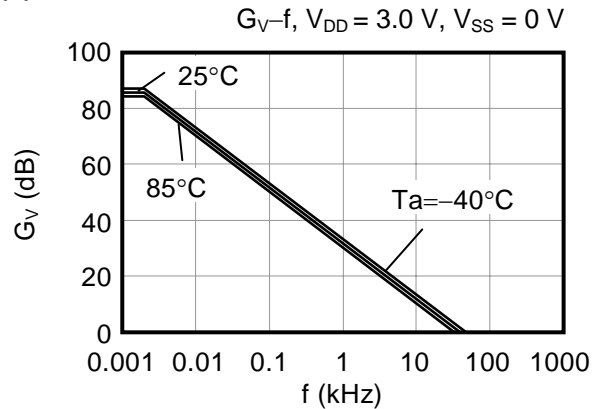


2. Voltage gain vs. Frequency

(a) S-89110A



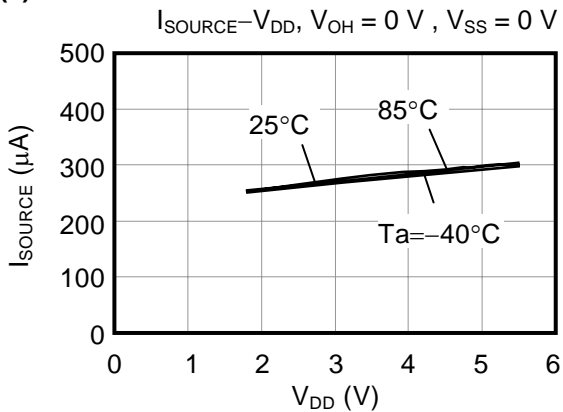
(b) S-89120A



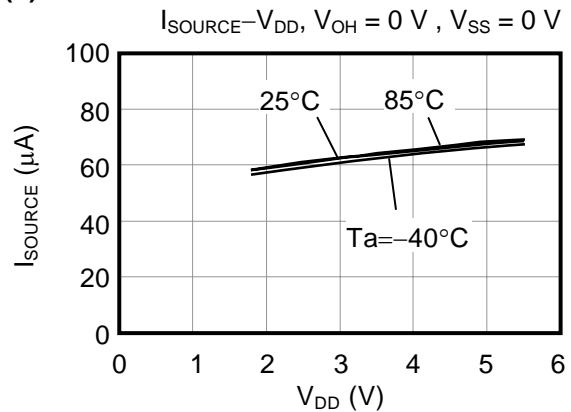
3. Output current

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

(a) S-89110A

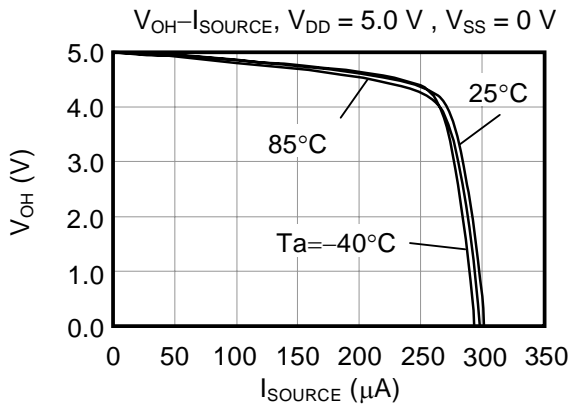
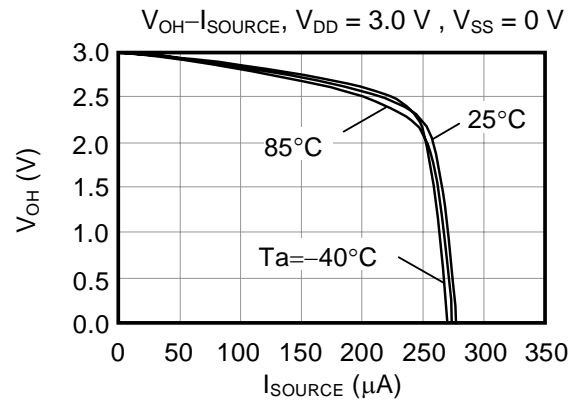
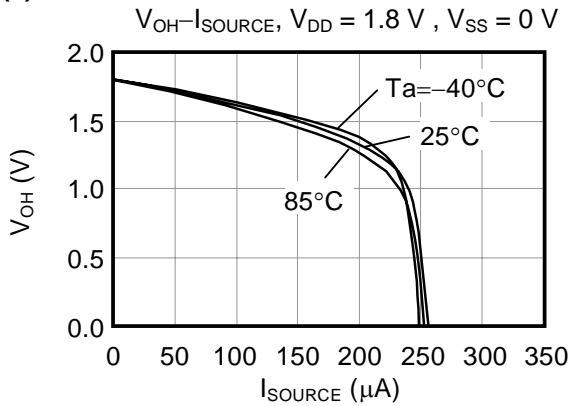


(b) S-89120A

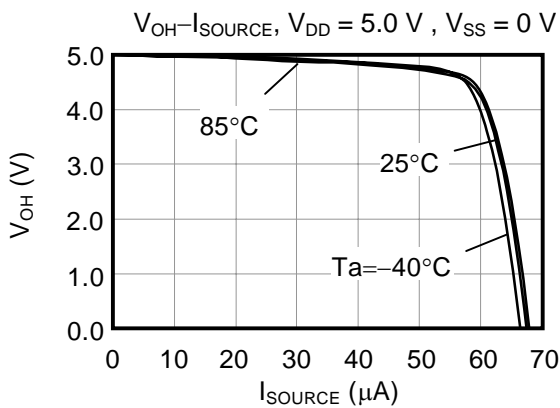
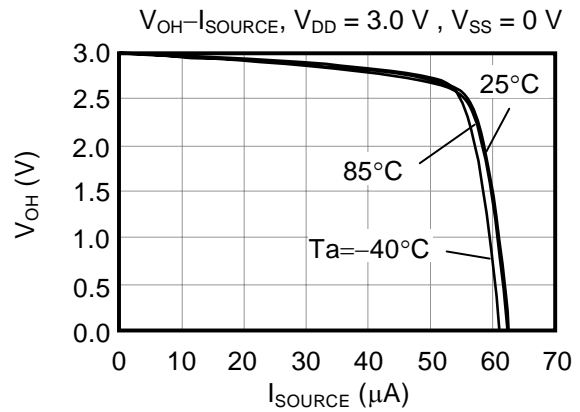
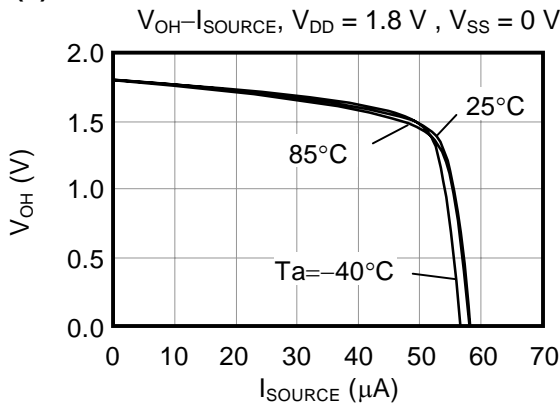


3-2. Output voltage (V_{OH}) vs. I_{SOURCE}

(a) S-89110A

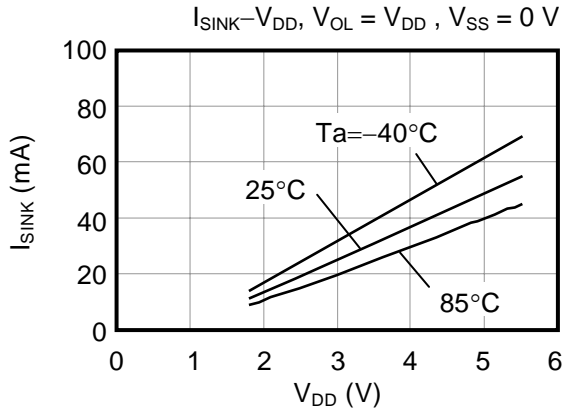


(b) S-89120A

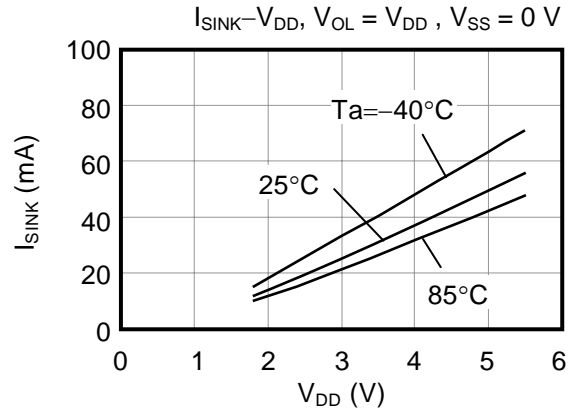


3-3. I_{SINK} vs. Power supply voltage

(a) S-89110A

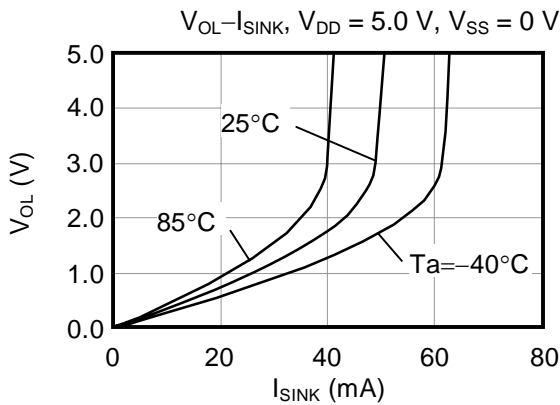
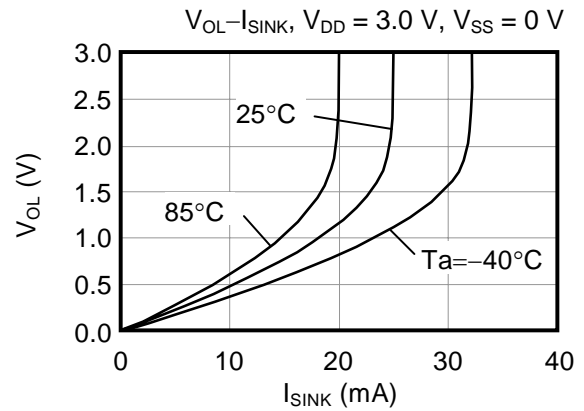
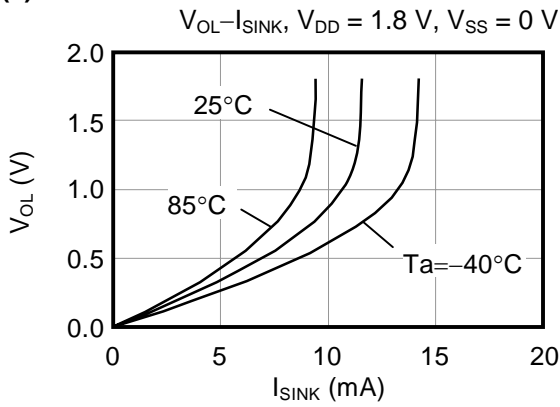


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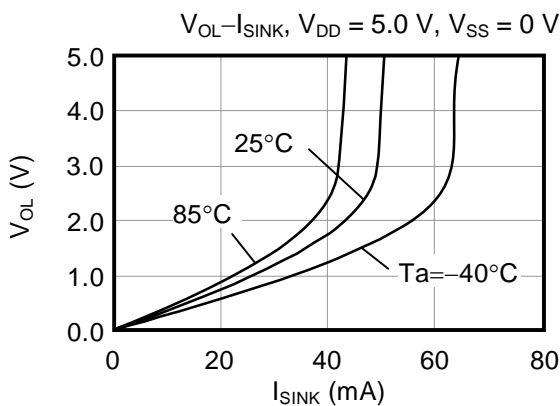
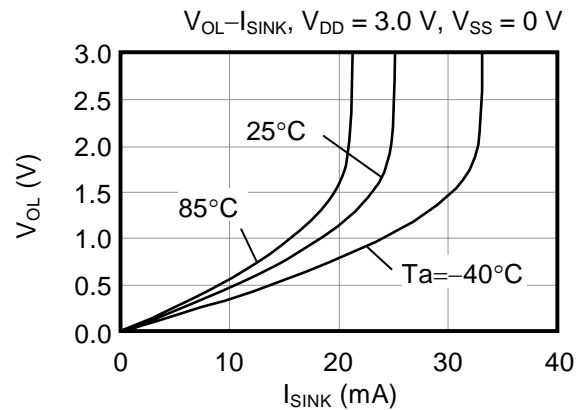
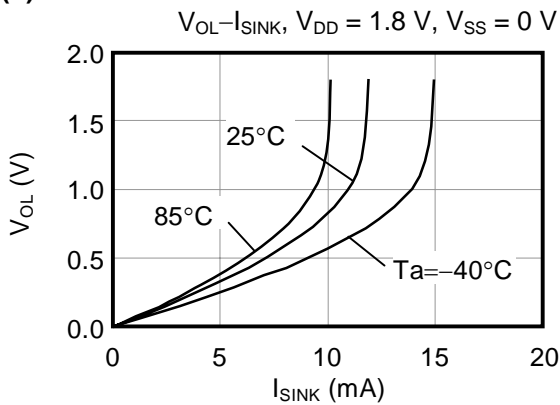


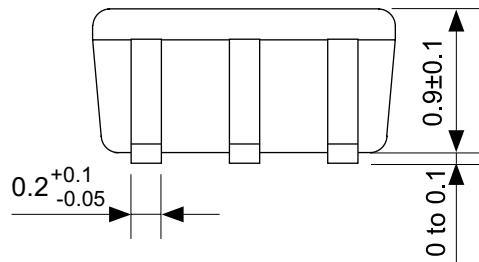
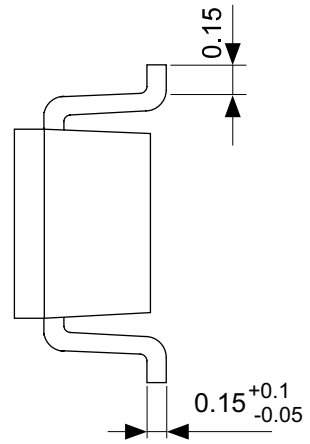
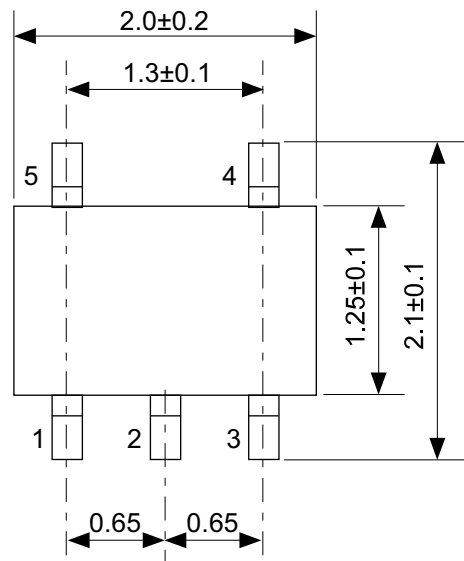
3-4. Output voltage (V_{OL}) vs. I_{SINK}

(a) S-89110A



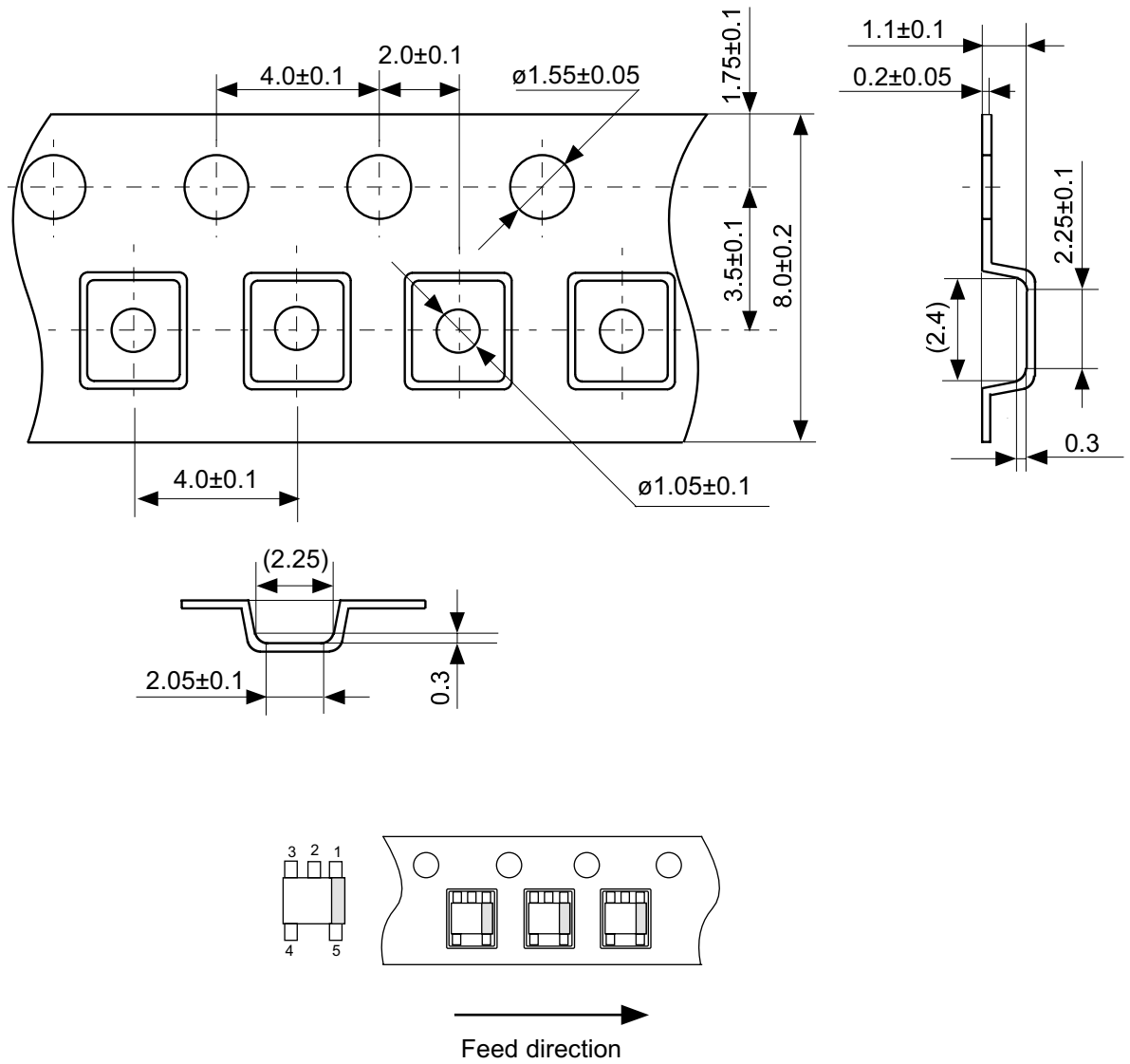
(b) S-89120A





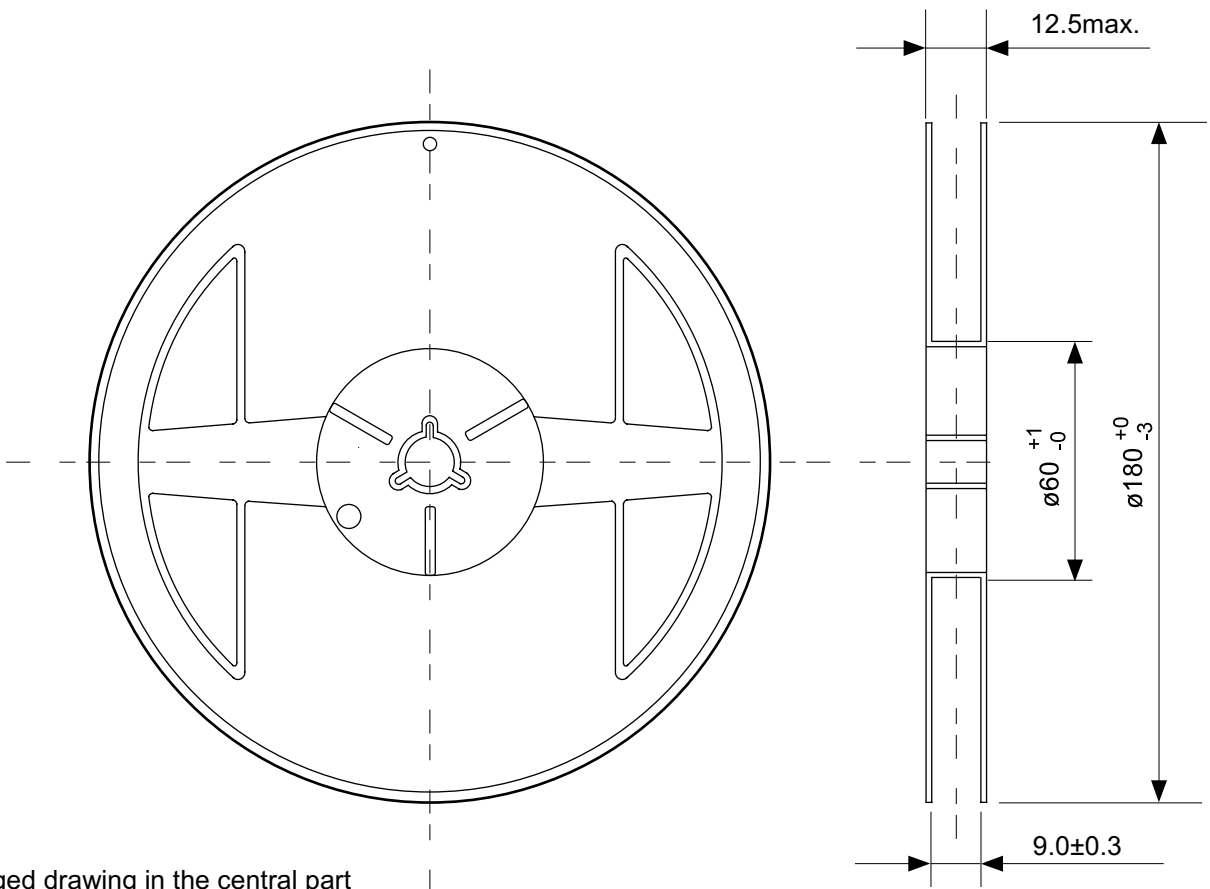
No. NP005-B-P-SD-1.1

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

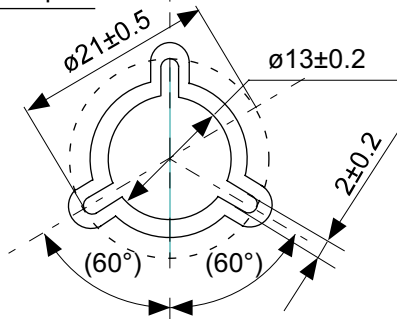


No. NP005-B-C-SD-2.0

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.			

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