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 μA (S-89110A)
  I_{DD} = 10 μA (S-89120A)
- Low input offset voltage: 4.0 mV (max.)
- No external capaciters 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 Code List

Table 1

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

Remark Delivery form : Taping only

■ Pin Configuration

SC-88A
Top view

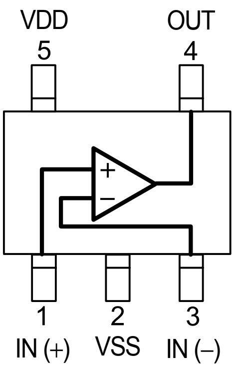


Figure 1

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

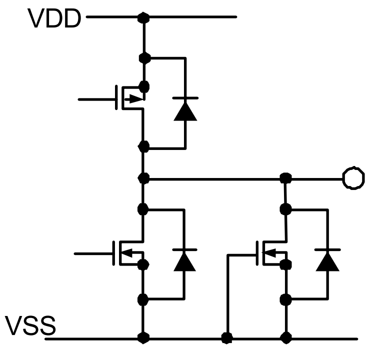


Figure 2

<2> Input pin

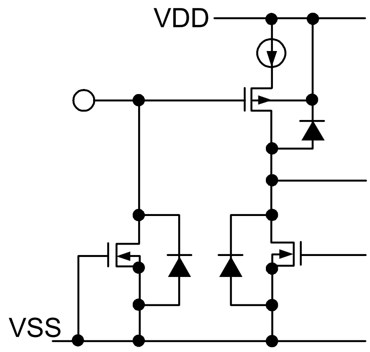


Figure 3

<3> VDD pin

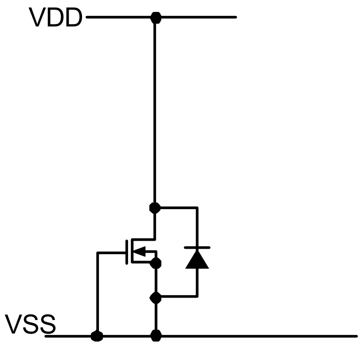


Figure 4

■ Absolute Maximum Ratings

Table 3

Parameter	Symbol	Ratings	Unit
Power supply voltage	$V_{DD} - V_{SS}$	10.0	V
Input voltage	V_{IN}	V_{SS} to V_{DD} (7.0 max.)	V
Output voltage	V_{OUT}	V_{SS} to V_{DD} (7.0 max.)	V
Differential input voltage	V_{IND}	±7.0	V
Power dissipation	P_D	200	mW
Operating temperature range	T_{opr}	–40 to +85	°C
Storage temperature range	T_{stg}	–55 to +125	°C

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.

■ 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 V

Table 5

DC Characteristics (V_{DD} = 5.0 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 9**
		S-89120A		—	10	30	μA	
Input offset voltage	V_{IO}	—		–4	±3	+4	mV	**Figure 5**
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 6**
Voltage gain (open loop)	G_V	—		70	80	—	dB	—
Maximum output swing voltage	V_{OH}	R_L = 1.0 MΩ		4.9	—	—	V	**Figure 7**
	V_{OL}	R_L = 1.0 MΩ				0.1		**Figure 8**
Common-mode input signal rejection ratio	CMRR	—		60	70	—	dB	**Figure 6**
Power supply voltage rejection ratio	PSRR	—		60	70	—	dB	**Figure 5**
Source current	I_{SOURCE}	S-89110A	V_{OH} = 0 V	120	—	—	μA	**Figure 10**
		S-89120A		25	—	—		
Sink current	I_{SINK}	$V_{OL} = V_{DD}$		20	—	—	mA	**Figure 11**

Table 6

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

Parameter	Symbol	Measurement Conditions		Min.	Typ.	Max.	Unit
Slew rate	SR	S-89110A	R_L = 1.0 MΩ, C_L = 15 pF (Refer to **Figure 12.**)	—	0.07	—	V/μs
		S-89120A		—	0.015	—	
Gain-bandwidth product	GBP	S-89110A	—	—	180	—	kHz
		S-89120A		—	40	—	

2. V_{DD} = 3.0 V

Table 7

DC Characteristics (V_{DD} = 3.0 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 9**
		S-89120A		—	10	30	μA	
Input offset voltage	V_{IO}	—		–4	±3	+4	mV	**Figure 5**
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 6**
Voltage gain (open loop)	G_V	—		70	80	—	dB	—
Maximum output swing voltage	V_{OH}	R_L = 1.0 MΩ		2.9	—	—	V	**Figure 7**
	V_{OL}	R_L = 1.0 MΩ		—	—	0.1	V	**Figure 8**
Common-mode input signal rejection ratio	CMRR	—		60	70	—	dB	**Figure 6**
Power supply voltage rejection ratio	PSRR	—		60	70	—	dB	**Figure 5**
Source current	I_{SOURCE}	S-89110A	V_{OH} = 0 V	120	—	—	μA	**Figure 10**
	I_{SOURCE}	S-89120A		25	—	—		
Sink current	I_{SINK}	V_{OL} = V_{DD}		15	—	—	mA	**Figure 11**

Table 8

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

Parameter	Symbol	Measurement Conditions		Min.	Typ.	Max.	Unit
Slew rate	SR	S-89110A	R_L = 1.0 MΩ, C_L = 15 pF (Refer to **Figure 12.**)	—	0.07	—	V/μs
		S-89120A		—	0.015	—	
Gain-bandwidth product	GBP	S-89110A	—	—	175	—	kHz
		S-89120A		—	35	—	

3. V_{DD} = 1.8 V

Table 9

DC Characteristics (V_{DD} = 1.8 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 9**
		S-89120A		—	10	30	μA	
Input offset voltage	V_{IO}	—		−4	±3	+4	mV	**Figure 5**
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 6**
Voltage gain (open loop)	G_V	—		70	80	—	dB	—
Maximum output swing voltage	V_{OH}	R_L = 1.0 MΩ		1.7	—	—	V	**Figure 7**
	V_{OL}	R_L = 1.0 MΩ		—	—	0.1	V	**Figure 8**
Common-mode input signal rejection ratio	CMRR	—		60	70	—	dB	**Figure 6**
Power supply voltage rejection ratio	PSRR	—		60	70	—	dB	**Figure 5**
Source current	I_{SOURCE}	S-89110A	V_{OH} = 0 V	100	—	—	μA	**Figure 10**
	I_{SOURCE}	S-89120A		20	—	—		
Sink current	I_{SINK}	$V_{OL} = V_{DD}$		5	—	—	mA	**Figure 11**

Table 10

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

Parameter	Symbol	Measurement Conditions		Min.	Typ.	Max.	Unit
Slew rate	SR	S-89110A	R_L = 1.0 MΩ, C_L = 15 pF (Refer to **Figure 12.**)	—	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

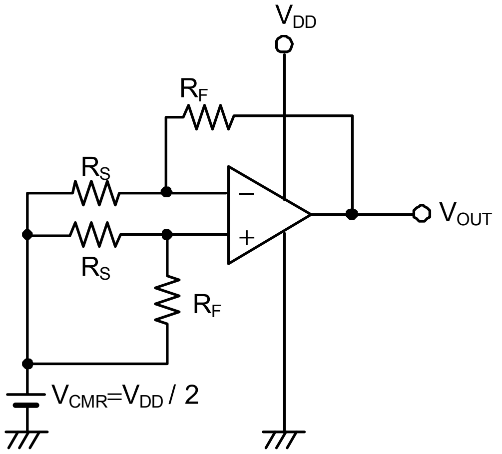


Figure 5

- **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 V: $V_{DD} = V_{DD1}$, $V_{OUT} = V_{OUT1}$
  When V_{DD} = 5.0 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

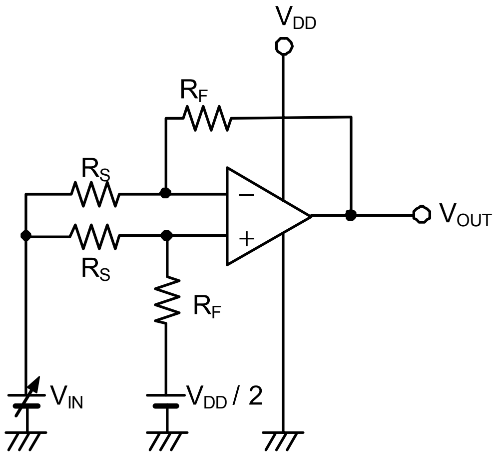


Figure 6

- **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 $V_{IN} = V_{CMR}$ (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

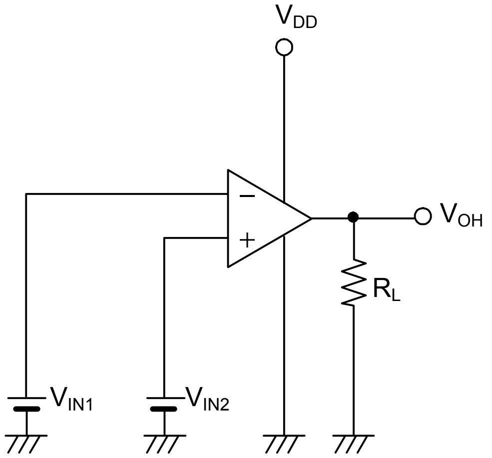


Figure 7

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

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

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

  $R_L = 1\ M\Omega$

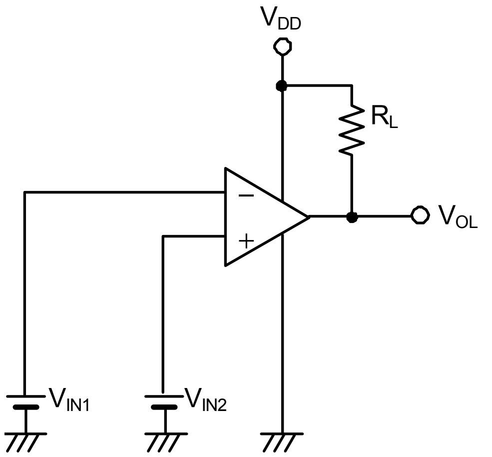


Figure 8

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

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

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

  $R_L = 1\ M\Omega$

4. Current consumption

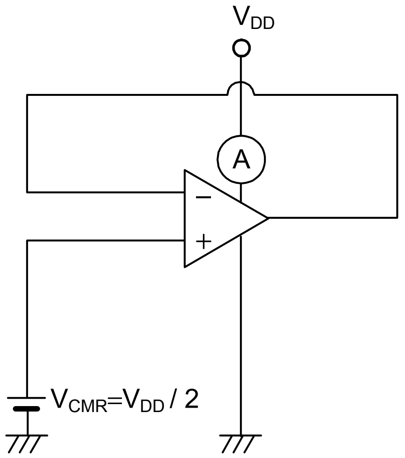


Figure 9

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

5. Source current

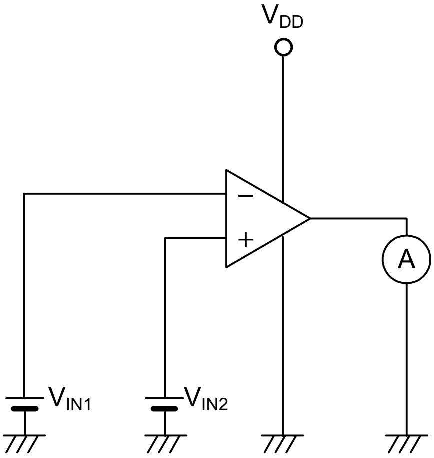


Figure 10

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

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

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

6. Sink current

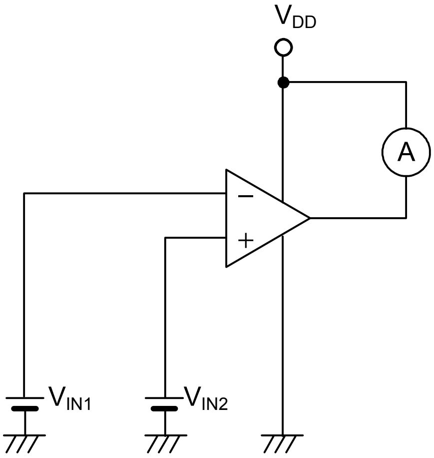


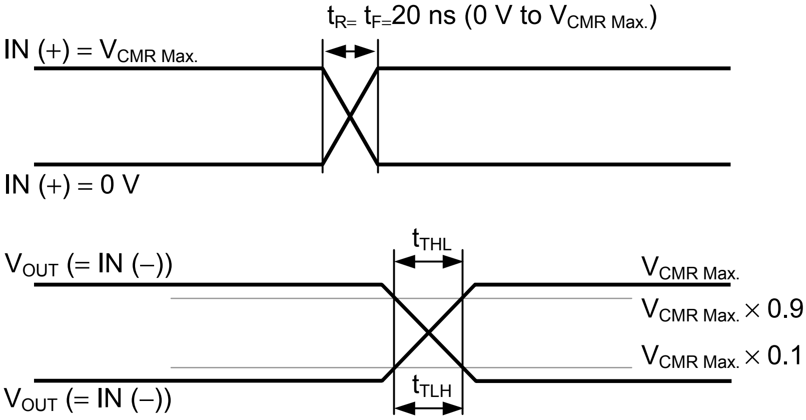
Figure 11

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

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

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

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 12

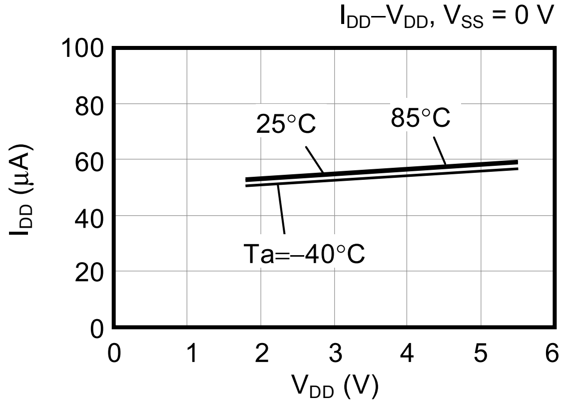
■ Precaution

- 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.

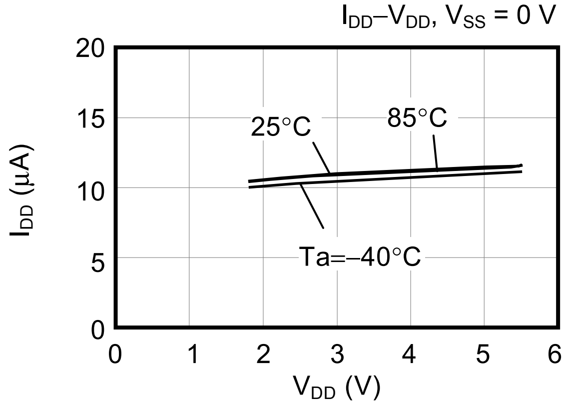
■ Characteristics (Reference Data)

1. Current consumption vs. Power supply voltage

(a) S-89110A

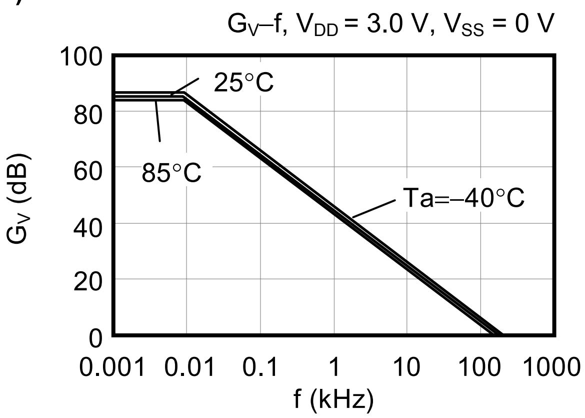


(b) S-89120A

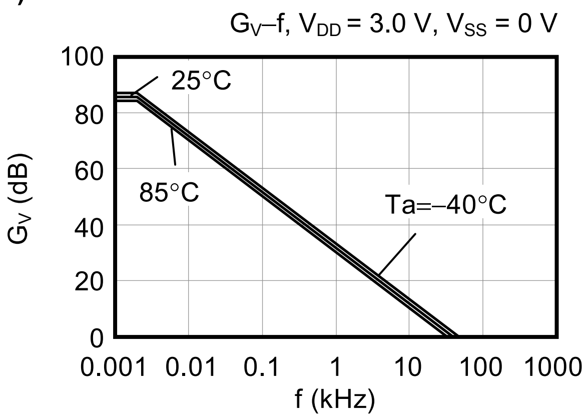


2. Voltage gain vs. Frequency

(a) S-89110A



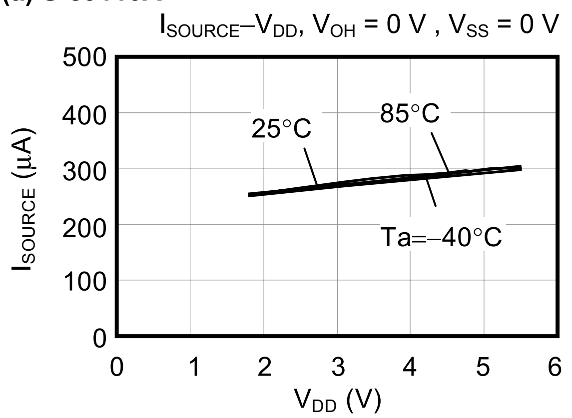
(b) S-89120A



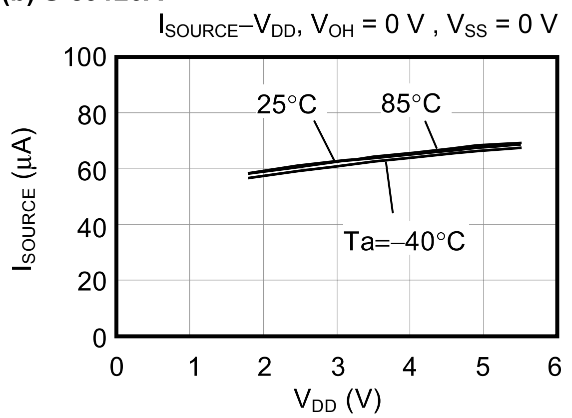
3. Output current

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

(a) S-89110A

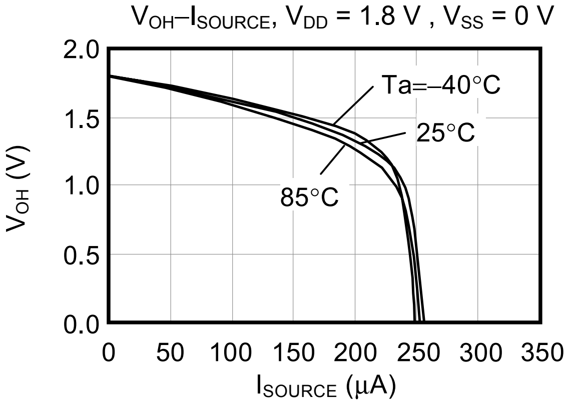


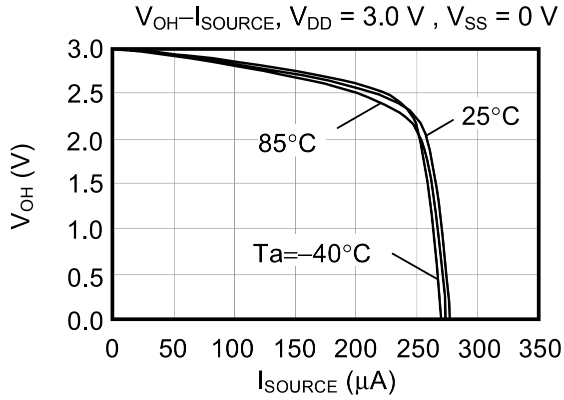
(b) S-89120A

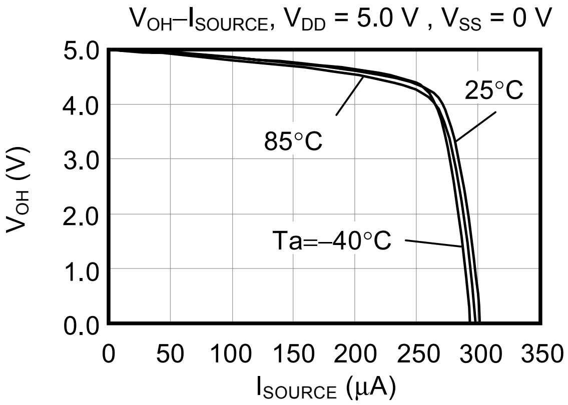


3-2. Output voltage (V_{OH}) vs. I_{SOURCE}

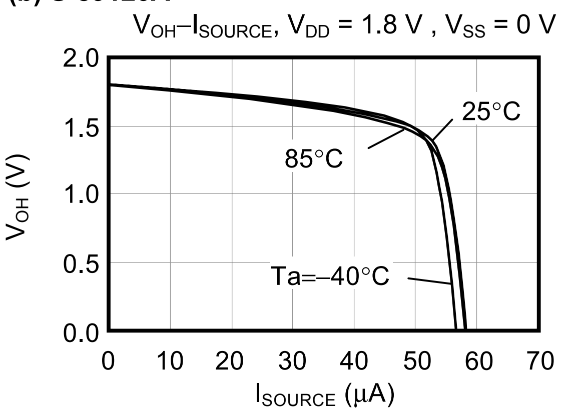
(a) S-89110A

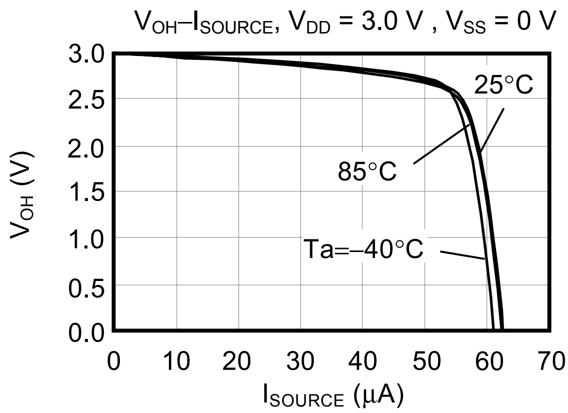


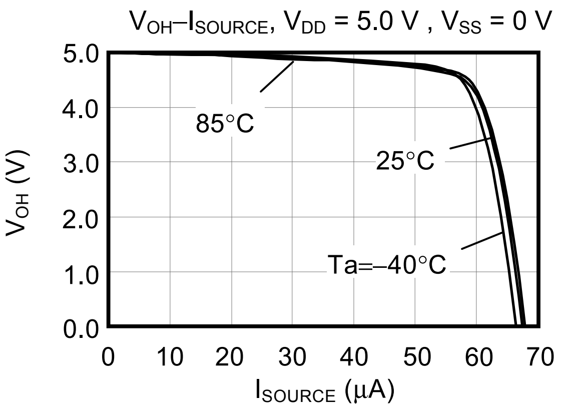




(b) S-89120A

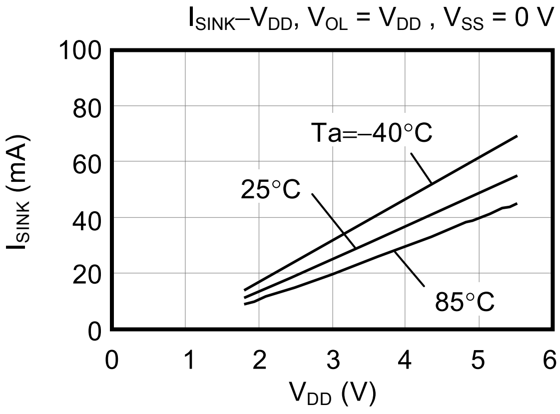




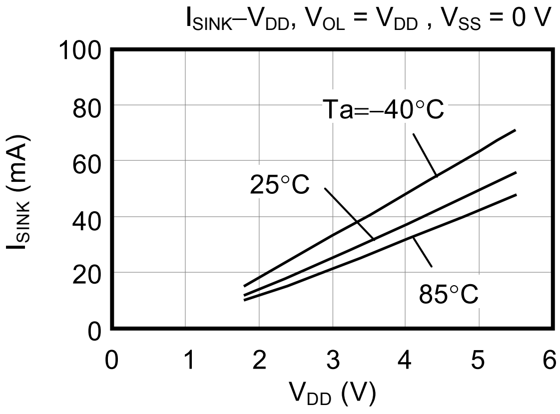


3-3. I_{SINK} vs. Power supply voltage

(a) S-89110A



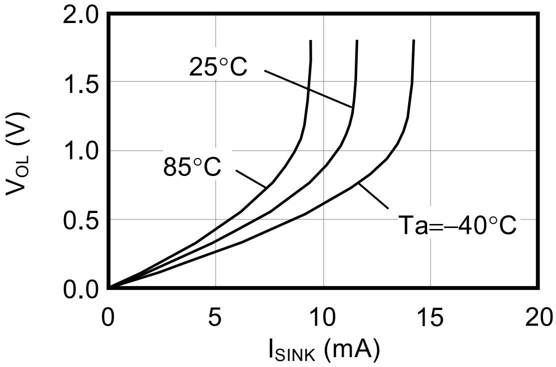
(b) S-89120A



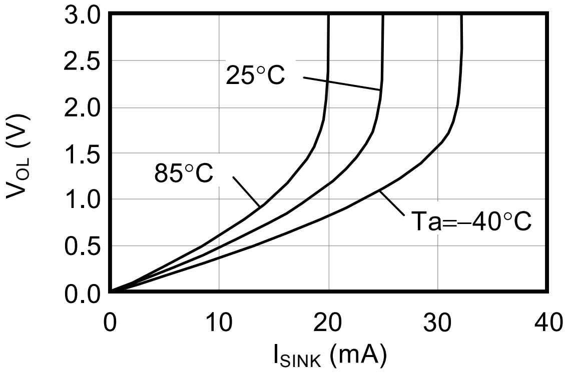
3-4. Output voltage (V_{OL}) vs. I_{SINK}

(a) S-89110A

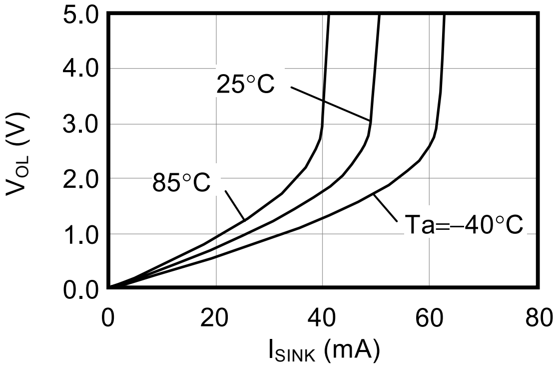
V_{OL}–I_{SINK}, V_{DD} = 1.8 V, V_{SS} = 0 V



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

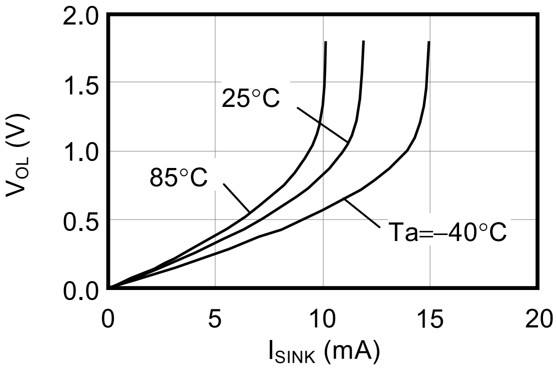


V_{OL}–I_{SINK}, V_{DD} = 5.0 V, V_{SS} = 0 V

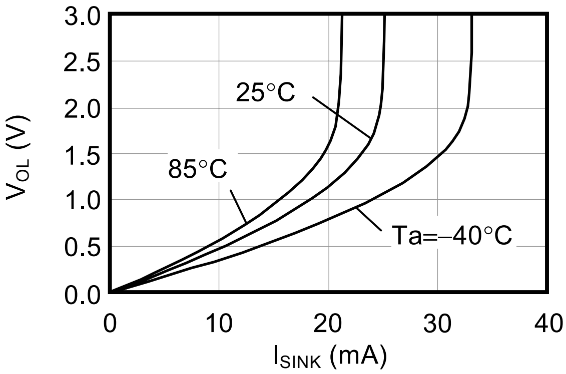


(b) S-89120A

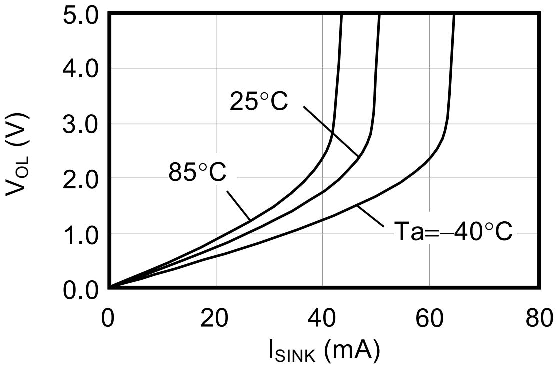
V_{OL}–I_{SINK}, V_{DD} = 1.8 V, V_{SS} = 0 V

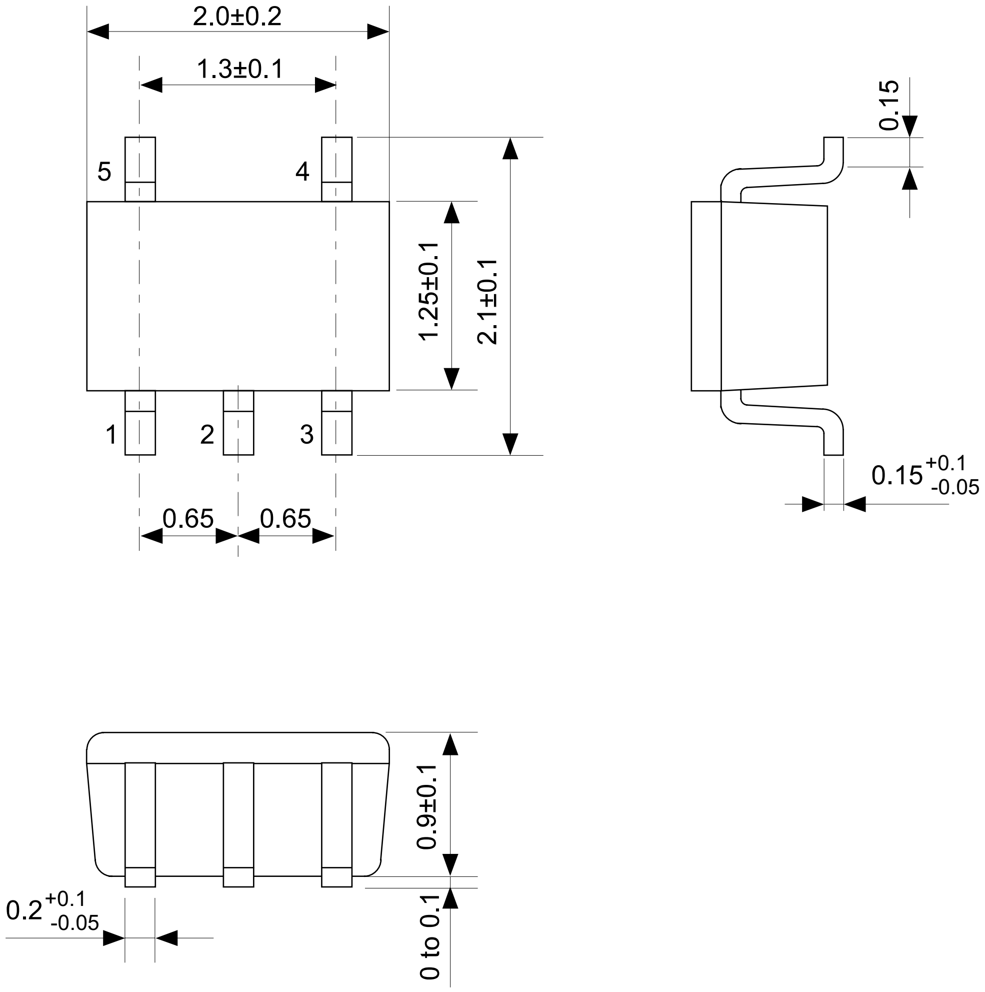


V_{OL}–I_{SINK}, V_{DD} = 3.0 V, V_{SS} = 0 V



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

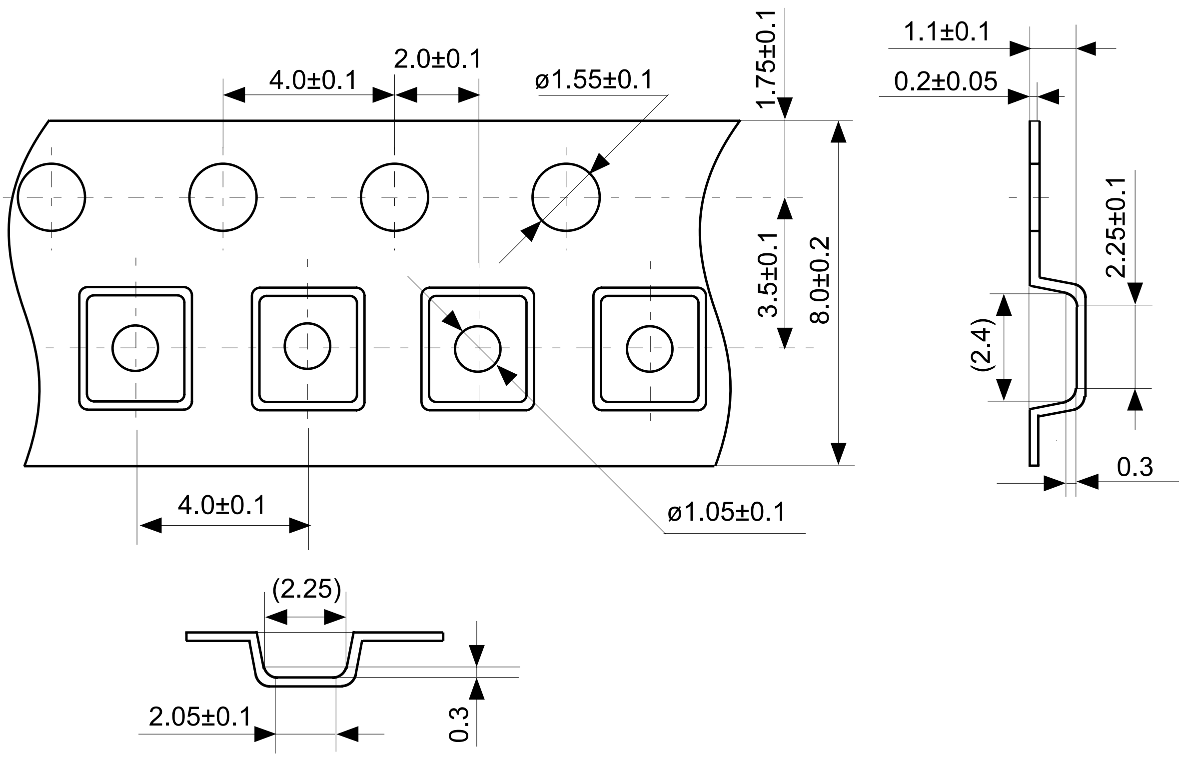


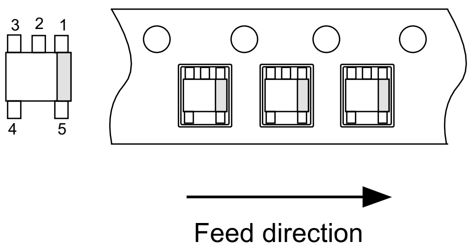


No. NP005-B-P-SD-1.1

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

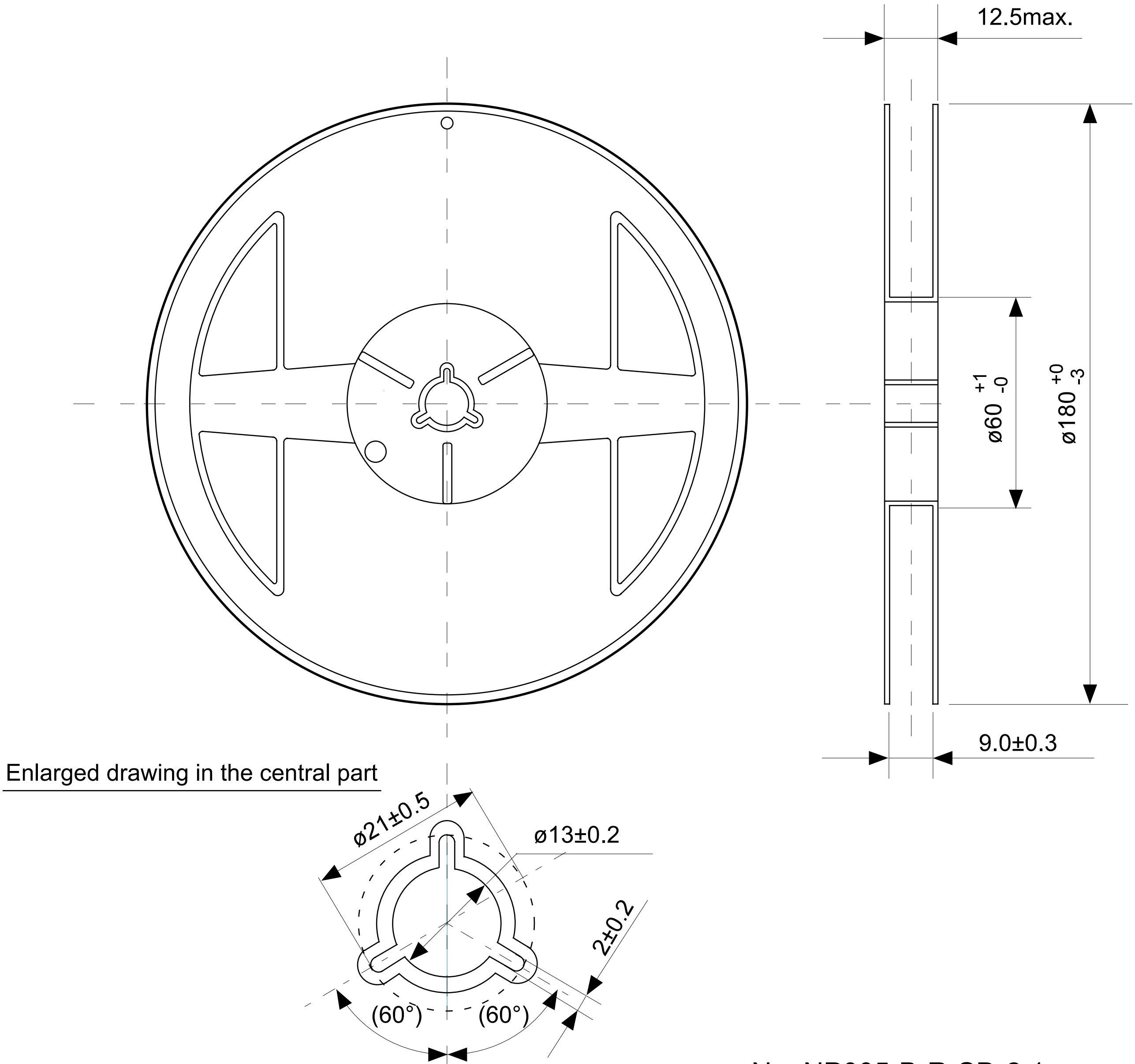
Seiko Instruments Inc.





No. NP005-B-C-SD-1.1

TITLE	SC88A-B-Carrier Tape
No.	NP005-B-C-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



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.