

MINI ANALOG SERIES
CMOS SINGLE OPERATIONAL AMPLIFIER
S-891xxA Series

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

The S-891xxA Series 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.

■ Features

- CMOS operational amplifier
- Low operating voltage: $V_{DD} = 1.8$ to 5.5 V
- Low current consumption: $I_{DD} = 50$ μ A (S-89110ANC)
 $I_{DD} = 10$ μ A (S-89120ANC)
- Low input offset voltage (4.0 mV max.)
- No external capacitors required for internal phase compensation
- Output full swing
- Small package (SC-88A: 2.0 mm $\times$ 2.1 mm)

■ Application

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

■ Package

SC-88A (PKG drawing code: NP005-B)

■ Selection Guide
Table 1

Current consumption	Product Name
$I_{DD} = 50$ μ A	S-89110ANC-1A1-TF
$I_{DD} = 10$ μ A	S-89120ANC-1A2-TF

■ Absolute Maximum Ratings
Table 2

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	$^{\circ}$ C
Storage temperature range	T_{stg}	-55 to +125	$^{\circ}$ 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 3

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

■ Pin Configuration

5-Pin SC-88A Top View

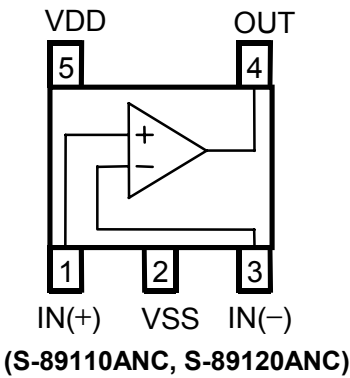


Figure 1

Table 4

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 circuits]

<1> Output pin

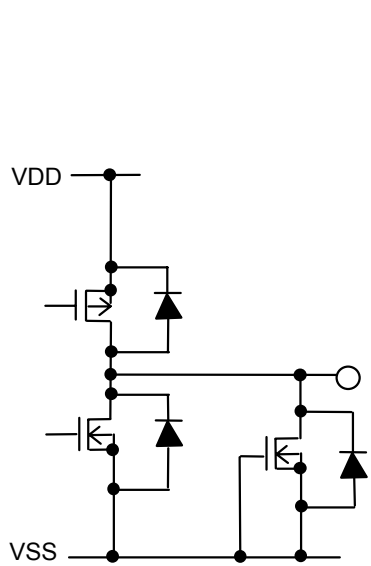


Figure 2

<2> Input pin

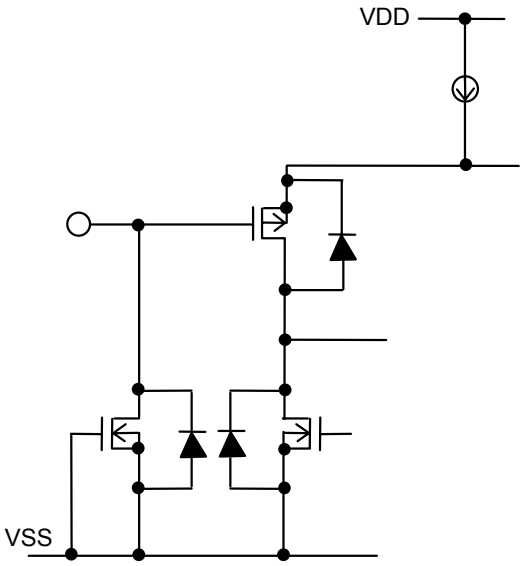


Figure 3

<3> VDD pin

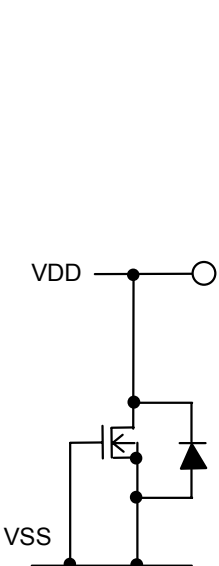


Figure 4

■ Electrical Characteristics

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

DC Characteristics ($V_{DD} = 5.0\text{ V}$)**Table 5**

(Ta = 25°C unless otherwise specified)

Parameter	Model No.	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	Measurement Circuit
Input offset voltage	—	V_{IO}	—	—	± 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	—
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 7
	—	V_{OL}	$R_L = 1.0\text{ M}\Omega$	—	—	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
Supply current	S-89110A	I_{DD}	—	—	50	120	μA	Figure 9
	S-89120A	I_{DD}	—	—	10	30	μA	Figure 9
Source current	S-89110A	I_{SOURCE}	$V_{OH} = 0\text{ V}$	120	—	—	μA	Figure 10
	S-89120A	I_{SOURCE}	$V_{OH} = 0\text{ V}$	25	—	—	μA	Figure 10
Sink current	—	I_{SINK}	$V_{OL} = V_{DD}$	20	—	—	mA	Figure 11

AC Characteristics ($V_{DD} = 5.0\text{ V}$)**Table 6**

(Ta = 25°C unless otherwise specified)

Parameter	Model No.	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit
Slew rate	S-89110A	SR	$R_L = 1.0\text{ M}\Omega$ $C_L = 15\text{ pF}$ (Refer to Figure 12.)	—	0.07	—	V/ μs
	S-89120A	SR		—	0.015	—	V/ μs
Gain-bandwidth product	S-89110A	GBP	—	—	180	—	kHz
	S-89120A	GBP		—	40	—	kHz

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

DC Characteristics ($V_{DD} = 3.0\text{ V}$)

Table 7

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

Parameter	Model No.	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	Measurement Circuit
Input offset voltage	—	V_{IO}	—	—	± 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	—
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 7
	—	V_{OL}	$R_L = 1.0\text{ M}\Omega$	—	—	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
Supply current	S-89110A	I_{DD}	—	—	50	120	μA	Figure 9
	S-89120A	I_{DD}	—	—	10	30	μA	Figure 9
Source current	S-89110A	I_{SOURCE}	$V_{OH} = 0\text{ V}$	120	—	—	μA	Figure 10
	S-89120A	I_{SOURCE}	$V_{OH} = 0\text{ V}$	25	—	—	μA	Figure 10
Sink current	—	I_{SINK}	$V_{OL} = V_{DD}$	15	—	—	mA	Figure 11

AC Characteristics ($V_{DD} = 3.0\text{ V}$)

Table 8

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

Parameter	Model No.	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit
Slew rate	S-89110A	SR	$R_L = 1.0\text{ M}\Omega$ $C_L = 15\text{ pF}$ (Refer to Figure 12.)	—	0.07	—	V/ μs
	S-89120A	SR		—	0.015	—	V/ μs
Gain-bandwidth product	S-89110A	GBP	—	—	175	—	kHz
	S-89120A	GBP		—	35	—	kHz

3. $V_{DD} = 1.8\text{ V}$ DC Characteristics ($V_{DD} = 1.8\text{ V}$)**Table 9**

(Ta = 25°C unless otherwise specified)

Parameter	Model No.	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit	Measurement Circuit
Input offset voltage	—	V_{IO}	—	—	± 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	—
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 7
	—	V_{OL}	$R_L = 1.0\text{ M}\Omega$	—	—	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
Supply current	S-89110A	I_{DD}	—	—	50	120	μA	Figure 9
	S-89120A	I_{DD}	—	—	10	30	μA	Figure 9
Source current	S-89110A	I_{SOURCE}	$V_{OH} = 0\text{ V}$	100	—	—	μA	Figure 10
	S-89120A	I_{SOURCE}	$V_{OH} = 0\text{ V}$	20	—	—	μA	Figure 10
Sink current	—	I_{SINK}	$V_{OL} = V_{DD}$	5	—	—	mA	Figure 11

AC Characteristics ($V_{DD} = 1.8\text{ V}$)**Table 10**

(Ta = 25°C unless otherwise specified)

Parameter	Model No.	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit
Slew rate	S-89110A	SR	$R_L = 1.0\text{ M}\Omega$ $C_L = 15\text{ pF}$ (Refer to Figure 12.)	—	0.07	—	V/ μs
	S-89120A	SR		—	0.015	—	V/ μs
Gain-bandwidth product	S-89110A	GBP	—	—	160	—	kHz
	S-89120A	GBP		—	30	—	kHz

■ Measurement Circuit

1. Power supply voltage rejection ratio, input offset voltage

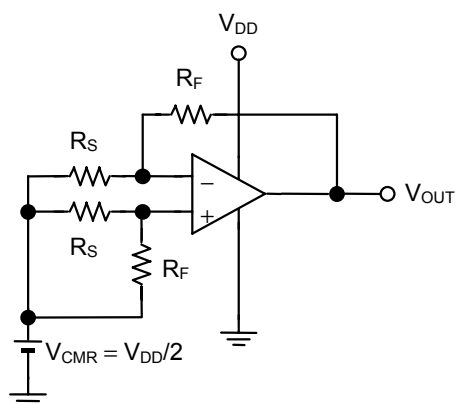


Figure 5

- Power supply voltage rejection ratio
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

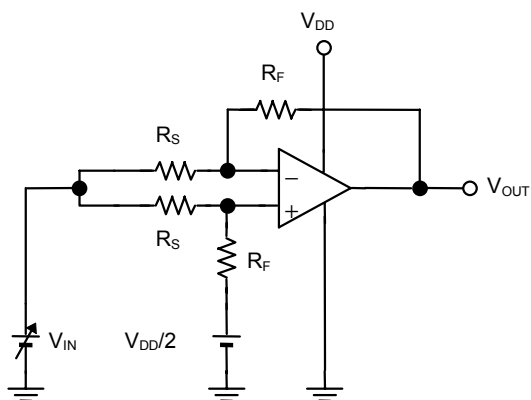


Figure 6

- Common-mode input signal rejection ratio
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 $V_{IN} = V_{DD}/2$: $V_{IN} = V_{IN2}$, $V_{OUT} = V_{OUT2}$

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

- Common-mode input voltage range
The common-mode input voltage range is the range of V_{IN2} in which V_{OUT} satisfies the common-mode input signal rejection ratio specifications.

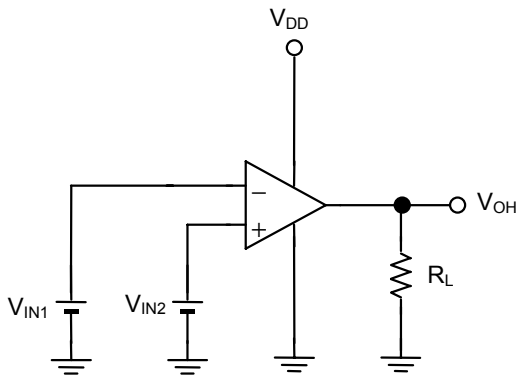
3. Maximum output swing voltage (V_{OH})

Figure 7

- Maximum output swing voltage (V_{OH})

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

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

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

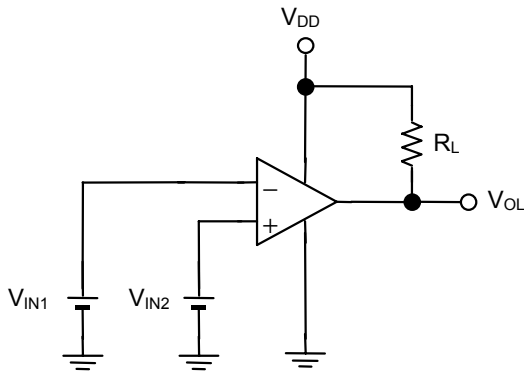
4. Maximum output swing voltage (V_{OL})

Figure 8

- Maximum output swing voltage (V_{OL})

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

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

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

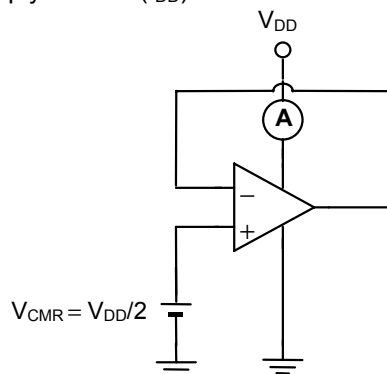
5. Supply current (I_{DD})

Figure 9

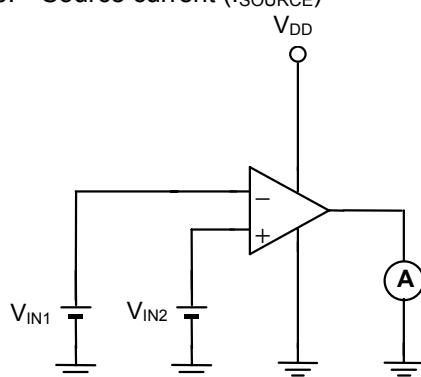
6. Source current (I_{SOURCE})

Figure 10

- Source current (I_{SOURCE})

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

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

7. Sink current (I_{SINK})

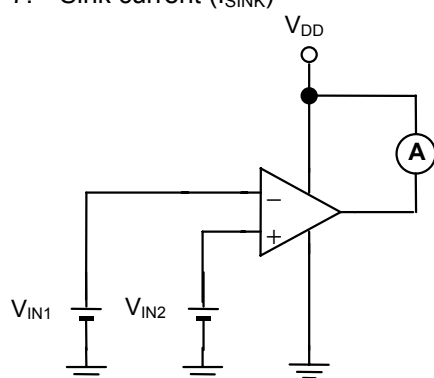


Figure 11

- Sink current (I_{SINK})

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

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

8. Slew rate (SR): Measured by the voltage follower circuit

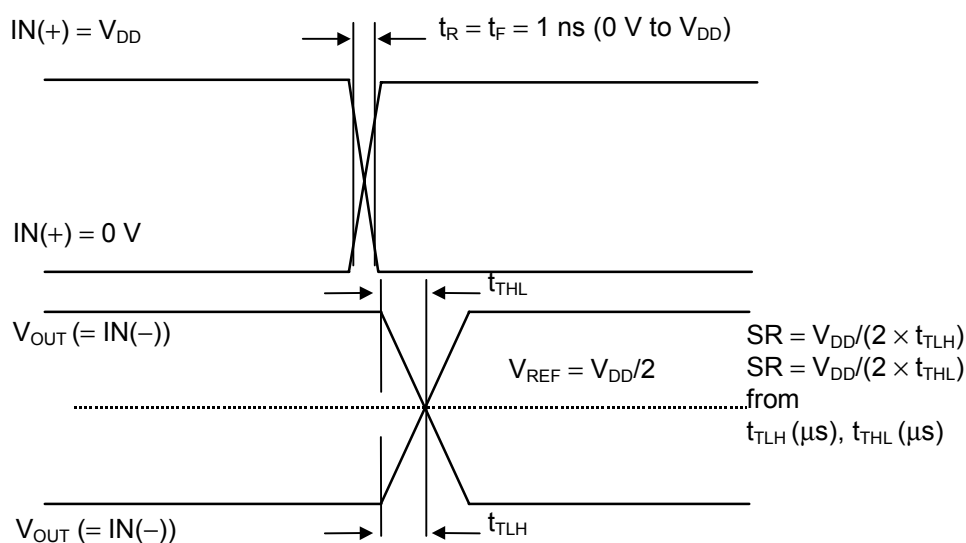
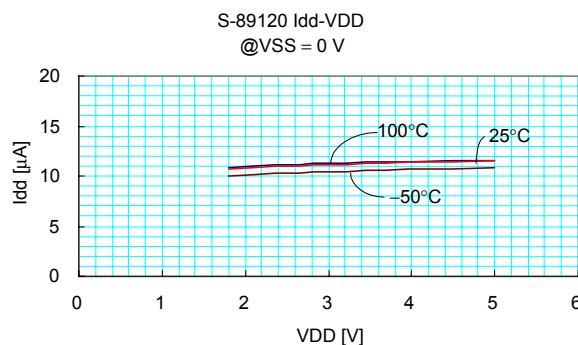
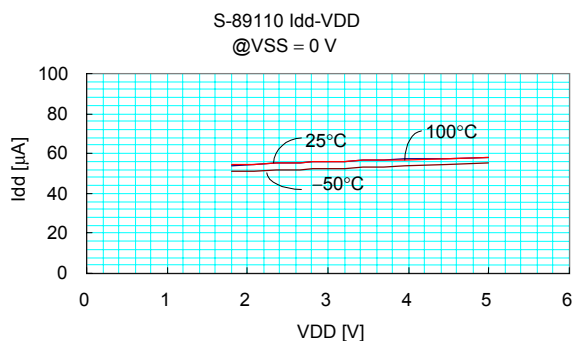


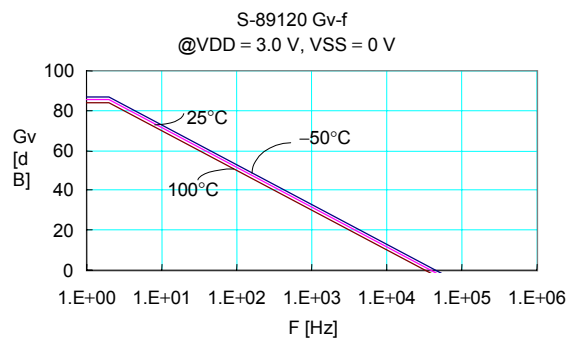
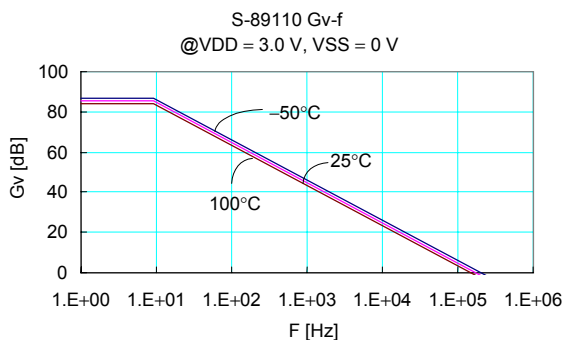
Figure 12

■ Operational Amplifier Characteristics (All Data Indicates Typical Values for One Circuit)

1. Current consumption vs. Power supply voltage

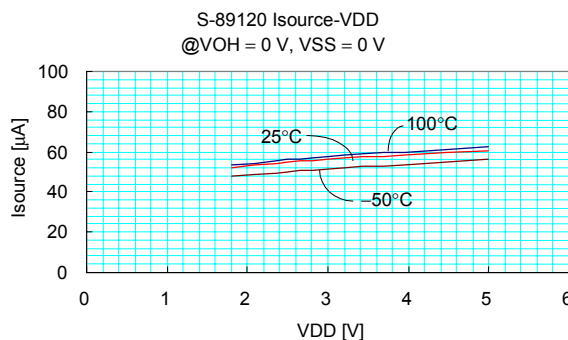
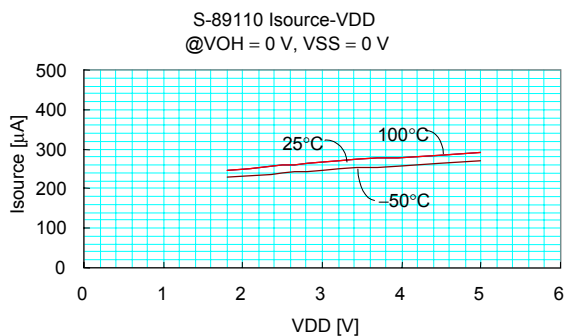


2. Voltage gain vs. Frequency

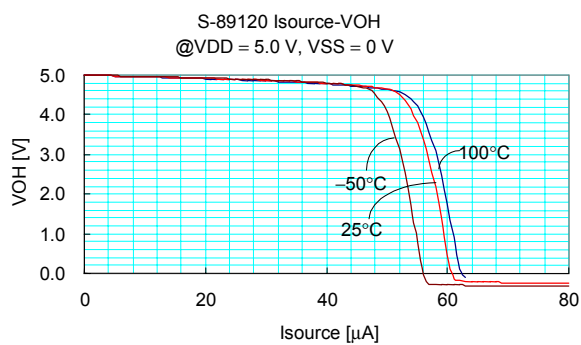
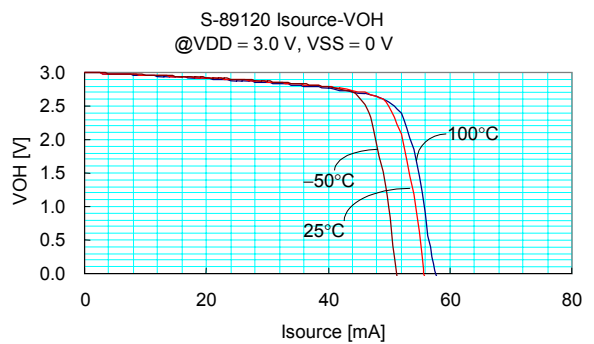
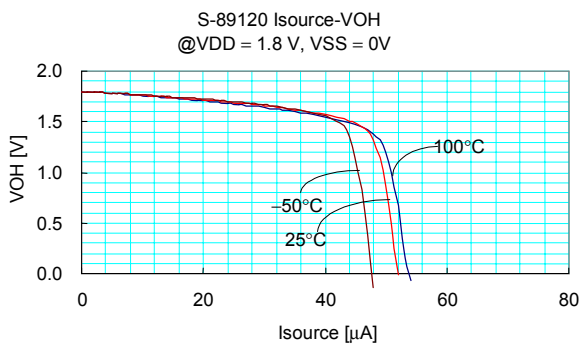
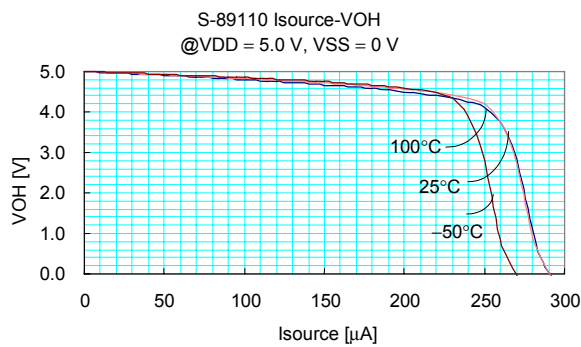
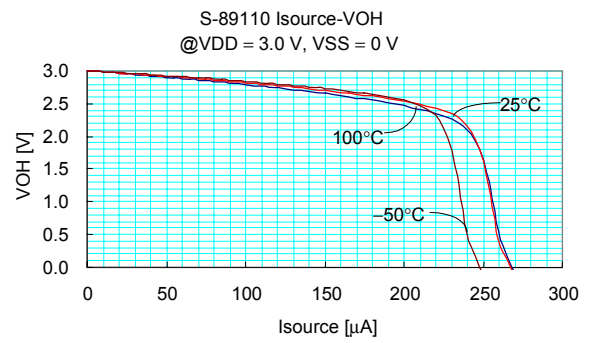
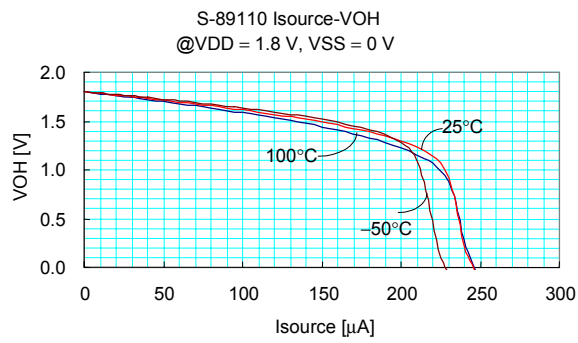


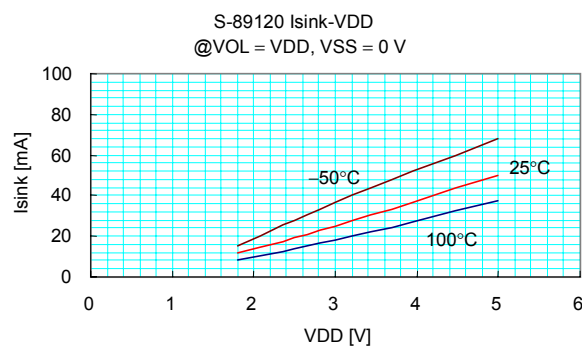
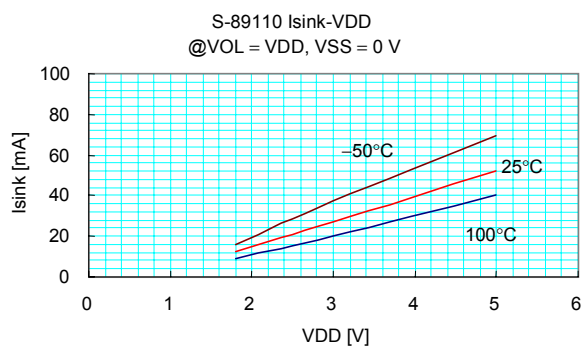
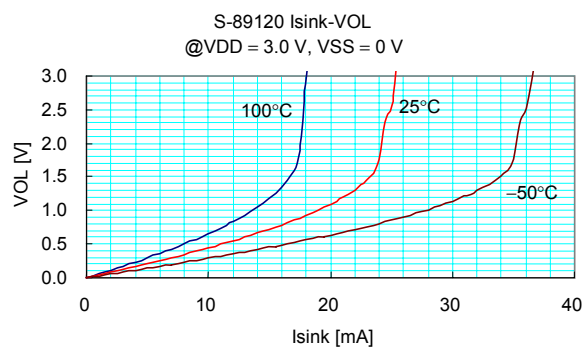
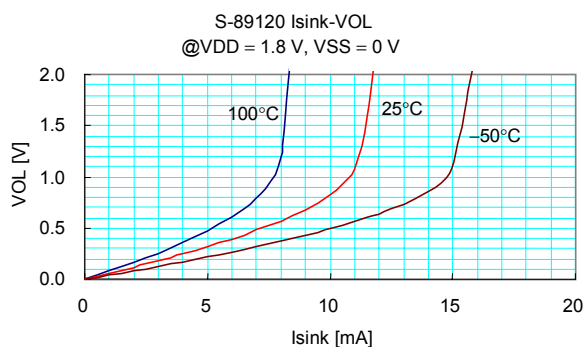
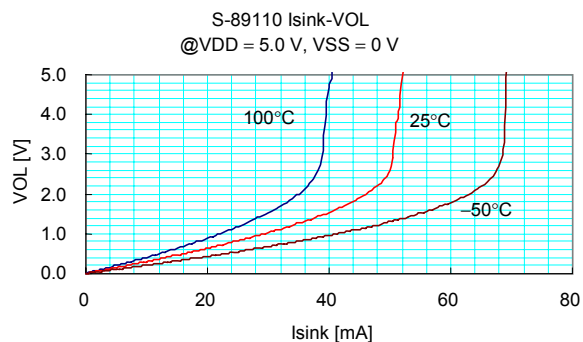
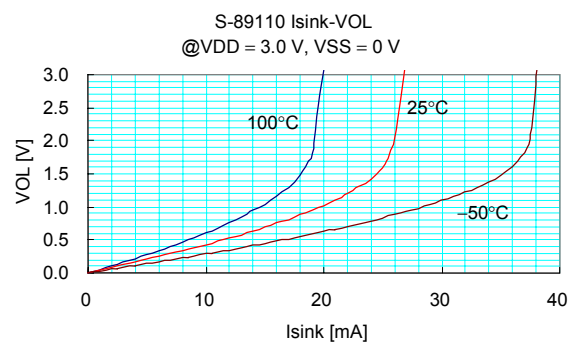
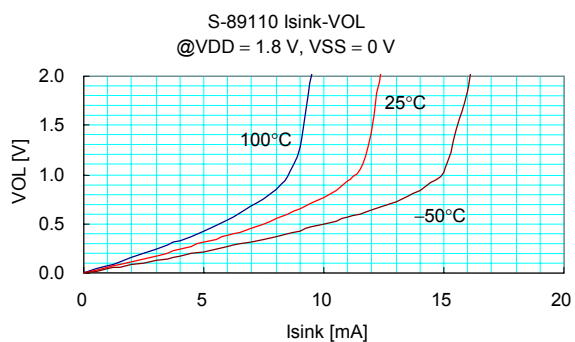
3. Output current

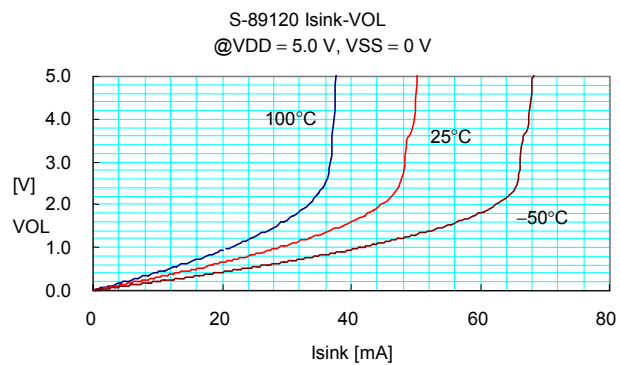
3-1. I_{SOURCE} vs. Power supply voltage



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



3-3. I_{SINK} vs. Power supply voltage3-4. Output voltage (V_{OL}) vs. I_{SINK} 

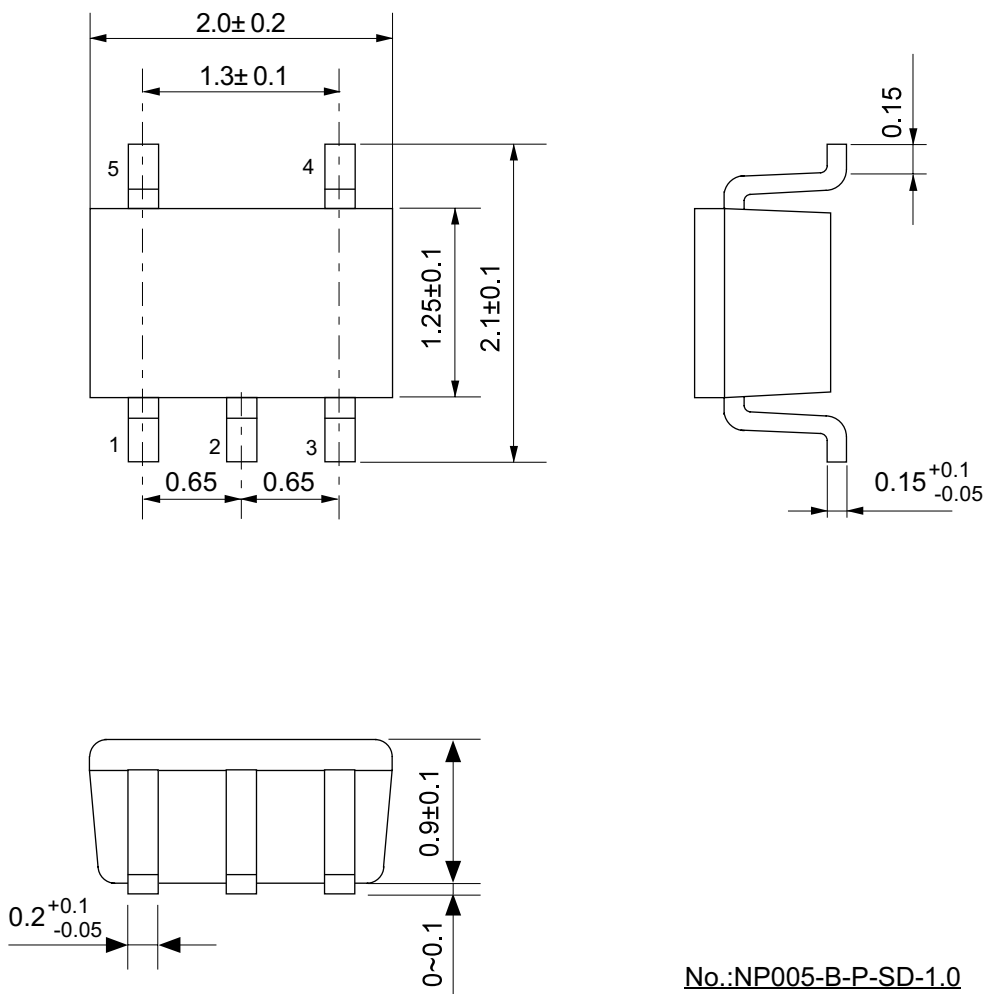


■ SC-88A

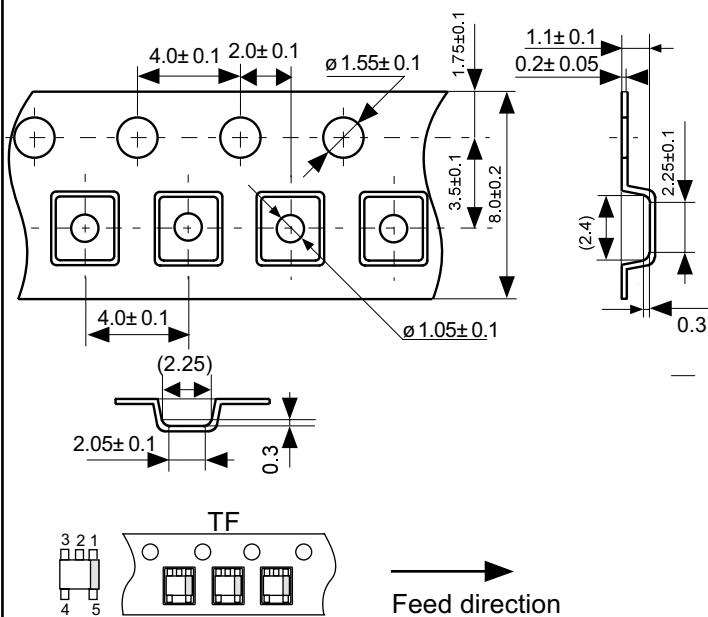
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● Dimensions

Unit: mm

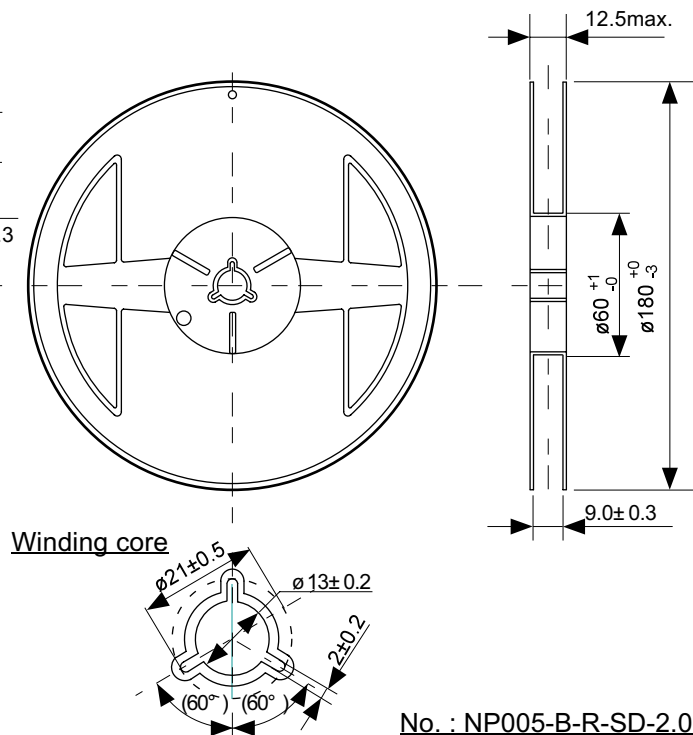


●Taping Specifications



●Reel Specifications

3000 pcs/reel



No. : NP005-B-C-SD-1.0

No. : NP005-B-R-SD-2.0

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