



# S-89530A/89531A Series

## MINI ANALOG SERIES 0.7 $\mu$ A Rail-to-Rail CMOS COMPARATOR

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Rev.4.0\_00

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

The S-89530A/89531A Series are CMOS type comparators that feature Rail-to-Rail <sup>\*1</sup> I/O and can be driven at a lower voltage and lower current consumption than existing comparators, making the S-89530A/89531A for use in battery-powered compact portable devices.

\*1. Rail-to-Rail is a registered trademark of Motorola Inc.

### ■ Features

- Can be driven lower voltage than existing general-purpose comparators:  $V_{DD} = 0.9 \text{ V to } 5.5 \text{ V}$
- Low current consumption:  $I_{DD} = 0.7 \mu\text{A (Typ.)}$
- Rail-to-Rail wide input and output voltage range:  $V_{CMR} = V_{SS} \text{ to } V_{DD}$
- Low input offset voltage:  $5.0 \text{ mV max.}$
- Lead-free, halogen-free <sup>\*1</sup>

\*1. Refer to “■ Product Code List” for details.

### ■ Applications

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

### ■ Package

Package Name	Drawing Code		
	Package	Tape	Reel
SC-88A	NP005-B-P-SD	NP005-B-C-SD	NP005-B-R-SD

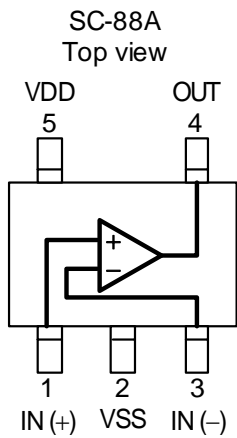
### ■ Product Code List

Table 1

Input Offset Voltage	Product Name (Single)
$V_{IO} = 10 \text{ mV max.}$	S-89530ACNC-HCBTFz
$V_{IO} = 5 \text{ mV max.}$	S-89531ACNC-HCCTFz

Remark z: G or S

■ **Pin Configuration**



**Figure 1**

**Table 2**

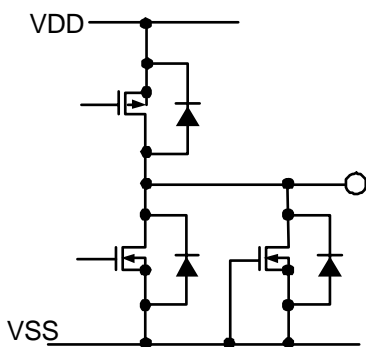
Pin No.	Symbol	Description	Internal Equivalent Circuit
1	IN(+)	Non-inverted input pin	<b>Figure 3</b>
2	VSS	GND pin	—
3	IN(-)	Inverted input pin	<b>Figure 3</b>
4	OUT	Output pin	<b>Figure 2</b>
5	VDD	Positive power supply pin	<b>Figure 4</b>

■ **Internal Equivalent Circuits**

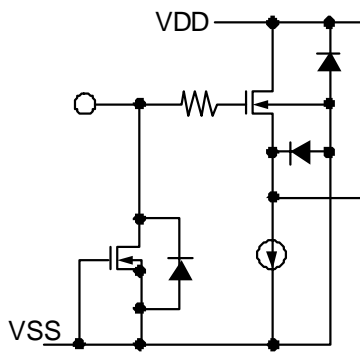
(1) Output pin

(2) Input pin

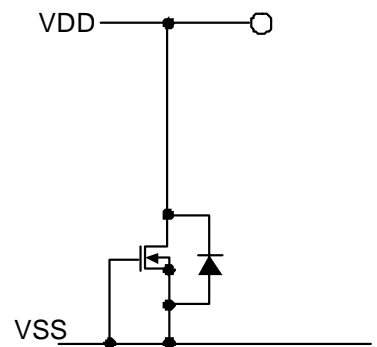
(3) VDD pin



**Figure 2**



**Figure 3**



**Figure 4**

■ **Absolute Maximum Ratings**

**Table 3**

(Ta = 25°C unless otherwise specified)

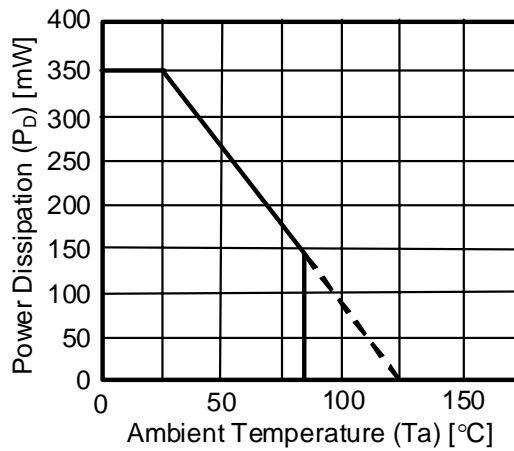
Parameter	Symbol	Ratings	Unit
Power supply voltage	$V_{DD}$	$V_{SS}-0.3$ to $V_{SS}+7.0$	V
Input voltage	$V_{IN}$	$V_{SS}-0.3$ to $V_{SS}+7.0$ (7.0 max.)	V
Output voltage	$V_{OUT}$	$V_{SS}-0.3$ to $V_{DD}+0.3$ (7.0 max.)	V
Differential input voltage	$V_{IND}$	$\pm 5.5$	V
Power dissipation	$P_D$	200 (When not mounted on board)	mW
		$350^{*1}$	mW
Operating temperature	$T_{opr}$	-40 to +85	°C
Storage temperature	$T_{sto}$	-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 Voltage Range**

**Table 4**

Parameter	Symbol	Range	Unit
Operating power supply voltage range	$V_{DD}$	0.9 to 5.5	V

■ **Electrical Characteristics**

The S-89530ACNC and S-89531ACNC only differ in the input offset voltage. All other specifications are the same.

1.  $V_{DD} = 3.0$  V

**Table 5**

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

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

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Measurement circuit
Supply current	$I_{DDH}$	$V_{IN1} = V_{SS}, V_{IN2} = V_{DD}, R_L = \infty$	—	0.7	1.4	$\mu\text{A}$	<b>Figure 11</b>
	$I_{DDL}$	$V_{IN1} = V_{DD}, V_{IN2} = V_{SS}, R_L = \infty$	—	0.25	0.5		
Input offset voltage	$V_{IO}$	S-89530A: $V_{CMR} = 1.5$ V	-10	$\pm 5$	+10	mV	<b>Figure 7</b>
		S-89531A: $V_{CMR} = 1.5$ V	-5	$\pm 3$	+5		
Input offset current	$I_{IO}$	—	—	1	—	$\mu\text{A}$	—
Input bias current	$I_{BIAS}$	—	—	1	—		
Common-mode input voltage range	$V_{CMR}$	—	0	—	3.0	V	<b>Figure 8</b>
Voltage gain (open loop)	$A_{VOL}$	$V_{CMR} = 1.5$ V, $R_L = 1$ M $\Omega$	—	86	—	dB	—
Maximum output swing voltage	$V_{OH}$	$R_L = 1$ M $\Omega$	2.98	—	—	V	<b>Figure 9</b>
	$V_{OL}$	$R_L = 1$ M $\Omega$	—	—	0.02		<b>Figure 10</b>
Common-mode input signal rejection ratio	CMRR	$V_{SS} \leq V_{CMR} \leq V_{DD}$	45	65	—	dB	<b>Figure 8</b>
Power supply voltage rejection ratio	PSRR	$V_{DD} = 0.9$ V to 5.5 V	66	75	—	dB	<b>Figure 6</b>
Source current*1	$I_{SOURCE}$	$V_{OUT} = V_{DD} - 0.1$ V	380	500	—	$\mu\text{A}$	<b>Figure 12</b>
		$V_{OUT} = 0$ V	4000	5500	—		
Sink current	$I_{SINK}$	$V_{OUT} = 0.1$ V	400	550	—	$\mu\text{A}$	<b>Figure 13</b>
		$V_{OUT} = V_{DD}$	4800	6000	—		

\*1. Be sure to use the product with a source current of no more than 7 mA.

**Table 6**

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

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

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Rise propagation delay time	$t_{PLH}$	Overdrive = 100 mV $C_L = 15$ pF (Refer to <b>Figure 14</b> )	—	110	—	$\mu\text{s}$
Fall propagation delay time	$t_{PHL}$		—	280	—	
Rise response time	$t_{TLH}$		—	10	—	
Fall response time	$t_{THL}$		—	30	—	

**2.  $V_{DD} = 1.8$  V**

**Table 7**

DC Characteristics ( $V_{DD} = 1.8$  V) ( $T_a = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Measurement circuit
Supply current	$I_{DDH}$	$V_{IN1} = V_{SS}, V_{IN2} = V_{DD}, R_L = \infty$	—	0.7	1.4	$\mu\text{A}$	<b>Figure 11</b>
	$I_{DDL}$	$V_{IN1} = V_{DD}, V_{IN2} = V_{SS}, R_L = \infty$	—	0.25	0.5		
Input offset voltage	$V_{IO}$	S-89530A: $V_{CMR} = 0.9$ V	-10	$\pm 5$	+10	mV	<b>Figure 7</b>
		S-89531A: $V_{CMR} = 0.9$ V	-5	$\pm 3$	+5		
Input offset current	$I_{IO}$	—	—	1	—	pA	—
Input bias current	$I_{BIAS}$	—	—	1	—		
Common-mode input voltage range	$V_{CMR}$	—	0	—	1.8	V	<b>Figure 8</b>
Voltage gain (open loop)	$A_{VOL}$	$V_{CMR} = 0.9$ V, $R_L = 1$ M $\Omega$	—	80	—	dB	—
Maximum output swing voltage	$V_{OH}$	$R_L = 1$ M $\Omega$	1.78	—	—	V	<b>Figure 9</b>
	$V_{OL}$	$R_L = 1$ M $\Omega$	—	—	0.02		<b>Figure 10</b>
Common-mode input signal rejection ratio	CMRR	$V_{SS} \leq V_{CMR} \leq V_{DD}$	35	55	—	dB	<b>Figure 8</b>
		$V_{SS} \leq V_{CMR} \leq V_{DD} - 0.2$ V	45	60	—		
Power supply voltage rejection ratio	PSRR	$V_{DD} = 0.9$ V to 5.5 V	66	75	—	dB	<b>Figure 6</b>
Source current	$I_{SOURCE}$	$V_{OUT} = V_{DD} - 0.1$ V	200	250	—	$\mu\text{A}$	<b>Figure 12</b>
		$V_{OUT} = 0$ V	1000	1500	—		
Sink current	$I_{SINK}$	$V_{OUT} = 0.1$ V	220	300	—	$\mu\text{A}$	<b>Figure 13</b>
		$V_{OUT} = V_{DD}$	1200	1800	—		

**Table 8**

AC Characteristics ( $V_{DD} = 1.8$  V) ( $T_a = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Rise propagation delay time	$t_{PLH}$	Overdrive = 100 mV $C_L = 15$ pF (Refer to <b>Figure 14</b> )	—	90	—	$\mu\text{s}$
Fall propagation delay time	$t_{PHL}$		—	160	—	
Rise response time	$t_{TLH}$		—	8	—	
Fall response time	$t_{THL}$		—	25	—	

**3.  $V_{DD} = 0.9$  V**

**Table 9**

DC Characteristics ( $V_{DD} = 0.9$  V) (Ta = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Measurement circuit
Supply current	$I_{DDH}$	$V_{IN1} = V_{SS}, V_{IN2} = V_{DD}, R_L = \infty$	—	0.7	1.3	$\mu$ A	<b>Figure 11</b>
	$I_{DDL}$	$V_{IN1} = V_{DD}, V_{IN2} = V_{SS}, R_L = \infty$	—	0.25	0.5		
Input offset voltage	$V_{IO}$	S-89530A: $V_{CMR} = 0.45$ V	-10	$\pm 5$	+10	mV	<b>Figure 7</b>
		S-89531A: $V_{CMR} = 0.45$ V	-5	$\pm 3$	+5		
Input offset current	$I_{IO}$	—	—	1	—	pA	—
Input bias current	$I_{BIAS}$	—	—	1	—		
Common-mode input voltage range	$V_{CMR}$	—	0	—	0.9	V	<b>Figure 8</b>
Voltage gain (open loop)	$A_{VOL}$	$V_{CMR} = 0.45$ V, $R_L = 1$ M $\Omega$	—	74	—	dB	—
Maximum output swing voltage	$V_{OH}$	$R_L = 1$ M $\Omega$	0.88	—	—	V	<b>Figure 9</b>
	$V_{OL}$	$R_L = 1$ M $\Omega$	—	—	0.02		<b>Figure 10</b>
Common-mode input signal rejection ratio	CMRR	$V_{SS} \leq V_{CMR} \leq V_{DD}$	25	50	—	dB	<b>Figure 8</b>
		$V_{SS} \leq V_{CMR} \leq V_{DD} - 0.3$ V	40	60	—		
Power supply voltage rejection ratio	PSRR	$V_{DD} = 0.9$ V to 5.5 V	66	75	—	dB	<b>Figure 6</b>
Source current	$I_{SOURCE}$	$V_{OUT} = V_{DD} - 0.1$ V	10	45	—	$\mu$ A	<b>Figure 12</b>
		$V_{OUT} = 0$ V	12	70	—		
Sink current	$I_{SINK}$	$V_{OUT} = 0.1$ V	10	65	—	$\mu$ A	<b>Figure 13</b>
		$V_{OUT} = V_{DD}$	12	120	—		

**Table 10**

AC Characteristics ( $V_{DD} = 0.9$  V) (Ta = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Rise propagation delay time	$t_{PLH}$	Overdrive = 100 mV $C_L = 15$ pF (Refer to <b>Figure 14</b> )	—	65	—	$\mu$ s
Fall propagation delay time	$t_{PHL}$		—	65	—	$\mu$ s
Rise response time	$t_{TLH}$		—	5	—	$\mu$ s
Fall response time	$t_{THL}$		—	20	—	$\mu$ s

■ **Measurement Circuits**

1. **Power supply voltage rejection ratio**

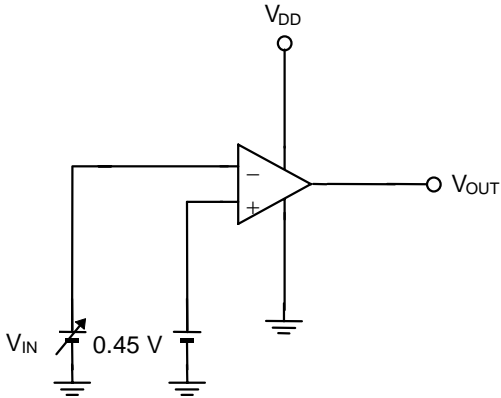


Figure 6

- The power supply voltage rejection ratio (PSRR) is calculated by the following expression, with the value of  $V_{IO}$  measured at each  $V_{DD}$ .

Measurement conditions:

When  $V_{DD} = 0.9$  V:  $V_{DD} = V_{DD1}$ ,  $V_{IO} = V_{IO1}$

When  $V_{DD} = 5.5$  V:  $V_{DD} = V_{DD2}$ ,  $V_{IO} = V_{IO2}$

$$PSRR = 20 \log \left( \left| \frac{V_{DD1} - V_{DD2}}{V_{IO1} - V_{IO2}} \right| \right)$$

2. **Input offset voltage**

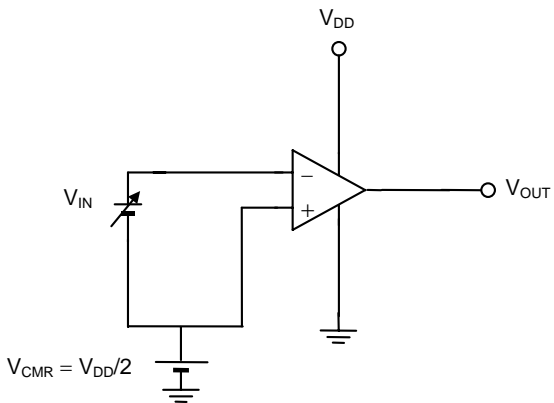


Figure 7

- Input offset voltage ( $V_{IO}$ )  
 The input offset voltage ( $V_{IO}$ ) is defined as  $V_{IN}$  at which  $V_{OUT}$  changes by changing  $V_{IN}$ .

3. Common-mode input signal rejection rate, common-mode input voltage range

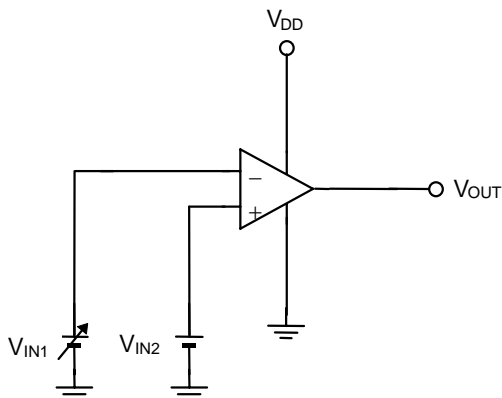


Figure 8

- Common-mode input signal rejection ratio (CMRR)  
The common-mode input signal rejection ratio, CMRR, can be calculated by the following expression, with the offset voltage ( $V_{IO}$ ) defined as  $V_{IN1}$  minus  $V_{IN2}$  at which  $V_{OUT}$  is changed by changing  $V_{IN1}$ .

Measurement conditions:

When  $V_{IN2} = V_{CMR}(\text{max.})$ :  $V_{IO} = V_{IO1}$

When  $V_{IN2} = V_{CMR}(\text{min.})$ :  $V_{IO} = V_{IO2}$

$$CMRR = 20 \log \left( \frac{V_{CMR}(\text{max.}) - V_{CMR}(\text{min.})}{V_{IO1} - V_{IO2}} \right)$$

- Common-mode input voltage range ( $V_{CMR}$ )  
The common-mode input voltage range is the range of  $V_{IN2}$  within which  $V_{OUT}$  satisfies the common mode input signal rejection ratio specification.

4. Maximum output swing voltage

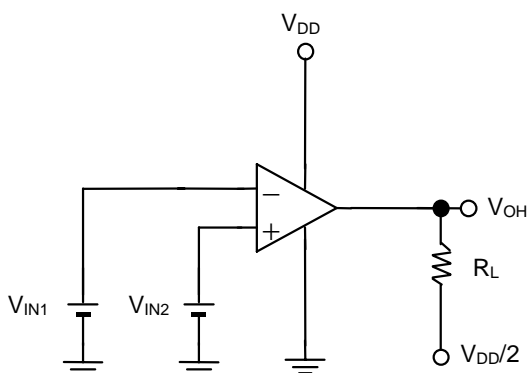


Figure 9

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

Measurement conditions:  $V_{IN1} = \frac{V_{DD}}{2} - 0.1 \text{ V}$

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

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

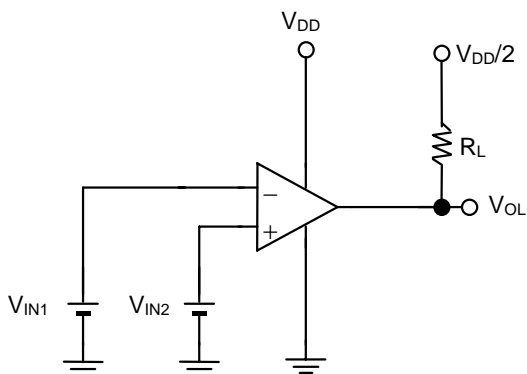


Figure 10

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

Measurement conditions:  $V_{IN1} = \frac{V_{DD}}{2} + 0.1 \text{ V}$

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

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



5. Supply current

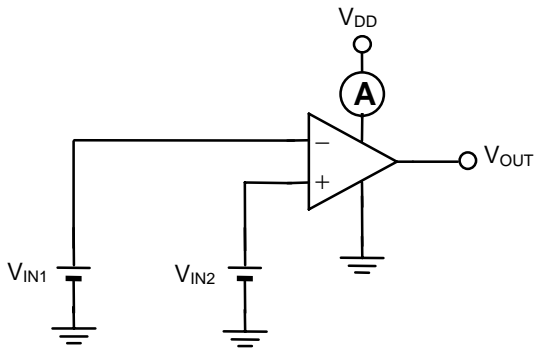


Figure 11

- Supply current ( $I_{DDH}$ )  
Measurement conditions:  $V_{IN1} = V_{SS}$   
 $V_{IN2} = V_{DD}$
- Supply current ( $I_{DDL}$ )  
Measurement conditions:  $V_{IN1} = V_{DD}$   
 $V_{IN2} = V_{SS}$

6. Source current

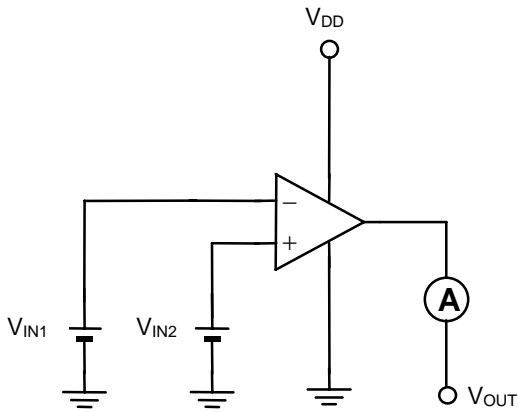


Figure 12

- Source current ( $I_{SOURCE}$ )  
Measurement conditions:  $V_{IN1} = \frac{V_{DD}}{2} - 0.1 V$   
 $V_{IN2} = \frac{V_{DD}}{2} + 0.1 V$   
 $V_{OUT} = V_{DD} - 0.1 V$  or  
 $V_{OUT} = 0 V$

7. Sink current

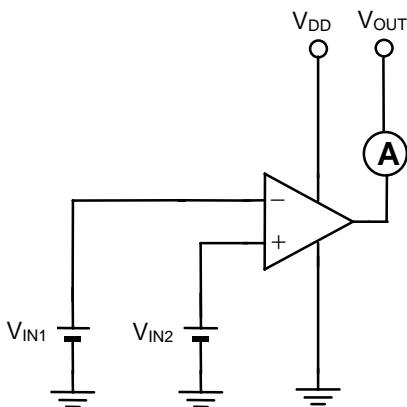


Figure 13

- Sink current ( $I_{SINK}$ )  
Measurement conditions:  $V_{IN1} = \frac{V_{DD}}{2} + 0.1 V$   
 $V_{IN2} = \frac{V_{DD}}{2} - 0.1 V$   
 $V_{OUT} = 0.1 V$  or  
 $V_{OUT} = V_{DD}$

8. Propagation delay time/transient response time

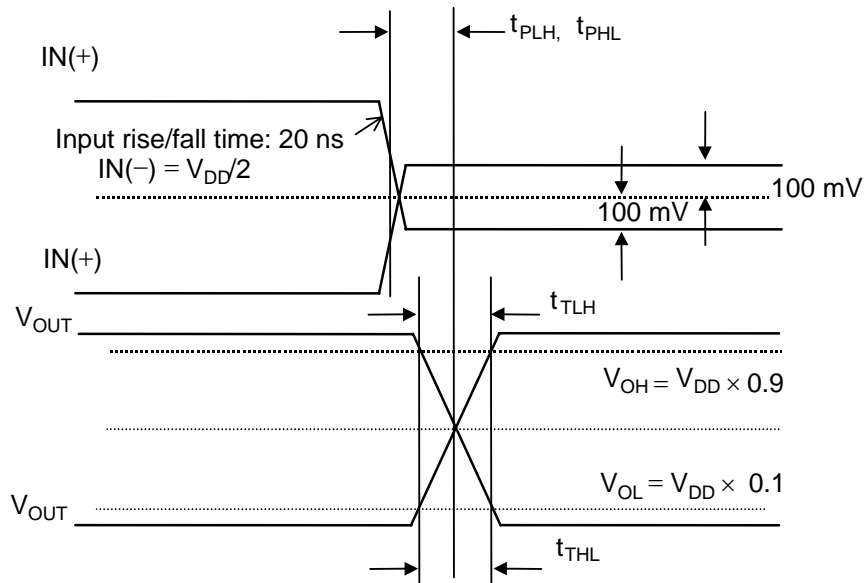


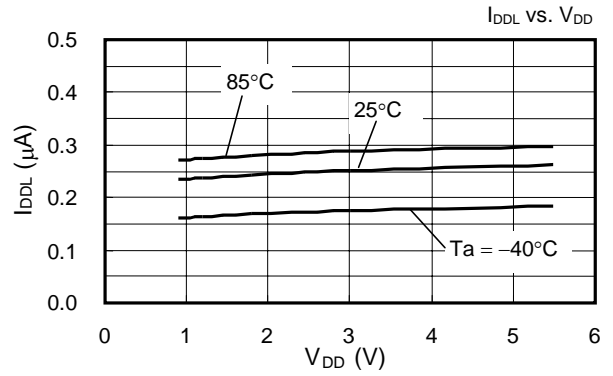
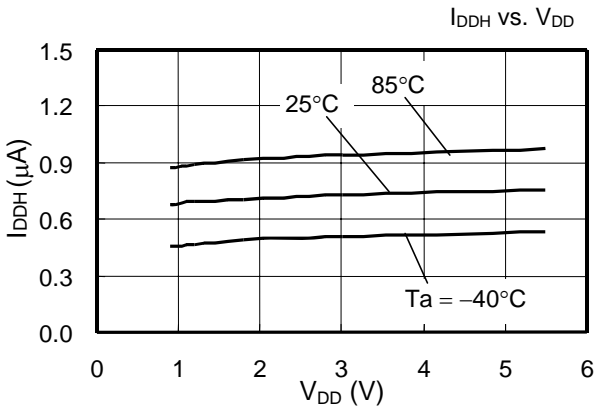
Figure 14

■ Cautions

- When  $R_L = 100 \text{ k}\Omega$ ,  $V_{OH}$  may rise only 0.65 V if the temperature is  $-40^\circ\text{C}$  and  $V_{DD} = 0.9 \text{ V}$ .  
 If the temperature is  $-20^\circ\text{C}$ , however,  $V_{OH}$  rises to 0.8 V, which is 100 mV below  $V_{DD}$ , when  $V_{DD} = 0.9 \text{ V}$ , even if  $R_L = 100 \text{ k}\Omega$ .  
 If  $V_{DD}$  is 1.2 V,  $V_{OH}$  rises to 0.88 V, which is 20 mV below  $V_{DD}$  when  $R_L = 100 \text{ k}\Omega$ , even at  $-40^\circ\text{C}$ .  
 The temperature characteristics data described above can be used as reference data. Note that 100% testing under these conditions has not been performed.
- Be sure to use the product with a source current of no more than 7 mA.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.

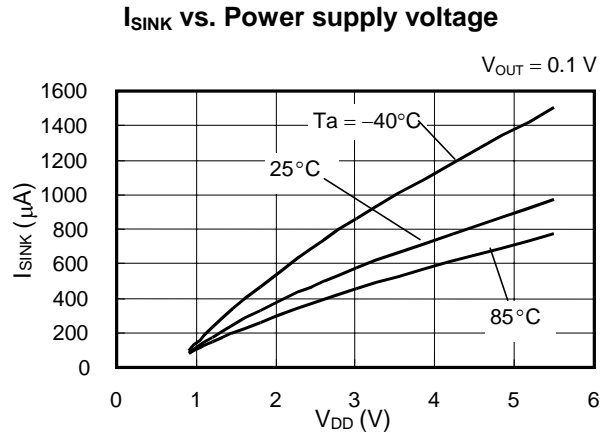
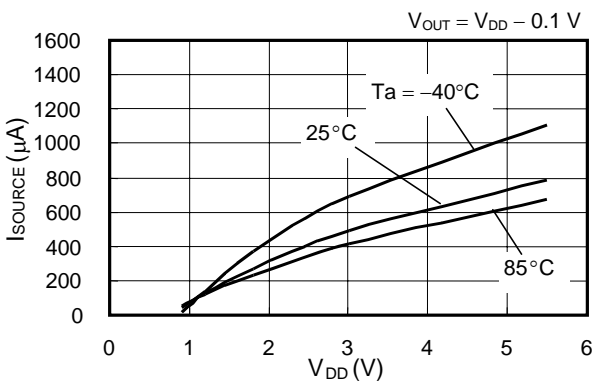
■ Characteristics (Reference Data)

1. Current consumption vs. Power supply voltage

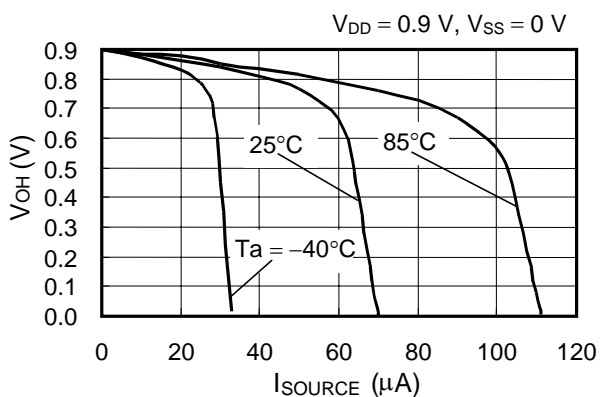
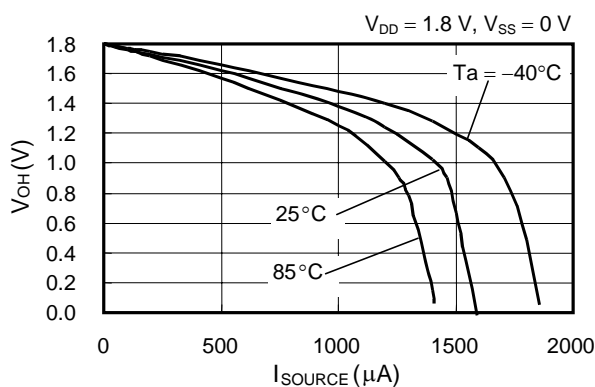
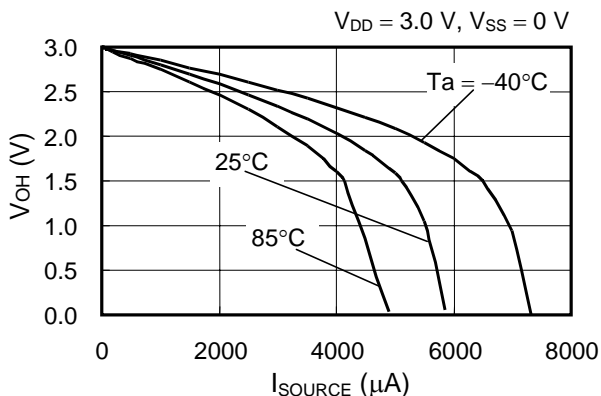


2. Output current

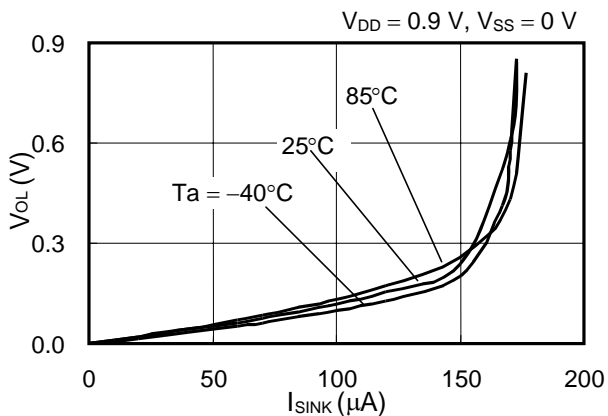
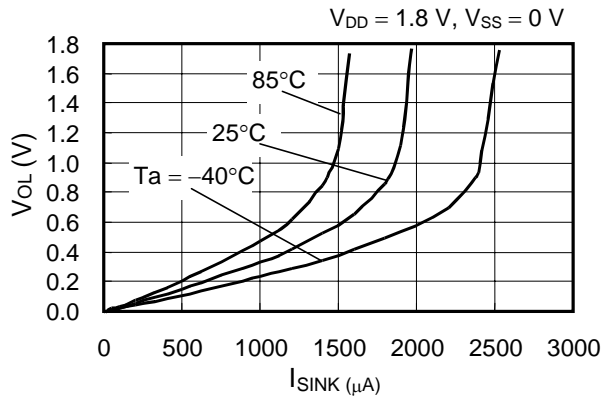
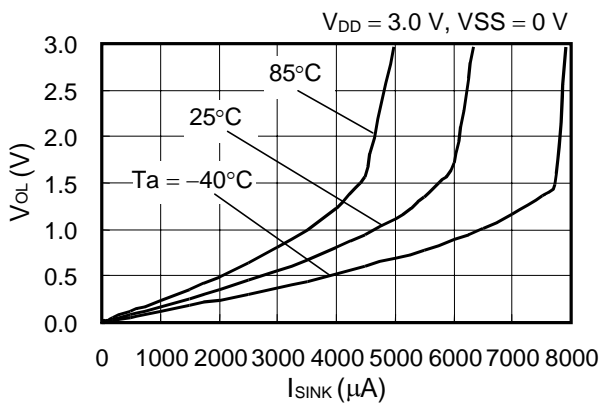
2-1.  $I_{SOURCE}$  vs. Power supply voltage

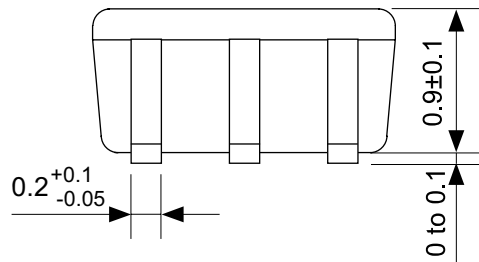
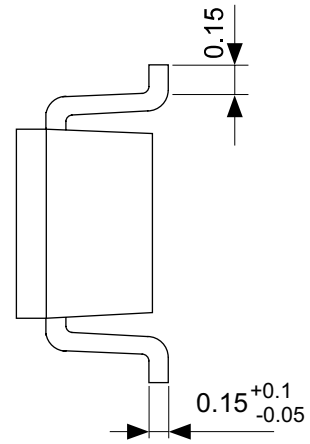
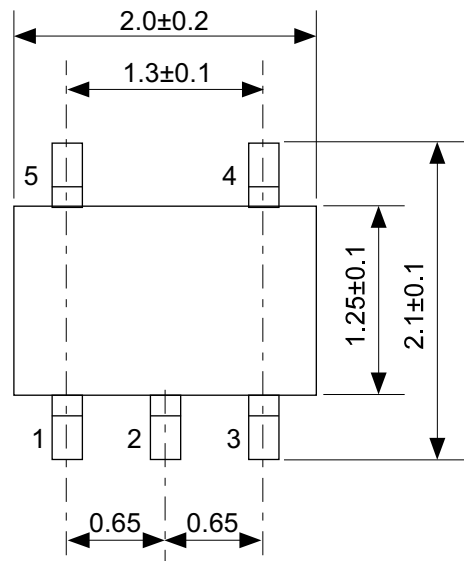


**2-2. Output voltage ( $V_{OH}$ ) vs.  $I_{SOURCE}$**



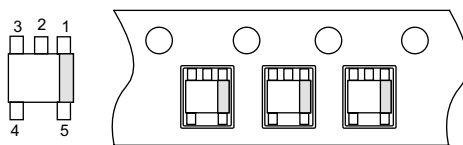
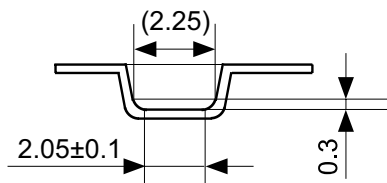
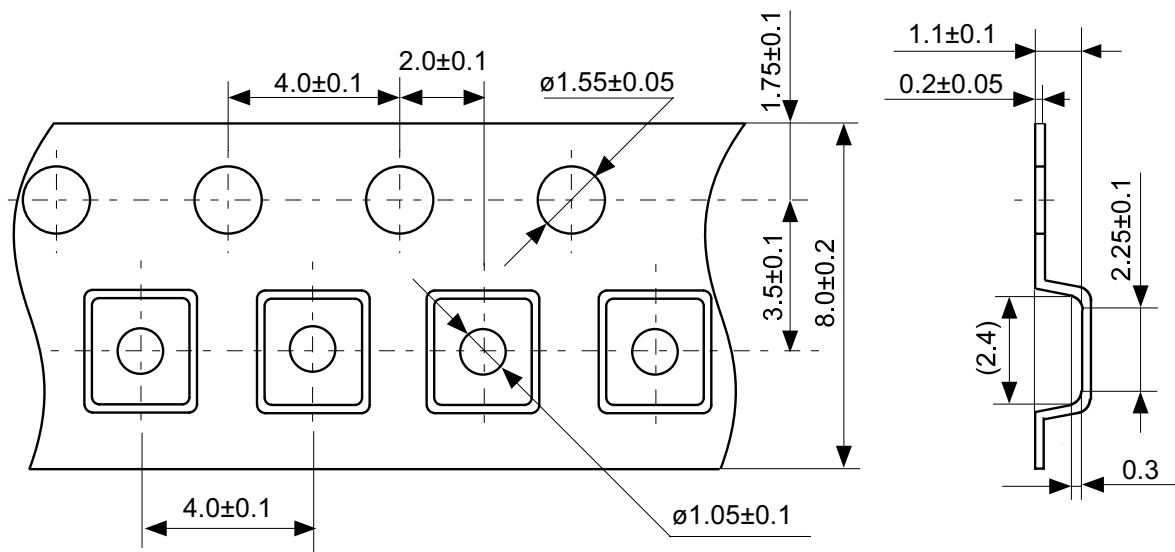
**2-3. Output Voltage ( $V_{OL}$ ) vs.  $I_{SINK}$**





No. NP005-B-P-SD-1.1

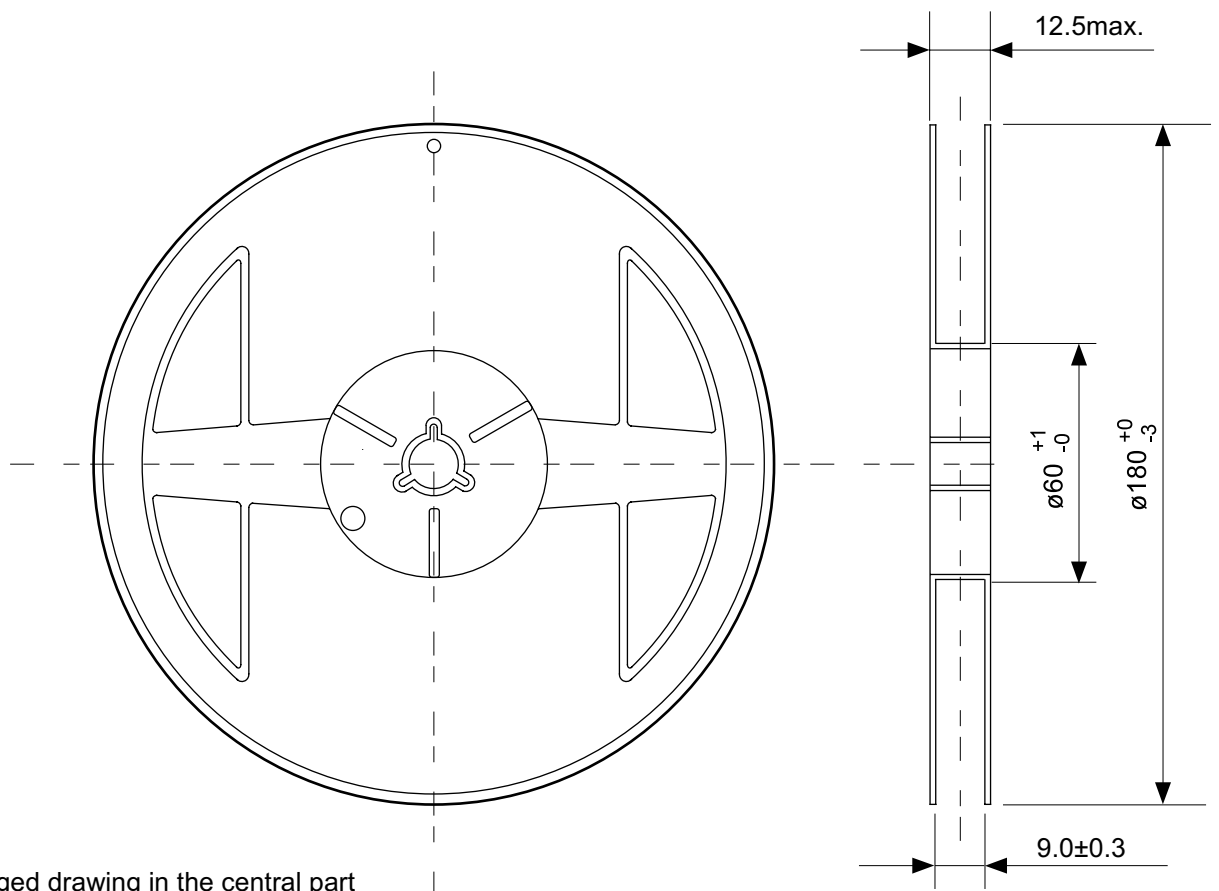
TITLE	SC88A-B-PKG Dimensions
No.	NP005-B-P-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



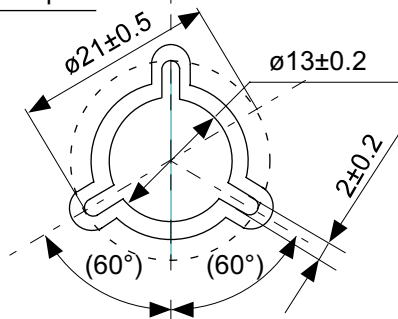
→  
Feed direction

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.			



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