MINI ANALOG SERIES
0.7 μA Rail-to-Rail CMOS COMPARATOR
S-89530A/89531A

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 [*1] I/O and can be driven at a lower voltage and lower current consumpsion 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 V to 5.5 V
- Low current consumption: I_{DD} = 0.7 μA (Typ.)
- Rail-to-Rail [*1] wide input and output voltage range: $V_{CMR} = V_{SS}$ to V_{DD}
- Low input offset voltage: 5.0 mV max.
- Small package: 5-Pin SC-88A 2.0 mm × 2.1 mm
- Lead-free products

■ Applications

- 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

Input Offset Voltage	Product Name (Single)
V_{IO} = 10 mV max.	S-89530ACNC-HCBTFG
V_{IO} = 5 mV max.	S-89531ACNC-HCCTFG

■ Pin Configuration

SC-88A
Top view

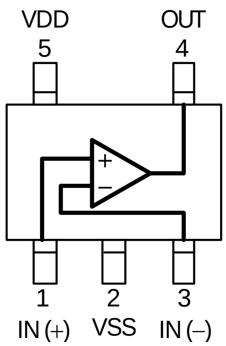


Figure 1

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 Circuits

(1) Output pin

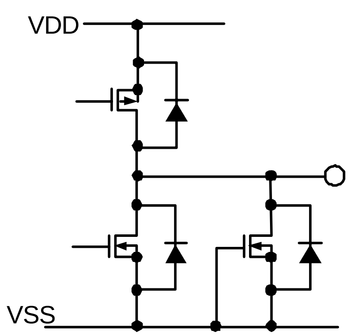


Figure 2

(2) Input pin

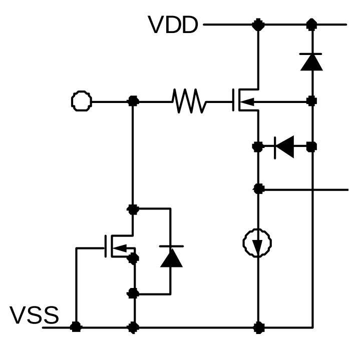


Figure 3

(3) VDD pin

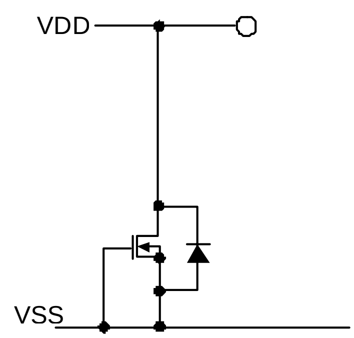


Figure 4

■ 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}	±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_{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.

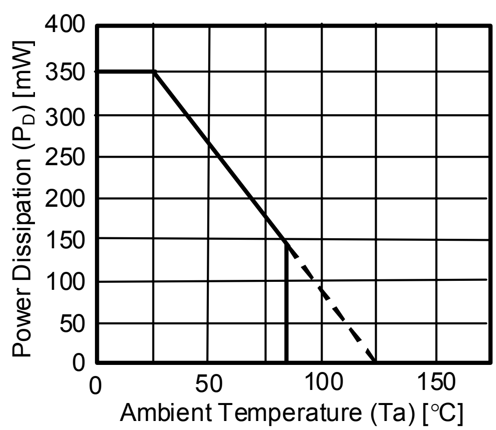


Figure 5 Power Dissipation of Package (When Mounted on Board)

■ Recommended Operating 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) (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	1.4	μA	**Figure 11**
	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	±5	+10	mV	**Figure 7**
		S-89531A: V_{CMR} = 1.5 V	−5	±3	+5		
Input offset current	I_{IO}	—	—	1	—	pA	—
Input bias current	I_{BIAS}	—	—	1	—		
Common-mode input voltage range	V_{CMR}	—	0	—	3.0	V	**Figure 8**
Voltage gain (open loop)	A_{VOL}	V_{CMR} = 1.5 V, R_L = 1 MΩ	—	86	—	dB	—
Maximum output swing voltage	V_{OH}	R_L = 1 MΩ	2.98	—	—	V	**Figure 9**
	V_{OL}	R_L = 1 MΩ	—	—	0.02		**Figure 10**
Common-mode input signal rejection ratio	CMRR	$V_{SS} \leq V_{CMR} \leq V_{DD}$	45	65	—	dB	**Figure 8**
Power supply voltage rejection ratio	PSRR	V_{DD} = 0.9 V to 5.5 V	66	75	—	dB	**Figure 6**
Source current*1	I_{SOURCE}	$V_{OUT} = V_{DD} - 0.1$ V	380	500	—	μA	**Figure 12**
		V_{OUT} = 0 V	4000	5500	—		
Sink current	I_{SINK}	V_{OUT} = 0.1 V	400	550	—	μA	**Figure 13**
		$V_{OUT} = V_{DD}$	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) (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 **Figure 14**)	—	110	—	μs
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) (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	1.4	μA	**Figure 11**
	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	±5	+10	mV	**Figure 7**
		S-89531A: V_{CMR} = 0.9 V	−5	±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	**Figure 8**
Voltage gain (open loop)	A_{VOL}	V_{CMR} = 0.9 V, R_L = 1 MΩ	—	80	—	dB	—
Maximum output swing voltage	V_{OH}	R_L = 1 MΩ	1.78	—	—	V	**Figure 9**
	V_{OL}	R_L = 1 MΩ	—	—	0.02		**Figure 10**
Common-mode input signal rejection ratio	CMRR	$V_{SS} \leq V_{CMR} \leq V_{DD}$	35	55	—	dB	**Figure 8**
		$V_{SS} \leq V_{CMR} \leq V_{DD} - 0.2$ V	45	60	—		
Power supply voltage rejection ratio	PSRR	V_{DD} = 0.9 V to 5.5 V	66	75	—	dB	**Figure 6**
Source current	I_{SOURCE}	$V_{OUT} = V_{DD} - 0.1$ V	200	250	—	μA	**Figure 12**
		V_{OUT} = 0 V	1000	1500	—		
Sink current	I_{SINK}	V_{OUT} = 0.1 V	220	300	—	μA	**Figure 13**
		$V_{OUT} = V_{DD}$	1200	1800	—		

Table 8

AC Characteristics (V_{DD} = 1.8 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 **Figure 14**)	—	90	—	μs
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	μA	**Figure 11**
	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	±5	+10	mV	**Figure 7**
		S-89531A: V_{CMR} = 0.45 V	−5	±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	**Figure 8**
Voltage gain (open loop)	A_{VOL}	V_{CMR} = 0.45 V, R_L = 1 MΩ	—	74	—	dB	—
Maximum output swing voltage	V_{OH}	R_L = 1 MΩ	0.88	—	—	V	**Figure 9**
	V_{OL}	R_L = 1 MΩ	—	—	0.02		**Figure 10**
Common-mode input signal rejection ratio	CMRR	$V_{SS} \le V_{CMR} \le V_{DD}$	25	50	—	dB	**Figure 8**
		$V_{SS} \le V_{CMR} \le V_{DD} - 0.3$ V	40	60	—		
Power supply voltage rejection ratio	PSRR	V_{DD} = 0.9 V to 5.5 V	66	75	—	dB	**Figure 6**
Source current	I_{SOURCE}	$V_{OUT} = V_{DD} - 0.1$ V	10	45	—	μA	**Figure 12**
		V_{OUT} = 0 V	12	70	—		
Sink current	I_{SINK}	V_{OUT} = 0.1 V	10	65	—	μA	**Figure 13**
		$V_{OUT} = V_{DD}$	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 **Figure 14**)	—	65	—	μs
Fall propagation delay time	t_{PHL}		—	65	—	μs
Rise response time	t_{TLH}		—	5	—	μs
Fall response time	t_{THL}		—	20	—	μs

■ Measurement Circuits

1. Power supply voltage rejection ratio

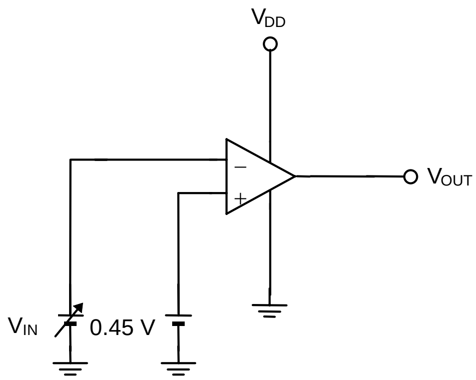


Figure 6

- 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

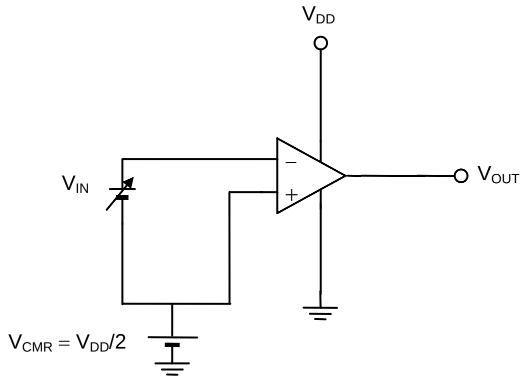


Figure 7

- 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

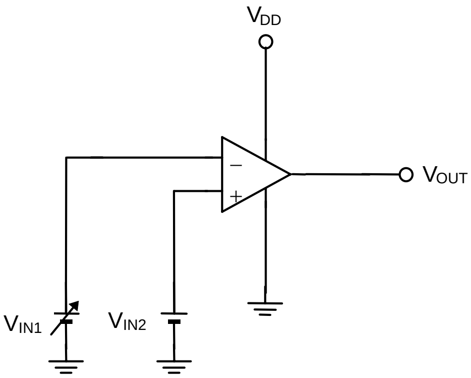


Figure 8

- 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 $V_{IN2} = V_{CMR}$ (max.): $V_{IO} = V_{IO1}$
  When $V_{IN2} = V_{CMR}$ (min.): $V_{IO} = V_{IO2}$

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

- 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

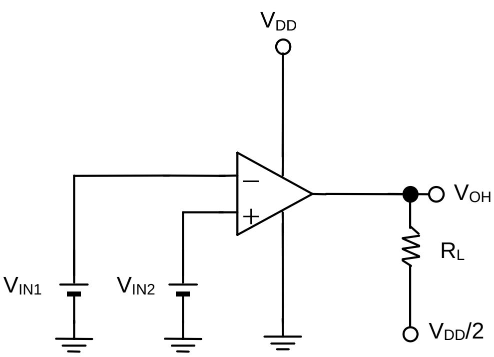


Figure 9

- Maximum output swing voltage (V_{OH})
  Measurement conditions: $V_{IN1} = \frac{V_{DD}}{2} - 0.1\,V$

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

  $R_L = 1\ M\Omega$

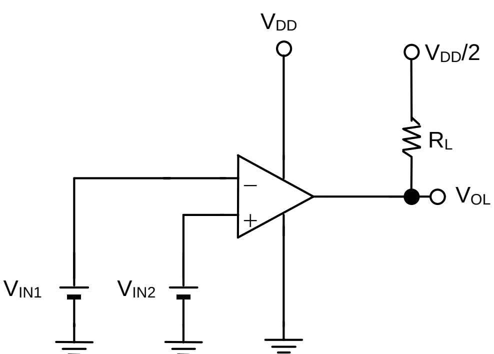


Figure 10

- Maximum output swing voltage (V_{OL})
  Measurement conditions: $V_{IN1} = \frac{V_{DD}}{2} + 0.1\,V$

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

  $R_L = 1\ M\Omega$

5. Supply current

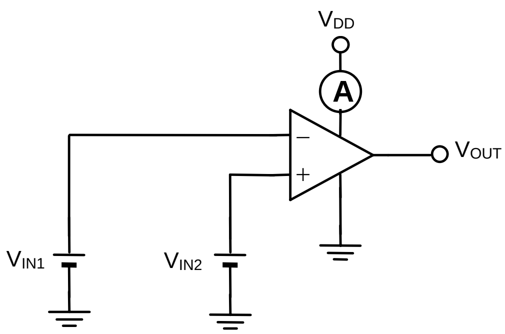


Figure 11

- 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

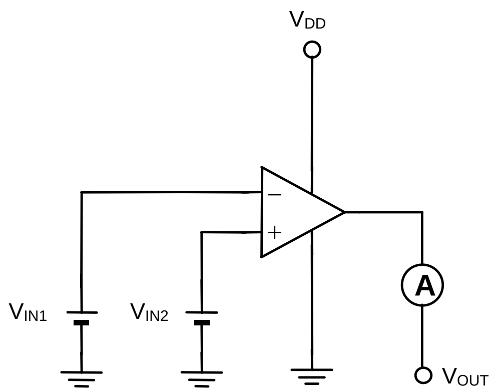


Figure 12

- 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

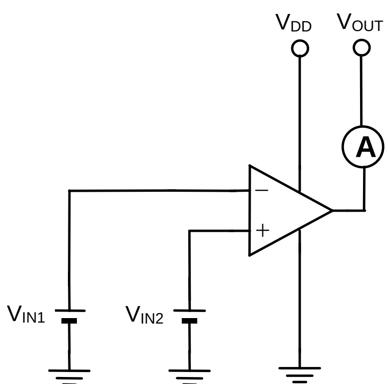


Figure 13

- 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

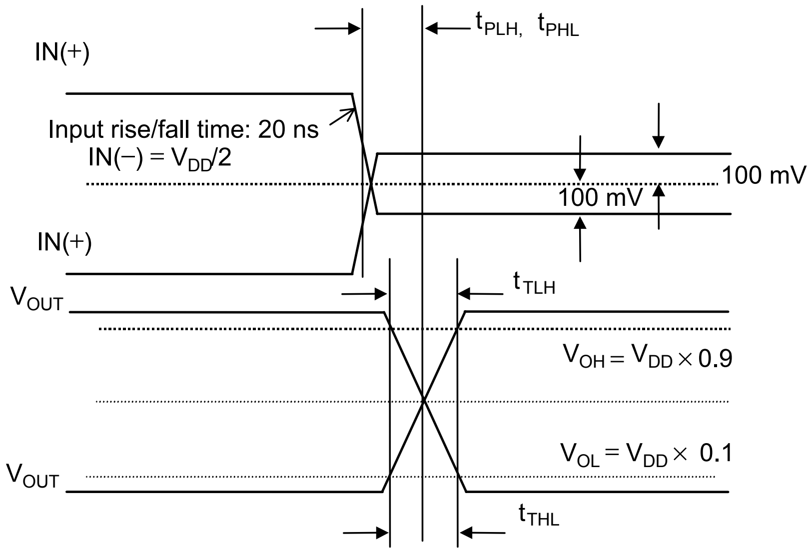


Figure 14

■ Cautions

- When R_L = 100 kΩ, V_{OH} may rise only 0.65 V if the temperature is –40°C and V_{DD} = 0.9 V.

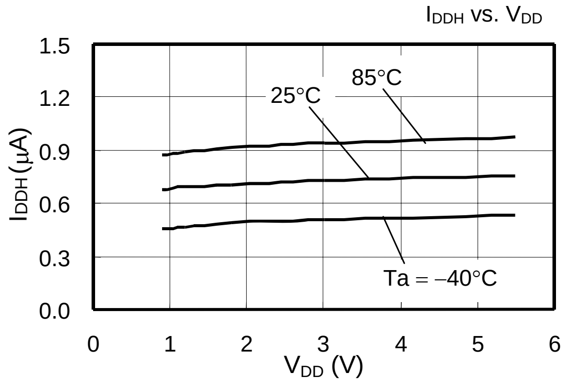
  If the temperature is –20°C, however, V_{OH} rises to 0.8 V, which is 100 mV below V_{DD}, when V_{DD} = 0.9 V, even if R_L = 100 kΩ.

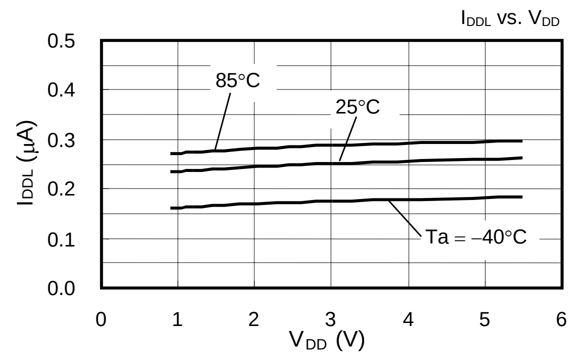
  If V_{DD} is 1.2 V, V_{OH} rises to 0.88 V, which is 20 mV below V_{DD} when R_L = 100 kΩ, even at –40°C.

  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 ofthe built-in electrostatic protection circuit.

■ Characteristics (Reference Data)

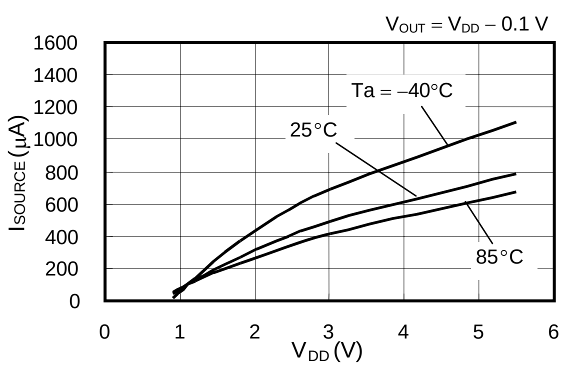
1. Current consumption vs. Power supply voltage



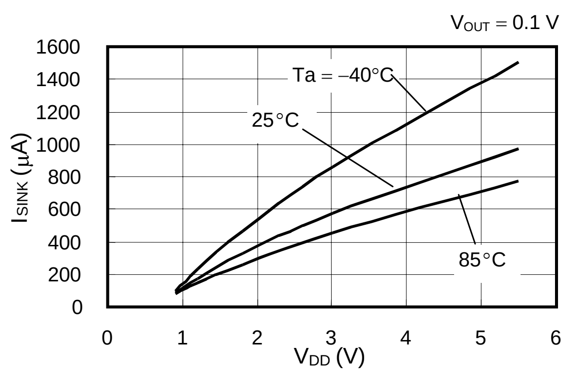


2. Output current

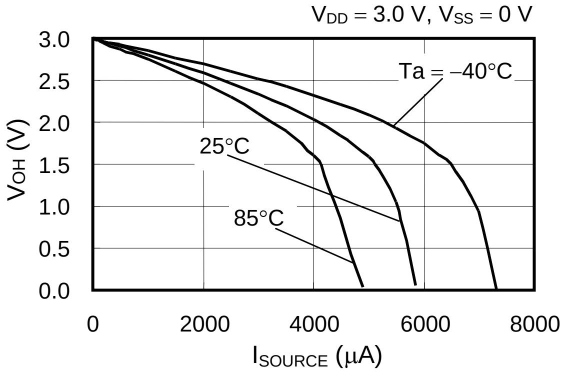
2-1. I_{SOURCE} vs. Power supply voltage

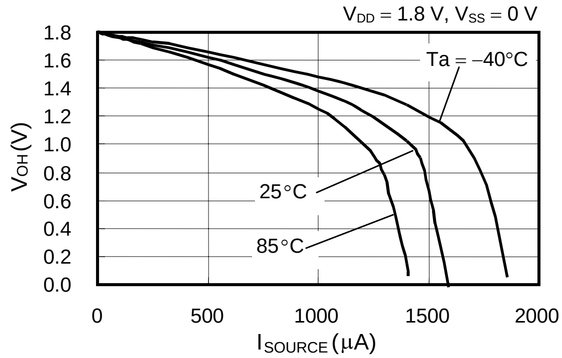


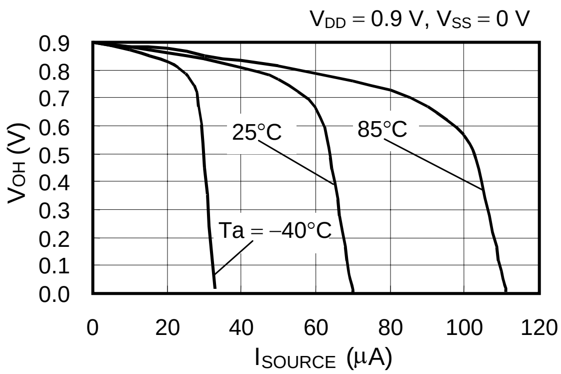
I_{SINK} vs. Power supply voltage



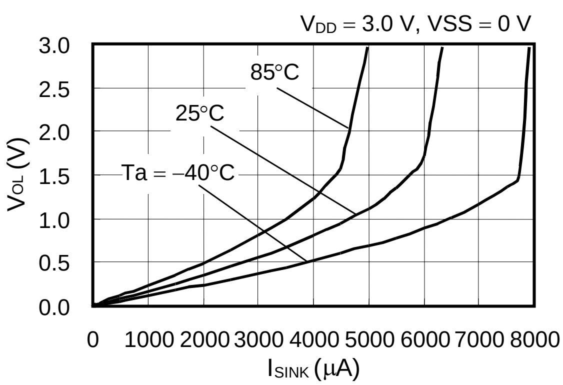
2-2. Output voltage (V_{OH}) vs. I_{SOURCE}

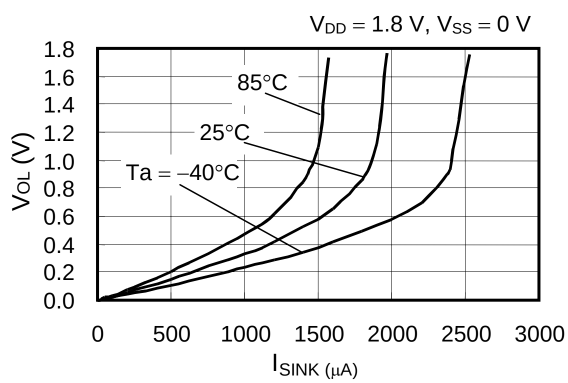


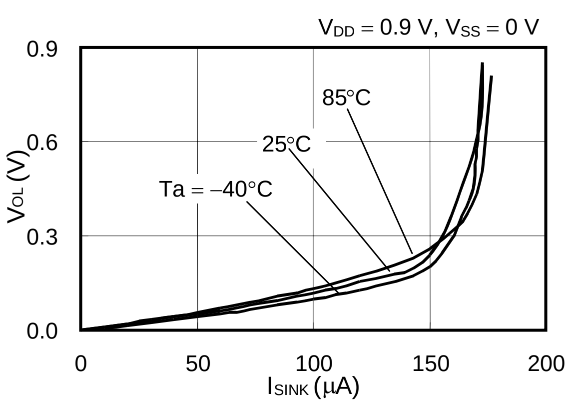


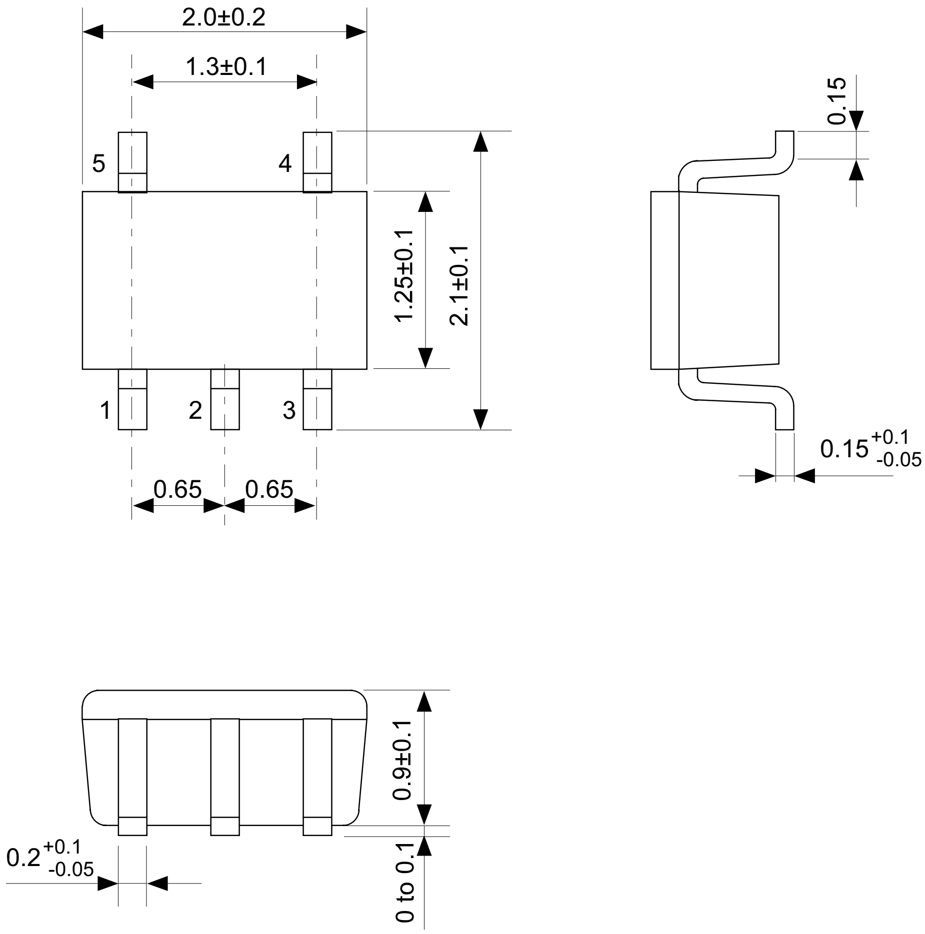


2-3. Output Voltage (V_{OL}) vs. I_{SINK}





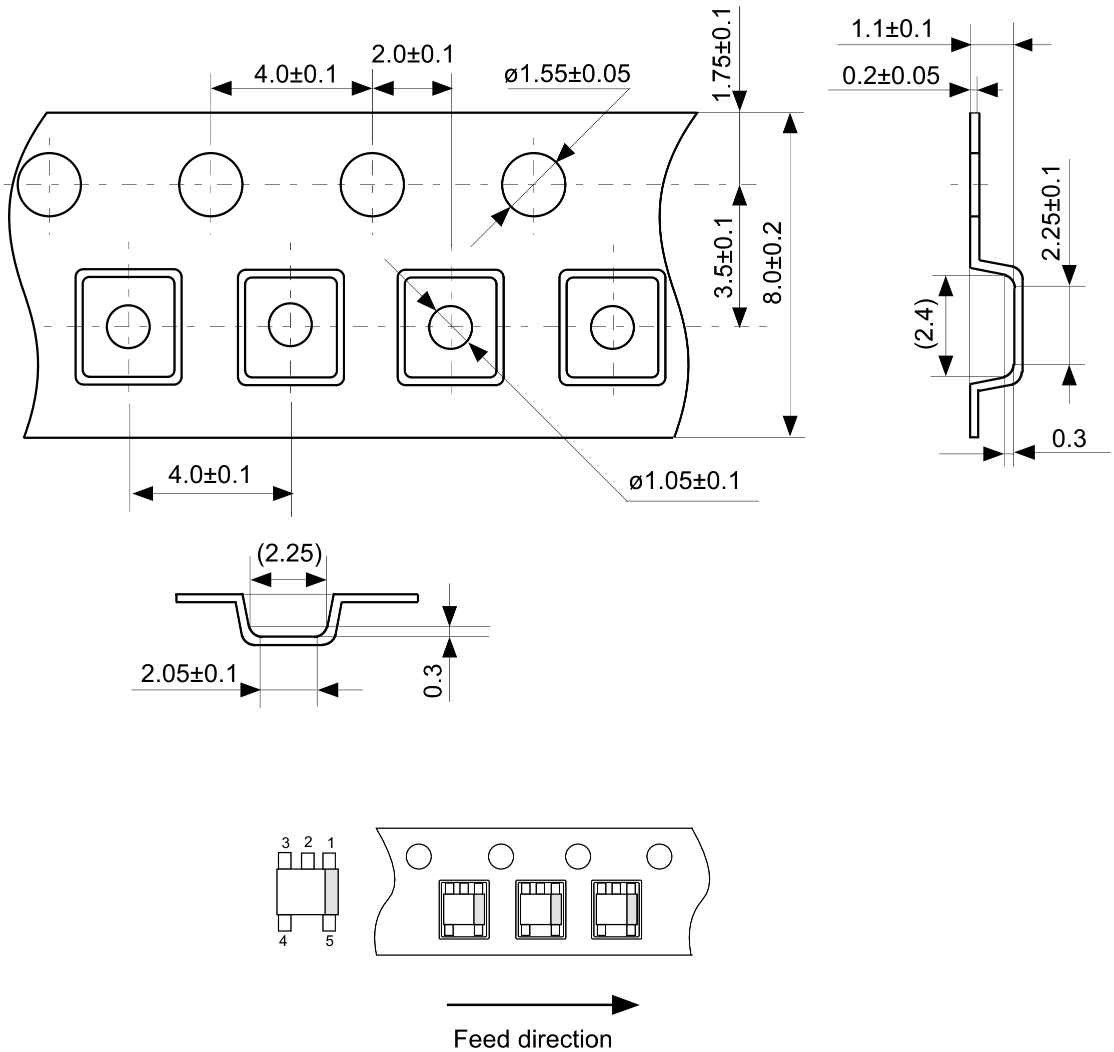




No. NP005-B-P-SD-1.1

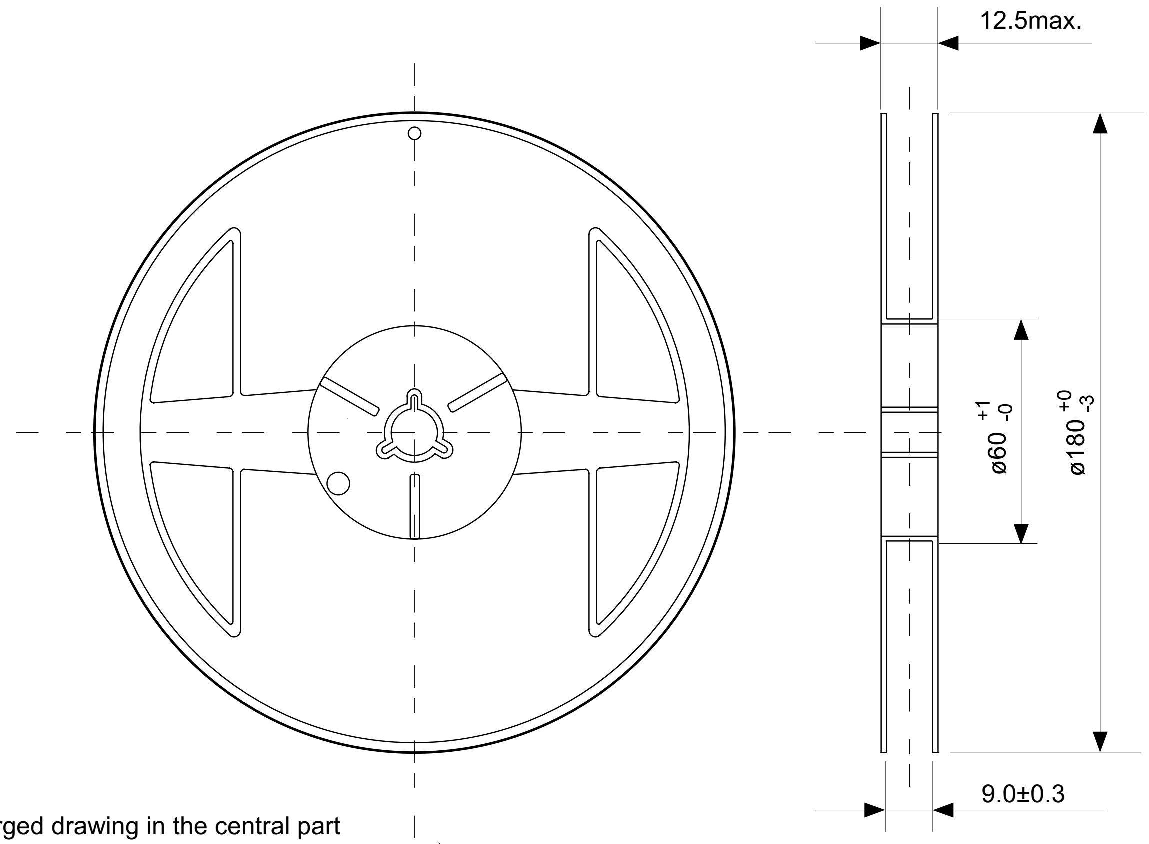
TITLE	SC88A-B-PKG Dimensions
No.	NP005-B-P-SD-1.1
SCALE	
UNIT	mm

Seiko Instruments Inc.

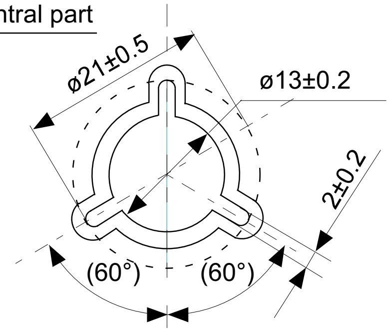


No. NP005-B-C-SD-2.0

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.