MINI ANALOG SERIES
0.7μA RAIL-TO-RAIL CMOS COMPARATOR

S-8953xA/B Series

The mini-analog series is a family of standard analog circuits available in small packages.

The S-8953xA/B series is an ultra-low voltage operation and ultra-low current consumption CMOS comparator which provides rail-to-rail operation on both the input and output. The output can swing within 20mV of each rail with R_L=1MΩ. Minimum operation voltage of 0.9V and low current consumption of 0.7μA (typ.) have been achieved.

The S-8953xA/B series gives the optimum solution for small battery-powered portable equipments along with the small and thin package features. The S-8953xA is a single comparator available in miniature SC-88A package. The S-8953xB is a dual comparator available in newly developed 8-pin SON(A) package.

■ Features

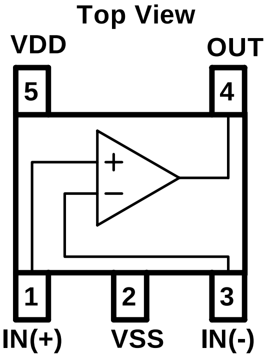
- CMOS comparator
- Low operating voltage: V_{DD} =0.9V to 5.5V
- Low current consumption: I_{DD}=0.7μA (typ.)
- Rail-to-rail* wide input and output voltage range: V_{SS} to V_{DD}
- Low input offset voltage: 5.0mV max.
- Small package: 5-pin SC-88A 2.0 mm × 2.1mm
  8-pin SON(A) 2.9 mm × 3.0 mm

■ Applications

- Cellular phone
- PDA
- Notebook PC
- Digital camera
- Camcorder

■ Pin Configuration

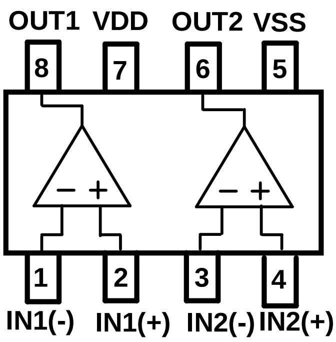
5-pin SC-88A
Top View



(S-8953xACNC)

Figure 1

8-pin SON(A)
Top View



(S-8953xBCPN)

Figure 2

Table 1 Pin Description (S-8953xACNC)

Pin No.	Symbol	Description
1	IN(+)	Non-inverting input pin
2	VSS	GND pin
3	IN(-)	Inverting input pin
4	OUT	Output pin
5	VDD	Positive power supply pin

Table 2 Pin Description (S-8953xBCPN)

Pin No.	Symbol	Functions
1	IN1(–)	Inverting input pin 1
2	IN1(+)	Non-inverting input pin 1
3	IN2(–)	Inverting input pin 2
4	IN2(+)	Non-inverting input pin 2
5	VSS	GND pin
6	OUT2	Output pin 2
7	VDD	Positive power pin
8	OUT1	Output pin 1

■ Packages

- 5-pin SC-88A (Package drawing code: NP005-B)
- 8-pin SON(A) (Package drawing code: PN008-A)

∗ Rail-to-rail is a registered trade mark of Motorola Japan Ltd.

■ Selection Guide

Table 3

Offset voltage	Product Name (single).	Product Name (dual).
V_{IO} =10mV max.	S-89530ACNC-HCB-TF	S-89530BCPN-HFB-TF
V_{IO} = 50mV max.	S-89531ACNC-HCC-TF	S-89531BCPN-HFC-TF

■ Absolute Maximum Ratings

Table 4

(Ta=25°C, unless otherwise specified)

Parameter		Symbol	Ratings	Unit
Power voltage		V_{DD}	7.0	V
Input voltage		V_{IN}	0 to 7.0	V
Differential input voltage		V_{IND}	±5.5	V
Allowable loss	SC-88A	P_D	200	mW
	SON		300	
Operating temperature		T_{opr}	−40 to +85	°C
Storage temperature		T_{stg}	−55 to +125	°C

Note: Although the IC contains protection circuit against static electricity, excessive static electricity or voltage which exceeds the limit of the protection circuit should not be applied to.

■ Recommended Operating Power Voltage Range

Table 5

Parameter	Symbol	Range
Operating Power Voltage Range	V_{DDope}	0.9V to 5.5V

■ Electric Characteristics

Difference between the S-89530ACNC and S-89531ACNC , between the S-89530BCPN and S-89531BCPN is only offset voltage.
Other specifications are the same.

1. V_{DD}=3.0V

DC Characteristics(V_{DD}=3.0V) (per Comparator)

Table 6

(Ta=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test circuit
Supply current	I_{DDH}	$V_{IN1}=V_{SS}, V_{IN2}=V_{DD}, R_L=\infty$	—	0.7	1.4	μA	Fig.8
	I_{DDL}	$V_{IN1}=V_{DD}, V_{IN2}=V_{SS}, R_L=\infty$	—	0.25	0.5	μA	Fig.8
Offset voltage	V_{IO}	S-89530A/B: V_{CMR}=1.5V	—	5	10	mV	Fig.3
		S-89531A/B: V_{CMR}=1.5V	—	3	5	mV	Fig.3
Input offset current	I_{IO}	—	—	1	—	pA	—
Input bias current	I_{BIAS}	—	—	1	—	pA	—
Common-mode input voltage	V_{CMR}	—	0	—	3.0	V	Fig.5
Open loop voltage gain	A_{VOL}	V_{CMR}=1.5V, R_L=1MΩ	—	86	—	dB	—
Output voltage swing High	V_{OH}	R_L=1MΩ	2.98	—	—	V	Fig.6
Output voltage swing Low	V_{OL}	R_L=1MΩ	—	—	0.02	V	Fig.7
Common-mode rejection ratio	CMRR	$V_{SS} \leq V_{CMR} \leq V_{DD}$	45	65	—	dB	Fig.5
Power supply rejection ratio	PSRR	V_{DD}=0.9V to 5.5V	66	75	—	dB	Fig.4
Source current (1)	I_{SOURCE}	$V_{OUT}=V_{DD}$-0.1V	380	500	—	μA	Fig.9
		V_{OUT}=0V	4000	5500	—	μA	Fig.9
Sink current	I_{SINK}	V_{OUT}=0.1V	400	550	—	μA	Fig.10
		$V_{OUT}=V_{DD}$	4800	6000	—	μA	Fig.10

AC Characteristics(V_{DD}=3.0V)

Table 7

(Ta=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test circuit
Rise propagation delay time	t_{PLH}	Overdrive =100mV C_L=15pF	—	110	—	μs	Fig.11
Fall propagation delay time	t_{PHL}		—	280	—	μs	Fig.11
Output rise time	t_{TLH}		—	10	—	μs	Fig.11
Output fall time	t_{THL}		—	30	—	μs	Fig.11

(1) Source current should be used in the range less than 7mA.

2. V_{DD}=1.8V

DC Characteristics (V_{DD}=1.8V) (per Comparator)

Table 8

(Ta=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test circuit
Supply current	I_{DDH}	$V_{IN1}=V_{SS}$,$V_{IN2}=V_{DD}$,$R_L=\infty$	—	0.7	1.4	μA	Fig.8
	I_{DDL}	$V_{IN1}=V_{DD}$,$V_{IN2}=V_{SS}$,$R_L=\infty$	—	0.25	0.5	μA	Fig.8
Offset voltage	V_{IO}	S-89530A/B: V_{CMR}=0.9V	—	5	10	mV	Fig.3
		S-89531A/B: V_{CMR}=0.9V	—	3	5	mV	Fig.3
Input offset current	I_{IO}	—	—	1	—	pA	—
Input bias current	I_{BIAS}	—	—	1	—	pA	—
Common-mode input voltage	V_{CMR}	—	0	—	1.8	V	Fig.5
Open loop voltage gain	A_{VOL}	V_{CMR}=0.9V, R_L=1MΩ	—	80	—	dB	—
Output voltage swing High	V_{OH}	R_L=1MΩ	1.78	—	—	V	Fig.6
Output voltage swing Low	V_{OL}	R_L=1MΩ	—	—	0.02	V	Fig.7
Common-mode rejection ratio	CMRR	$V_{SS}\leq V_{CMR}\leq V_{DD}$	35	55	—	dB	Fig.5
		$V_{SS}\leq V_{CMR}\leq V_{DD}$-0.2V	45	60	—	dB	Fig.5
Power supply rejection ratio	PSRR	V_{DD}=0.9V to 5.5V	66	75	—	dB	Fig.4
Source current	I_{SOURCE}	$V_{OUT}=V_{DD}$-0.1V	200	250	—	μA	Fig.9
		V_{OUT}=0V	1000	1500	—	μA	Fig.9
Sink current	I_{SINK}	V_{OUT}=0.1V	220	300	—	μA	Fig.10
		$V_{OUT}=V_{DD}$	1200	1800	—	μA	Fig.10

AC Characteristics(V_{DD}=1.8V)

Table 9

(Ta=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test circuit
Rise propagation delay time	t_{PLH}	Overdrive =100mV C_L=15pF	—	90	—	μs	Fig.11
Fall propagation delay time	t_{PHL}		—	160	—	μs	Fig.11
Output rise time	t_{TLH}		—	8	—	μs	Fig.11
Output fall time	t_{THL}		—	25	—	μs	Fig.11

3. V_{DD}=0.9V

DC Characteristics(V_{DD}=0.9V) (per Comparator)

Table 10 (Ta=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test circuit
Supply current	I_{DDH}	$V_{IN1}=V_{SS},V_{IN2}=V_{DD},R_L=\infty$	—	0.7	1.3	µA	Fig.8
	I_{DDL}	$V_{IN1}=V_{DD},V_{IN2}=V_{SS},R_L=\infty$	—	0.25	0.5	µA	Fig.8
Offset voltage	V_{IO}	S-89530A/B: V_{CMR}=0.45V	—	5	10	mV	Fig.3
		S-89531A/B: V_{CMR}=0.45V	—	3	5	mV	Fig.3
Input offset current	I_{IO}	—	—	1	—	pA	—
Input bias current	I_{BIAS}	—	—	1	—	pA	—
Common-mode input voltage	V_{CMR}	—	0	—	0.9	V	Fig.5
Open loop voltage gain	A_{VOL}	V_{CMR}=0.45V, R_L=1MΩ	—	74	—	dB	—
Output voltage swing High	V_{OH}	R_L=1MΩ	0.88	—	—	V	Fig.6
Output voltage swing Low	V_{OL}	R_L=1MΩ	—	—	0.02	V	Fig.7
Common-mode rejection ratio	CMRR	$V_{SS}\leq V_{CMR}\leq V_{DD}$	25	50	—	dB	Fig.5
		$V_{SS}\leq V_{CMR}\leq V_{DD}$-0.3V	40	60		dB	Fig.5
Power supply rejection ratio	PSRR	V_{DD}=0.9V to 5.5V	66	75	—	dB	Fig.4
Source current	I_{SOURCE}	$V_{OUT}=V_{DD}$-0.1V	10	45	—	µA	Fig.9
		V_{OUT}=0V	12	70	—	µA	Fig.9
Sink current	I_{SINK}	V_{OUT}=0.1V	10	65	—	µA	Fig.10
		$V_{OUT}=V_{DD}$	12	120	—	µA	Fig.10

AC Characteristics(V_{DD}=0.9V)

Table 11

(Ta=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test circuit
Rise propagation delay time	t_{PLH}	Overdrive =100mV, C_L=15pF	—	65	—	µs	Fig.11
Fall propagation delay time	t_{PHL}		—	65	—	µs	Fig.11
Output rise time	t_{TLH}		—	5	—	µs	Fig.11
Output fall time	t_{THL}		—	20	—	µs	Fig.11

■ Measurement Conditions

1. Offset voltage

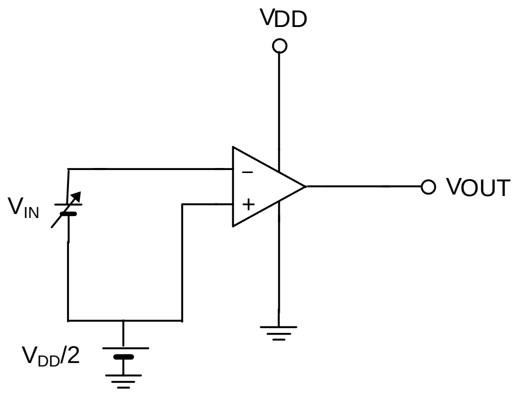


Figure 3

- Offset voltage(V_{IO}),

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

2. Power supply rejection ratio

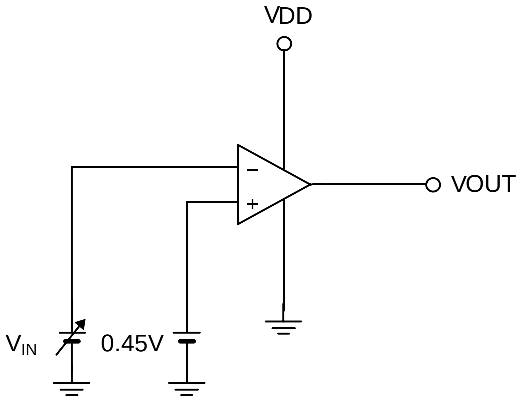


Figure 4

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

  Measurement conditions :
  V_{DD1} is defined as V_{DD} and V_{IO1} is defined as V_{IO} when V_{DD} is 0.9 V.
  V_{DD2} is defined as V_{DD} and V_{IO2} is defined as V_{IO} when V_{DD} is 5.5 V.

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

- Common-mode input voltage(V_{CMR})
  Common-mode input voltage is the input voltage range in which V_{OUT} satisfies the specification for the common-mode rejection ratio when V_{IN} changes.

3. Common-mode rejection rate, Common-mode input voltage

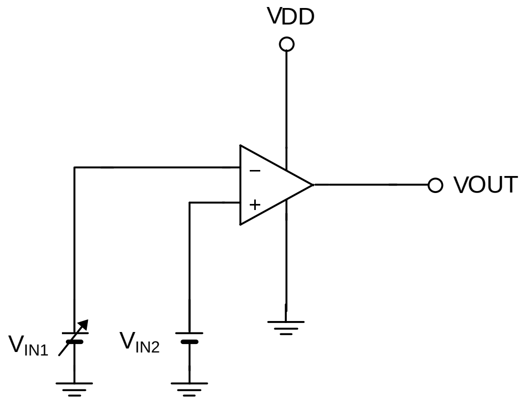


Figure 5

- Common-mode rejection ratio (CMRR)
  The offset voltage, V_{IO} is defined as V_{IN1}-V_{IN2} at which V_{OUT} changes when changing V_{IN1}. The common-mode rejection ratio, CMRR is calculated by the following expression.

  Measurement conditions:
  V_{IO1} is V_{IO} when $V_{IN2} = V_{CMR}$ (Max.)
  V_{IO2} is V_{IO} when $V_{IN2} = V_{CMR}$ (Min.)

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

- Common-mode input voltage (V_{CMR})
  Common-mode input voltage is the input voltage range in which V_{OUT} satisfies the specification for common-mode rejection ratio when V_{IN1} changes.

4. Output voltage swing

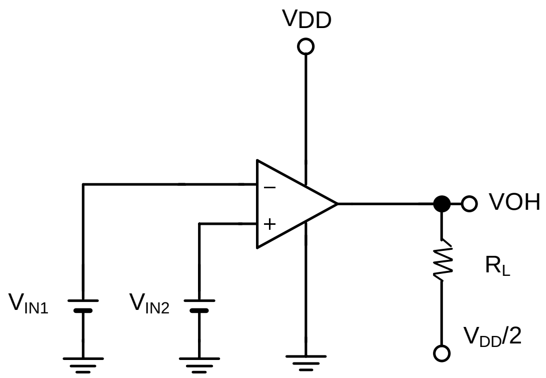


Figure 6

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

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

  R_L=1MΩ

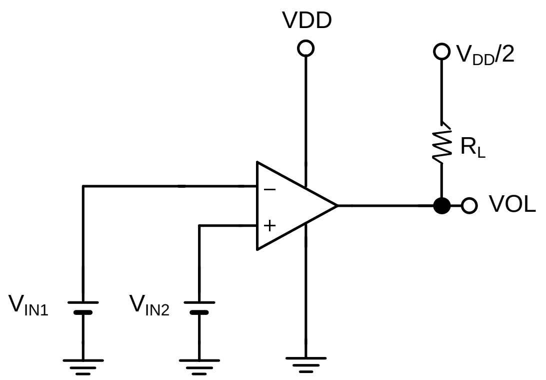


Figure 7

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

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

  R_L=1MΩ

5. Supply current

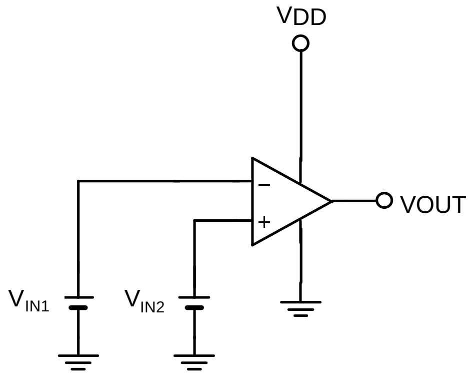


Figure 8

- 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

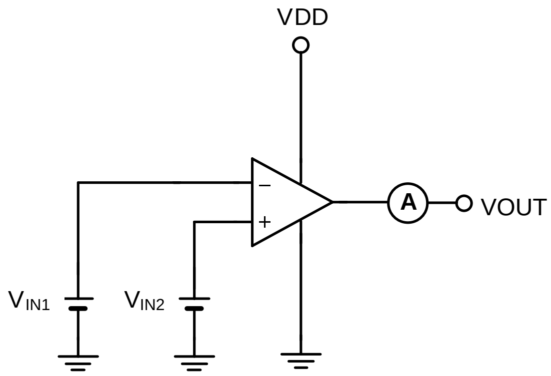


Figure 9

- Source current (I_{SOURCE})

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

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

$V_{OUT}=V_{DD}-0.1V$ or
$V_{OUT}=0V$

7. Sink current (I_{SINK})

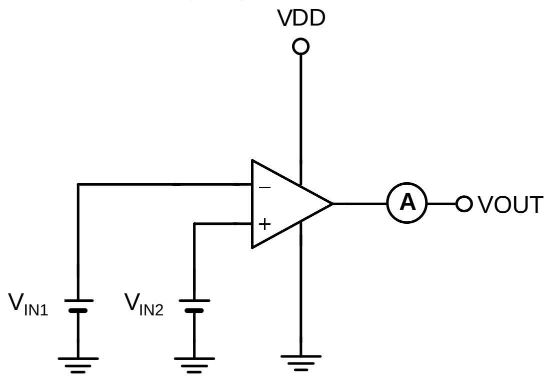


Figure 10

- Sink current (I_{SINK})

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

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

$V_{OUT}=0.1V$ or
$V_{OUT}=V_{DD}$

8. Propagation delay time / Transient response time

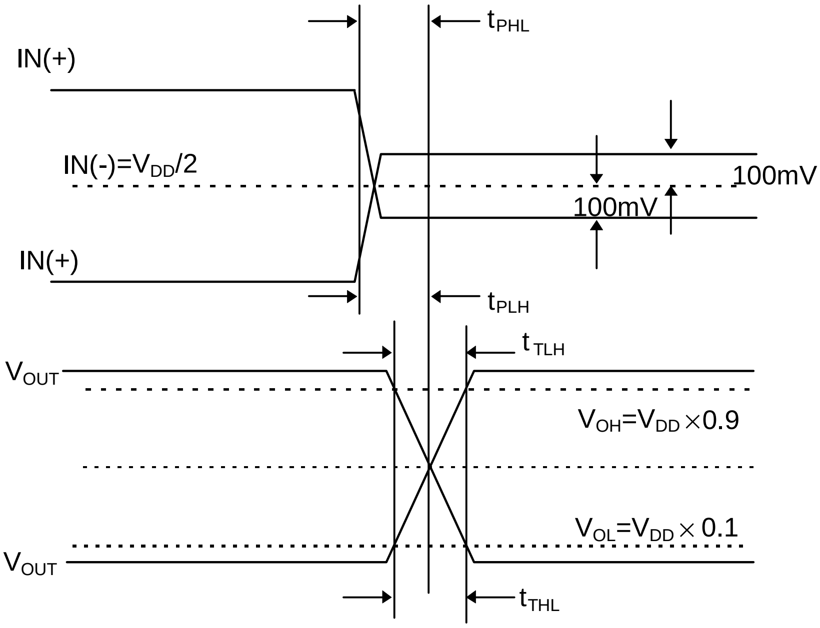


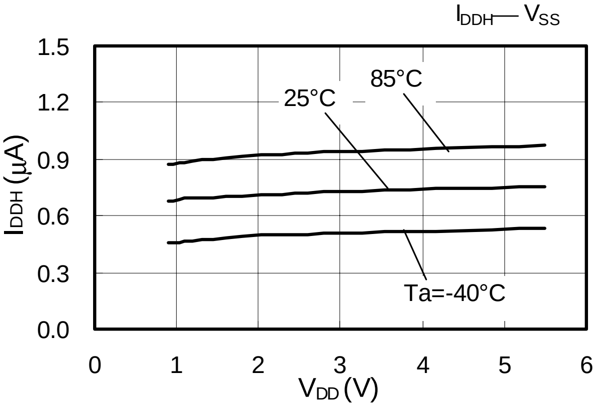
Figure 11

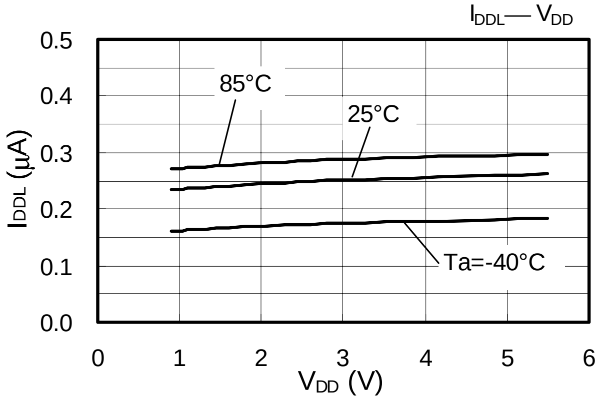
■ Note

- For R_L= 100kΩ, V_{OH} may rise only 0.65V provided that the temperature is -40°C and V_{DD} = 0.9V.
- If the temperature is -20°C, however, V_{OH} rises to 0.8V, which is 100mV below V_{DD}, for R_L = 100kΩ and V_{DD} = 0.9V.
- If V_{DD} is 1.2V, V_{OH} rises to 0.88V, which is 20mV below V_{DD}, for R_L= 100kΩ even at -40°C.
- These temperature characteristics data described above can be used as references. Note that a 100% testing for these conditions are not accomplished.

■ Typical Performance Characteristics

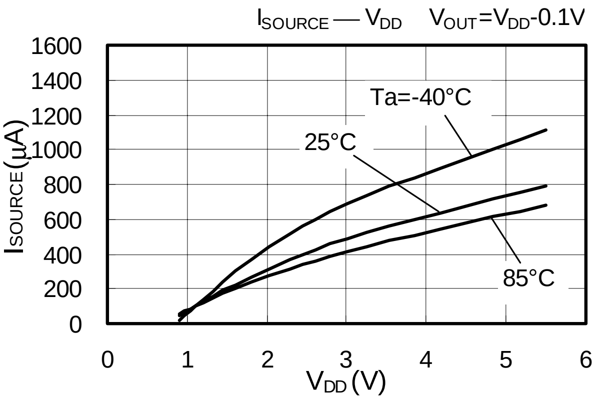
1. Current consumption– Supply voltage



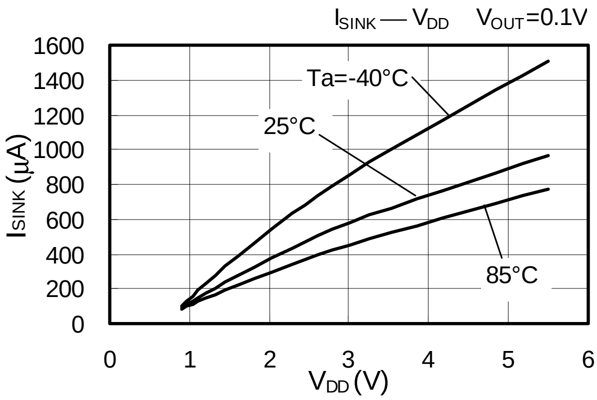


2. Output current

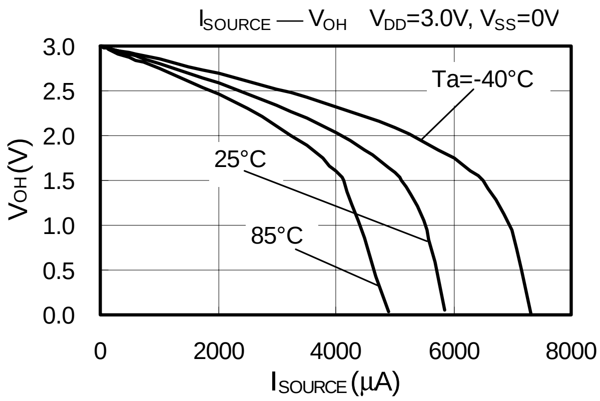
2-1. I_{SOURCE}- Supply voltage

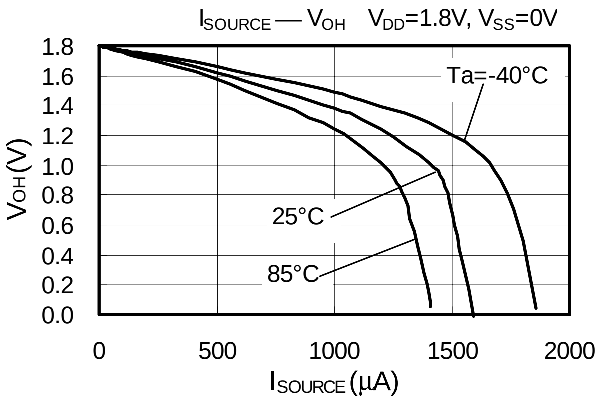


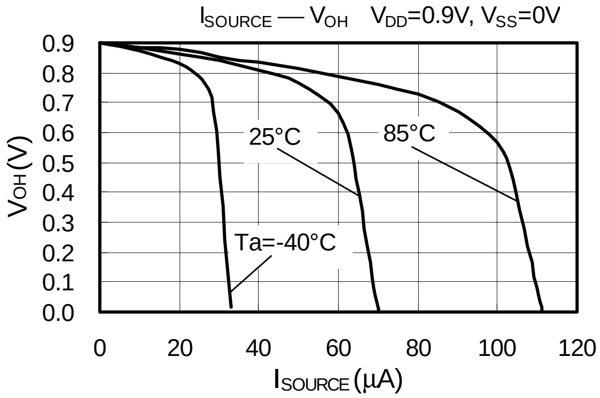
I_{SINK}– Supply voltage



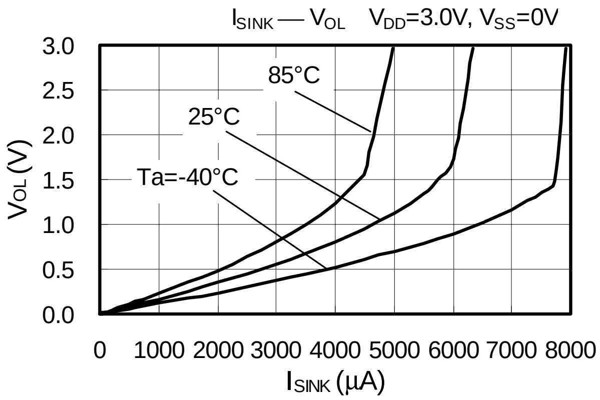
2-2. Output voltage(V_{OH})- I_{SOURCE}

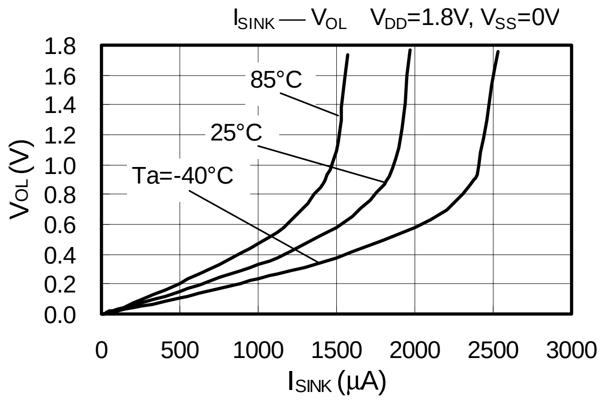


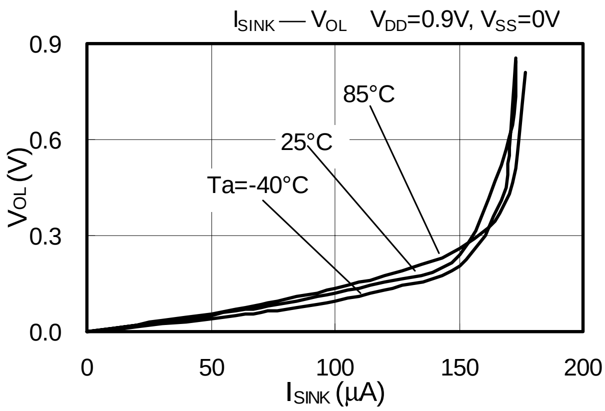




2-3. Output Voltage(V_{OL})- I_{SINK}



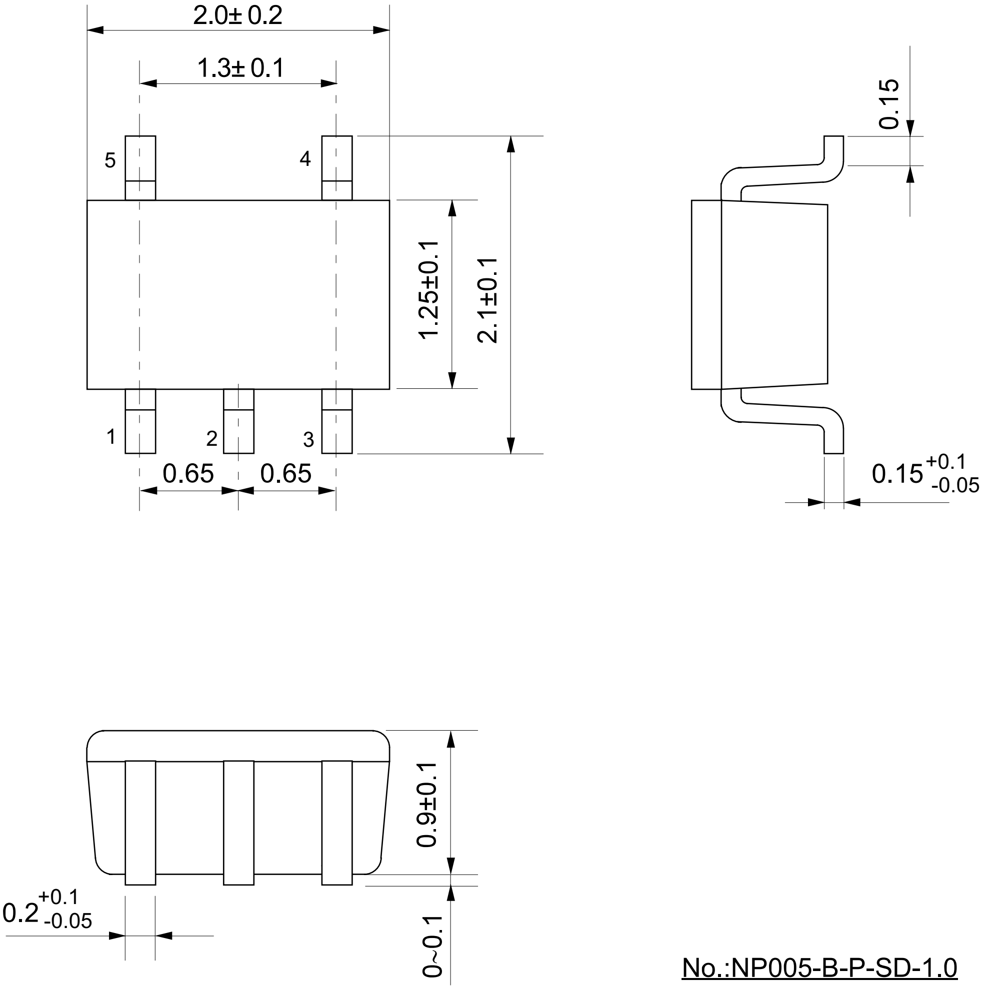




■ SC-88A

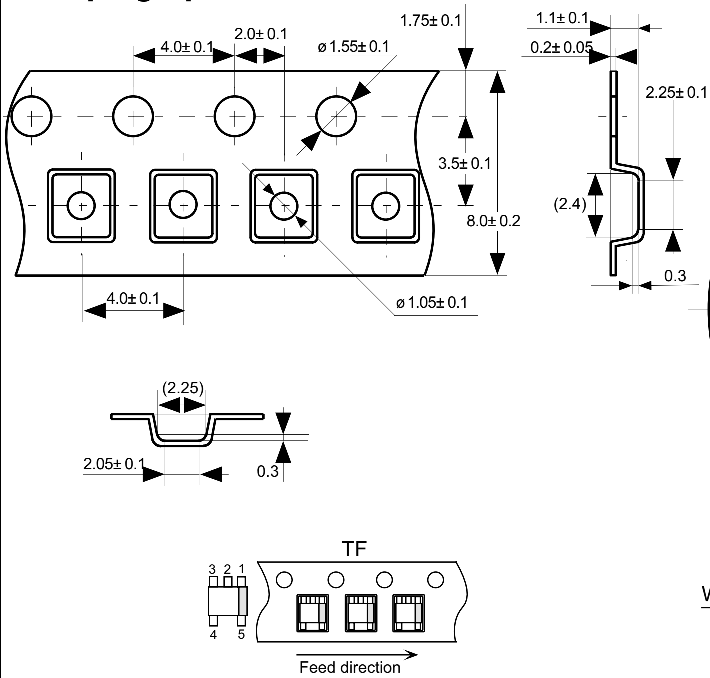
●Dimensions

Unit : mm



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

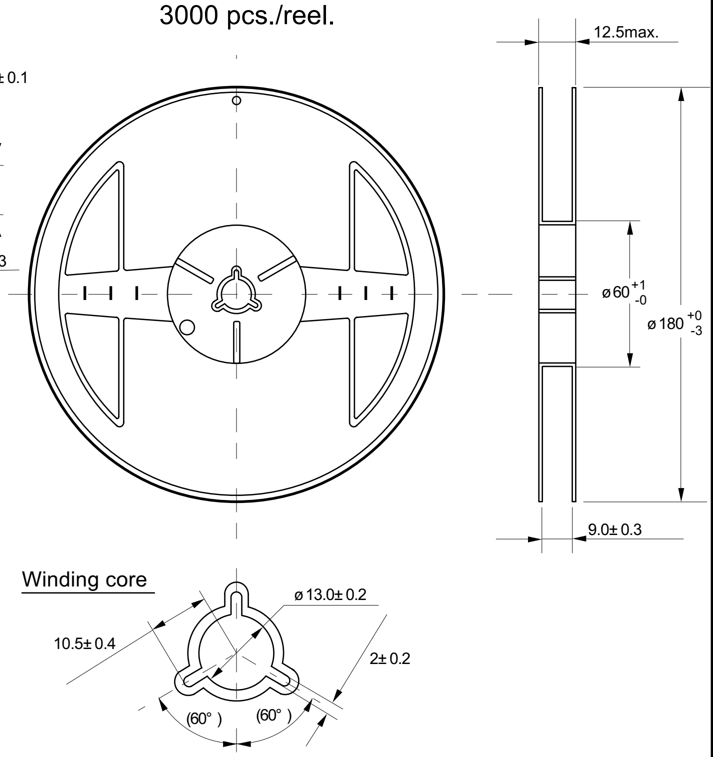
●Taping Specifications



No.:NP005-B-C-SD-0.0

●Reel Specifications

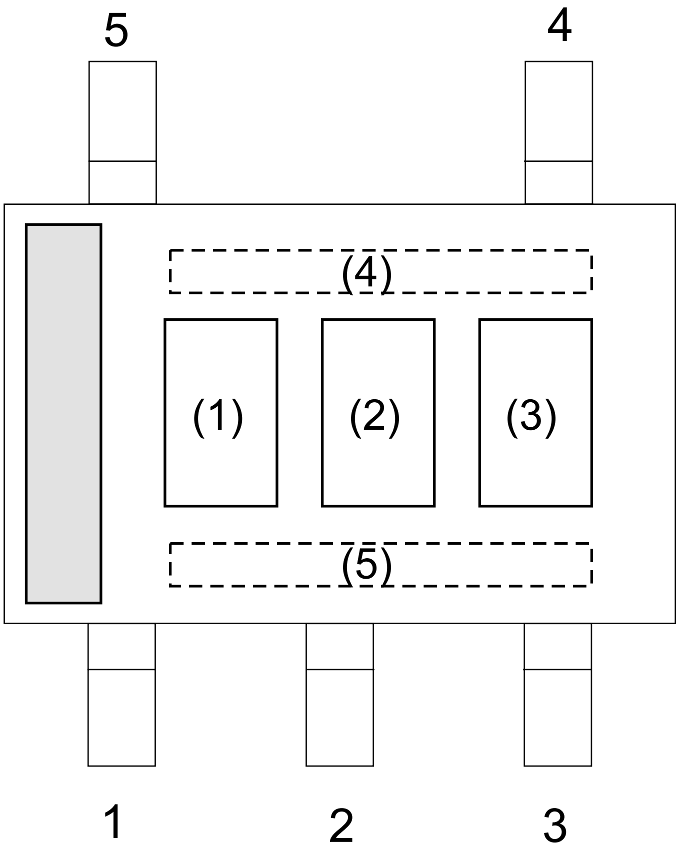
3000 pcs./reel.



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

Markings

SC-88A



(1) to (3) : Product name

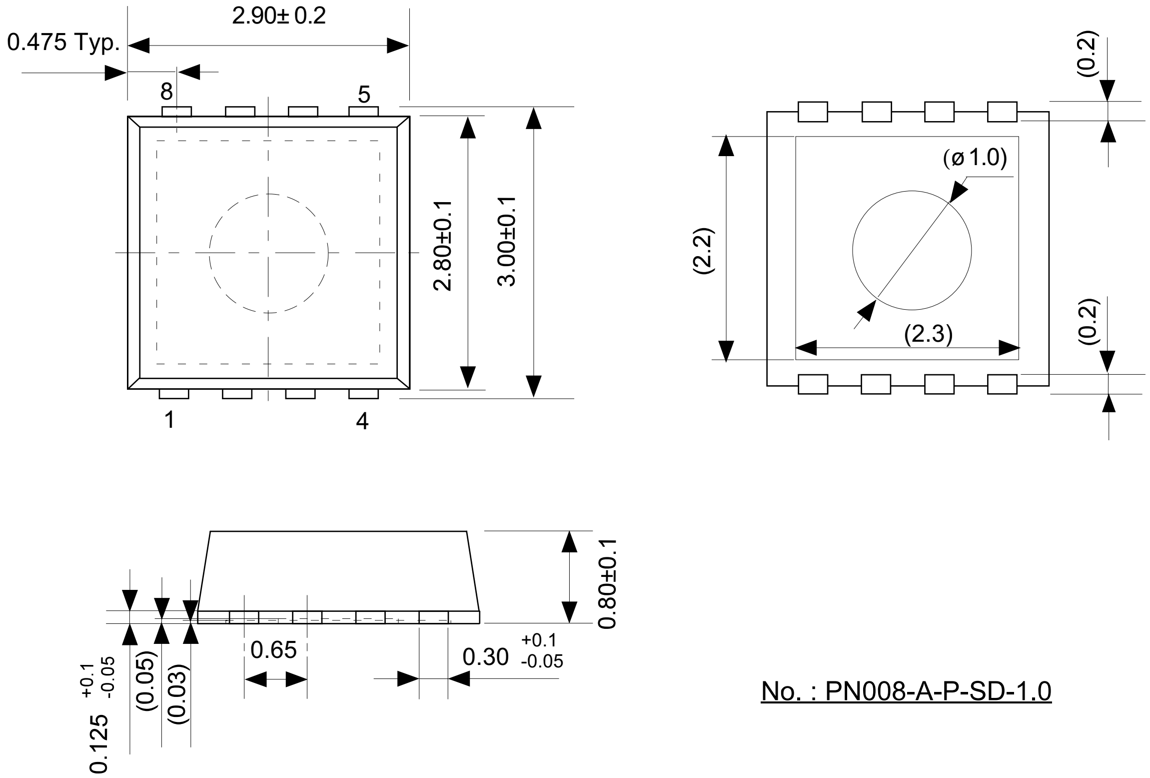
(4) , (5) : Product Lot

■ 8-pin SON(A) [SON8A(2928)]

PN008-A 010306

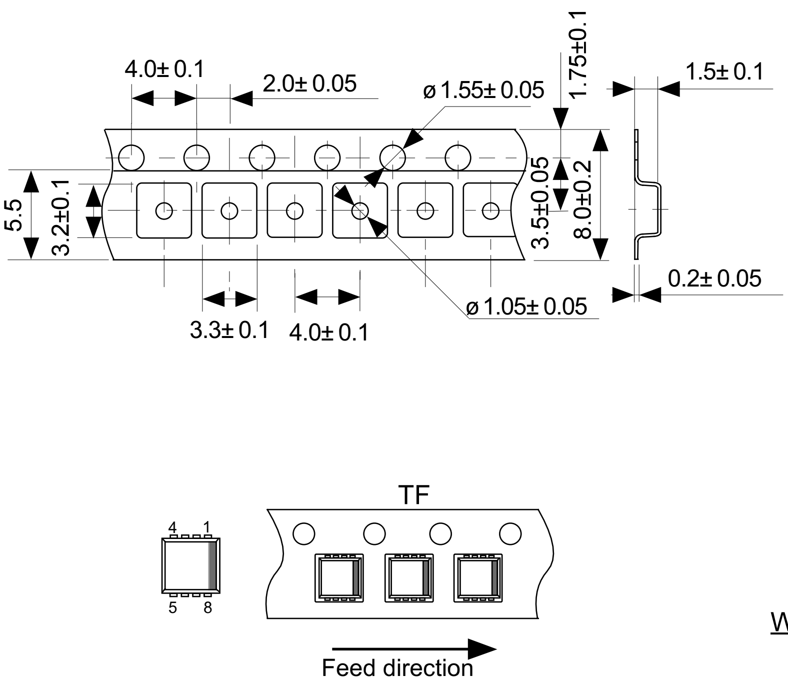
● Dimensions

Unit : mm



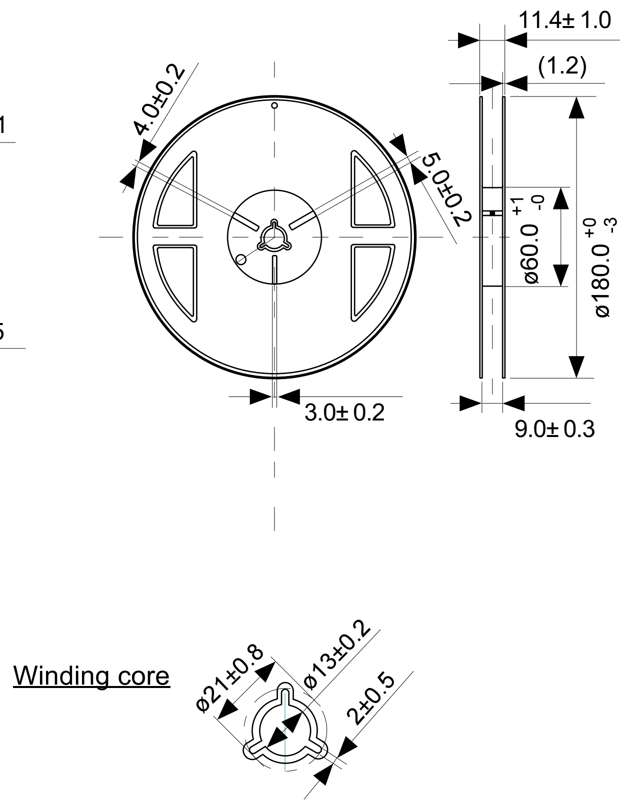
No. : PN008-A-P-SD-1.0

● Taping Specifications



No. : PN008-A-C-SD-1.0

● Reel Specifications



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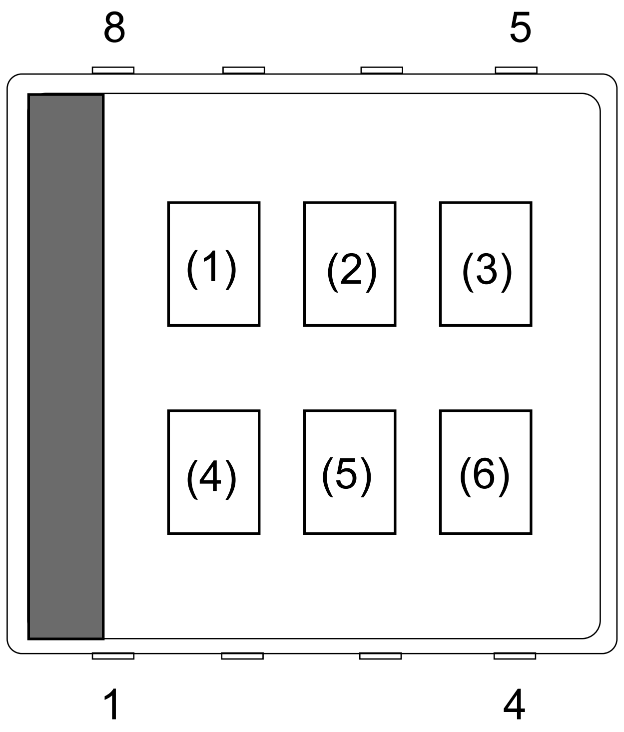
■ Markings

● 8-pin SON(A) [SON8A(2928)]



(1) (3) : Product name

(4) : Year of assembly

(5), (6) : Lot No.

No. : PN008-A-M-SD-1.0