

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

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 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 mV max.
- Lead-free, Sn100%, halogen-free^{*1}

*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-HCBTF□
$V_{IO} = 5\text{ mV max.}$	S-89531ACNC-HCCTF□

Remark □: G, S or U

■ Pin Configuration

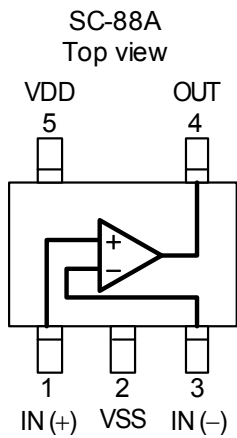


Figure 1

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

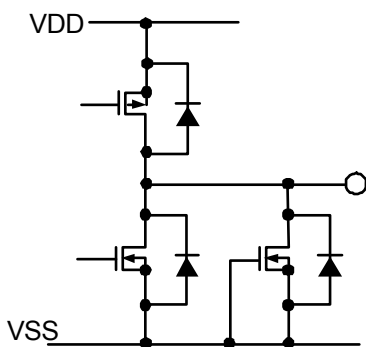


Figure 2

(2) Input pin

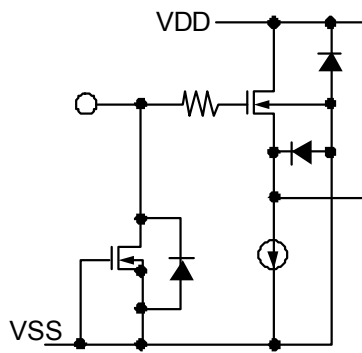


Figure 3

(3) VDD pin

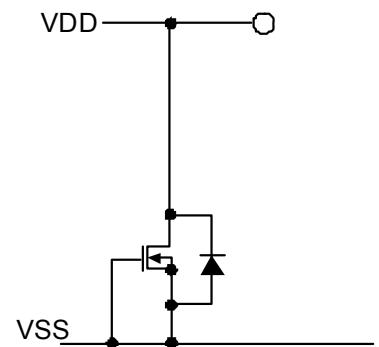


Figure 4

■ **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_{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.

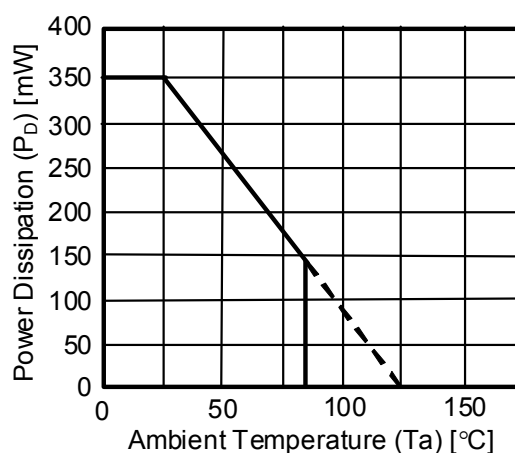


Figure 5 Power Dissipation of Package (When Mounted on Board)

■ **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	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, $R_L = 1$ M Ω	—	86	—	dB	—
Maximum output swing voltage	V_{OH}	$R_L = 1$ M Ω	2.98	—	—	V	Figure 9
	V_{OL}	$R_L = 1$ M Ω	—	—	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)

($T_a = 25^\circ\text{C}$ 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 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) ($T_a = 25^\circ\text{C}$ 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	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, $R_L = 1$ M Ω	—	80	—	dB	—
Maximum output swing voltage	V_{OH}	$R_L = 1$ M Ω	1.78	—	—	V	Figure 9
	V_{OL}	$R_L = 1$ M Ω	—	—	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) ($T_a = 25^\circ\text{C}$ 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 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)

($T_a = 25^\circ\text{C}$ 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	1.3	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, $R_L = 1$ M Ω	—	74	—	dB	—
Maximum output swing voltage	V_{OH}	$R_L = 1$ M Ω	0.88	—	—	V	Figure 9
	V_{OL}	$R_L = 1$ M Ω	—	—	0.02		Figure 10
Common-mode input signal rejection ratio	CMRR	$V_{SS} \leq V_{CMR} \leq V_{DD}$	25	50	—	dB	Figure 8
		$V_{SS} \leq V_{CMR} \leq V_{DD} - 0.3$ V	40	60	—		
Power supply voltage rejection ratio	PSRR	$V_{DD} = 0.9$ V to 5.5 V	66	75	—	dB	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)

($T_a = 25^\circ\text{C}$ 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 Figure 14)	—	65	—	μs
Fall propagation delay time	t_{PHL}		—	65	—	
Rise response time	t_{TLH}		—	5	—	
Fall response time	t_{THL}		—	20	—	

■ **Measurement Circuits**

1. Power supply voltage rejection ratio

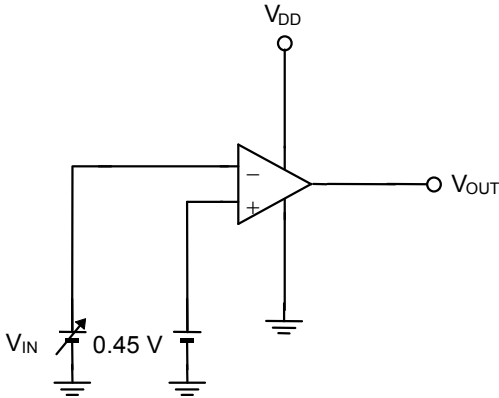


Figure 6

- 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 $V_{DD} = 0.9\text{ V}$: $V_{DD} = V_{DD1}$, $V_{IO} = V_{IO1}$

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

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

2. Input offset voltage

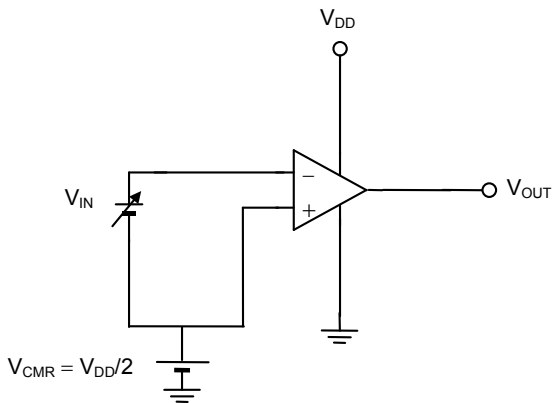


Figure 7

- 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

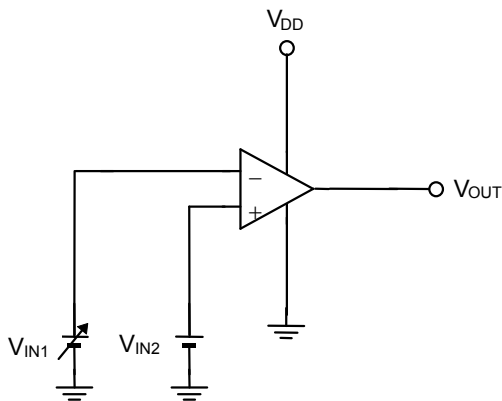


Figure 8

- 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

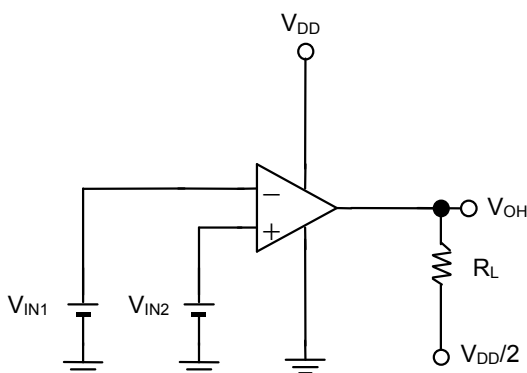


Figure 9

- Maximum output swing voltage (V_{OH})
 Measurement conditions: $V_{IN1} = \frac{V_{DD}}{2} - 0.1 \text{ V}$
 $V_{IN2} = \frac{V_{DD}}{2} + 0.1 \text{ V}$
 $R_L = 1 \text{ M}\Omega$

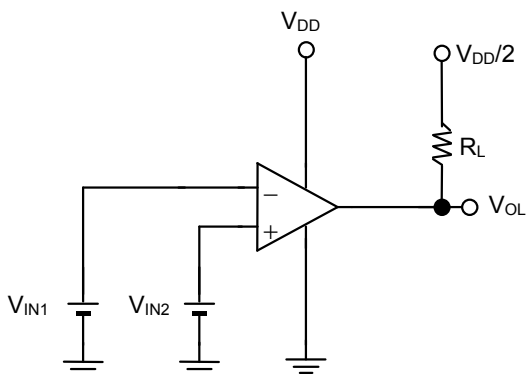


Figure 10

- 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

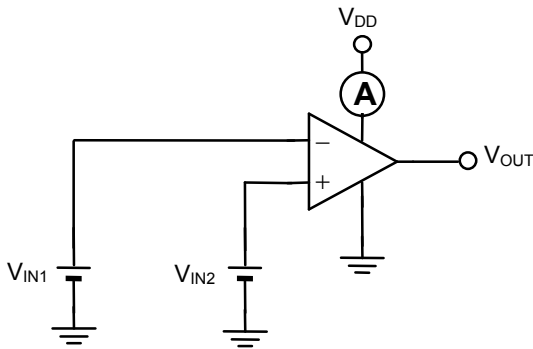


Figure 11

- 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

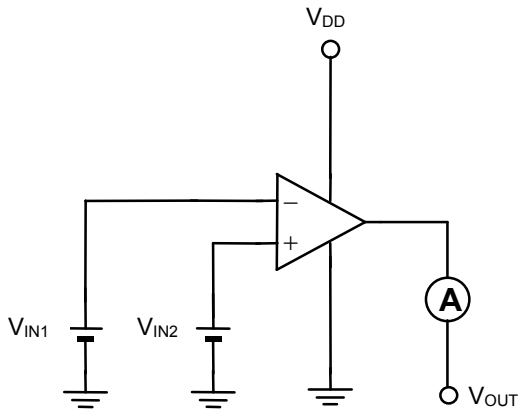


Figure 12

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

7. Sink current

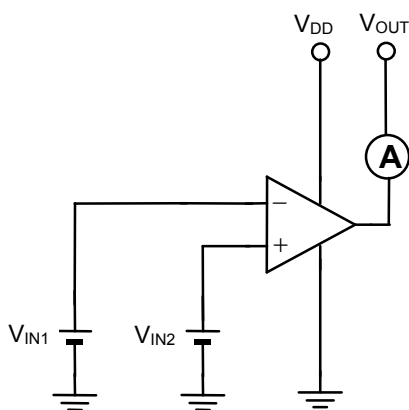


Figure 13

- 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

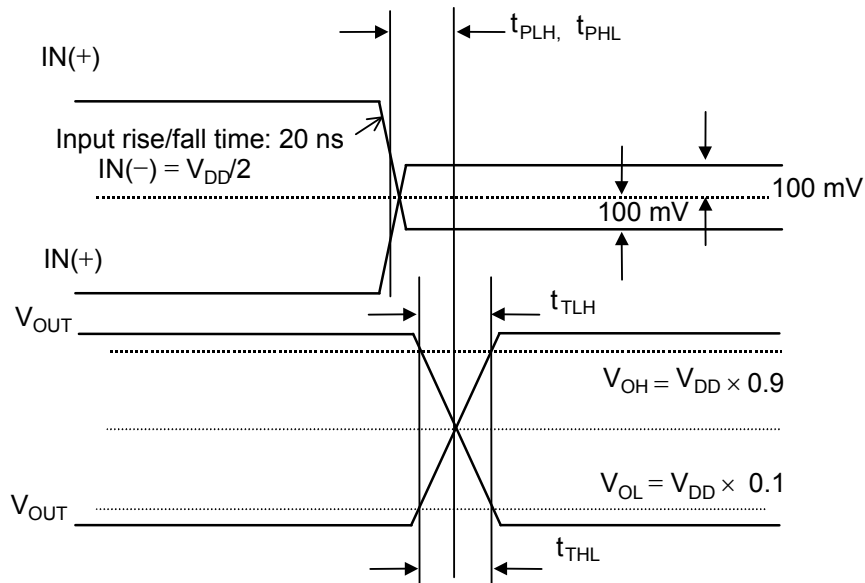


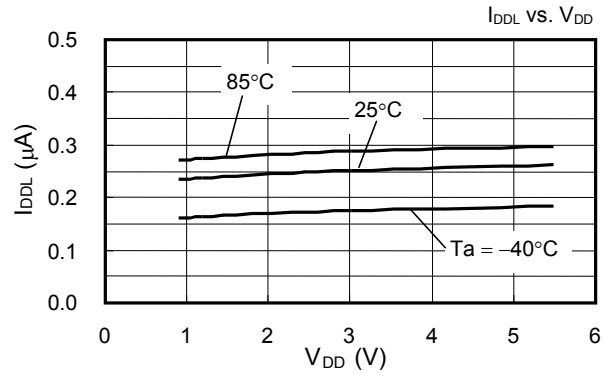
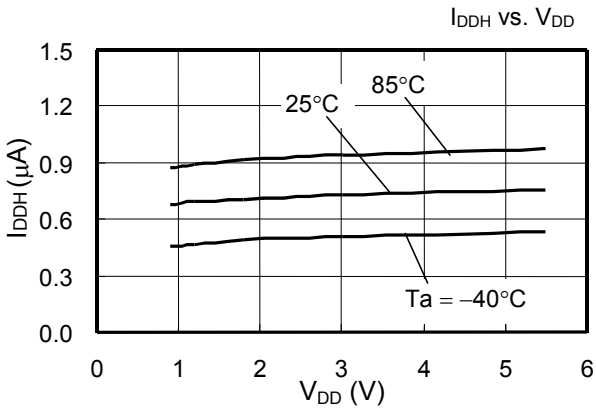
Figure 14

■ Cautions

- When $R_L = 100 \text{ k}\Omega$, V_{OH} may rise only 0.65 V if the temperature is -40°C and $V_{DD} = 0.9 \text{ V}$.
 If the temperature is -20°C , however, V_{OH} rises to 0.8 V, which is 100 mV below V_{DD} , when $V_{DD} = 0.9 \text{ V}$, 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°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.

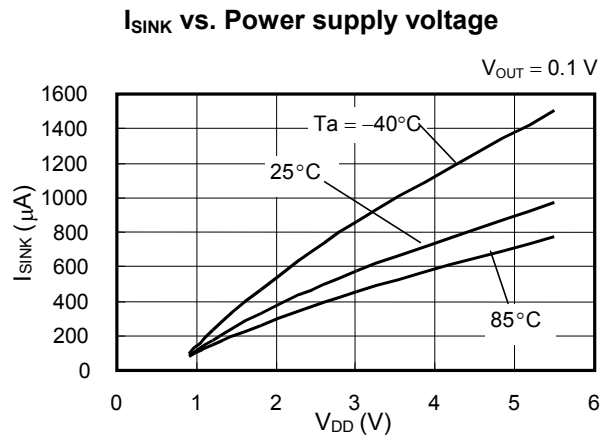
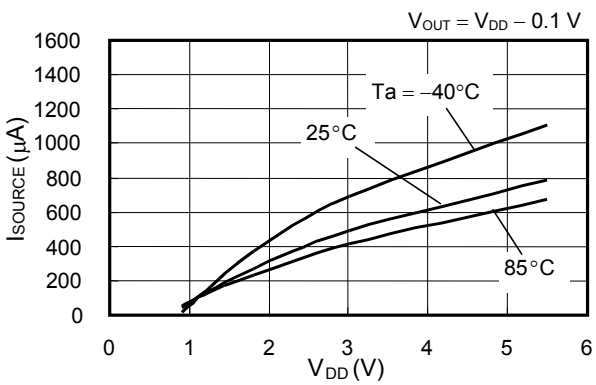
■ **Characteristics (Reference Data)**

1. Current consumption vs. Power supply voltage

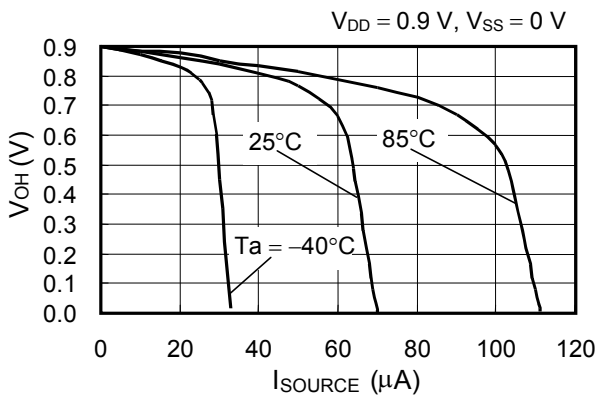
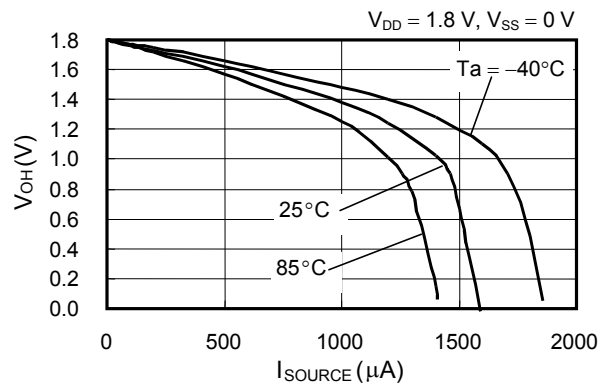
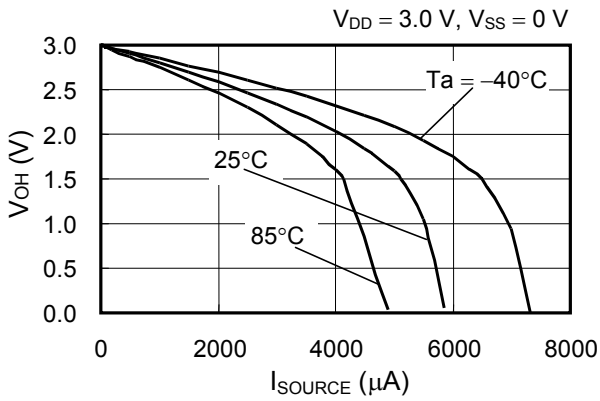


2. Output current

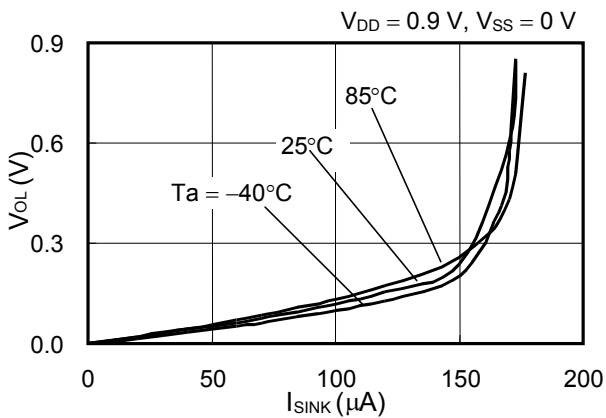
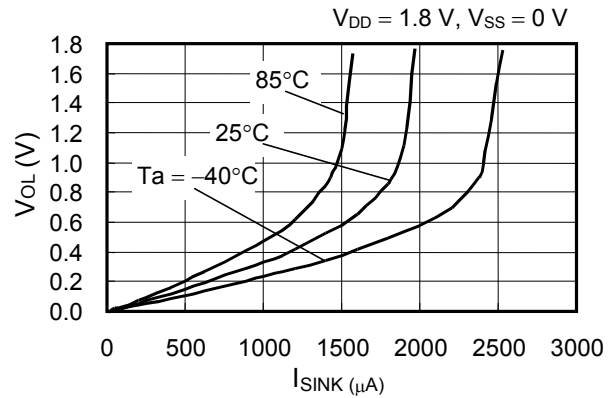
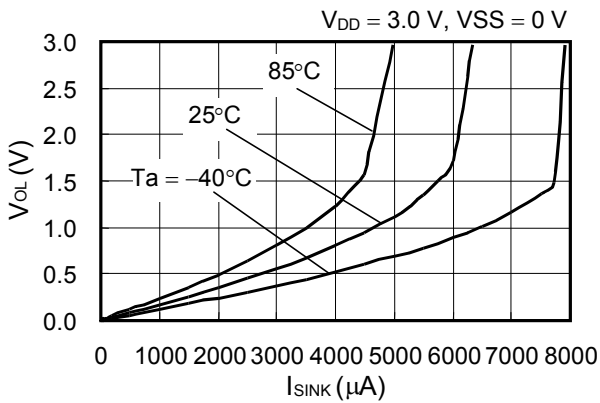
2-1. I_{SOURCE} vs. Power supply voltage

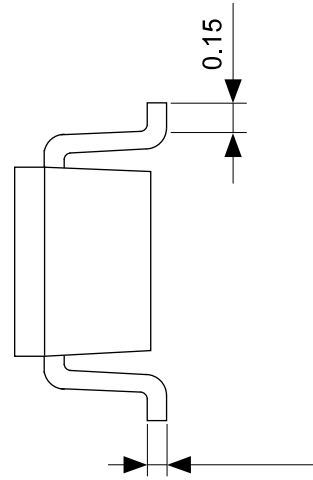
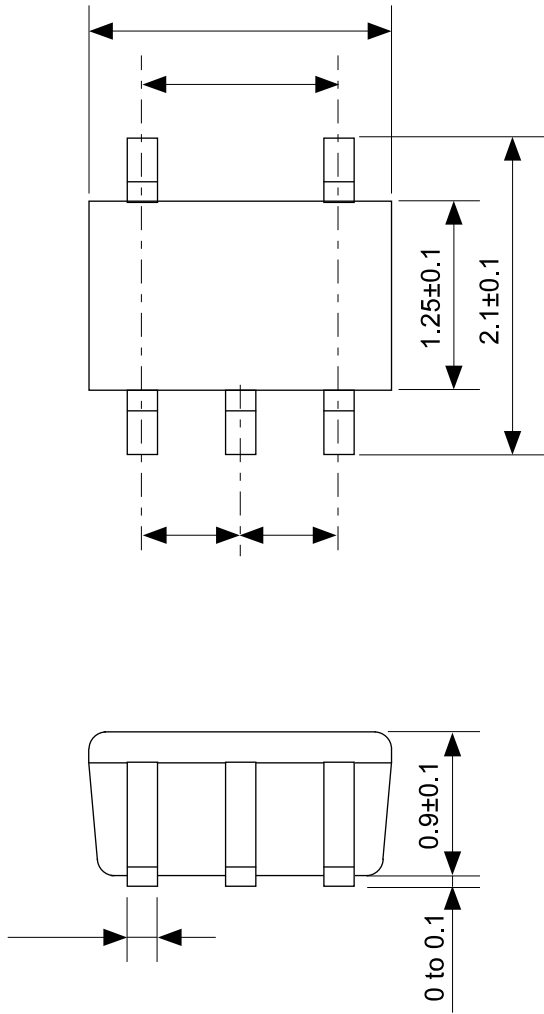


2-2. Output voltage (V_{OH}) vs. I_{SOURCE}

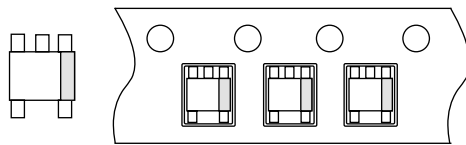
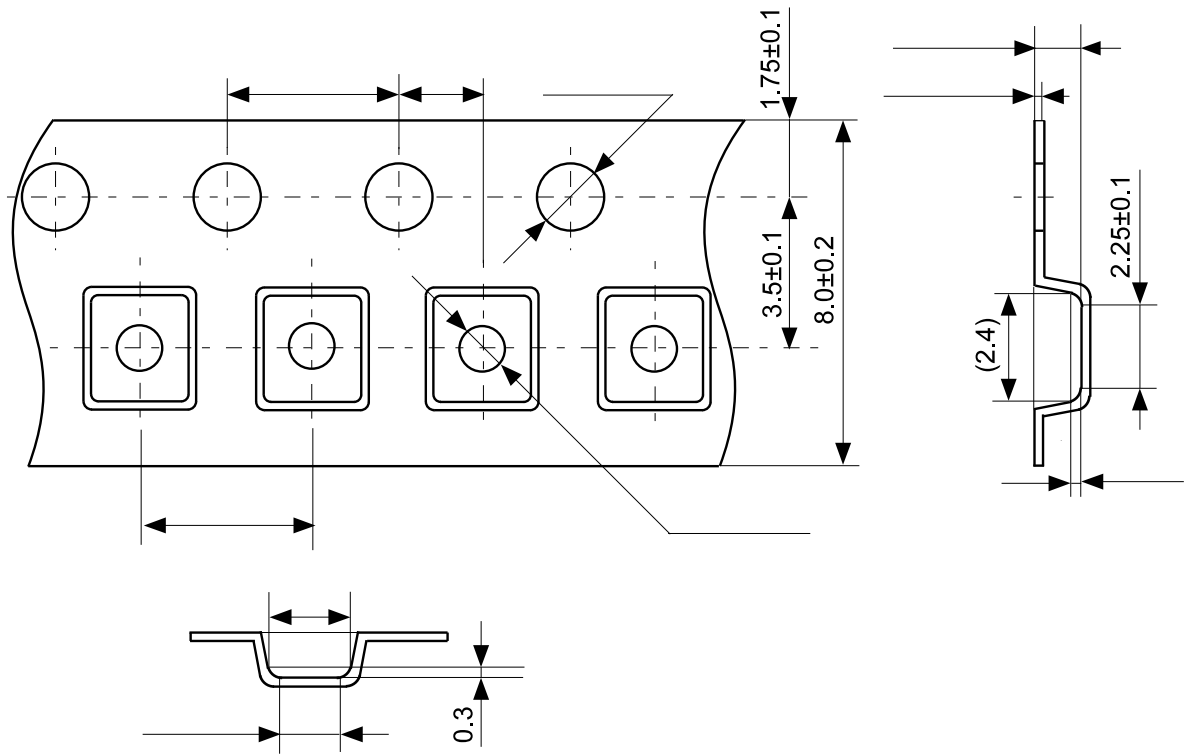


2-3. Output Voltage (V_{OL}) vs. I_{SINK}

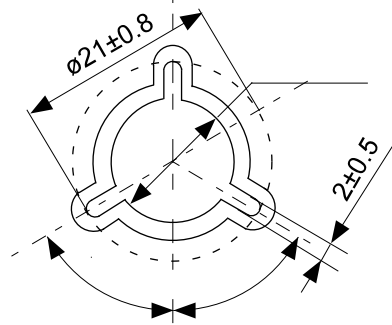
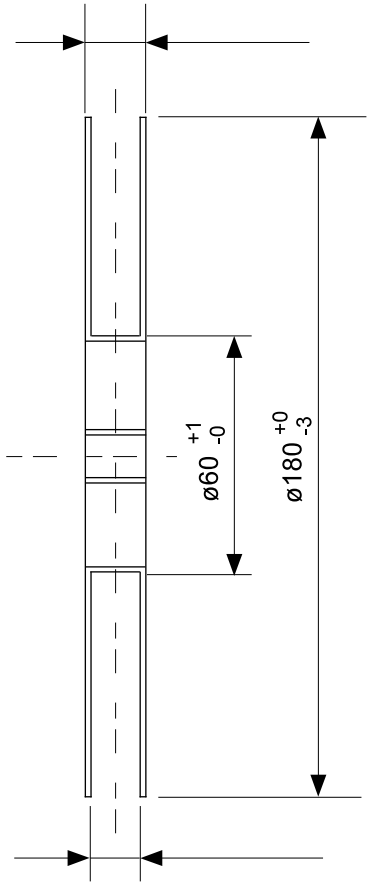
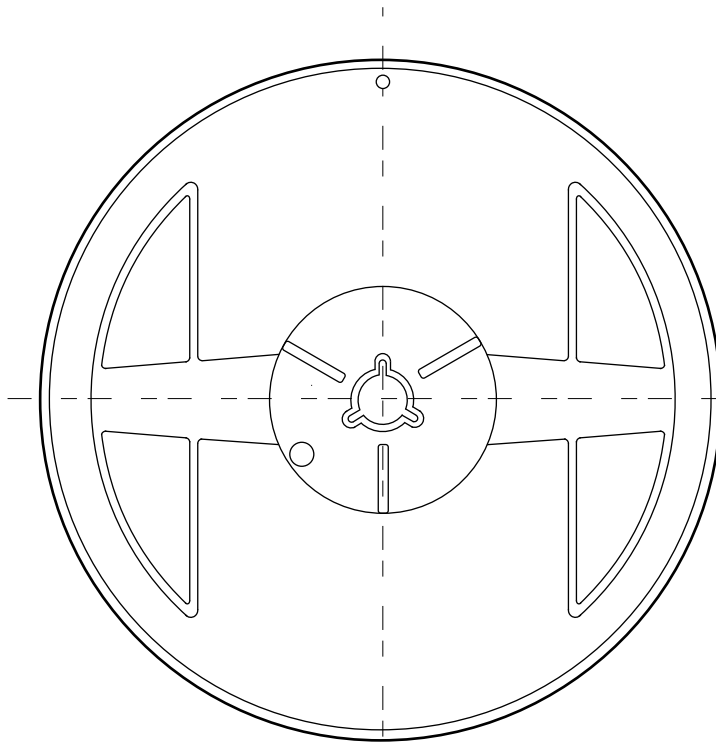




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The user of the products should therefore take responsibility to give thorough consideration to safety design including redundancy, fire spread prevention measures, and malfunction prevention to prevent accidents causing injury or death, fires and social damage, etc. that may ensue from the products' failure or malfunction.
The entire system must be sufficiently evaluated and applied on customer's own responsibility.
10. The products are not designed to be radiation-proof. The necessary radiation measures should be taken in the product design by the customer depending on the intended use.
11. The products do not affect human health under normal use. However, they contain chemical substances and heavy metals and should therefore not be put in the mouth. The fracture surfaces of wafers and chips may be sharp. Be careful when handling these with the bare hands to prevent injuries, etc.
12. When disposing of the products, comply with the laws and ordinances of the country or region where they are used.
13. The information described herein contains copyright information and know-how of ABLIC Inc.
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14. For more details on the information described herein, contact our sales office.

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