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# TC75S54F, TC75S54FU, TC75S54FE

## Single Operational Amplifier

The TC75S54F/TC75S54FU/TC75S54FE is a CMOS single-operation amplifier which incorporates a phase compensation circuit. It is designed for use with a low-voltage, low-current power supply; this differentiates this device from conventional general-purpose bipolar op-amps.

### Features

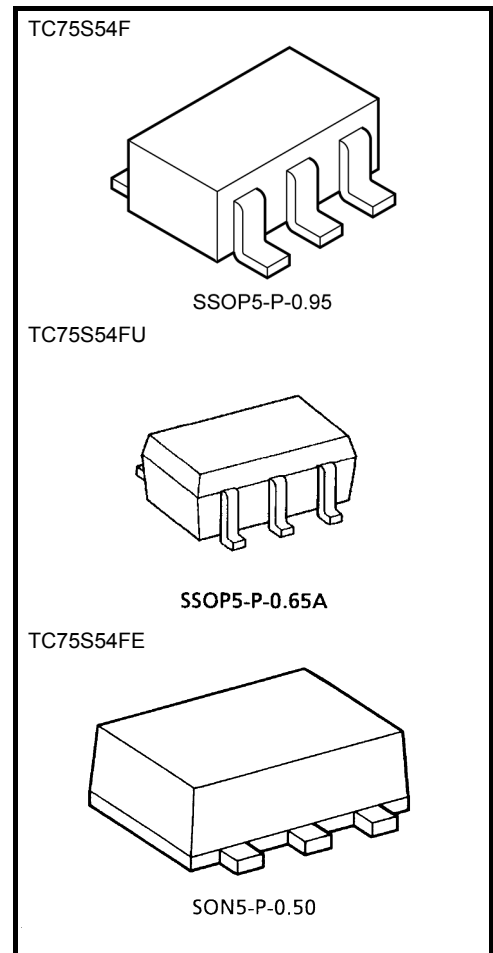
- Low-voltage operation :  $V_{DD} = \pm 0.9$  to  $\pm 3.5$  V or 1.8 to 7 V
- Low-current power supply :  $I_{DD} (V_{DD} = 3 \text{ V}) = 100 \mu\text{A}$  (typ.)
- Built-in phase-compensated op-amp, obviating the need for any external device
- Ultra-compact package

### Absolute Maximum Ratings ( $T_a = 25^\circ\text{C}$ )

| Characteristics            |             | Symbol           | Rating               | Unit             |
|----------------------------|-------------|------------------|----------------------|------------------|
| Supply voltage             |             | $V_{DD}, V_{SS}$ | 7                    | V                |
| Differential input voltage |             | $DV_{IN}$        | $\pm 7$              | V                |
| Input voltage              |             | $V_{IN}$         | $V_{DD}$ to $V_{SS}$ | V                |
| Power dissipation          | TC75S54F/FU | $P_D$            | 200                  | mW               |
|                            | TC75S54FE   |                  | 100                  |                  |
| Operating temperature      |             | $T_{opr}$        | -40 to 85            | $^\circ\text{C}$ |
| Storage temperature        |             | $T_{stg}$        | -55 to 125           | $^\circ\text{C}$ |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

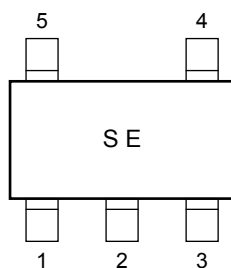


#### Weight

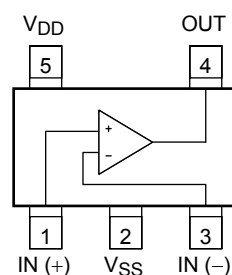
- SSOP5-P-0.95 : 0.014 g (typ.)
- SSOP5-P-0.65A : 0.006 g (typ.)
- SON5-P-0.50 : 0.003 g (typ.)

Start of commercial production  
1995-01

## Marking (top view)



## Pin Connection (top view)



## Electrical Characteristics

### DC Characteristics ( $V_{DD} = 3.0\text{ V}$ , $V_{SS} = \text{GND}$ , $T_a = 25^\circ\text{C}$ )

| Characteristics                          | Symbol              | Test Circuit | Test Condition                        | Min | Typ. | Max | Unit          |
|--|---------------------|--------------|---------------------------------------|-----|------|-----|---------------|
| Input offset voltage                     | $V_{IO}$            | 1            | $R_S = 1\text{ k}\Omega$              | —   | 2    | 10  | mV            |
| Input offset current                     | $I_{IO}$            | —            | —                                     | —   | 1    | —   | pA            |
| Input bias current                       | $I_I$               | —            | —                                     | —   | 1    | —   | pA            |
| Common mode input voltage                | $CMV_{IN}$          | 2            | —                                     | 0.0 | —    | 2.1 | V             |
| Voltage gain (open loop)                 | $G_V$               | —            | —                                     | 60  | 70   | —   | dB            |
| Maximum output voltage                   | $V_{OH}$            | 3            | $R_L \geq 100\text{ k}\Omega$         | 2.9 | —    | —   | V             |
|  | $V_{OL}$            | 4            | $R_L \geq 100\text{ k}\Omega$         | —   | —    | 0.1 |               |
| Common mode input signal rejection ratio | CMRR                | 2            | $V_{IN} = 0.0\text{ to }2.1\text{ V}$ | 60  | 70   | —   | dB            |
| Supply voltage rejection ratio           | SVRR                | 1            | $V_{DD} = 1.8\text{ to }7.0\text{ V}$ | 60  | 70   | —   | dB            |
| Supply current                           | $I_{DD}$            | 5            | —                                     | —   | 100  | 200 | $\mu\text{A}$ |
| Source current                           | $I_{\text{source}}$ | 6            | —                                     | 100 | 200  | —   | $\mu\text{A}$ |
| Sink current                             | $I_{\text{sink}}$   | 7            | —                                     | 200 | 700  | —   | $\mu\text{A}$ |

### DC Characteristics ( $V_{DD} = 1.8\text{ V}$ , $V_{SS} = \text{GND}$ , $T_a = 25^\circ\text{C}$ )

| Characteristics           | Symbol              | Test Circuit | Test Condition                | Min | Typ. | Max | Unit          |
|---------------------------|---------------------|--------------|-------------------------------|-----|------|-----|---------------|
| Input offset voltage      | $V_{IO}$            | 1            | $R_S = 10\text{ k}\Omega$     | —   | 2    | 10  | mV            |
| Input offset current      | $I_{IO}$            | —            | —                             | —   | 1    | —   | pA            |
| Input bias current        | $I_I$               | —            | —                             | —   | 1    | —   | pA            |
| Common mode input voltage | $CMV_{IN}$          | 2            | —                             | 0.2 | —    | 0.9 | V             |
| Voltage gain (open loop)  | $G_V$               | —            | —                             | 60  | 70   | —   | dB            |
| Maximum output voltage    | $V_{OH}$            | 3            | $R_L \geq 100\text{ k}\Omega$ | 1.7 | —    | —   | V             |
|                           | $V_{OL}$            | 4            | $R_L \geq 100\text{ k}\Omega$ | —   | —    | 0.1 |               |
| Supply current            | $I_{DD}$            | 5            | —                             | —   | 80   | 160 | $\mu\text{A}$ |
| Source current            | $I_{\text{source}}$ | 6            | —                             | 80  | 160  | —   | $\mu\text{A}$ |
| Sink current              | $I_{\text{sink}}$   | 7            | —                             | 200 | 600  | —   | $\mu\text{A}$ |

## AC Characteristics ( $V_{DD} = 3.0\text{ V}$ , $V_{SS} = \text{GND}$ , $T_a = 25^\circ\text{C}$ )

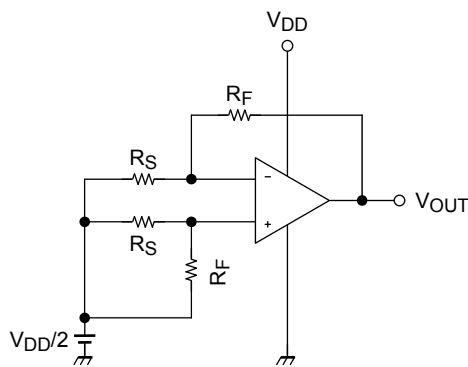
| Characteristics            | Symbol | Test Circuit | Test Condition | Min | Typ. | Max | Unit             |
|----------------------------|--------|--------------|----------------|-----|------|-----|------------------|
| Slew rate                  | SR     | —            | —              | —   | 0.7  | —   | V/ $\mu\text{s}$ |
| Unity gain cross frequency | $f_T$  | —            | —              | —   | 0.9  | —   | MHz              |

## AC Characteristics ( $V_{DD} = 1.8\text{ V}$ , $V_{SS} = \text{GND}$ , $T_a = 25^\circ\text{C}$ )

| Characteristics            | Symbol | Test Circuit | Test Condition | Min | Typ. | Max | Unit             |
|----------------------------|--------|--------------|----------------|-----|------|-----|------------------|
| Slew rate                  | SR     | —            | —              | —   | 0.6  | —   | V/ $\mu\text{s}$ |
| Unity gain cross frequency | $f_T$  | —            | —              | —   | 0.8  | —   | MHz              |

## Test Circuit

### 1. SVRR, $V_{IO}$



- SVRR**  
 For each of the two  $V_{DD}$  values, measure the  $V_{OUT}$  value, as indicated below, and calculate the value of SVRR using the equation shown.

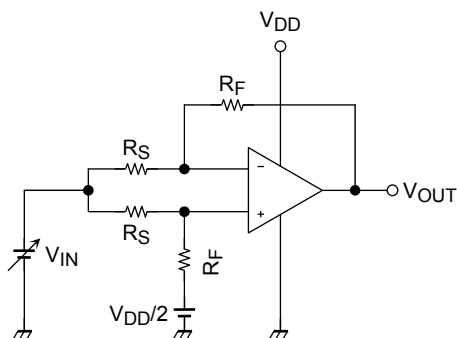
When  $V_{DD} = 1.8\text{ V}$ ,  $V_{DD} = V_{DD1}$  and  $V_{OUT} = V_{OUT1}$   
 When  $V_{DD} = 7.0\text{ V}$ ,  $V_{DD} = V_{DD2}$  and  $V_{OUT} = V_{OUT2}$

$$SVRR = 20 \lambda \log \left( \left| \frac{V_{OUT1} - V_{OUT2}}{V_{DD1} - V_{DD2}} \right| \times \frac{R_S}{R_F + R_S} \right)$$

- $V_{IO}$**   
 Measure the value of  $V_{OUT}$  and calculate the value of  $V_{IO}$  using the following equation.

$$V_{IO} = \left( V_{OUT} - \frac{V_{DD}}{2} \right) \times \frac{R_S}{R_F + R_S}$$

### 2. CMRR, $CMV_{IN}$



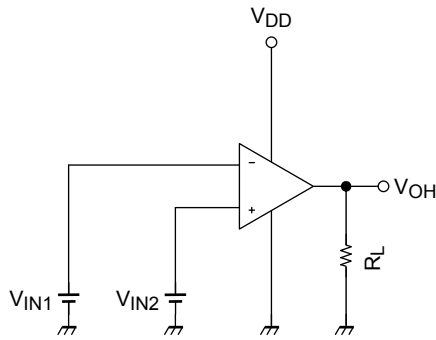
- CMRR**  
 Measure the  $V_{OUT}$  value, as indicated below, and calculate the value of the CMRR using the equation shown.

When  $V_{IN} = 0.0\text{ V}$ ,  $V_{IN} = V_{IN1}$  and  $V_{OUT} = V_{OUT1}$   
 When  $V_{IN} = 2.1\text{ V}$ ,  $V_{IN} = V_{IN2}$  and  $V_{OUT} = V_{OUT2}$

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

- $CMV_{IN}$**   
 Input range within which the CMRR specification guarantees  $V_{OUT}$  value (as varied by the  $V_{IN}$  value).

**3.  $V_{OH}$**

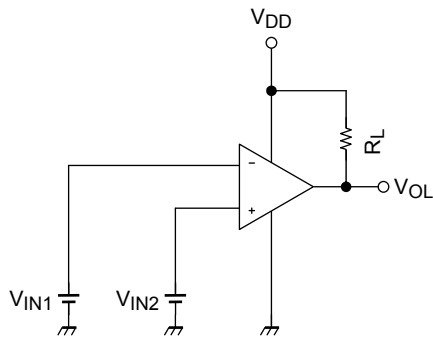


- $V_{OH}$   

$$V_{IN1} = \frac{V_{DD}}{2} - 0.05 \text{ V}$$

$$V_{IN2} = \frac{V_{DD}}{2} + 0.05 \text{ V}$$

**4.  $V_{OL}$**

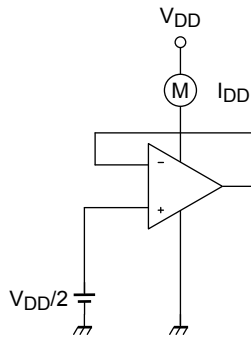


- $V_{OL}$   

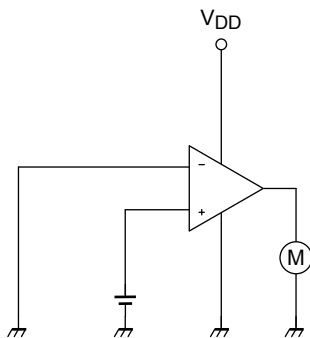
$$V_{IN1} = \frac{V_{DD}}{2} + 0.05 \text{ V}$$

$$V_{IN2} = \frac{V_{DD}}{2} - 0.05 \text{ V}$$

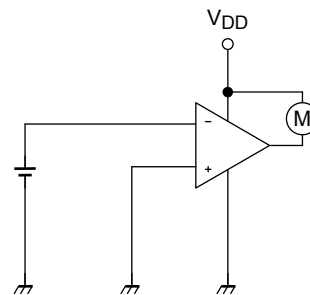
**5.  $I_{DD}$**

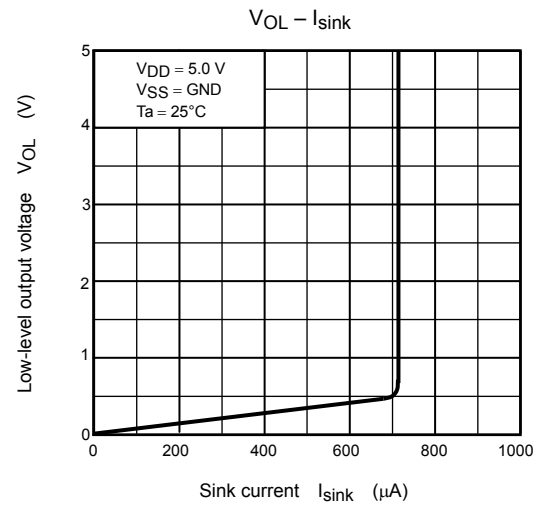
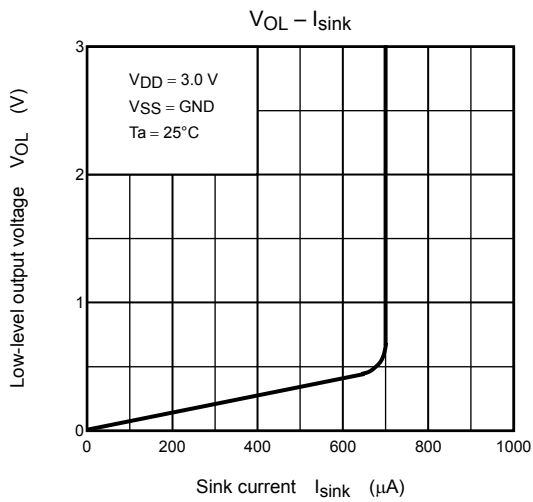
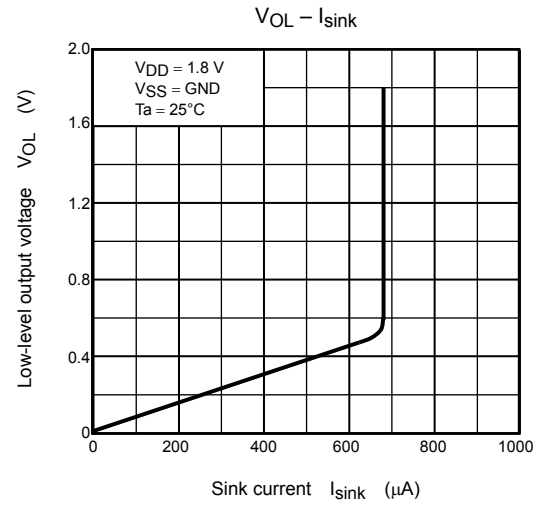
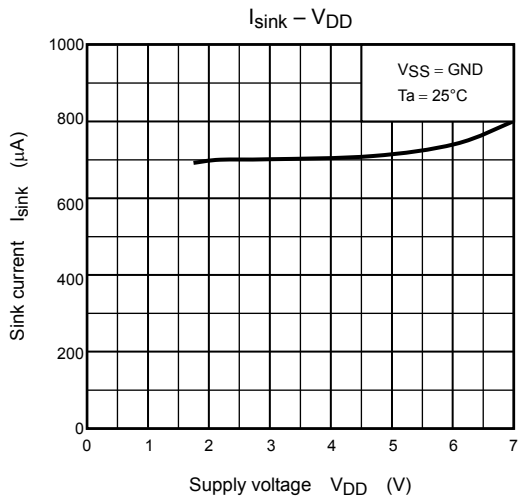
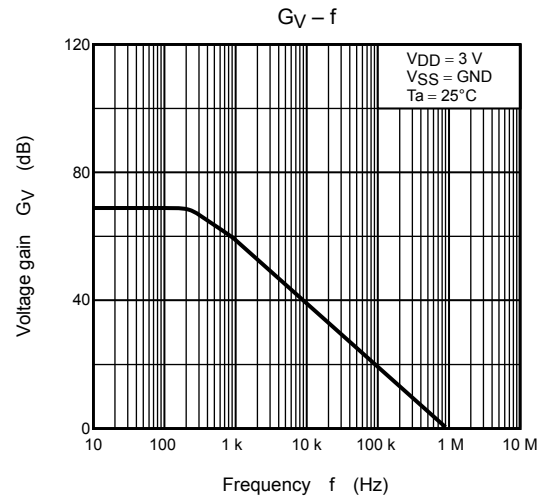
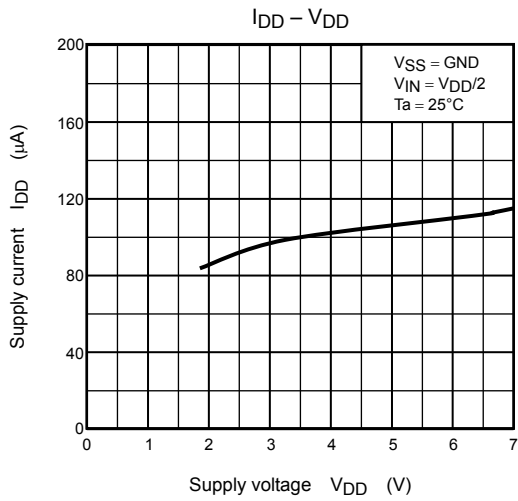


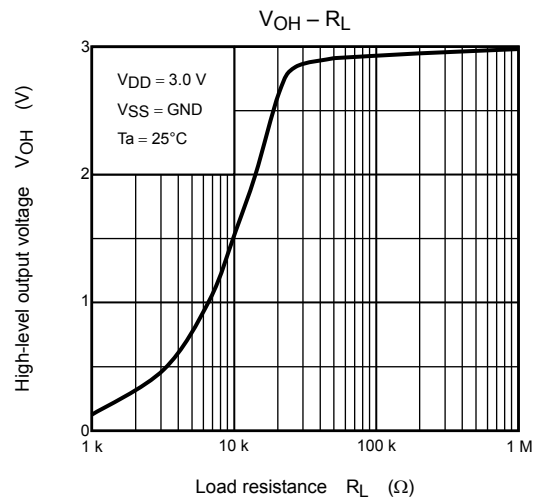
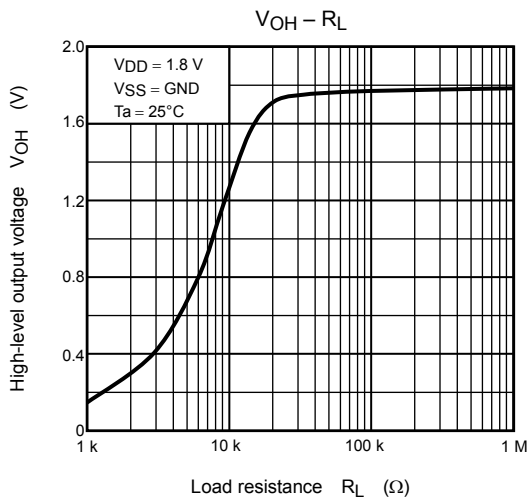
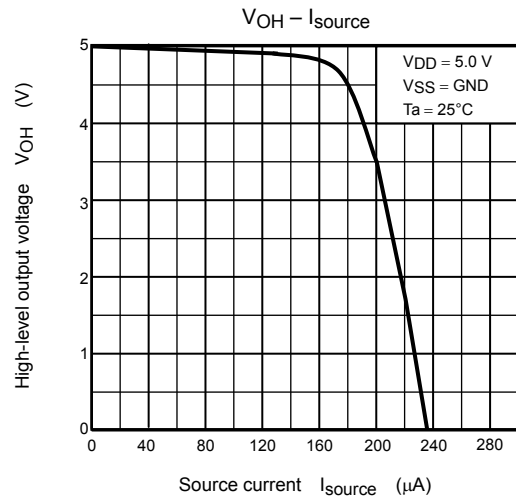
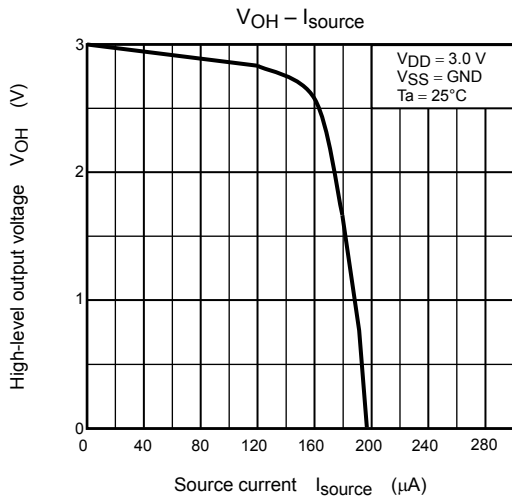
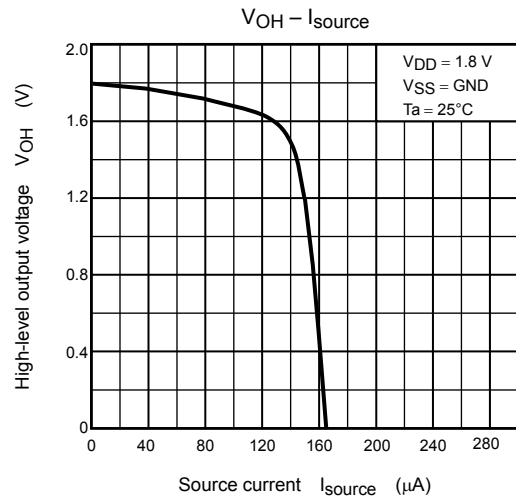
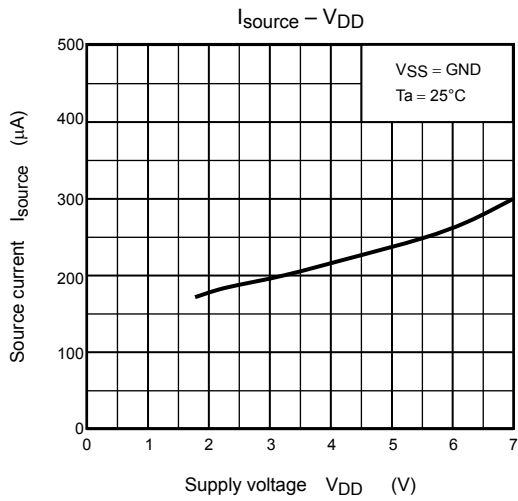
**6.  $I_{source}$**

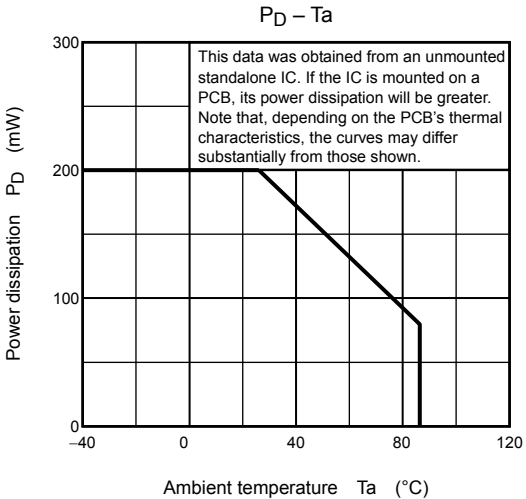
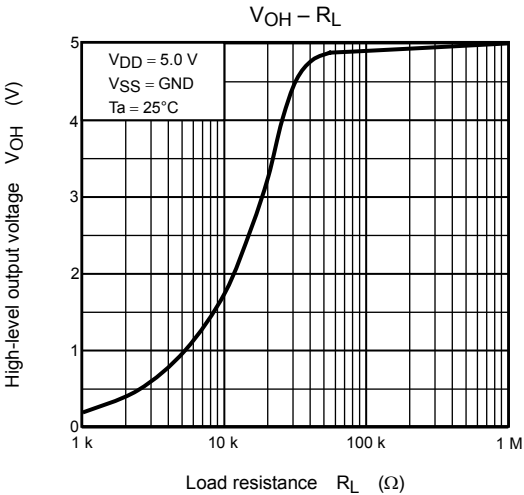


**7.  $I_{sink}$**







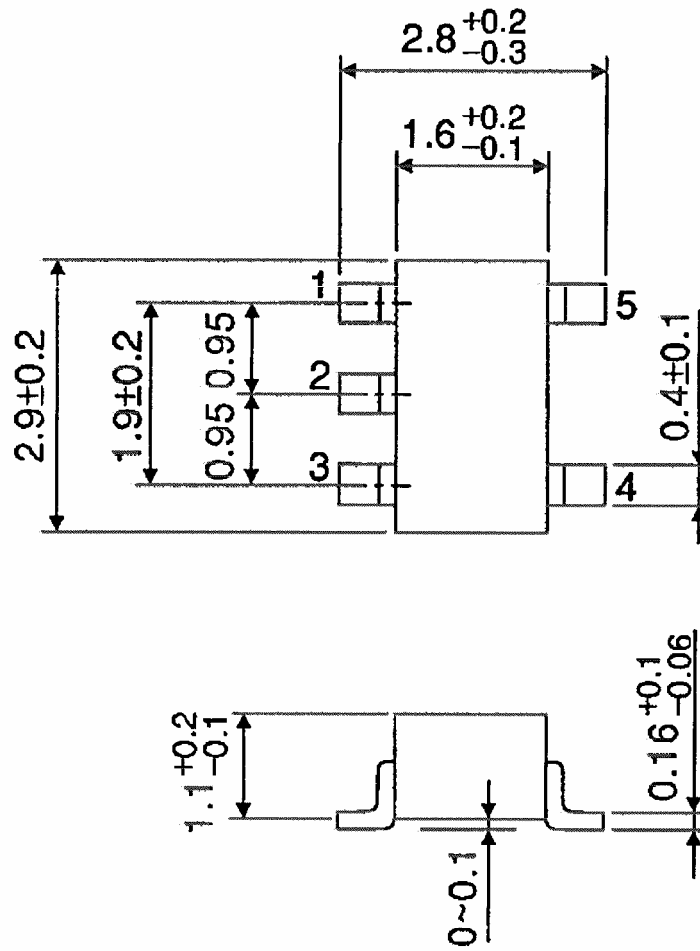




## Package Dimensions

SSOP5-P-0.95

Unit : mm

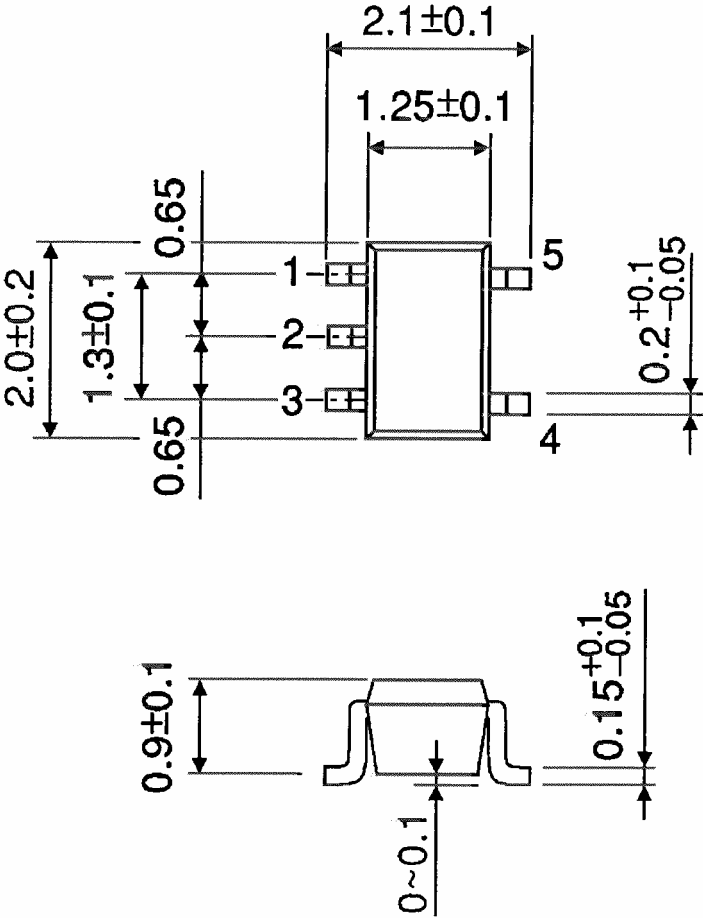


Weight: 0.014 g (typ.)

Package Dimensions

SSOP5-P-0.65A

Unit : mm

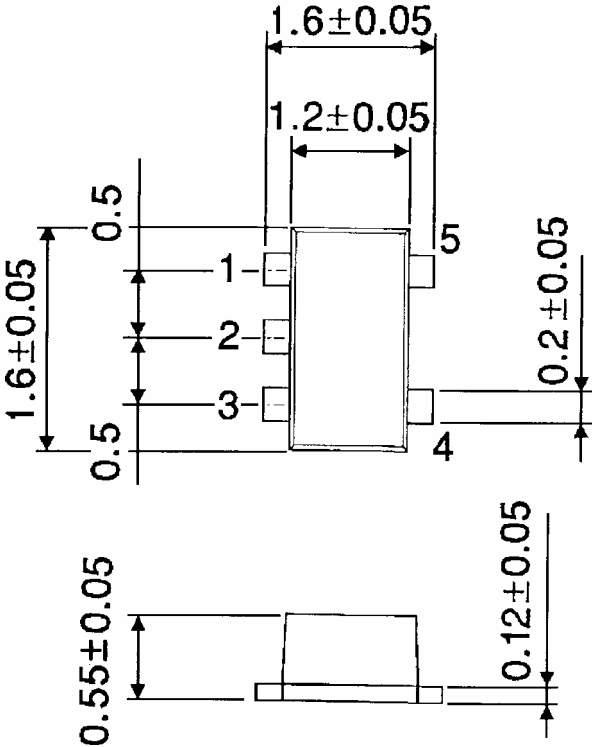


Weight: 0.006 g (typ.)

**Package Dimensions**

SON5-P-0.50

Unit : mm



Weight: 0.003 g (typ.)

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