

TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

# TC75S55F, TC75S55FU

## Single Operational Amplifier

The TC75S55F/TC75S55FU 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

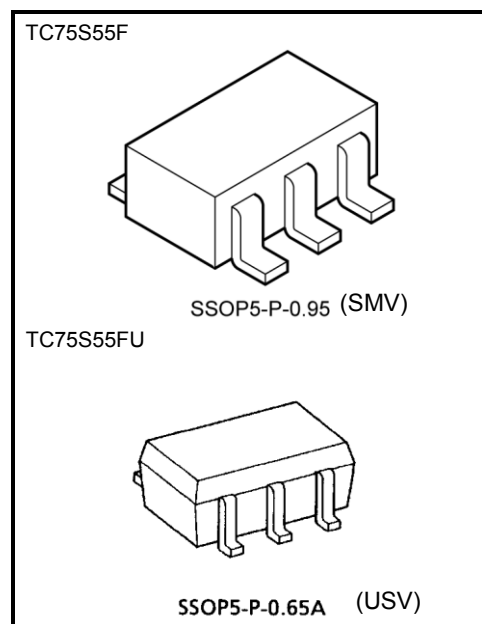
- Low-voltage operation :  $V_{DD} = \pm 0.9$  to 3.5 V or 1.8 to 7 V
- Low-current power supply :  $I_{DD} (V_{DD} = 3 \text{ V}) = 10 \mu\text{A}$  (typ.)
- Built-in phase-compensated op-amp, obviating the need for any external device
- Ultra-compact package

### 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          | $P_D$            | 200                  | mW               |
| 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.).



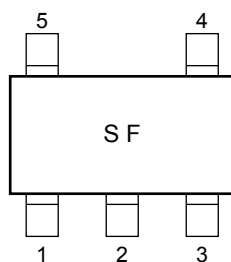
Weight

SSOP5-P-0.95 : 0.014 g (typ.)

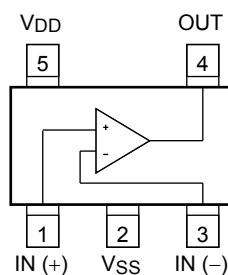
SSOP5-P-0.65A : 0.006 g (typ.)

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            | $R_S = 10\text{ k}\Omega$             | —   | 2    | 10  | mV            |
| Input offset current                     | $I_{IO}$     | —            | —                                     | —   | 1    | —   | pA            |
| Input bias current                       | $I_I$        | —            | —                                     | —   | 1    | —   | pA            |
| Common mode input voltage                | $CMV_{IN}$   | 2            | —                                     | 0.0 | —    | 2.1 | V             |
| Voltage gain (open loop)                 | $G_V$        | —            | —                                     | 60  | 70   | —   | dB            |
| Maximum output voltage                   | $V_{OH}$     | 3            | $R_L \geq 1\text{ M}\Omega$           | 2.9 | —    | —   | V             |
|                                          | $V_{OL}$     | 4            | $R_L \geq 1\text{ M}\Omega$           | —   | —    | 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            | —                                     | —   | 10   | 20  | $\mu\text{A}$ |
| Source current                           | $I_{source}$ | 6            | —                                     | 10  | 20   | —   | $\mu\text{A}$ |
| Sink current                             | $I_{sink}$   | 7            | —                                     | 100 | 450  | —   | $\mu\text{A}$ |

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            | $R_S = 100\text{ k}\Omega$  | —   | 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 | —    | 0.9 | V             |
| Voltage gain (open loop)  | $G_V$        | —            | —                           | 60  | 70   | —   | dB            |
| Maximum output voltage    | $V_{OH}$     | 3            | $R_L \geq 1\text{ M}\Omega$ | 1.7 | —    | —   | V             |
|                           | $V_{OL}$     | 4            | $R_L \geq 1\text{ M}\Omega$ | —   | —    | 0.1 |               |
| Supply current            | $I_{DD}$     | 5            | —                           | —   | 8    | 16  | $\mu\text{A}$ |
| Source current            | $I_{source}$ | 6            | —                           | 8   | 16   | —   | $\mu\text{A}$ |
| Sink current              | $I_{sink}$   | 7            | —                           | 100 | 400  | —   | $\mu\text{A}$ |

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

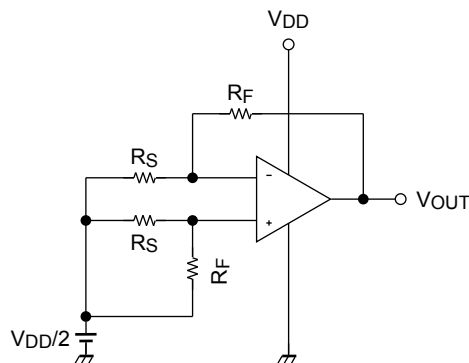
| Characteristics            | Symbol | Test Circuit | Test Condition | Min | Typ. | Max | Unit             |
|----------------------------|--------|--------------|----------------|-----|------|-----|------------------|
| Slew rate                  | SR     | —            | —              | —   | 0.08 | —   | V/ $\mu\text{s}$ |
| Unity gain cross frequency | $f_T$  | —            | —              | —   | 160  | —   | kHz              |

### 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     | —            | —              | —   | 0.06 | —   | V/ $\mu\text{s}$ |
| Unity gain cross frequency | $f_T$  | —            | —              | —   | 140  | —   | kHz              |

## 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  $V_{OUT} = V_{OUT1}$

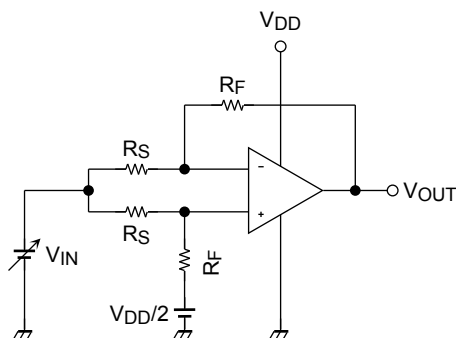
When  $V_{DD} = 7.0\text{ V}$ ,  $V_{DD} = V_{DD2}$  and  $V_{OUT} = V_{OUT2}$

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

- $V_{IO}$**   
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.

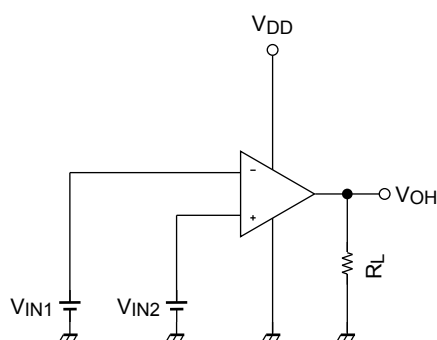
When  $V_{IN} = 0.0\text{ V}$ ,  $V_{IN} = V_{IN1}$  and  $V_{OUT} = V_{OUT1}$

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

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

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

### 3. V<sub>OH</sub>

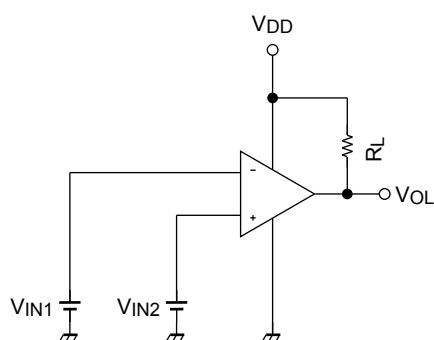


- V<sub>OH</sub>  

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

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

### 4. V<sub>OL</sub>

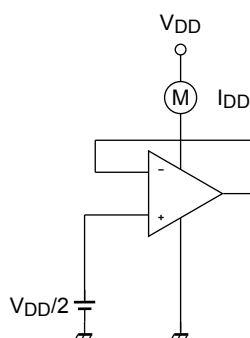


- V<sub>OL</sub>  

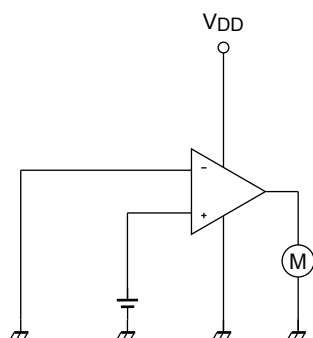
$$V_{IN1} = \frac{V_{DD}}{2} + 0.05 \text{ V}$$

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

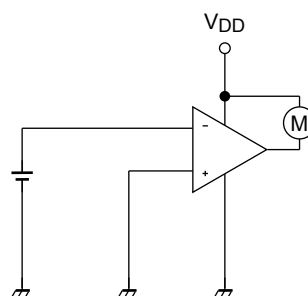
### 5. I<sub>DD</sub>

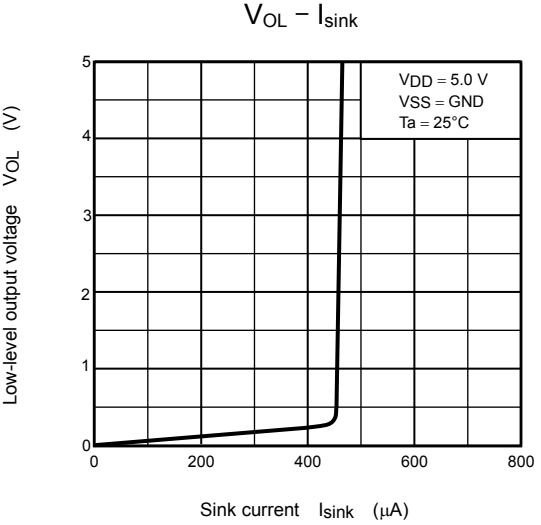
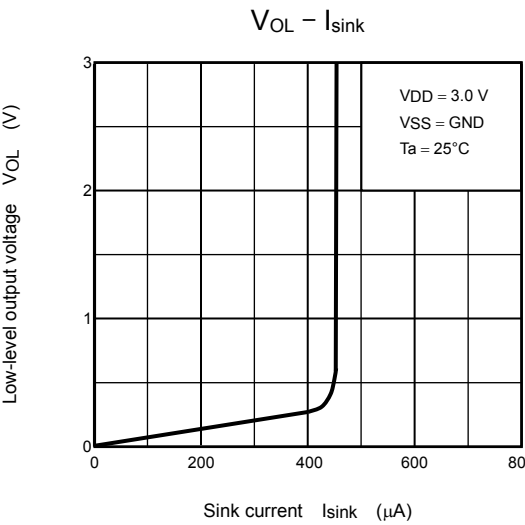
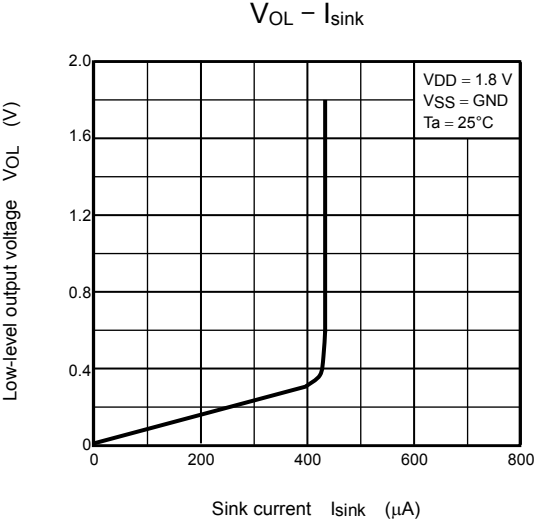
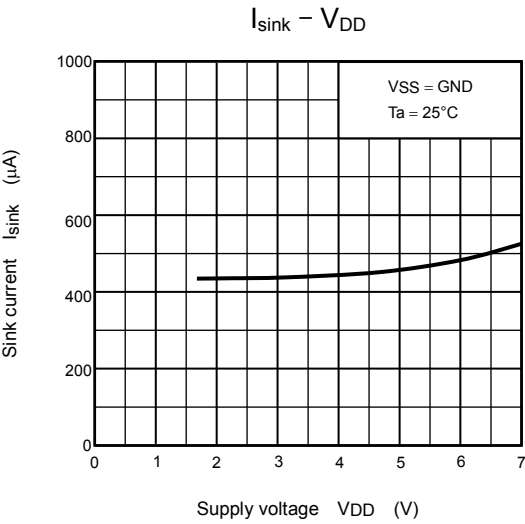
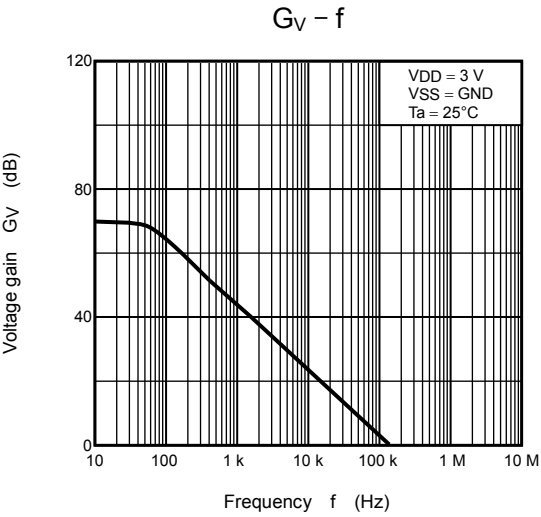
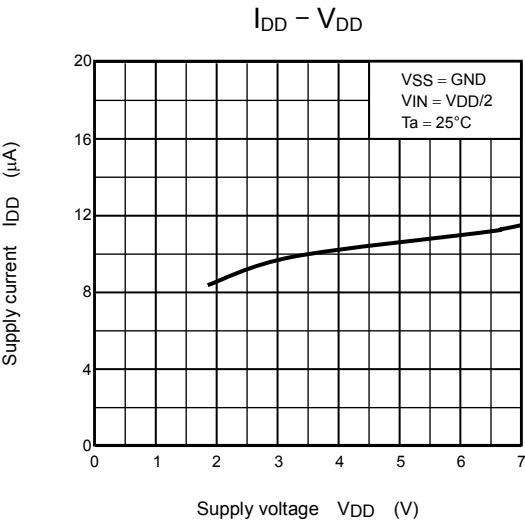


### 6. I<sub>source</sub>

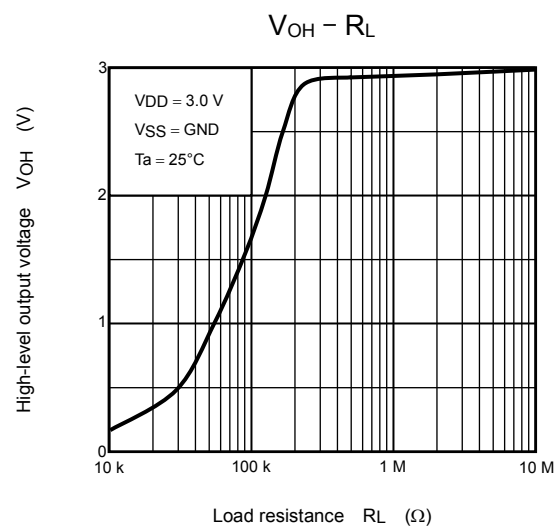
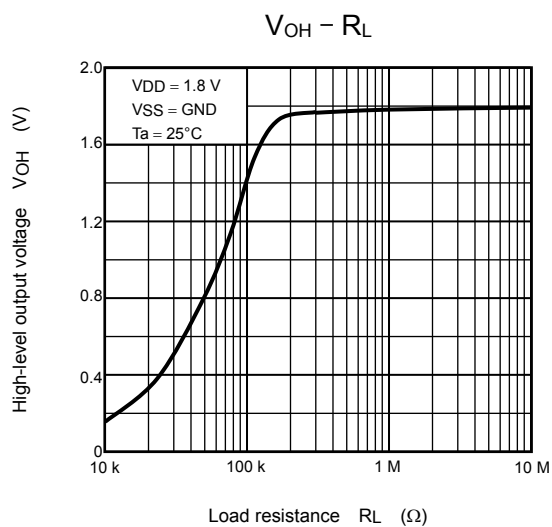
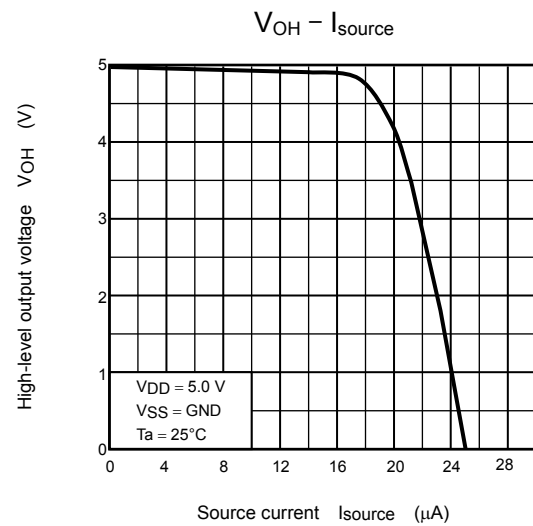
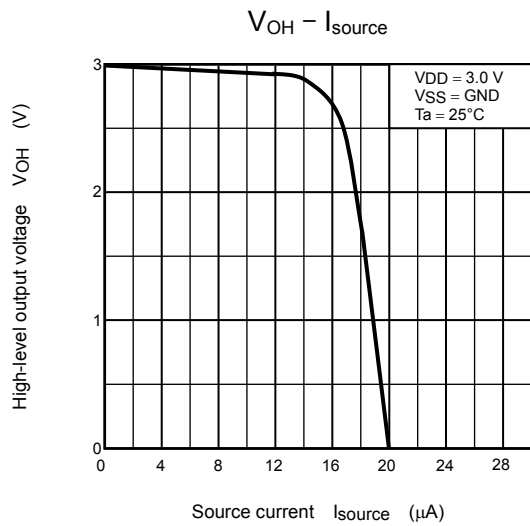
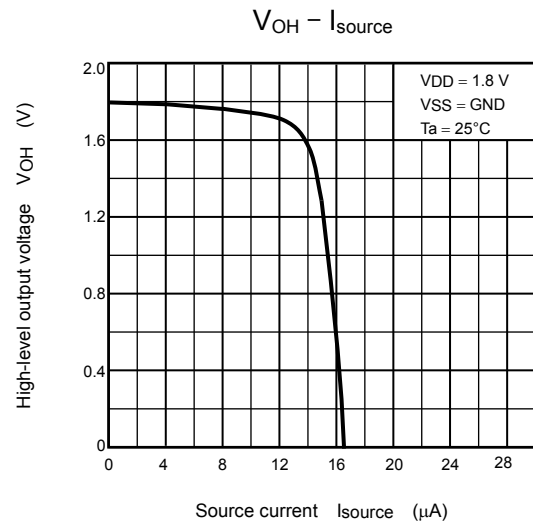
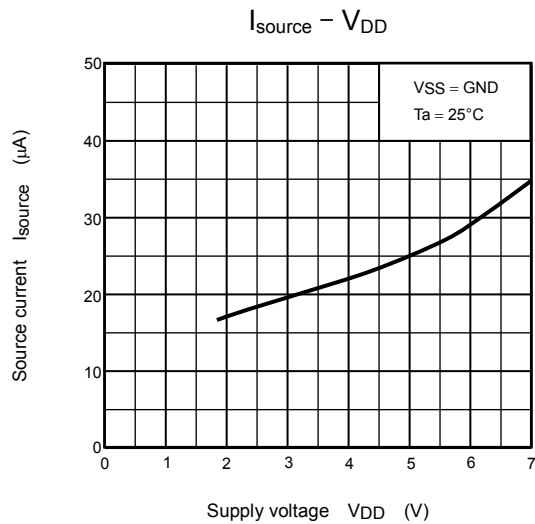


### 7. I<sub>sink</sub>

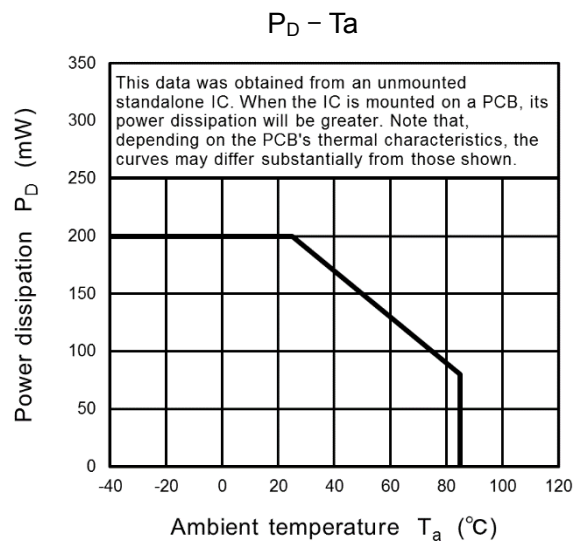
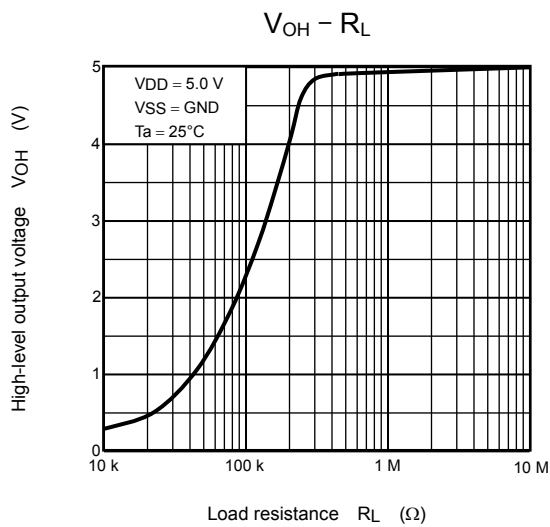




The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.



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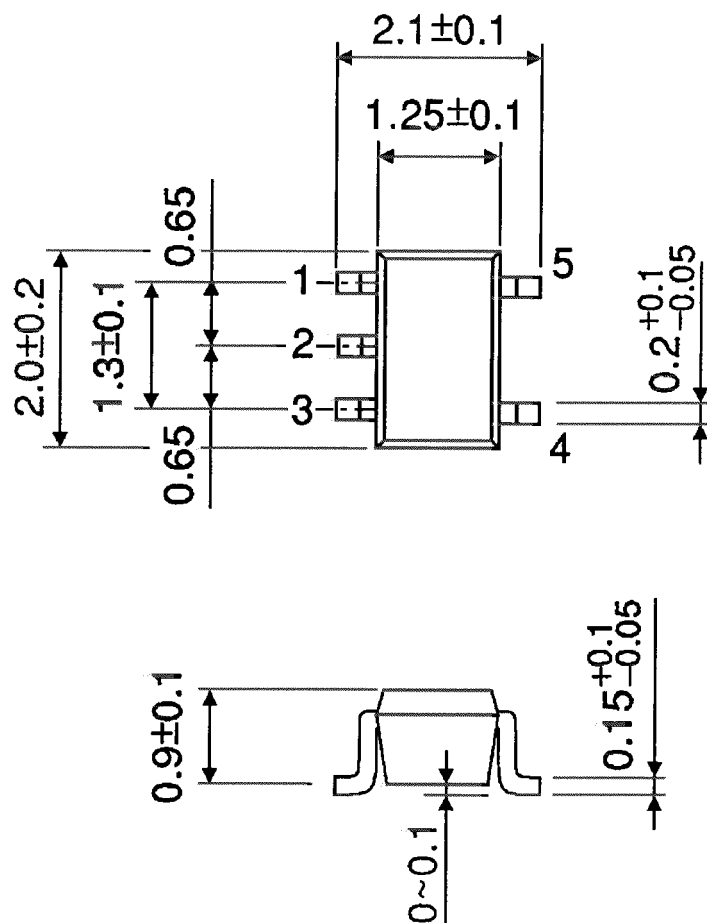
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## Package Dimensions

SSOP5-P-0.65A

Unit : mm



Weight: 0.006 g (typ.)

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