

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7W66F, TC7W66FU, TC7W66FK

## Dual Bilateral Switch

The TC7W66 is a high speed CMOS Dual Bilateral Switch fabricated with silicon gate CMOS technology.

It consists of four independent high speed switches capable of controlling either digital or analog signals while maintaining the CMOS low power dissipation.

Control input (C) is provided to control the switch.

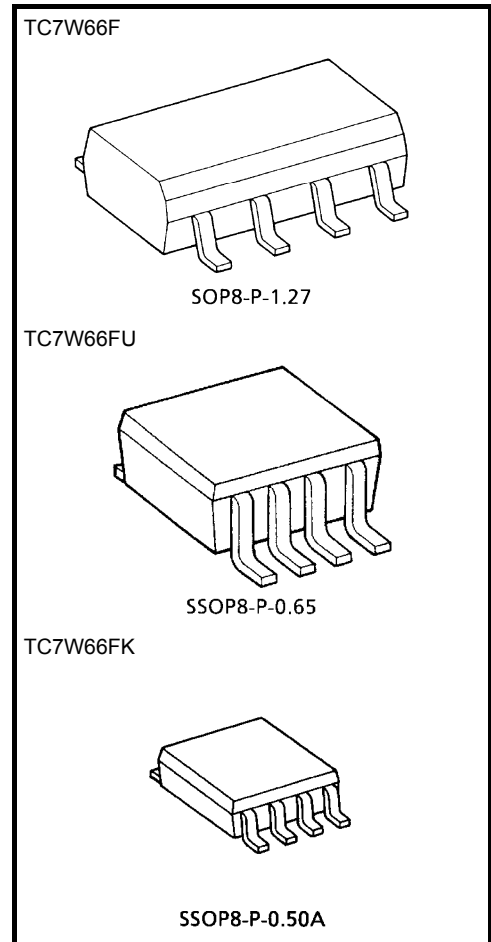
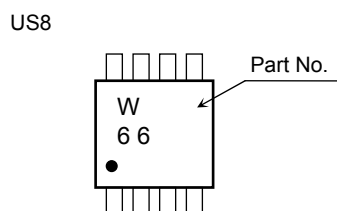
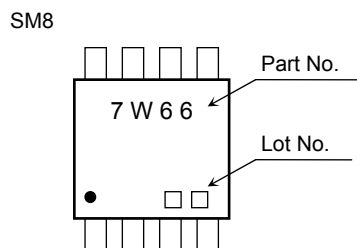
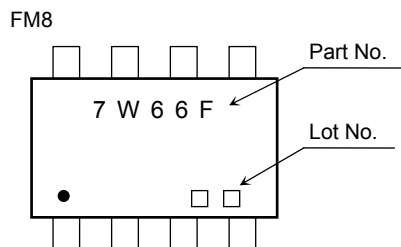
The switch turns ON while the C input is high, and the switch turns OFF while low.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.

### Features

- High speed:  $t_{pd} = 7 \text{ ns}$  (typ.) at  $V_{CC} = 5 \text{ V}$
- Low power dissipation:  $I_{CC} = 1 \mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- Low ON resistance:  $R_{ON} = 50 \Omega$  (typ.) at  $V_{CC} = 9 \text{ V}$
- High degree of linearity:  $THD = 0.05$  (typ.) at  $V_{CC} = 5 \text{ V}$
- Pin and function compatible with TC4W66

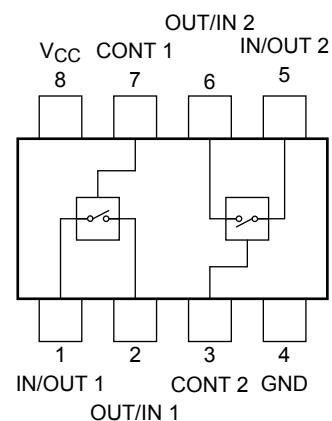
### Marking



### Weight

- SOP8-P-1.27: 0.05 g (typ.)
- SSOP8-P-0.65: 0.02 g (typ.)
- SSOP8-P-0.50A: 0.01 g (typ.)

### Pin Configuration (top view)



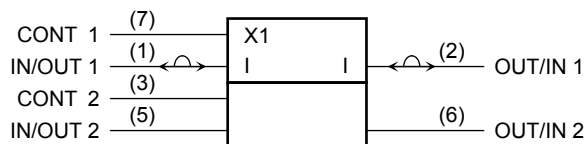
## Absolute Maximum Ratings (Ta = 25°C)

| Characteristics                    | Symbol           | Rating                        | Unit |
|------------------------------------|------------------|-------------------------------|------|
| Supply voltage range               | V <sub>CC</sub>  | -0.5 to 13                    | V    |
| DC input voltage                   | V <sub>IN</sub>  | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| DC output voltage                  | V <sub>OUT</sub> | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| Input diode current                | I <sub>IK</sub>  | ±20                           | mA   |
| Output diode current               | I <sub>OK</sub>  | ±20                           | mA   |
| DC output current                  | I <sub>OUT</sub> | ±25                           | mA   |
| DC V <sub>CC</sub> /ground current | I <sub>CC</sub>  | ±25                           | mA   |
| Power dissipation                  | P <sub>D</sub>   | 300 (FM8, SM8)                | mW   |
|                                    |                  | 200 (US8)                     |      |
| Storage temperature range          | T <sub>stg</sub> | -65 to 150                    | °C   |
| Lead temperature (10 s)            | T <sub>L</sub>   | 260                           | °C   |

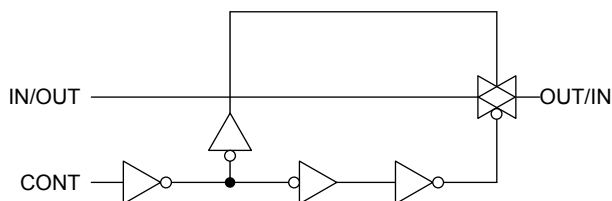
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.)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

## Logic Diagram



## Logic Diagram (1/2 TC7W66)



## Truth Table

| Control | Switch Function |
|---------|-----------------|
| H       | ON              |
| L       | OFF             |

## Operating Ranges

| Characteristics             | Symbol     | Rating                        | Unit |
|-----------------------------|------------|-------------------------------|------|
| Supply voltage              | $V_{CC}$   | 2 to 12                       | V    |
| Control input voltage       | $V_{IN}$   | 0 to $V_{CC}$                 | V    |
| Switch I/O voltage          | $V_{I/O}$  | 0 to $V_{CC}$                 | V    |
| Operating temperature range | $T_{opr}$  | -40 to 85                     | °C   |
| Input rise and fall time    | $t_r, t_f$ | 0 to 1000 ( $V_{CC} = 2.0$ V) | ns   |
|                             |            | 0 to 500 ( $V_{CC} = 4.5$ V)  |      |
|                             |            | 0 to 400 ( $V_{CC} = 6.0$ V)  |      |
|                             |            | 0 to 250 ( $V_{CC} = 10.0$ V) |      |

## Electrical Characteristics

### DC Electrical Characteristics

| Characteristics                                      | Symbol     | Test Condition  | $T_a = 25^\circ\text{C}$                     |                 |  | $T_a = -40$<br>to $85^\circ\text{C}$ |      | Unit       |               |
|--|------------|---|--|-----------------|--|--------------------------------------|------|------------|---------------|
|  |            |   | $V_{CC}$ (V)                                 | Min             | Typ.   | Max                                  | Min  |            | Max           |
| Control input voltage                                | High level | —   | 2.0  | 1.5             | —  | —                                    | 1.5  | —          | V             |
|  |            |   | 4.5  | 3.15            | —  | —                                    | 3.15 | —          |               |
|  |            |   | 9.0  | 6.3             | —  | —                                    | 6.3  | —          |               |
|  |            |   | 12.0   | 8.4             | —  | —                                    | 8.4  | —          |               |
|  | Low level  | —   | 2.0  | —               | —  | 0.5                                  | —    | 0.5        |               |
|  |            |   | 4.5  | —               | —  | 1.35                                 | —    | 1.35       |               |
|  |            |   | 9.0  | —               | —  | 2.7                                  | —    | 2.7        |               |
|  |            |   | 12.0   | —               | —  | 3.6                                  | —    | 3.6        |               |
| ON resistance  | $R_{ON}$   | $V_{IN} = V_{IHC}$<br>$V_{I/O} = V_{CC}$ to GND<br>$I_{I/O} \leq 1$ mA              | 4.5  | —               | 96   | 170                                  | —    | 200        | $\Omega$      |
|  |            |   | 9.0  | —               | 55   | 85                                   | —    | 100        |               |
|  |            |   | 12.0   | —               | 45   | 80                                   | —    | 90         |               |
|  |            |   | 2.0  | —               | 160  | —                                    | —    | —          |               |
|  |            | $V_{IN} = V_{IHC}$<br>$V_{I/O} = V_{CC}$ or GND<br>$I_{I/O} \leq 1$ mA              | 4.5  | —               | 70   | 100                                  | —    | 130        |               |
|  |            |   | 9.0  | —               | 50   | 75                                   | —    | 95         |               |
|  |            |   | 12.0   | —               | 45   | 70                                   | —    | 90         |               |
|  |            |   | Difference of ON resistance between switches | $\Delta R_{ON}$ | $V_{IN} = V_{IHC}$<br>$V_{I/O} = V_{CC}$ to GND<br>$I_{I/O} \leq 1$ mA | 4.5                                  | —    | 10         |               |
| 9.0  | —          | 5   |  |                 |  | —                                    | —    | —          |               |
| 12.0   | —          | 5   |  |                 |  | —                                    | —    | —          |               |
| Input/output leakage current (switch off)            | $I_{OFF}$  | $V_{OS} = V_{CC}$ or GND<br>$V_{IS} = \text{GND}$ or $V_{CC}$<br>$V_{IN} = V_{ILC}$ | 12.0   | —               | —  | $\pm 100$                            | —    | $\pm 1000$ | nA            |
| Switch input leakage current (switch on output open) | $I_{IZ}$   | $V_{OS} = V_{CC}$ or GND<br>$V_{INH} = V_{IHC}$                                     | 12.0   | —               | —  | $\pm 100$                            | —    | $\pm 1000$ | nA            |
| Control input current                                | $I_{IN}$   | $V_{IN} = V_{CC}$ or GND  | 6.0  | —               | —  | $\pm 100$                            | —    | $\pm 1000$ | nA            |
| Quiescent supply current                             | $I_{CC}$   | $V_{IN} = V_{CC}$ or GND  | 6.0  | —               | —  | 1.0                                  | —    | 10.0       | $\mu\text{A}$ |
|  |            |   | 9.0  | —               | —  | 4.0                                  | —    | 40.0       |               |
|  |            |   | 12.0   | —               | —  | 8.0                                  | —    | 80.0       |               |

## AC Electrical Characteristics (C<sub>L</sub> = 50 pF, input t<sub>r</sub> = t<sub>f</sub> = 6 ns)

| Characteristics                           | Symbol                               | Test Condition  | Ta = 25°C           |     |      | Ta = -40 to 85°C |     | Unit |     |
|---|--------------------------------------|---|---------------------|-----|------|------------------|-----|------|-----|
|   |                                      |   | V <sub>CC</sub> (V) | Min | Typ. | Max              | Min |      | Max |
| Phase difference between input and output | φ <sub>I/O</sub>                     | —   | 2.0                 | —   | 10   | 50               | —   | 65   | ns  |
|   |                                      |   | 4.5                 | —   | 4    | 10               | —   | 13   |     |
|   |                                      |   | 9.0                 | —   | 3    | 8                | —   | 10   |     |
|   |                                      |   | 12.0                | —   | 3    | 7                | —   | 9    |     |
| Output enable time                        | t <sub>pZL</sub><br>t <sub>pZH</sub> | R <sub>L</sub> = 1 kΩ   | 2.0                 | —   | 18   | 100              | —   | 125  | ns  |
|   |                                      |   | 4.5                 | —   | 8    | 20               | —   | 25   |     |
|   |                                      |   | 9.0                 | —   | 6    | 12               | —   | 22   |     |
|   |                                      |   | 12.0                | —   | 6    | 12               | —   | 18   |     |
| Output disable time                       | t <sub>pLZ</sub><br>t <sub>pHZ</sub> | R <sub>L</sub> = 1 kΩ   | 2.0                 | —   | 20   | 115              | —   | 145  | ns  |
|   |                                      |   | 4.5                 | —   | 10   | 23               | —   | 29   |     |
|   |                                      |   | 9.0                 | —   | 8    | 20               | —   | 25   |     |
|   |                                      |   | 12.0                | —   | 8    | 18               | —   | 22   |     |
| Maximum control input frequency           | —                                    | R <sub>L</sub> = 1 kΩ<br>C <sub>L</sub> = 15 pF<br>V <sub>OUT</sub> = 1/2 V <sub>CC</sub> | 2.0                 | —   | 30   | —                | —   | —    | MHz |
|   |                                      |   | 4.5                 | —   | 30   | —                | —   | —    |     |
|   |                                      |   | 9.0                 | —   | 30   | —                | —   | —    |     |
|   |                                      |   | 12.0                | —   | 30   | —                | —   | —    |     |
| Control input capacitance                 | C <sub>IN</sub>                      | —   | —                   | 5   | 10   | —                | 10  | pF   |     |
| Switch terminal capacitance               | C <sub>I/O</sub>                     | —   | —                   | 6   | —    | —                | —   | pF   |     |
| Feed through capacitance                  | C <sub>IOS</sub>                     | —   | —                   | 0.5 | —    | —                | —   | pF   |     |
| Power dissipation capacitance             | C <sub>PD</sub>                      | (Note)  | —                   | 15  | —    | —                | —   | pF   |     |

Note: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

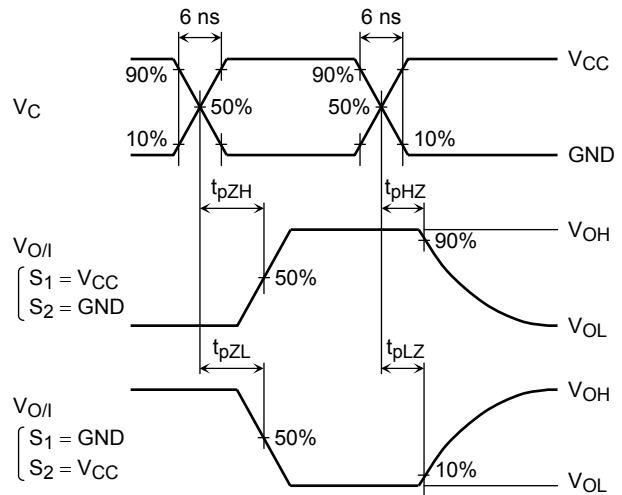
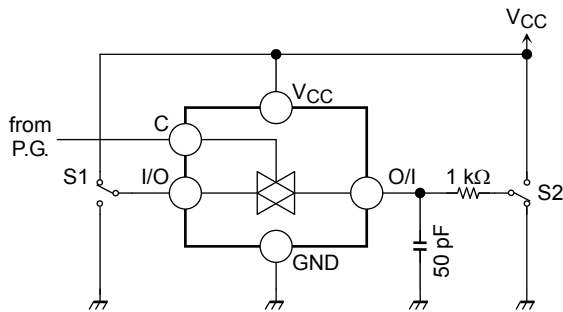
$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/2$$

## Analog Switch Characteristics (GND = 0 V, Ta = 25°C)

| Characteristics                            | Symbol           | Test Condition   | V <sub>CC</sub> (V) | Typ. | Unit |
|--|------------------|--|---------------------|------|------|
|  |                  |  |                     |      |      |
| Sine wave distortion (T.H.D)               | —                | f <sub>IN</sub> = 1 kHz,<br>V <sub>IN</sub> = 4.0 V <sub>p-p</sub> @V <sub>CC</sub> = 4.5 V<br>R <sub>L</sub> = 10 kΩ,<br>V <sub>IN</sub> = 8.0 V <sub>p-p</sub> @V <sub>CC</sub> = 9.0 V<br>C <sub>L</sub> = 50 pF        | 4.5                 | 0.05 | %    |
|  |                  |  | 9.0                 | 0.04 |      |
| Frequency response (switch ON)             | f <sub>max</sub> | Adjust f <sub>IN</sub> voltage to obtain 0dBm at V <sub>OS</sub><br>Increase f <sub>IN</sub> frequency until dB<br>Meter reads -3dB<br>R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF<br>f <sub>IN</sub> = 1 MHz, sine wave | 4.5                 | 200  | MHz  |
|  |                  |  | 9.0                 | 200  |      |
| Feedthrough attenuation (switch OFF)       | —                | V <sub>IN</sub> is centered at V <sub>CC</sub> /2<br>Adjust input for 0dBm<br>R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF<br>f <sub>IN</sub> = 1 MHz, sine wave   | 4.5                 | -60  | dB   |
|  |                  |  | 9.0                 | -60  |      |
| Crosstalk (control input to signal output) | —                | R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF<br>f <sub>IN</sub> = 1 MHz, square wave (t <sub>r</sub> = t <sub>f</sub> = 6 ns)  | 4.5                 | 60   | mV   |
|  |                  |  | 9.0                 | 100  |      |
| Crosstalk (between any switches)           | —                | Adjust V <sub>IN</sub> to obtain 0dBm at input<br>R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF<br>f <sub>IN</sub> = 1 MHz, sine wave   | 4.5                 | -60  | dB   |
|  |                  |  | 9.0                 | -60  |      |

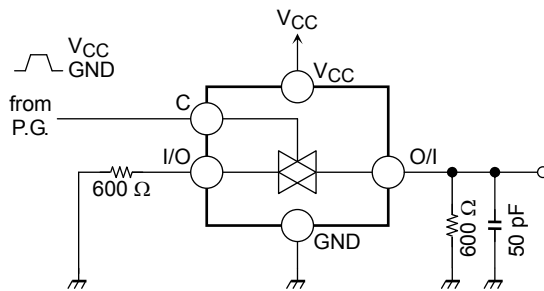
**Switching Characteristics Test Circuits**

**1.  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$**

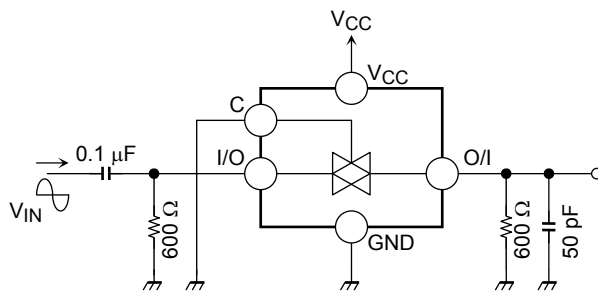


**2. Cross Talk (control input-switch output)**

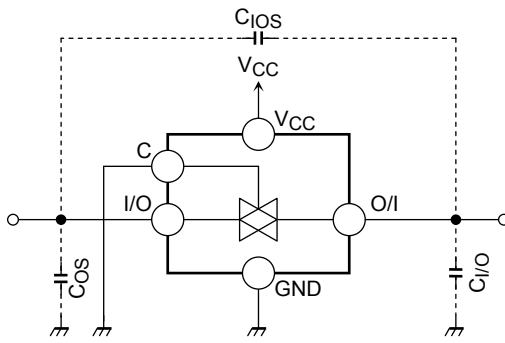
$f_{in} = 1 \text{ MHz}$ , duty = 50%,  $t_r = t_f = 6 \text{ ns}$



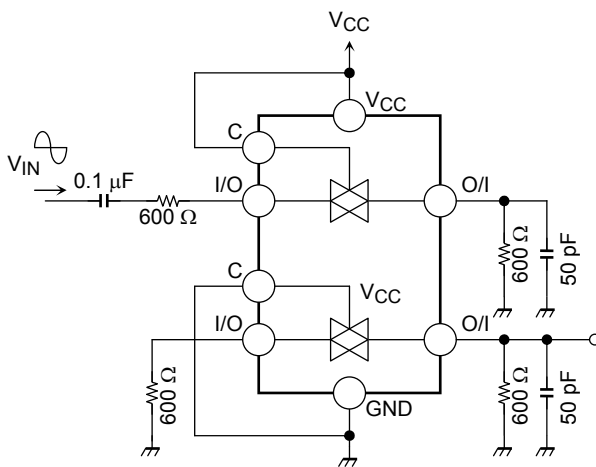
**3. Feed Through Attenuation**



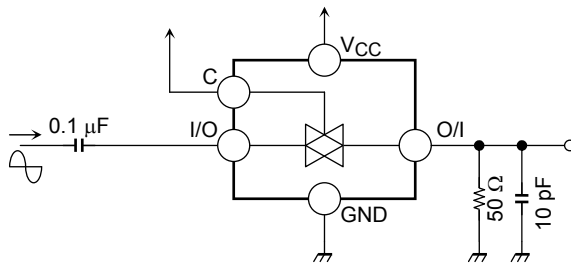
**4. Clos, C<sub>I/O</sub>**



**5. Cross Talk (between any two switches)**



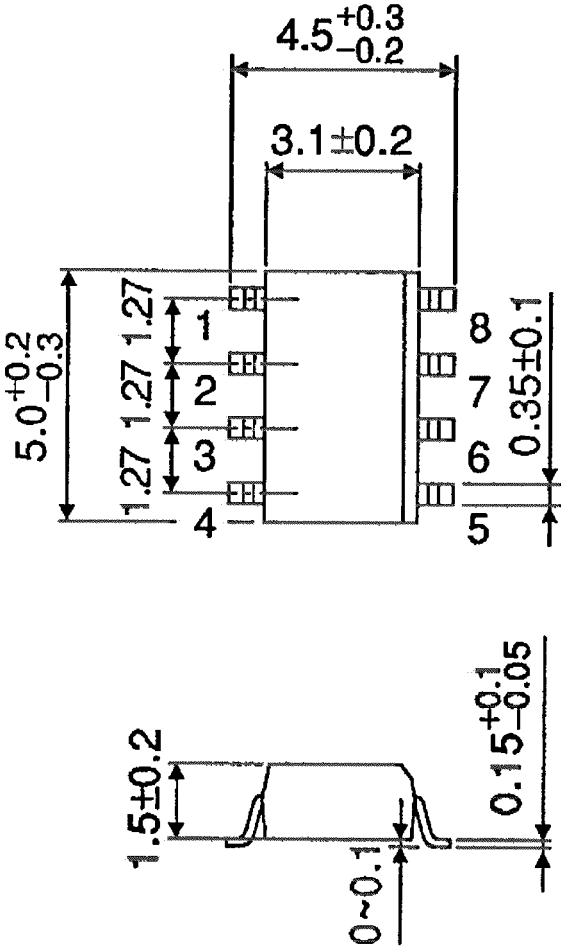
**6. Frequency Response (switch ON)**



Package Dimensions

SOP8-P-1.27

Unit : mm

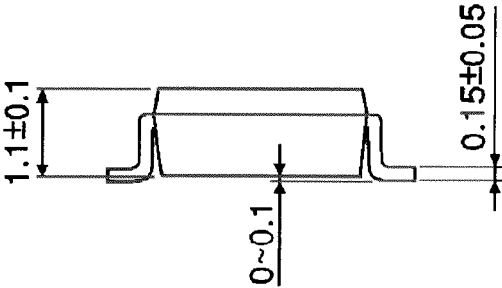
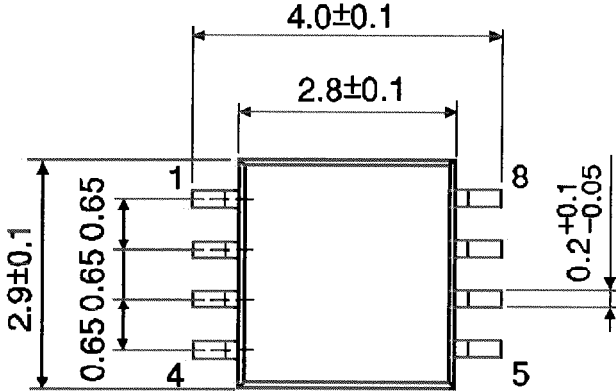


Weight: 0.05 g (typ.)

**Package Dimensions**

SSOP8-P-0.65

Unit : mm



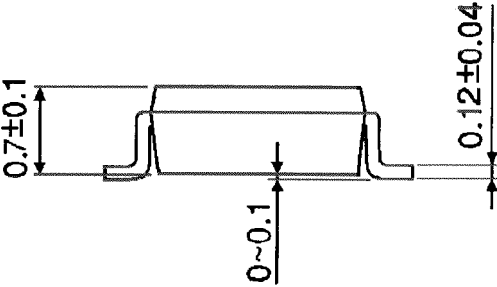
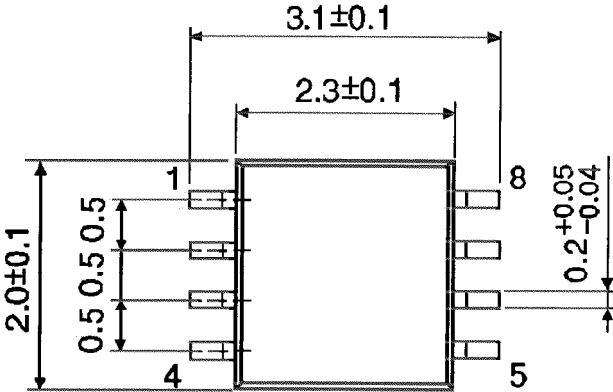
Weight: 0.02 g (typ.)



**Package Dimensions**

SSOP8-P-0.50A

Unit : mm



Weight: 0.01 g (typ.)

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