

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# TC7W53F, TC7W53FU, TC7W53FK

## 2-CHANNEL MULTIPLEXER / DEMULTIPLEXER

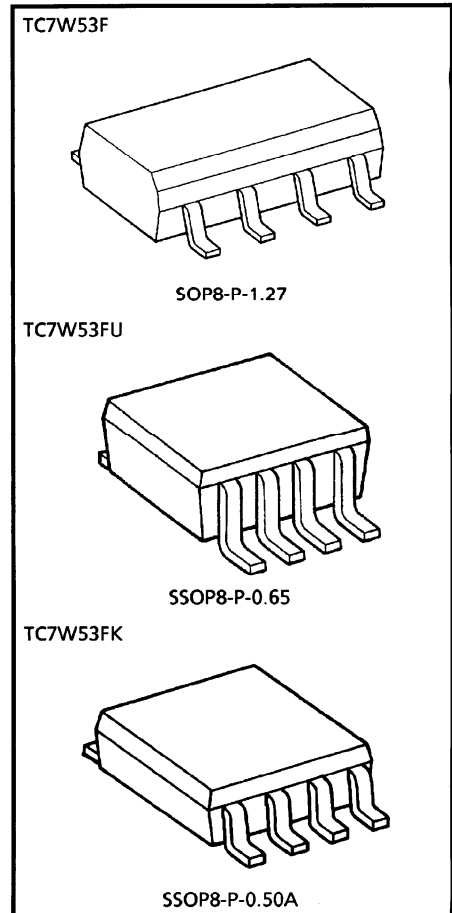
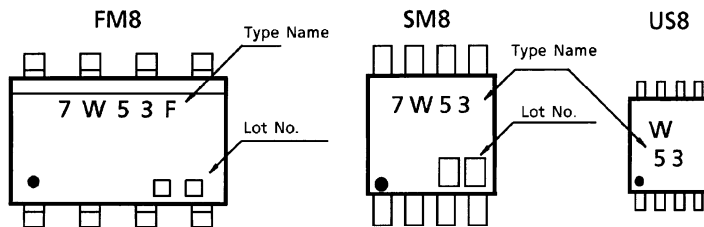
The TC7W53 is a high speed CMOS ANALOG MULTIPLEXER/DEMULTIPLEXER fabricated with silicon gate CMOS technology. They achieve the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The TC7W53 has a 2 channel configuration. The digital signal to the control terminal turns "ON" the corresponding switch of each channel a large amplitude signal ( $V_{CC}-V_{EE}$ ) can then be switched by the small logical amplitude ( $V_{CC}-GND$ ) control signal. For example, in the case of  $V_{CC} = 5V$ ,  $GND = 0V$ ,  $V_{EE} = 5V$ , signals between  $-5V$  and  $+5V$  can be switched from the logical circuit with a single power supply of 5V. As the ON-resistance of each switch is low, they can be connected to circuit with low input impedance. All inputs are equipped with protection circuits against static discharge or transient excess voltage.

### FEATURES

- High Speed .....  $t_{pd} = 15ns$  (Typ.)  
at  $V_{CC} = 5V$ ,  $V_{EE} = 0V$
- Low Power Dissipation .....  $I_{CC} = 4\mu A$  (Max.) at  $T_a = 25^\circ C$
- High Noise Immunity .....  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (Min.)
- Low ON Resistance .....  $R_{ON} = 50\Omega$  (Typ.)  
at  $V_{CC}-V_{EE} = 9V$
- High Degree of Linearity .....  $THD = 0.02$  (Typ.)  
at  $V_{CC}-V_{EE} = 9V$
- Pin and Function Compatible with TC4W53

### MARKING



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

**MAXIMUM RATINGS (Ta = 25°C)**

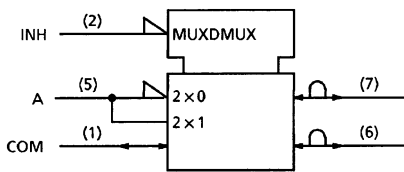
| CHARACTERISTIC                  | SYMBOL                           | RATING                                    | UNIT |
|---------------------------------|----------------------------------|---|------|
| Supply Voltage Range            | V <sub>CC</sub>                  | -0.5~7                                    | V    |
|                                 | V <sub>CC</sub> ~V <sub>EE</sub> | -0.5~13                                   |      |
| Control Input Voltage           | V <sub>IN</sub>                  | -0.5~V <sub>CC</sub> +0.5                 | V    |
| Switch I/O Voltage              | V <sub>I/O</sub>                 | V <sub>EE</sub> -0.5~V <sub>CC</sub> +0.5 | V    |
| Control Input Diode Current     | I <sub>CK</sub>                  | ± 20                                      | mA   |
| I/O Diode Current               | I <sub>I/O</sub>                 | ± 20                                      | mA   |
| Switch Through Current          | I <sub>T</sub>                   | ± 25                                      | mA   |
| DC V <sub>CC</sub> /GND Current | I <sub>CC</sub>                  | ± 25                                      | mA   |
| Power Dissipation               | P <sub>D</sub>                   | 300 (FM8, SM8)                            | mW   |
|                                 |                                  | 200 (US8)                                 |      |
| Storage Temperature             | T <sub>stg</sub>                 | -65~150                                   | °C   |
| Lead Temperature (10 s)         | T <sub>L</sub>                   | 260                                       | °C   |

**TRUTH TABLE**

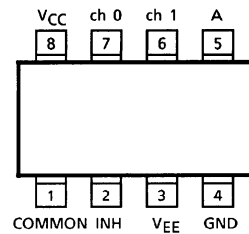
| CONTROL INPUT |   | ON CHANNEL |
|---------------|---|------------|
| INH           | A |            |
| L             | L | ch 0       |
| L             | H | ch 1       |
| H             | x | NONE       |

x : Don't care

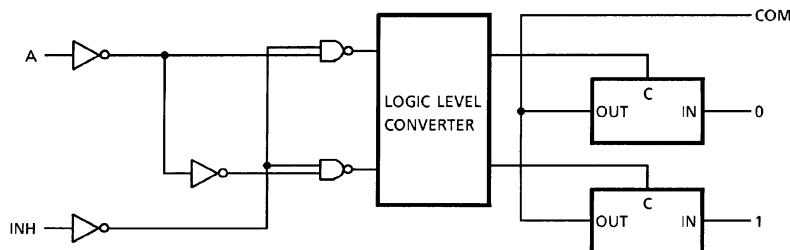
**LOGIC SYMBOL**



**PIN ASSIGNMENT (TOP VIEW)**



**LOGIC DIAGRAM**



RECOMMENDED OPERATING CONDITIONS

| CHARACTERISTIC           | SYMBOL                           | RATING                          | UNIT |
|--------------------------|----------------------------------|---------------------------------|------|
| Supply Voltage           | V <sub>CC</sub>                  | 2~6                             | V    |
|                          | V <sub>EE</sub>                  | -6~0                            | V    |
|                          | V <sub>CC</sub> ~V <sub>EE</sub> | 2~12                            | V    |
| Control Input Voltage    | V <sub>IN</sub>                  | 0~V <sub>CC</sub>               | V    |
| Switch I/O Voltage       | V <sub>I/O</sub>                 | 0~V <sub>CC</sub>               | V    |
| Operating Temperature    | T <sub>opr</sub>                 | -40~85                          | °C   |
| Input Rise and Fall Time | t <sub>r</sub> , t <sub>f</sub>  | 0~1000 (V <sub>CC</sub> = 2.0V) | ns   |
|                          |                                  | 0~500 (V <sub>CC</sub> = 4.5V)  |      |
|                          |                                  | 0~400 (V <sub>CC</sub> = 6.0V)  |      |

DC ELECTRICAL CHARACTERISTICS

| CHARACTERISTIC                                       | SYMBOL           |   | V <sub>EE</sub><br>(V) | V <sub>CC</sub><br>(V) | Ta = 25°C |      |      | Ta = -40~85°C |       | UNIT |
|--|------------------|---|------------------------|------------------------|-----------|------|------|---------------|-------|------|
|  |                  |   |                        |                        | MIN.      | TYP. | MAX. | MIN.          | MAX.  |      |
| High-Level Control Input Voltage                     | V <sub>IHC</sub> |   |                        | 2.0                    | 1.5       | —    | —    | 1.5           | —     | V    |
|  |                  |   |                        | 4.5                    | 3.15      | —    | —    | 3.15          | —     |      |
|  |                  |   |                        | 6.0                    | 4.2       | —    | —    | 4.2           | —     |      |
| Low-Level Control Input Voltage                      | V <sub>ILC</sub> |   |                        | 2.0                    | —         | —    | 0.5  | —             | 0.5   | V    |
|  |                  |   |                        | 4.5                    | —         | —    | 1.35 | —             | 1.35  |      |
|  |                  |   |                        | 6.0                    | —         | —    | 1.8  | —             | 1.8   |      |
| ON Resistance  | R <sub>ON</sub>  | V <sub>IN</sub> = V <sub>IHC</sub><br>V <sub>I/O</sub> = V <sub>CC</sub> to GND<br>V <sub>I/O</sub> ≤ 2mA                   | GND                    | 4.5                    | —         | 85   | 180  | —             | 225   | Ω    |
|  |                  |   | -4.5                   | 4.5                    | —         | 55   | 120  | —             | 150   |      |
|  |                  |   | -6.0                   | 6.0                    | —         | 50   | 100  | —             | 125   |      |
|  |                  | V <sub>IN</sub> = V <sub>IHC</sub><br>V <sub>I/O</sub> = V <sub>CC</sub> or GND<br>V <sub>I/O</sub> ≤ 2mA                   | GND                    | 2.0                    | —         | 150  | —    | —             | —     |      |
|  |                  |   | GND                    | 4.5                    | —         | 70   | 150  | —             | 190   |      |
|  |                  |   | -4.5                   | 4.5                    | —         | 50   | 100  | —             | 125   |      |
| Difference of ON Resistance Between Switches         | ΔR <sub>ON</sub> | V <sub>IN</sub> = V <sub>IHC</sub><br>V <sub>I/O</sub> = V <sub>CC</sub> to GND<br>V <sub>I/O</sub> ≤ 2mA                   | GND                    | 4.5                    | —         | 10   | 30   | —             | 35    | Ω    |
|  |                  |   | -4.5                   | 4.5                    | —         | 5    | 12   | —             | 15    |      |
|  |                  |   | -6.0                   | 6.0                    | —         | 5    | 10   | —             | 12    |      |
| Input / Output Leakage Current (SWITCH OFF)          | I <sub>OFF</sub> | V <sub>OS</sub> = GND<br>V <sub>IS</sub> = GND to V <sub>CC</sub><br>V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub> | GND                    | 6.0                    | —         | —    | ±60  | —             | ±600  | nA   |
|  |                  |   | -6.0                   | 6.0                    | —         | —    | ±100 | —             | ±1000 |      |
| Switch Input Leakage Current (SWITCH ON OUTPUT OPEN) | I <sub>IZ</sub>  | V <sub>OS</sub> = V <sub>CC</sub> or GND<br>V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub>                          | GND                    | 6.0                    | —         | —    | ±60  | —             | ±600  | nA   |
|  |                  |   | -6.0                   | 6.0                    | —         | —    | ±100 | —             | ±1000 |      |
| Control Input Current                                | I <sub>IN</sub>  | V <sub>IN</sub> = V <sub>CC</sub> or GND  | GND                    | 6.0                    | —         | —    | ±0.1 | —             | ±1.0  | μA   |
| Quiescent Supply Current                             | I <sub>CC</sub>  | V <sub>IN</sub> = V <sub>CC</sub> or GND  | GND                    | 6.0                    | —         | —    | 4    | —             | 40    | μA   |
|  |                  |   | -6.0                   | 6.0                    | —         | —    | 8    | —             | 80    |      |

AC ELECTRICAL CHARACTERISTICS ( $C_L = 50\text{pF}$ , Input  $t_r = t_f = 6\text{ns}$ , GND = 0V)

| CHARACTERISTIC                                  |                        | TEST CONDITION          | $V_{EE}$<br>(V) | $V_{CC}$<br>(V) | $T_a = 25^\circ\text{C}$ |      |      | $T_a = -40 \sim 85^\circ\text{C}$ |      | UNIT |
|---|------------------------|-------------------------|-----------------|-----------------|--------------------------|------|------|-----------------------------------|------|------|
|   |                        |                         |                 |                 | MIN.                     | TYP. | MAX. | MIN.                              | MAX. |      |
| Phase Difference<br>Between Input and<br>Output | $\phi I/O$             |                         | GND             | 2.0             | —                        | 25   | 60   | —                                 | 75   | ns   |
|   |                        |                         | GND             | 4.5             | —                        | 6    | 12   | —                                 | 15   |      |
|   |                        |                         | GND             | 6.0             | —                        | 5    | 10   | —                                 | 13   |      |
|   |                        |                         | -4.5            | 4.5             | —                        | 4    | —    | —                                 | —    |      |
| Output Enable<br>Time                           | $t_{pZL}$<br>$t_{pZH}$ | $R_L = 1\text{k}\Omega$ | GND             | 2.0             | —                        | 50   | 225  | —                                 | 280  | ns   |
|   |                        |                         | GND             | 4.5             | —                        | 14   | 45   | —                                 | 56   |      |
|   |                        |                         | GND             | 6.0             | —                        | 12   | 38   | —                                 | 48   |      |
|   |                        |                         | -4.5            | 4.5             | —                        | 14   | —    | —                                 | —    |      |
| Output Disable<br>Time                          | $t_{pLZ}$<br>$t_{pHZ}$ | $R_L = 1\text{k}\Omega$ | GND             | 2.0             | —                        | 95   | 225  | —                                 | 280  | ns   |
|   |                        |                         | GND             | 4.5             | —                        | 30   | 45   | —                                 | 56   |      |
|   |                        |                         | GND             | 6.0             | —                        | 26   | 38   | —                                 | 48   |      |
|   |                        |                         | -4.5            | 4.5             | —                        | 26   | —    | —                                 | —    |      |
| Control Input<br>Capacitance                    | $C_{IN}$               |                         | —               | —               | —                        | 5    | 10   | —                                 | 10   | pF   |
| Common Terminal<br>Capacitance                  | $C_{IS}$               |                         | -5.0            | 5.0             | —                        | 11   | 20   | —                                 | 20   | pF   |
| Switch Terminal<br>Capacitance                  | $C_{OS}$               |                         | -5.0            | 5.0             | —                        | 7    | 15   | —                                 | 15   | pF   |
| Feed Through<br>Capacitance                     | $C_{IOS}$              |                         | -5.0            | 5.0             | —                        | 0.75 | 2    | —                                 | 2    | pF   |
| Power Dissipation<br>Capacitance                | $C_{PD}$               | (Note 1)                | GND             | 5.0             | —                        | 67   | —    | —                                 | —    | pF   |

(Note 1) :  $C_{PD}$  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 :

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

**ANALOG SWITCH CHARACTERISTICS (GND = 0V, Ta = 25°C)**

| CHARACTERISTIC                             |                  | TEST CONDITION  | V <sub>EE</sub>                       | V <sub>CC</sub> | TYP. | UNIT  |     |
|--|------------------|---|---------------------------------------|-----------------|------|-------|-----|
|  |                  |   | (V)                                   | (V)             |      |       |     |
| Sine Wave Distortion (T.H.D)               |                  | R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 50pF<br>f <sub>IN</sub> = 1kHz  | V <sub>IN</sub> = 4.0V <sub>p-p</sub> | - 2.25          | 2.25 | 0.025 | %   |
|  |                  |   | V <sub>IN</sub> = 8.0V <sub>p-p</sub> | - 4.5           | 4.5  | 0.02  |     |
|  |                  |   | V <sub>IN</sub> = 11 V <sub>p-p</sub> | - 6.0           | 6.0  | 0.018 |     |
| Frequency Response (Switch ON)             | f <sub>MAX</sub> | Adjust f <sub>IN</sub> voltage to obtain 0dBm at V <sub>OS</sub> Increase f <sub>IN</sub> until dB Meter reads -3dB<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF<br>f <sub>IN</sub> = 1MHz, Sine Wave | *1                                    | - 2.25          | 2.25 | 120   | MHz |
|  |                  |   | *2                                    |                 |      | 95    |     |
|  |                  |   | *1                                    | - 4.5           | 4.5  | 190   |     |
|  |                  |   | *2                                    |                 |      | 150   |     |
|  |                  |   | *1                                    | - 6.0           | 6.0  | 200   |     |
|  |                  |   | *2                                    |                 |      | 190   |     |
| Feedthrough Attenuation (Switch OFF)       |                  | Vin is centered at (V <sub>CC</sub> -V <sub>EE</sub> ) / 2<br>Adjust input for 0dBm<br>R <sub>L</sub> = 600Ω, C <sub>L</sub> = 50pF<br>f <sub>IN</sub> = 1MHz, Sine Wave                                | - 2.25                                | 2.25            | - 50 | dB    |     |
|  |                  |   | - 4.5                                 | 4.5             | - 50 |       |     |
|  |                  |   | - 6.0                                 | 6.0             | - 50 |       |     |
| Crosstalk (Control Input to Signal Output) |                  | R <sub>L</sub> = 600Ω, C <sub>L</sub> = 50pF<br>f <sub>IN</sub> = 1MHz, Square Wave (t <sub>r</sub> = t <sub>f</sub> = 6ns)   | - 2.25                                | 2.25            | 60   | mV    |     |
|  |                  |   | - 4.5                                 | 4.5             | 140  |       |     |
|  |                  |   | - 6.0                                 | 6.0             | 200  |       |     |
| Crosstalk (Between any switches)           |                  | Adjust V <sub>IN</sub> to obtain 0dBm at Input<br>R <sub>L</sub> = 600Ω, C <sub>L</sub> = 50pF<br>f <sub>IN</sub> = 1MHz, Sine Wave   | - 2.25                                | 2.25            | - 50 | dB    |     |
|  |                  |   | - 4.5                                 | 4.5             | - 50 |       |     |
|  |                  |   | - 6.0                                 | 6.0             | - 50 |       |     |

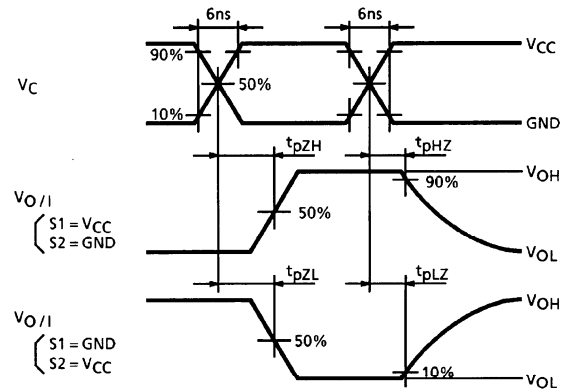
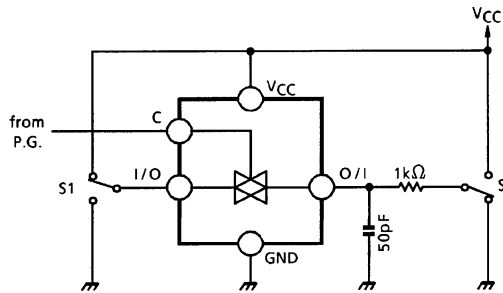
\*1 : Input COMMON Terminal, and measured at SWITCH Terminal.

\*2 : Input SWITCH Terminal, and measured at COMMON Terminal.

(Note): These characteristics are determined by design of device.

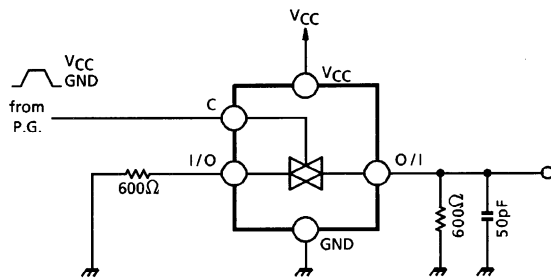
SWITCHING CHARACTERISTICS TEST CIRCUITS

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

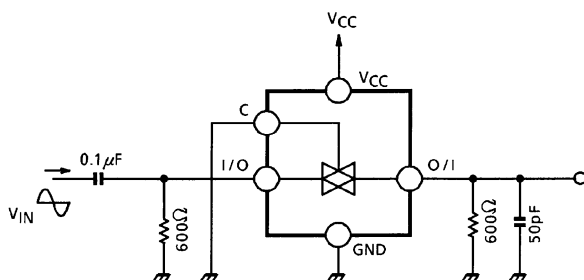


2. CROSS TALK (CONTROL INPUT-SWITCH OUTPUT)

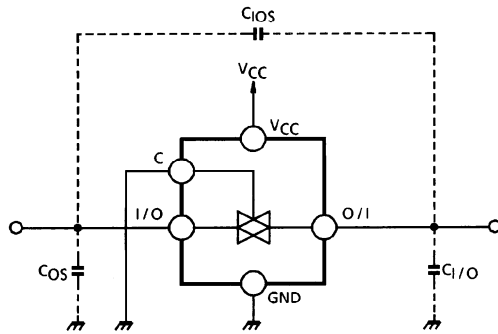
$f_{in} = 1\text{MHz}$ , duty = 50%,  $t_r = t_f = 6\text{ns}$



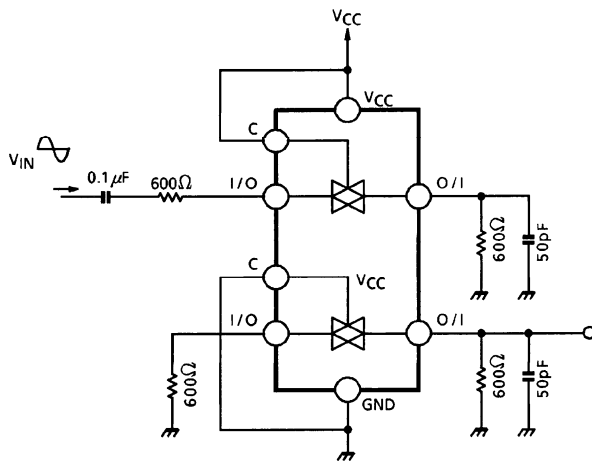
3. FEEDTHROUGH ATTENUATION



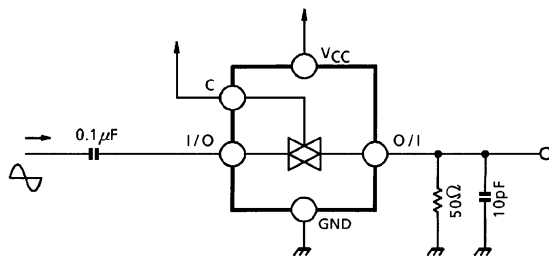
4.  $C_{ios}, C_{I/O}$



5. CROSS TALK (BETWEEN ANY TWO SWITCHES)

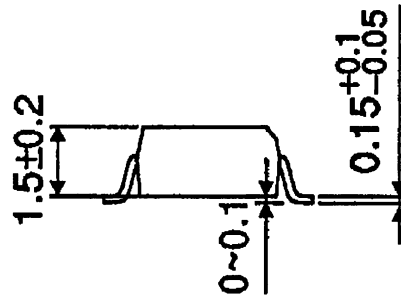
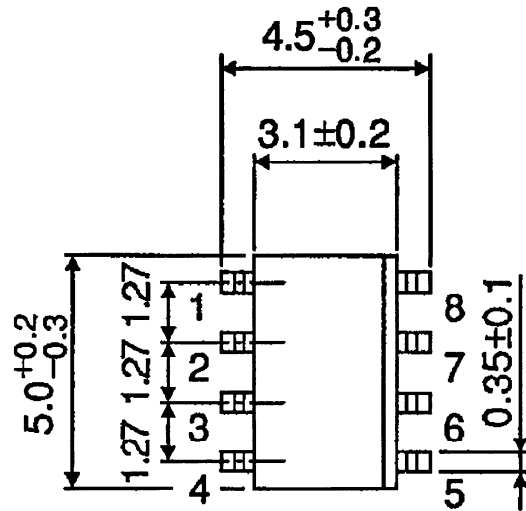


6. FREQUENCY RESPONSE (SWITCH ON)



PACKAGE DIMENSIONS  
SOP8-P-1.27

Unit : mm

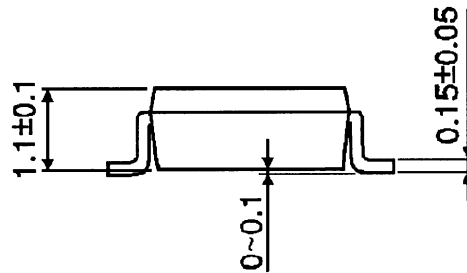
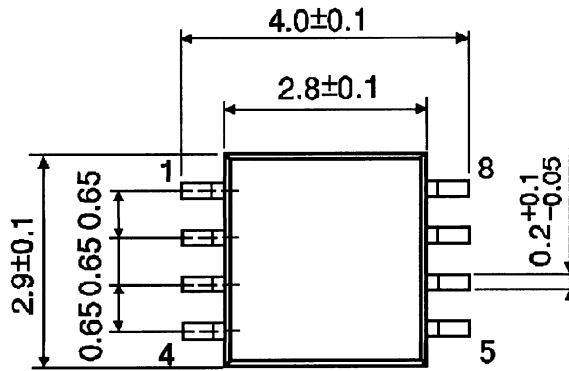


Weight : 0.05g (Typ.)



PACKAGE DIMENSIONS  
SSOP8-P-0.65

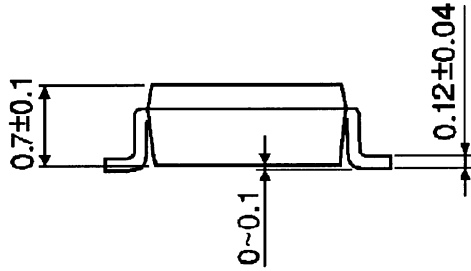
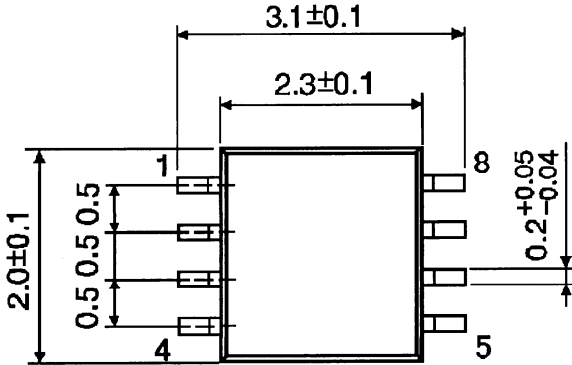
Unit : mm



Weight : 0.02g (Typ.)

PACKAGE DIMENSIONS  
SSOP8-P-0.50A

Unit : mm



Weight : 0.01g (Typ.)

**RESTRICTIONS ON PRODUCT USE**

000707EBA

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