

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC74HC4051AP, TC74HC4051AF, TC74HC4051AFT  
 TC74HC4052AP, TC74HC4052AF, TC74HC4052AFT  
 TC74HC4053AP, TC74HC4053AF, TC74HC4053AFN, TC74HC4053AFT

TC74HC4051AP/AF/AFT 8-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER  
 TC74HC4052AP/AF/AFT DUAL 4-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER  
 TC74HC4053AP/AF/AFN/AFT TRIPLE 2-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

The TC74HC4051A/4052A/4053A are high speed CMOS ANALOG MULTIPLEXER/DEMULTIPLEXER fabricated with silicon gate C<sup>2</sup>MOS technology. They achieve the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The TC74HC4051A has an 8 channel configuration, the TC74HC4052A has a 4 channel×2 configuration and the TC74HC4053A has a 2 channel×3 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 circuits with low input impedance.

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

## FEATURES:

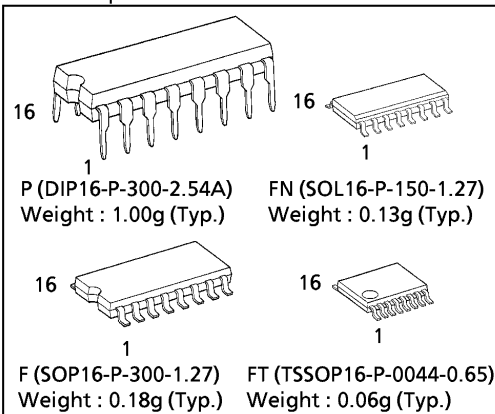
- High Speed..... $t_{pd} = 15ns$ (typ.) at  $V_{CC} = 5V$   
 $V_{EE} = 0V$
- Low Power Dissipation..... $I_{CC} = 4\mu A$ (Max.) at  $T_a = 25^\circ C$
- High Noise Immunity..... $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (Min.)
- Low ON Resistance..... $R_{ON} = 50\Omega$  (typ.)  
 at  $V_{CC}-V_{EE} = 9V$
- High Noise Immunity..... $THD = 0.02\%$  (typ.)  
 at  $V_{CC}-V_{EE} = 9V$
- Pin and Function Compatible with 4051/4052/4053B

## TRUTH TABLE

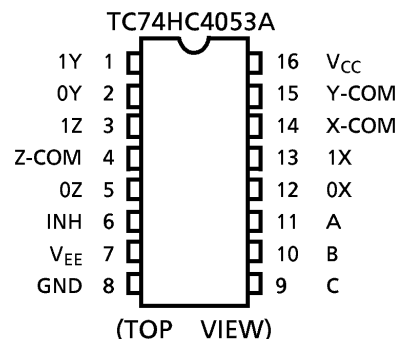
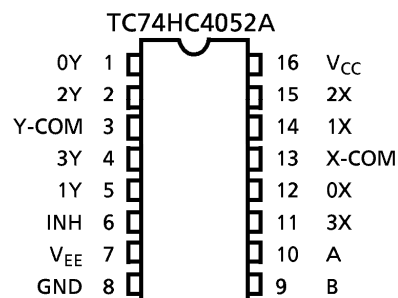
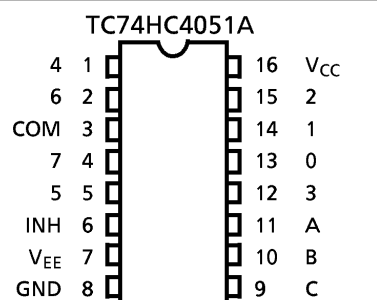
| CONTROL INPUTS |    |   |   | "ON" CHANNEL |         |          |
|----------------|----|---|---|--------------|---------|----------|
| INHIBIT        | C* | B | A | HC4051A      | HC4052A | HC4053A  |
| L              | L  | L | L | 0            | 0X, 0Y  | 0X,0Y,0Z |
| L              | L  | L | H | 1            | 1X, 1Y  | 1X,0Y,0Z |
| L              | L  | H | L | 2            | 2X, 2Y  | 0X,1Y,0Z |
| L              | L  | H | H | 3            | 3X, 3Y  | 1X,1Y,0Z |
| L              | H  | L | L | 4            | --      | 0X,0Y,1Z |
| L              | H  | L | H | 5            | --      | 1X,0Y,1Z |
| L              | H  | H | L | 6            | --      | 0X,1Y,1Z |
| L              | H  | H | H | 7            | --      | 1X,1Y,1Z |
| H              | X  | X | X | NONE         | NONE    | NONE     |

X: Don't Care, \*: Except HC4052A

(Note) The JEDEC SOP (FN) is not available in Japan.



## PIN ASSIGNMENT



961001EBA2

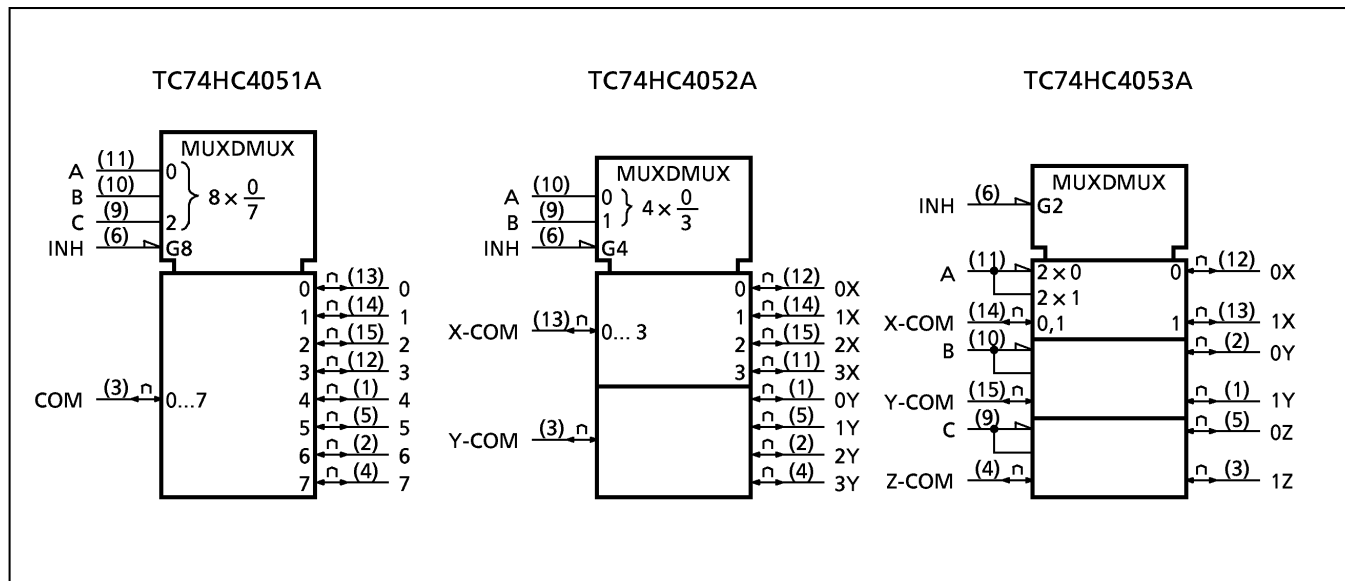
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The image contains three logic diagrams for the TC74HC4051A, TC74HC4052A, and TC74HC4053A chips. Each diagram shows the internal logic structure, including input buffers, a central Logic Level Converter, and output buffers.

- TC74HC4051A:** This diagram shows a 3-to-8 decoder. It has three inputs: A, B, and C, each with an inverter. An input enable (INH) is also shown with an inverter. The internal logic consists of eight 3-input AND gates. The outputs are labeled 0 through 7, each with an OUTC and IN buffer. A common output (COM) is also indicated.
- TC74HC4052A:** This diagram shows a 2-to-4 decoder. It has two inputs: A and B, each with an inverter. An input enable (INH) is also shown with an inverter. The internal logic consists of four 2-input AND gates. The outputs are labeled 0X, 1X, 2X, 3X, 0Y, 1Y, 2Y, and 3Y, each with an OUTC and IN buffer. A common output (Y-COM) is also indicated.
- TC74HC4053A:** This diagram shows a 3-to-8 decoder. It has three inputs: A, B, and C, each with an inverter. An input enable (INH) is also shown with an inverter. The internal logic consists of eight 3-input AND gates. The outputs are labeled 0X, 1X, 0Y, 1Y, 0Z, 1Z, and Z-COM, each with an OUTC and IN buffer.

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## IEC LOGIC SYMBOL



## ABSOLUTE MAXIMUM RATINGS

| PARAMETER                     | SYMBOL            | VALUE                            | UNIT |
|-------------------------------|-------------------|----------------------------------|------|
| Supply Voltage Range          | $V_{CC}$          | $-0.5 \sim 7$                    | V    |
| Supply Voltage Range          | $V_{CC} - V_{EE}$ | $-0.5 \sim 13$                   | V    |
| Control Input Voltage         | $V_{IN}$          | $-0.5 \sim V_{CC} + 0.5$         | V    |
| Switch I/O Voltage            | $V_{I/O}$         | $V_{EE} - 0.5 \sim V_{CC} + 0.5$ | V    |
| Control Input Diode Current   | $I_{ICK}$         | $\pm 20$                         | mA   |
| I/O Diode Current             | $I_{IOK}$         | $\pm 20$                         | mA   |
| Switch through Current        | $I_T$             | $\pm 25$                         | mA   |
| DC $V_{CC}$ or Ground Current | $I_{CC}$          | $\pm 50$                         | mA   |
| Power Dissipation             | $P_D$             | 500 (DIP)* / 180 (SOP, TSSOP)    | mW   |
| Storage Temperature           | $T_{stg}$         | $-65 \sim 150$                   | °C   |

\*500mW in the range of  $T_a = -40^\circ\text{C} \sim 65^\circ\text{C}$ . From  $T_a = 65^\circ\text{C}$  to  $85^\circ\text{C}$  a derating factor of  $-10\text{mW}/^\circ\text{C}$  shall be applied until 300mW.

## RECOMMENDED OPERATING CONDITIONS

| PARAMETER                        | SYMBOL            | VALUE                                                                                                              | UNIT |
|----------------------------------|-------------------|--------------------------------------------------------------------------------------------------------------------|------|
| Supply Voltage Range             | $V_{CC}$          | $2 \sim 6$                                                                                                         | V    |
| Supply Voltage Range             | $V_{EE}$          | $-6 \sim 0$                                                                                                        | V    |
| Supply Voltage Range             | $V_{CC} - V_{EE}$ | $2 \sim 12$                                                                                                        | V    |
| Control Input Voltage            | $V_{IN}$          | $0 \sim V_{CC}$                                                                                                    | V    |
| Switch I/O Voltage               | $V_{I/O}$         | $V_{EE} \sim V_{CC}$                                                                                               | V    |
| Operating Temperature            | $T_{opr}$         | $-40 \sim 85$                                                                                                      | °C   |
| Control Input Rise and Fall Time | $t_r, t_f$        | $0 \sim 1000 (V_{CC} = 2.0\text{V})$<br>$0 \sim 500 (V_{CC} = 4.5\text{V})$<br>$0 \sim 400 (V_{CC} = 6.0\text{V})$ | ns   |

## DC ELECTRICAL CHARACTERISTICS

| PARAMETER                                          | SYMBOL          | TEST<br>CONDITION                                                                                | $V_{EE}$ (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.                    |               |
| High - Level Control<br>Input Voltage              | $V_{IHC}$       |                                                                                                  |                            | 2.0<br>4.5<br>6.0        | 1.50<br>3.15<br>4.20     | —<br>—<br>—           | —<br>—<br>—           | 1.50<br>3.15<br>4.20              | —<br>—<br>—             | V             |
| Low - Level Control<br>Input Voltage               | $V_{ILC}$       |                                                                                                  |                            | 2.0<br>4.5<br>6.0        | —<br>—<br>—              | —<br>—<br>—           | 0.50<br>1.35<br>1.80  | —<br>—<br>—                       | 0.50<br>1.35<br>1.80    |               |
| ON Resistance                                      | $R_{ON}$        | $V_{IN} = V_{ILC}$ or $V_{IHC}$<br>$V_{I/O} = V_{CC}$ to $V_{EE}$<br>$I_{I/O} \leq 2\text{mA}$   | GND<br>-4.5<br>-6.0        | 4.5<br>4.5<br>6.0        | —<br>—<br>—              | 85<br>55<br>50        | 180<br>120<br>100     | —<br>—<br>—                       | 225<br>150<br>125       | $\Omega$      |
|                                                    |                 | $V_{IN} = V_{ILC}$ or $V_{IHC}$<br>$V_{I/O} = V_{CC}$ or $V_{EE}$<br>$I_{I/O} \leq 2\text{mA}$   | GND<br>GND<br>-4.5<br>-6.0 | 2.0<br>4.5<br>4.5<br>6.0 | —<br>—<br>—<br>—         | 150<br>70<br>50<br>45 | —<br>150<br>100<br>80 | —<br>—<br>—<br>—                  | —<br>190<br>125<br>100  |               |
| Difference of<br>ON Resistance<br>Between Switches | $\Delta R_{ON}$ | $V_{IN} = V_{ILC}$ or $V_{IHC}$<br>$V_{I/O} = V_{CC}$ to $V_{EE}$<br>$I_{I/O} \leq 2\text{mA}$   | GND<br>-4.5<br>-6.0        | 4.5<br>4.5<br>6.0        | —<br>—<br>—              | 10<br>5<br>5          | 30<br>12<br>10        | —<br>—<br>—                       | 35<br>15<br>12          |               |
| Input / Output<br>Leakage Current<br>(SWITCH OFF)  | $I_{OFF}$       | $V_{OS} = V_{CC}$ or GND<br>$V_{IS} = \text{GND}$ or $V_{CC}$<br>$V_{IN} = V_{ILC}$ or $V_{IHC}$ | GND<br>-6.0                | 6.0<br>6.0               | —<br>—                   | —<br>—                | $\pm 60$<br>$\pm 100$ | —<br>—                            | $\pm 600$<br>$\pm 1000$ | nA            |
| Switch Input<br>Leakage Current<br>(SWITCH ON)     | $I_{IZ}$        | $V_{OS} = V_{CC}$ or GND<br>$V_{IN} = V_{ILC}$ or $V_{IHC}$                                      | GND<br>-6.0                | 6.0<br>6.0               | —<br>—                   | —<br>—                | $\pm 60$<br>$\pm 100$ | —<br>—                            | $\pm 600$<br>$\pm 1000$ |               |
| Control Input Current                              | $I_{IN}$        | $V_{IN} = V_{CC}$ or GND                                                                         | GND                        | 6.0                      | —                        | —                     | $\pm 0.1$             | —                                 | $\pm 1.0$               | $\mu\text{A}$ |
| Quiescent Supply<br>Current                        | $I_{CC}$        | $V_{IN} = V_{CC}$ or GND                                                                         | GND<br>-6.0                | 6.0<br>6.0               | —<br>—                   | —<br>—                | 4.0<br>8.0            | —<br>—                            | 40.0<br>80.0            |               |

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

| PARAMETER                                    | SYMBOL                 | TEST CONDITION       | $V_{EE}$<br>(V)           | $V_{CC}$<br>(V)          | Ta = 25°C        |                       |                      | Ta = -40~85°C    |                      | UNIT |
|----------------------------------------------|------------------------|----------------------|---------------------------|--------------------------|------------------|-----------------------|----------------------|------------------|----------------------|------|
|                                              |                        |                      |                           |                          | MIN.             | TYP.                  | MAX.                 | MIN.             | MAX.                 |      |
| Phase difference<br>between Input and Output | $\phi$ I/O             | ALL TYPES            | GND<br>GND<br>GND<br>-4.5 | 2.0<br>4.5<br>6.0<br>4.5 | —<br>—<br>—<br>— | 25<br>6<br>5<br>4     | 60<br>12<br>10<br>—  | —<br>—<br>—<br>— | 75<br>15<br>13<br>—  |      |
| Output Enable Time                           | $t_{pZL}$<br>$t_{pZH}$ | *1 4051              | GND<br>GND<br>GND<br>-4.5 | 2.0<br>4.5<br>6.0<br>4.5 | —<br>—<br>—<br>— | 64<br>18<br>15<br>18  | 225<br>45<br>38<br>— | —<br>—<br>—<br>— | 280<br>56<br>48<br>— | ns   |
|                                              |                        |                      | GND<br>GND<br>GND<br>-4.5 | 2.0<br>4.5<br>6.0<br>4.5 | —<br>—<br>—<br>— | 64<br>18<br>15<br>18  | 225<br>45<br>38<br>— | —<br>—<br>—<br>— | 280<br>56<br>48<br>— |      |
|                                              |                        |                      | GND<br>GND<br>GND<br>-4.5 | 2.0<br>4.5<br>6.0<br>4.5 | —<br>—<br>—<br>— | 50<br>14<br>12<br>14  | 225<br>45<br>38<br>— | —<br>—<br>—<br>— | 280<br>56<br>48<br>— |      |
|                                              |                        | *1 4052              | GND<br>GND<br>GND<br>-4.5 | 2.0<br>4.5<br>6.0<br>4.5 | —<br>—<br>—<br>— | 100<br>33<br>28<br>29 | 250<br>50<br>43<br>— | —<br>—<br>—<br>— | 315<br>63<br>54<br>— |      |
|                                              |                        |                      | GND<br>GND<br>GND<br>-4.5 | 2.0<br>4.5<br>6.0<br>4.5 | —<br>—<br>—<br>— | 100<br>33<br>28<br>29 | 250<br>50<br>43<br>— | —<br>—<br>—<br>— | 315<br>63<br>54<br>— |      |
|                                              |                        |                      | GND<br>GND<br>GND<br>-4.5 | 2.0<br>4.5<br>6.0<br>4.5 | —<br>—<br>—<br>— | 95<br>30<br>26<br>26  | 225<br>45<br>38<br>— | —<br>—<br>—<br>— | 280<br>56<br>48<br>— |      |
| Control Input Capacitance                    | $C_{in}$               | ALL TYPES            | —                         | —                        | —                | 5                     | 10                   | —                | 10                   |      |
| COMMON Terminal<br>Capacitance               | $C_{IS}$               | 4051<br>4052<br>4053 | — 5.0                     | 5.0                      | —<br>—<br>—      | 36<br>19<br>11        | 70<br>40<br>20       | —<br>—<br>—      | 70<br>40<br>20       | pF   |
| SWITCH Terminal<br>Capacitance               | $C_{OS}$               | 4051<br>4052<br>4053 | — 5.0                     | 5.0                      | —<br>—<br>—      | 7<br>7<br>7           | 15<br>15<br>15       | —<br>—<br>—      | 15<br>15<br>15       |      |
| Feedthrough Capacitance                      | $C_{IOS}$              | 4051<br>4052<br>4053 | — 5.0                     | 5.0                      | —<br>—<br>—      | 0.95<br>0.85<br>0.75  | 2<br>2<br>2          | —<br>—<br>—      | 2<br>2<br>2          |      |
| Power Dissipation<br>Capacitance             | $C_{PD}$               | *2 4051              | GND                       | 5.0                      | —                | 70                    | —                    | —                | —                    |      |
|                                              |                        | 4052                 | GND                       | 5.0                      | —                | 71                    | —                    | —                | —                    |      |
|                                              |                        | 4053                 | GND                       | 5.0                      | —                | 67                    | —                    | —                | —                    |      |

\* 1:  $R_L = 1\text{k}\Omega$ \* 2:  $C_{PD}$  is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

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

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

| PARAMETER                                          | SYMBOL           | TEST CONDITION                                                                                                                                                                                    |                                                                                                                          | V <sub>EE</sub> (V)      | V <sub>CC</sub> (V)  | TYP.                    | UNIT |
|----------------------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------|----------------------|-------------------------|------|
|                                                    |                  |                                                                                                                                                                                                   |                                                                                                                          |                          |                      |                         |      |
| Sine Wave Distortion<br>( T . H . D )              |                  | RL = 10kΩ<br>CL = 50pF<br>f <sub>IN</sub> = 1kHz                                                                                                                                                  | V <sub>IN</sub> = 4.0V <sub>P-P</sub><br>V <sub>IN</sub> = 8.0V <sub>P-P</sub><br>V <sub>IN</sub> = 11.0V <sub>P-P</sub> | − 2.25<br>− 4.5<br>− 6.0 | 2.25<br>4.5<br>6.0   | 0.025<br>0.020<br>0.018 | %    |
| Frequency<br>Responce<br>( 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 Meter reads − 3dB<br><br>RL = 50Ω, CL = 10pF<br>f <sub>IN</sub> = 1MHz, Sine Wave | *1 ALL                                                                                                                   | − 2.25                   | 2.25                 | 120                     | MHz  |
|                                                    |                  |                                                                                                                                                                                                   | *2 4051<br>4052<br>4053                                                                                                  |                          |                      | 45<br>70<br>95          |      |
|                                                    |                  |                                                                                                                                                                                                   | *1 ALL                                                                                                                   | − 4.5                    | 4.5                  | 190                     |      |
|                                                    |                  |                                                                                                                                                                                                   | *2 4051<br>4052<br>4053                                                                                                  |                          |                      | 70<br>110<br>150        |      |
|                                                    |                  |                                                                                                                                                                                                   | *1 ALL                                                                                                                   | − 6.0                    | 6.0                  | 200                     |      |
|                                                    |                  |                                                                                                                                                                                                   | *2 4051<br>4052<br>4053                                                                                                  |                          |                      | 85<br>140<br>190        |      |
| Feed through<br>Attenuation<br>( Switch OFF )      |                  | Vin is centered at ( V <sub>CC</sub> - V <sub>EE</sub> ) / 2<br>Adjust input for 0dBm<br><br>RL = 600Ω, CL = 50pF<br>f <sub>IN</sub> = 1MHz, Sine Wave                                            | − 2.25<br>− 4.5<br>− 6.0                                                                                                 | 2.25<br>4.5<br>6.0       | − 50<br>− 50<br>− 50 | dB                      |      |
| Crosstalk<br>( Control Input to<br>Signal Output ) |                  | RL = 600Ω, CL = 50pF<br>f <sub>IN</sub> = 1MHz, Square Wave ( tr = tf = 6ns )                                                                                                                     | − 2.25<br>− 4.5<br>− 6.0                                                                                                 | 2.25<br>4.5<br>6.0       | 60<br>140<br>200     | mV                      |      |
| Crosstalk<br>( Between any switches )              |                  | Adjust V <sub>IN</sub> to obtain 0dBm at Input<br><br>RL = 600Ω, CL = 50pF<br>f <sub>IN</sub> = 1MHz, Sine Wave                                                                                   | − 2.25<br>− 4.5<br>− 6.0                                                                                                 | 2.25<br>4.5<br>6.0       | − 50<br>− 50<br>− 50 | dB                      |      |

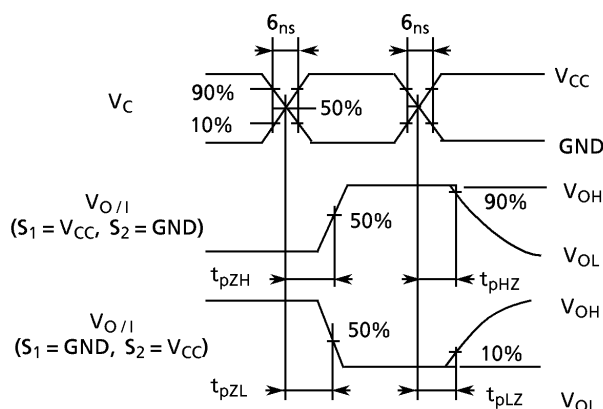
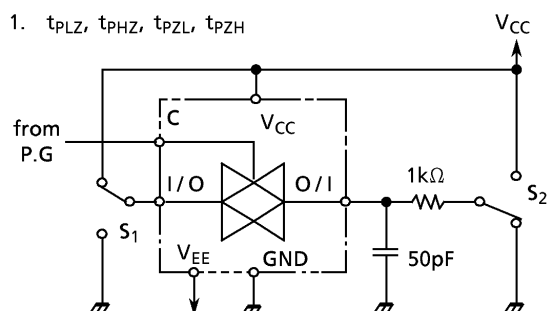
\* 1 : Input COMMON Terminal, and measured at SWITCH Terminal.

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

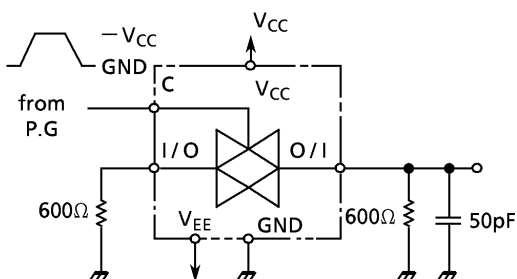
NOTE : These characteristics are determined by design of devices.

**SWITCHING CHARACTERISTICS TEST CIRCUITS**

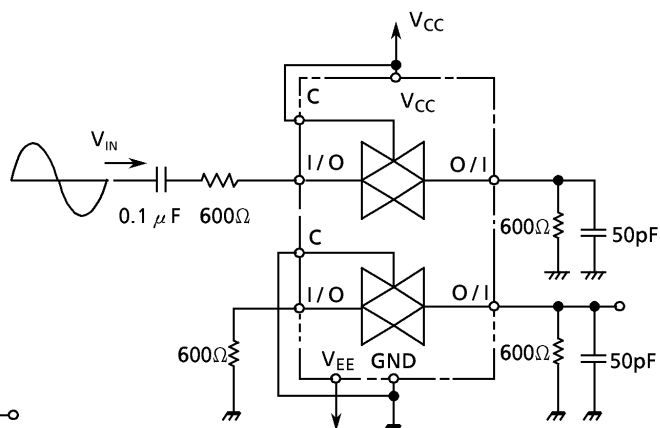
1.  $t_{PLZ}$ ,  $t_{PHZ}$ ,  $t_{PZL}$ ,  $t_{PZH}$



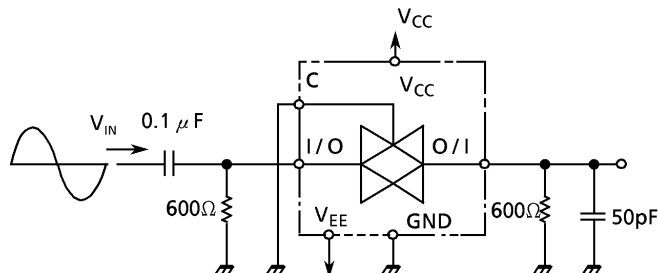
2. CROSS TALK (CONTROL INPUT – SWITCH OUTPUT)  
 $f_{in} = 1MHz$  duty = 50%  $t_r = t_f = 6ns$



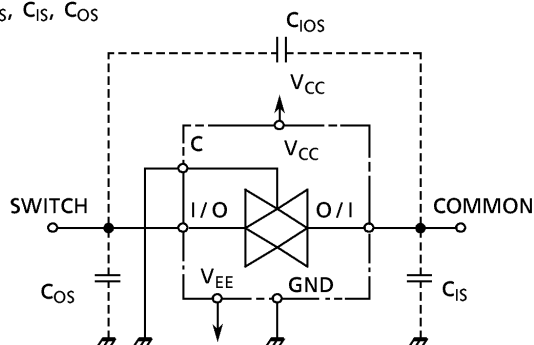
5. CROSS TALK (BETWEEN ANY TWO SWITCHES)



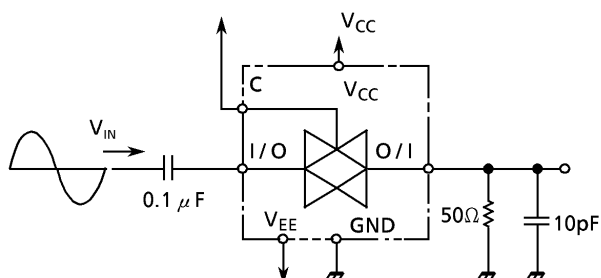
3. FEEDTHROUGH ATTENUATION



4.  $C_{IOS}$ ,  $C_{IS}$ ,  $C_{OS}$

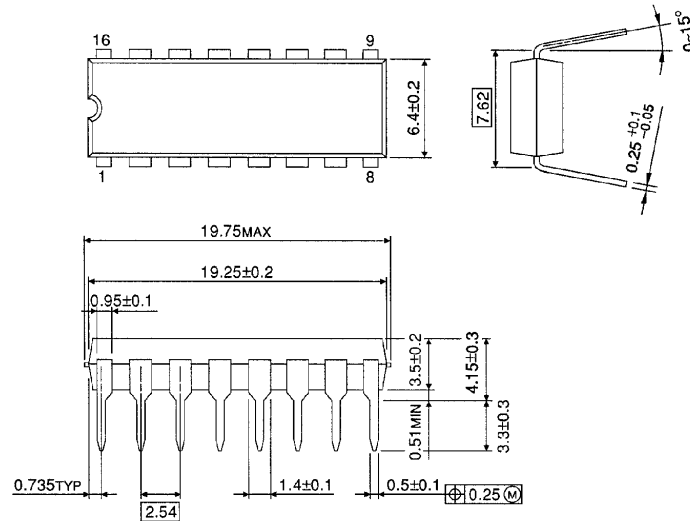


6. FREQUENCY RESPONSE (SWITCH ON)



**DIP 16PIN OUTLINE DRAWING (DIP16-P-300-2.54A)**

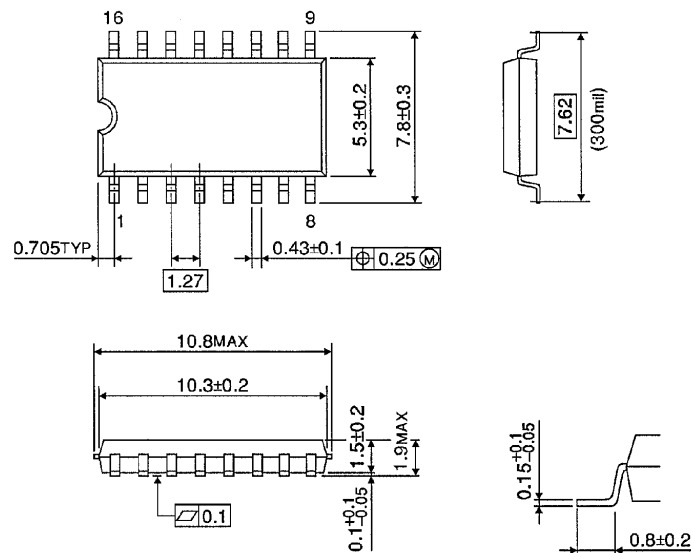
Unit in mm



Weight : 1.00g (Typ.)

**SOP 16PIN (200mil BODY) OUTLINE DRAWING (SOP16-P-300-1.27)**

Unit in mm

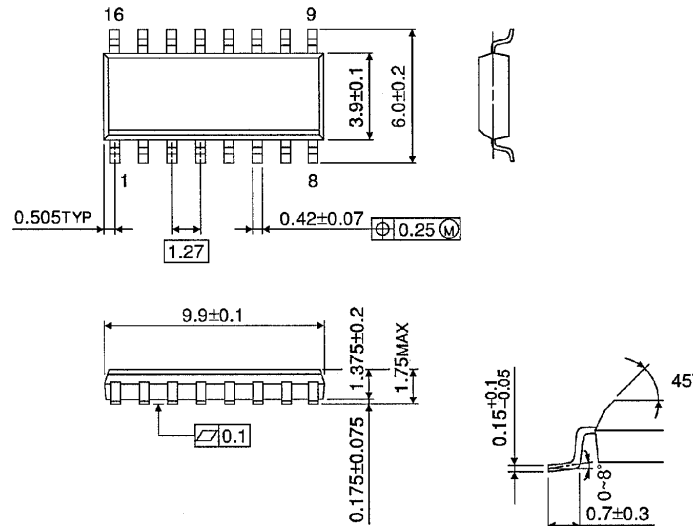


Weight : 0.18g (Typ.)

**SOP 16PIN (150mil BODY) OUTLINE DRAWING (SOL16-P-150 -1.27)**

Unit in mm

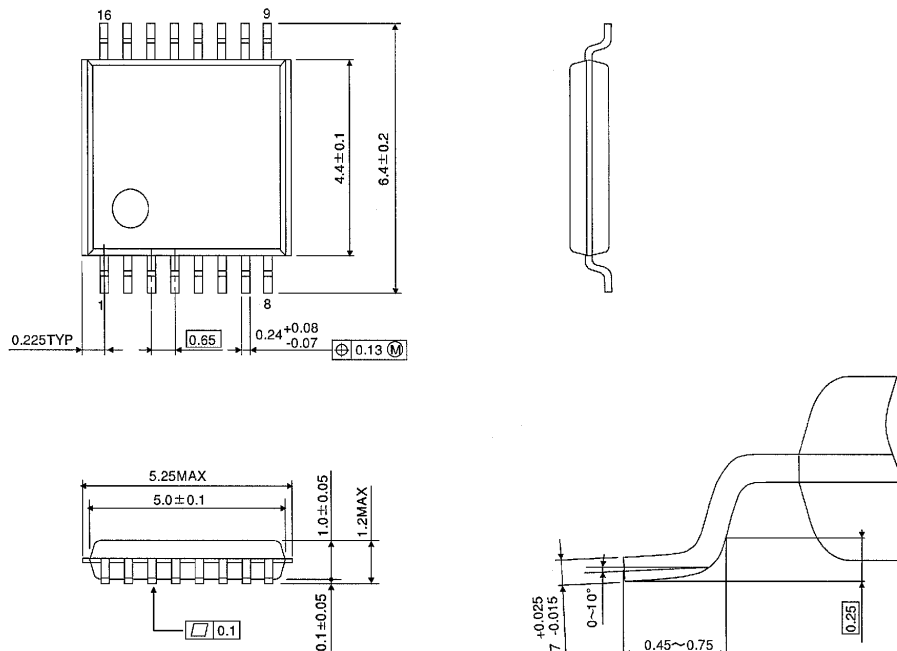
(Note) This package is not available in Japan.



Weight : 0.13g (Typ.)

**TSSOP 16PIN OUTLINE DRAWING (TSSOP16-P-0044-0.65)**

Unit in mm



Weight : 0.06g (Typ.)