

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74LVX4051F,TC74LVX4052F,TC74LVX4053F TC74LVX4051FT,TC74LVX4052FT,TC74LVX4053FT

TC74LVX4051F/FT 8-Channel Analog Multiplexer/Demultiplexer

TC74LVX4052F/FT Dual 4-Channel Analog Multiplexer/Demultiplexer

TC74LVX4053F/FT Triple 2-Channel Analog Multiplexer/Demultiplexer

The TC74LVX4051/4052/4053F/FT are high-speed, low-voltage drive analog multiplexer/demultiplexers using silicon gate CMOS technology. In 3 V and 5 V systems these can achieve high-speed operation with the low power dissipation that is a feature of CMOS.

The TC74LVX4051/4052/4053F/FT offer analog/digital signal selection as well as mixed signals. The 4051 has an 8-channel configuration, the 4052 has an 4-channel × 2 configuration, and the 4053 has a 2-channel × 3 configuration.

The switches for each channel are turned ON by the control pin digital signals.

Although the control signal logical amplitude ( $V_{CC} - GND$ ) is small, the device can perform large-amplitude ( $V_{CC} - V_{EE}$ ) signal switching.

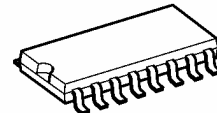
For example, if  $V_{CC} = 3\text{ V}$ ,  $GND = 0\text{ V}$ , and  $V_{EE} = -3\text{ V}$ , signals between  $-3\text{ V}$  and  $+3\text{ V}$  can be switched from the logical circuit using a single 3 V power supply.

All input pins are equipped with a newly developed input protection circuit that avoids the need for a diode on the plus side (forward side from the input to the  $V_{CC}$ ). As a result, for example, 5 V signals can be permitted on the inputs even when the power supply voltage to the circuits is off. As a result of this input power protection, the TC74LVX4051/4052/4053F/FT can be used in a variety of applications, including in the system which has two power supplies, and in battery backup circuits.

### Features

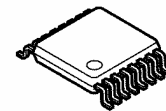
- Low ON resistance:  $R_{on} = 22\ \Omega$  (typ.) ( $V_{CC} - V_{EE} = 3\text{ V}$ )  
 $R_{on} = 15\ \Omega$  (typ.) ( $V_{CC} - V_{EE} = 6\text{ V}$ )
- High speed:  $t_{pd} = 3\text{ ns}$  (typ.) ( $V_{CC} = 3.0\text{ V}$ )
- Low power dissipation:  $I_{CC} = 4\ \mu\text{A}$  (max) ( $T_a = 25^\circ\text{C}$ )
- Input level:  $V_{IL} = 0.8\text{ V}$  (max) ( $V_{CC} = 3\text{ V}$ )  
 $V_{IH} = 2.0\text{ V}$  (min) ( $V_{CC} = 3\text{ V}$ )
- Power down protection is provided on all control inputs
- Pin and function compatible with 74HC4051/4052/4053

TC74LVX4051F, TC74LVX4052F,  
TC74LVX4053F



SOP16-P-300-1.27A

TC74LVX4051FT, TC74LVX4052FT,  
TC74LVX4053FT



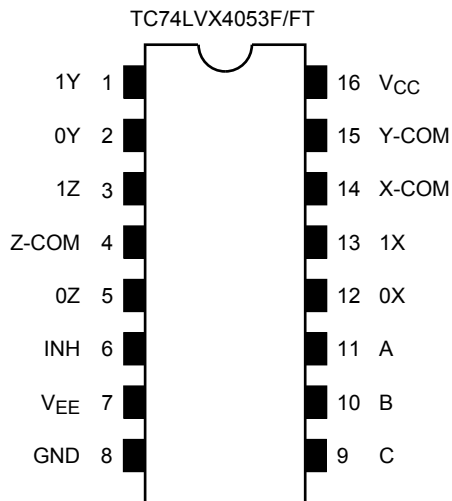
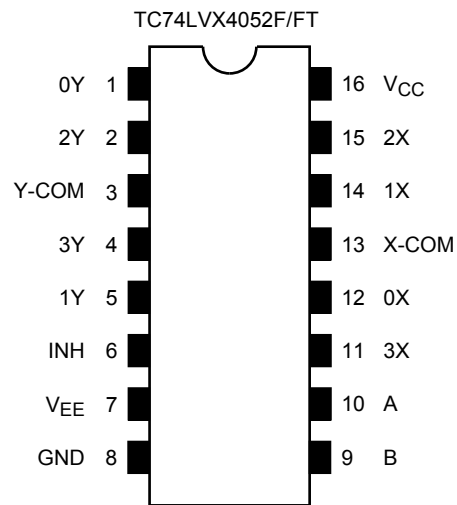
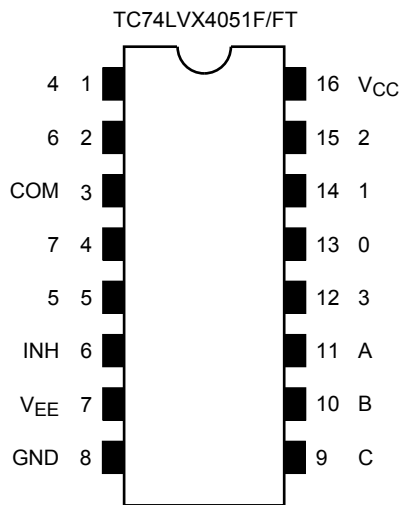
TSSOP16-P-0044-0.65A

#### Weight

SOP16-P-300-1.27A: 0.18 g (typ.)

TSSOP16-P-0044-0.65A: 0.06 g (typ.)

## Pin Assignment (top view)



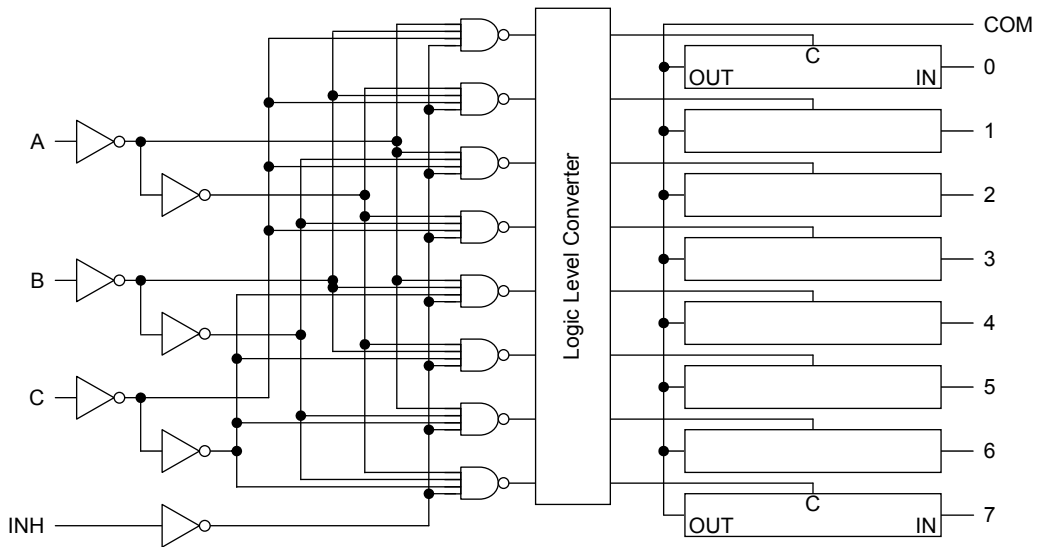
## Truth Table

| Control Inputs |    |   |   | "ON" Channel |             |             |
|----------------|----|---|---|--------------|-------------|-------------|
| Inhibit        | C* | B | A | LVX4051F/FT  | LVX4052F/FT | LVX4053F/FT |
| 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        |

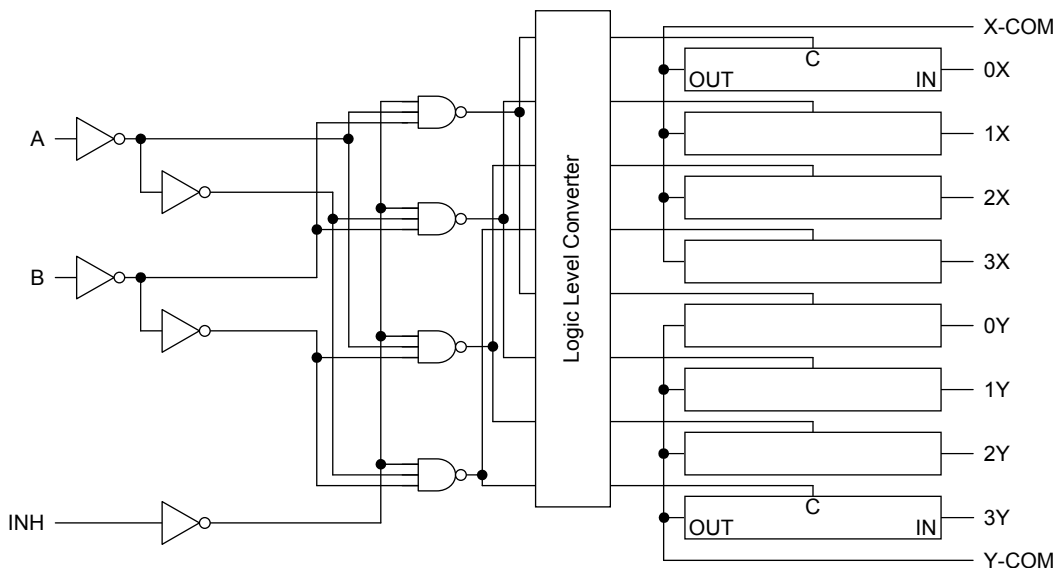
X: Don't care, \*: Except LVX4052F/FT

**System Diagram**

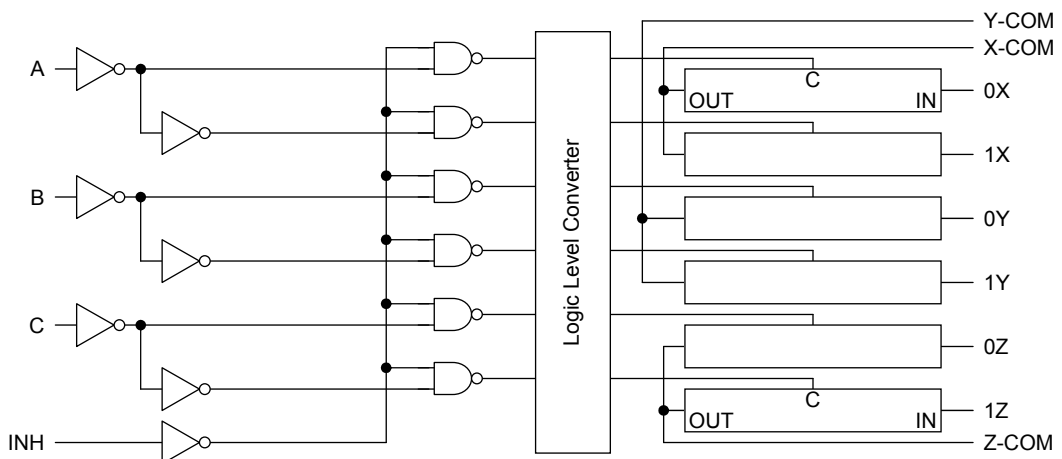
**TC74LVX4051F/FT**



**TC74LVX4052F/FT**



**TC74LVX4053F/FT**



## Absolute Maximum Ratings (Note)

| Characteristics               | Symbol              | Rating                          | Unit |
|-------------------------------|---------------------|---------------------------------|------|
| Power supply voltage          | $V_{CC}$            | -0.5~7.0                        | V    |
|                               | $V_{CC}\sim V_{EE}$ | -0.5~7.0                        |      |
| Control input voltage         | $V_{IN}$            | -0.5~7.0                        | V    |
| Switch I/O voltage            | $V_{I/O}$           | $V_{EE} - 0.5\sim V_{CC} + 0.5$ | V    |
| Input diode current           | $I_{IK}$            | -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             | $P_D$               | 180                             | mW   |
| Storage temperature           | $T_{stg}$           | -65~150                         | °C   |

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

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).

## Operating Ranges (Note)

| Characteristics          | Symbol              | Rating                            | Unit |
|--------------------------|---------------------|-----------------------------------|------|
| Power supply voltage     | $V_{CC}$            | 2~6                               | V    |
|                          | $V_{EE}$            | -4~0                              |      |
|                          | $V_{CC}\sim V_{EE}$ | 2~6                               |      |
| Input voltage            | $V_{IN}$            | 0~6.0                             | V    |
| Switch I/O voltage       | $V_{I/O}$           | $V_{EE}\sim V_{CC}$               | V    |
| Operating temperature    | $T_{opr}$           | -40~85                            | °C   |
| Input rise and fall time | dt/dv               | 0~100 ( $V_{CC} = 3.3 \pm 0.3$ V) | ns/V |
|                          |                     | 0~20 ( $V_{CC} = 5 \pm 0.5$ V)    |      |

Note: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs must be tied to either VCC or GND.

## Electrical Characteristics

### DC Electrical Characteristics

| Characteristics                                       |                  | Symbol   | Test Condition | Ta = 25°C           |                     |      | Ta = -40~85°C |       | Unit |      |     |      |
|---|------------------|--|----------------|---------------------|---------------------|------|---------------|-------|------|------|-----|------|
|   |                  |  |                | V <sub>EE</sub> (V) | V <sub>CC</sub> (V) | Min  | Typ.          | Max   |      | Min  | Max |      |
| Input voltage   | High-level       | V <sub>IH</sub>  | —              |                     | 2.0                 | 1.5  | —             | —     | 1.5  | —    | V   |      |
|   |                  |  |                |                     | 3.0                 | 2.0  | —             | —     | 2.0  | —    |     |      |
|   |                  |  |                |                     | 4.5                 | 3.15 | —             | —     | 3.15 | —    |     |      |
|   |                  |  |                |                     | 6.0                 | 4.2  | —             | —     | 4.2  | —    |     |      |
|   | Low-level        | V <sub>IL</sub>  | —              |                     |                     | 2.0  | —             | —     | 0.5  | —    |     | 0.5  |
|   |                  |  |                |                     |                     | 3.0  | —             | —     | 0.8  | —    |     | 0.8  |
|   |                  |  |                |                     |                     | 4.5  | —             | —     | 1.35 | —    |     | 1.35 |
|   |                  |  |                |                     |                     | 6.0  | —             | —     | 1.8  | —    |     | 1.8  |
| ON resistance   | R <sub>ON</sub>  | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub><br>I <sub>I/O</sub> = 2 mA     | GND            |                     | 2.0                 | —    | 200           | —     | —    | —    | Ω   |      |
|   |                  |  |                |                     | 3.0                 | —    | 45            | 86    | —    | 108  |     |      |
|   |                  |  |                |                     | 4.5                 | —    | 24            | 37    | —    | 46   |     |      |
|   |                  |  |                |                     | -3.0                | 3.0  | —             | 17    | 26   | —    |     | 33   |
|   |                  |  | GND            |                     | 2.0                 | —    | 28            | 73    | —    | 84   |     |      |
|   |                  |  |                |                     | 3.0                 | —    | 22            | 38    | —    | 44   |     |      |
|   |                  |  |                |                     | 4.5                 | —    | 17            | 27    | —    | 31   |     |      |
|   |                  |  |                |                     | -3.0                | 3.0  | —             | 15    | 24   | —    |     | 28   |
| Difference of ON resistance between switches          | ΔR <sub>ON</sub> | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub><br>I <sub>I/O</sub> = 2 mA     | GND            |                     | 2.0                 | —    | 10            | 25    | —    | 35   | Ω   |      |
|   |                  |  |                |                     | 3.0                 | —    | 5             | 15    | —    | 20   |     |      |
|   |                  |  |                |                     | 4.5                 | —    | 5             | 13    | —    | 18   |     |      |
|   |                  |  |                |                     | -3.0                | 3.0  | —             | 5     | 10   | —    |     | 15   |
| Input/Output leakage current (switch OFF)             | I <sub>OFF</sub> | V <sub>OS</sub> = V <sub>CC</sub> or GND<br>V <sub>IS</sub> = GND to V <sub>CC</sub><br>V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> | GND            |                     | 3.0                 | —    | —             | ±0.25 | —    | ±2.5 | μA  |      |
|   |                  |  |                |                     | -3.0                | 3.0  | —             | —     | ±0.5 | —    |     | ±5.0 |
| Input/Output leakage current (switch ON, output open) | I <sub>IN</sub>  | V <sub>OS</sub> = V <sub>CC</sub> or GND<br>V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub>   | GND            |                     | 3.0                 | —    | —             | ±0.25 | —    | ±2.5 | μA  |      |
|   |                  |  |                |                     | -3.0                | 3.0  | —             | —     | ±0.5 | —    |     | ±5.0 |
| Control input current                                 | I <sub>IN</sub>  | V <sub>IN</sub> = V <sub>CC</sub> or GND   | GND            |                     | 6.0                 | —    | —             | ±0.1  | —    | ±0.1 | μA  |      |
| Quiescent supply current                              | I <sub>CC</sub>  | V <sub>IN</sub> = V <sub>CC</sub> or GND   | GND            |                     | 3.0                 | —    | —             | 4.0   | —    | 40.0 | μA  |      |
|   |                  |  |                |                     | -3.0                | 3.0  | —             | —     | 8.0  | —    |     | 80.0 |

## AC Electrical Characteristics (C<sub>L</sub> = 50 pF, Input: t<sub>r</sub> = t<sub>f</sub> = 3 ns, GND = 0 V)

| Characteristics                           | Symbol                               | Test Condition     | Ta = 25°C           |                     |     | Ta = -40~85°C |     | Unit |     |     |    |
|---|--------------------------------------|--------------------|---------------------|---------------------|-----|---------------|-----|------|-----|-----|----|
|   |                                      |                    | V <sub>EE</sub> (V) | V <sub>CC</sub> (V) | Min | Typ.          | Max |      | Min | Max |    |
| Phase difference between input and output | φ <sub>I/O</sub>                     | All types          | GND                 | 2.0                 | —   | 3.2           | 6.0 | —    | 6.9 | ns  |    |
|   |                                      |                    | GND                 | 3.0                 | —   | 1.8           | 3.0 | —    | 3.5 |     |    |
|   |                                      |                    | GND                 | 4.5                 | —   | 1.3           | 1.8 | —    | 2.1 |     |    |
|   |                                      |                    | -3.0                | 3.0                 | —   | 1.1           | 1.3 | —    | 1.5 |     |    |
| Output enable time                        | t <sub>pZL</sub><br>t <sub>pZH</sub> | Figure 1 (Note 1)  | GND                 | 2.0                 | —   | 9.0           | 17  | —    | 20  | ns  |    |
|   |                                      |                    | GND                 | 3.0                 | —   | 5.7           | 9.0 | —    | 11  |     |    |
|   |                                      |                    | GND                 | 4.5                 | —   | 4.5           | 6.0 | —    | 7.0 |     |    |
|   |                                      |                    | -3.0                | 3.0                 | —   | 5.8           | 8.0 | —    | 10  |     |    |
| Output disable time                       | t <sub>pLZ</sub><br>t <sub>pHZ</sub> | Figure 1 (Note 1)  | GND                 | 2.0                 | —   | 13.5          | 21  | —    | 25  | ns  |    |
|   |                                      |                    | GND                 | 3.0                 | —   | 11.3          | 15  | —    | 18  |     |    |
|   |                                      |                    | GND                 | 4.5                 | —   | 10.3          | 12  | —    | 14  |     |    |
|   |                                      |                    | -3.0                | 3.0                 | —   | 10.9          | 13  | —    | 15  |     |    |
| Control input capacitance                 | C <sub>in</sub>                      | All types (Note 2) | —                   | —                   | —   | 5             | 10  | —    | 10  | pF  |    |
| COMMON terminal capacitance               | C <sub>IS</sub>                      | 4051               | Figure 2 (Note 2)   | -3.0                | 3.0 | —             | 11  | 25   | —   | 25  | pF |
|   |                                      | 4052               |                     |                     |     |               | 9   | 20   |     | 20  |    |
|   |                                      | 4053               |                     |                     |     |               | 7   | 15   |     | 15  |    |
| SWITCH terminal capacitance               | C <sub>OS</sub>                      | 4051               | Figure 2 (Note 2)   | -3.0                | 3.0 | —             | 6   | 13   | —   | 13  | pF |
|   |                                      | 4052               |                     |                     |     |               | 6   | 13   |     | 13  |    |
|   |                                      | 4053               |                     |                     |     |               | 6   | 13   |     | 13  |    |
| Feedthrough capacitance                   | C <sub>IOS</sub>                     | 4051               | Figure 2 (Note 2)   | -3.0                | 3.0 | —             | 3   | 6    | —   | 6   | pF |
|   |                                      | 4052               |                     |                     |     |               | 3   | 6    |     | 6   |    |
|   |                                      | 4053               |                     |                     |     |               | 3   | 6    |     | 6   |    |
| Power dissipation capacitance             | C <sub>PD</sub>                      | 4051               | Figure 2 (Note 3)   | GND                 | 6.0 | —             | 14  | —    | —   | —   | pF |
|   |                                      | 4052               |                     |                     |     |               | 24  |      |     |     |    |
|   |                                      | 4053               |                     |                     |     |               | 18  |      |     |     |    |

Note 1: R<sub>L</sub> = 1 kΩ

Note 2: C<sub>in</sub>, C<sub>IS</sub>, C<sub>OS</sub> and C<sub>IOS</sub> are guaranteed by the design.

Note 3: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.

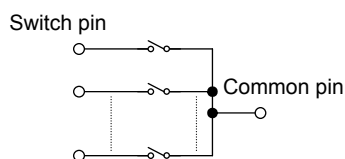
Average operating current can be obtained by the equation:

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

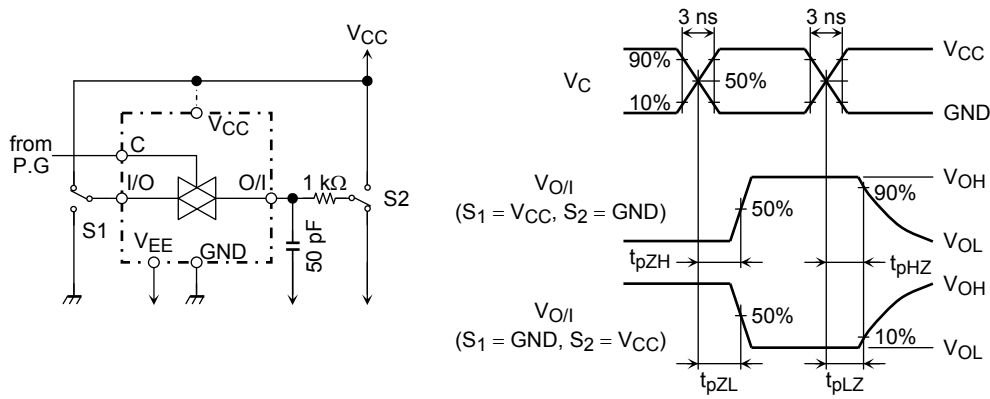
## Analog Switch Characteristics (GND = 0 V, Ta = 25°C) (Note)

| Characteristics                            | Symbol    | Test Condition  |                               | Typ. | Unit |       |     |
|--|-----------|---|-------------------------------|------|------|-------|-----|
|  |           | $V_{EE}$ (V)  | $V_{CC}$ (V)                  |      |      |       |     |
| Sine Wave Distortion (T.H.D)               |           | $R_L = 10\text{ k}\Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ kHz}$  | $V_{IN} = 2.0\text{ V}_{p-p}$ | 0    | 3.0  | 0.100 | %   |
|  |           |   | $V_{IN} = 4.0\text{ V}_{p-p}$ | 0    | 4.5  | 0.030 |     |
|  |           |   | $V_{IN} = 6.0\text{ V}_{p-p}$ | -0.3 | 3.0  | 0.020 |     |
| Frequency response (switch ON)             | $f_{max}$ | Adjust $f_{IN}$ voltage to obtain 0dBm at $V_{OS}$ .<br>Increase $f_{IN}$ frequency until dB meter reads -3dB.<br>$R_L = 50\ \Omega$ , $C_L = 10\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , sine wave<br>Figure 3 | 4051                          | 0    | 3.0  | 150   | MHz |
|  |           |   | 4052                          |      |      | 180   |     |
|  |           |   | 4053                          |      |      | 200   |     |
|  |           |   | 4051                          | 0    | 4.5  | 150   |     |
|  |           |   | 4052                          |      |      | 180   |     |
|  |           |   | 4053                          |      |      | 200   |     |
|  |           |   | 4051                          | -3.0 | 3.0  | 150   |     |
|  |           |   | 4052                          |      |      | 180   |     |
|  |           |   | 4053                          |      |      | 200   |     |
| Feed through attenuation (switch OFF)      |           | $V_{IN}$ is centered at $(V_{CC} - V_{EE})/2$ .<br>Adjust input for 0dBm.<br>$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , sine wave<br>Figure 4                                     | 0                             | 3.0  | -45  | dB    |     |
|  |           |   | 0                             | 4.5  | -45  |       |     |
|  |           |   | -3.0                          | 3.0  | -45  |       |     |
|  |           |   | 0                             | 3.0  | -60  |       |     |
|  |           |   | 0                             | 4.5  | -60  |       |     |
|  |           |   | -3.0                          | 3.0  | -60  |       |     |
| Crosstalk (control input to signal output) |           | $R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , square wave<br>( $t_r = t_f = 6\text{ ns}$ )<br>Figure 5   | 0                             | 3.0  | 90   | mV    |     |
|  |           |   | 0                             | 4.5  | 150  |       |     |
|  |           |   | -3.0                          | 3.0  | 120  |       |     |
| Crosstalk (between any switches)           |           | Adjust $V_{IN}$ to obtain 0dBm at input.<br>$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , sine wave<br>Figure 6  | 0                             | 3.0  | -45  | dB    |     |
|  |           |   | 0                             | 4.5  | -45  |       |     |
|  |           |   | -3.0                          | 3.0  | -45  |       |     |

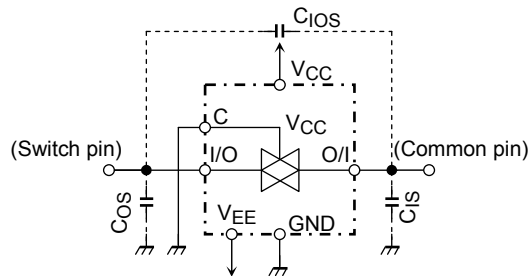
Note: These characteristics are determined by design of devices.



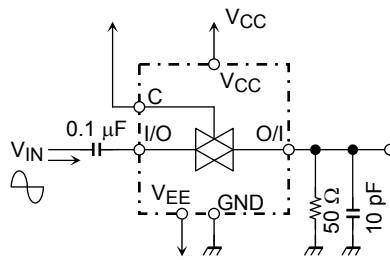
**AC Test Circuit**



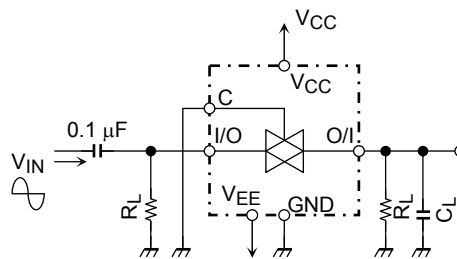
**Figure 1**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$



**Figure 2**  $C_{10S}$ ,  $C_{0S}$ ,  $C_{0I}$

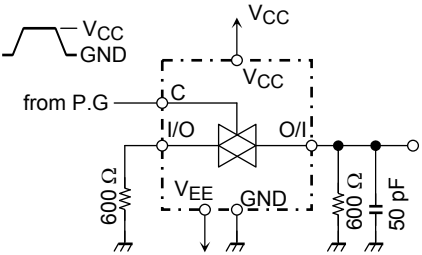


**Figure 3** Frequency Response (switch on)

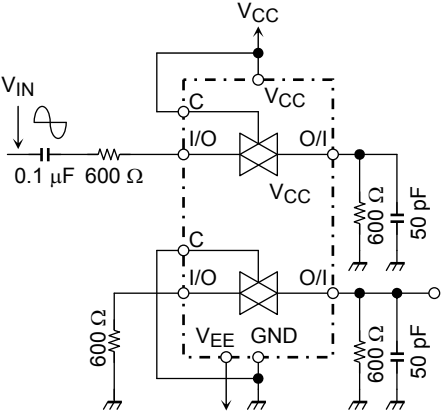


**Figure 4** Feedthrough





**Figure 5 Cross Talk (control input to output signal)**

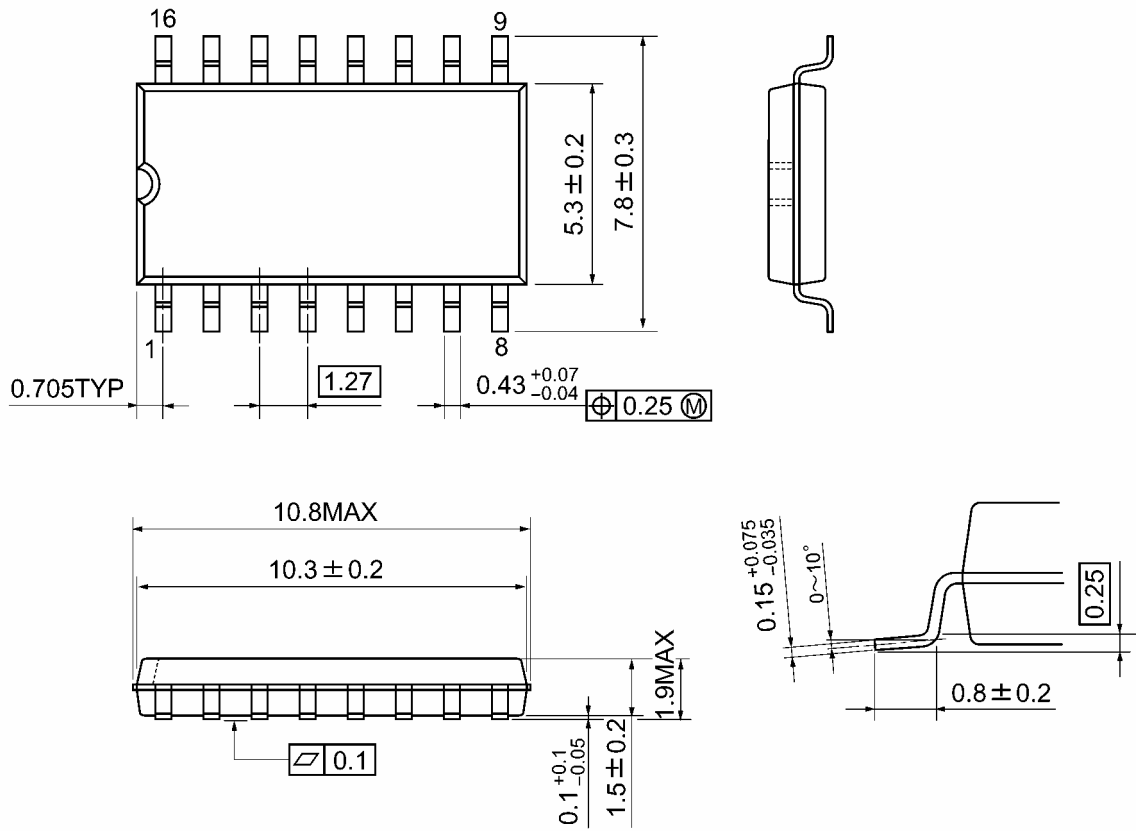


**Figure 6 Cross Talk (between any two switches)**

**Package Dimensions**

SOP16-P-300-1.27A

Unit: mm

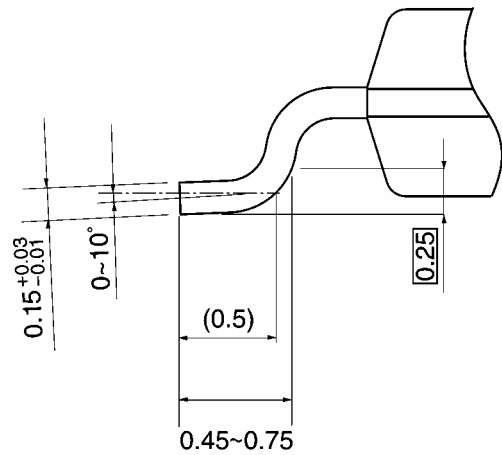
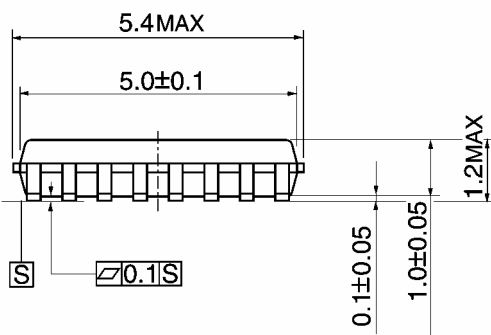
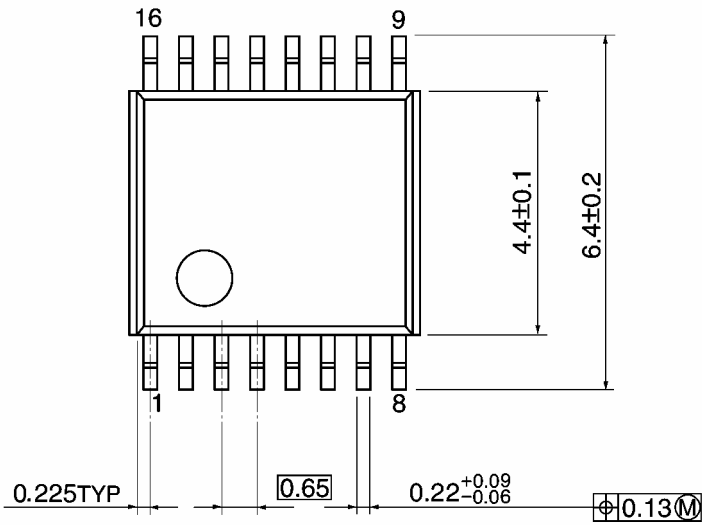


Weight: 0.18 g (typ.)

**Package Dimensions**

TSSOP16-P-0044-0.65A

Unit: mm



Weight: 0.06 g (typ.)

**RESTRICTIONS ON PRODUCT USE**

20070701-EN GENERAL

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In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc.
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