

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74LVX4051F, TC74LVX4051FT, TC74LVX4051FK TC74LVX4052F, TC74LVX4052FT, TC74LVX4052FK TC74LVX4053F, TC74LVX4053FT, TC74LVX4053FK

TC74LVX4051F/FT/FK

8-Channel Analog Multiplexer/Demultiplexer

TC74LVX4052F/FT/FK

Dual 4-Channel Analog Multiplexer/Demultiplexer

TC74LVX4053F/FT/FK

Triple 2-Channel Analog Multiplexer/Demultiplexer

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

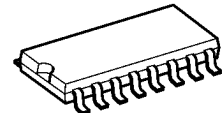
For example, if  $V_{CC} = 3\text{ V}$ ,  $GND = 0\text{ V}$ , and  $V_{EE} = -3\text{ V}$ , signals between  $-3\text{ V}$  and  $+3\text{ V}$  can be switched from the logical circuit using a single 3 V power supply.

All control 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 TC74LVX4051/4052/4053 can be used in a variety of applications, including in the system which has two power supplies, and in battery backup circuits.

### Features

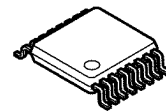
- Low ON resistance:  $R_{on} = 22\ \Omega$  (typ.) ( $V_{CC} - V_{EE} = 3\text{ V}$ )  
 $R_{on} = 15\ \Omega$  (typ.) ( $V_{CC} - V_{EE} = 6\text{ V}$ )
- High speed:  $t_{pd} = 3\text{ ns}$  (typ.) ( $V_{CC} = 3.0\text{ V}$ )
- Low power dissipation:  $I_{CC} = 4\ \mu\text{A}$  (max) ( $T_a = 25^\circ\text{C}$ )
- 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



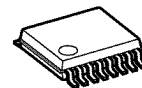
SOP16-P-300-1.27A

TC74LVX4051FT, TC74LVX4052FT,  
TC74LVX4053FT



TSSOP16-P-0044-0.65A

TC74LVX4051FK, TC74LVX4052FK,  
TC74LVX4053FK

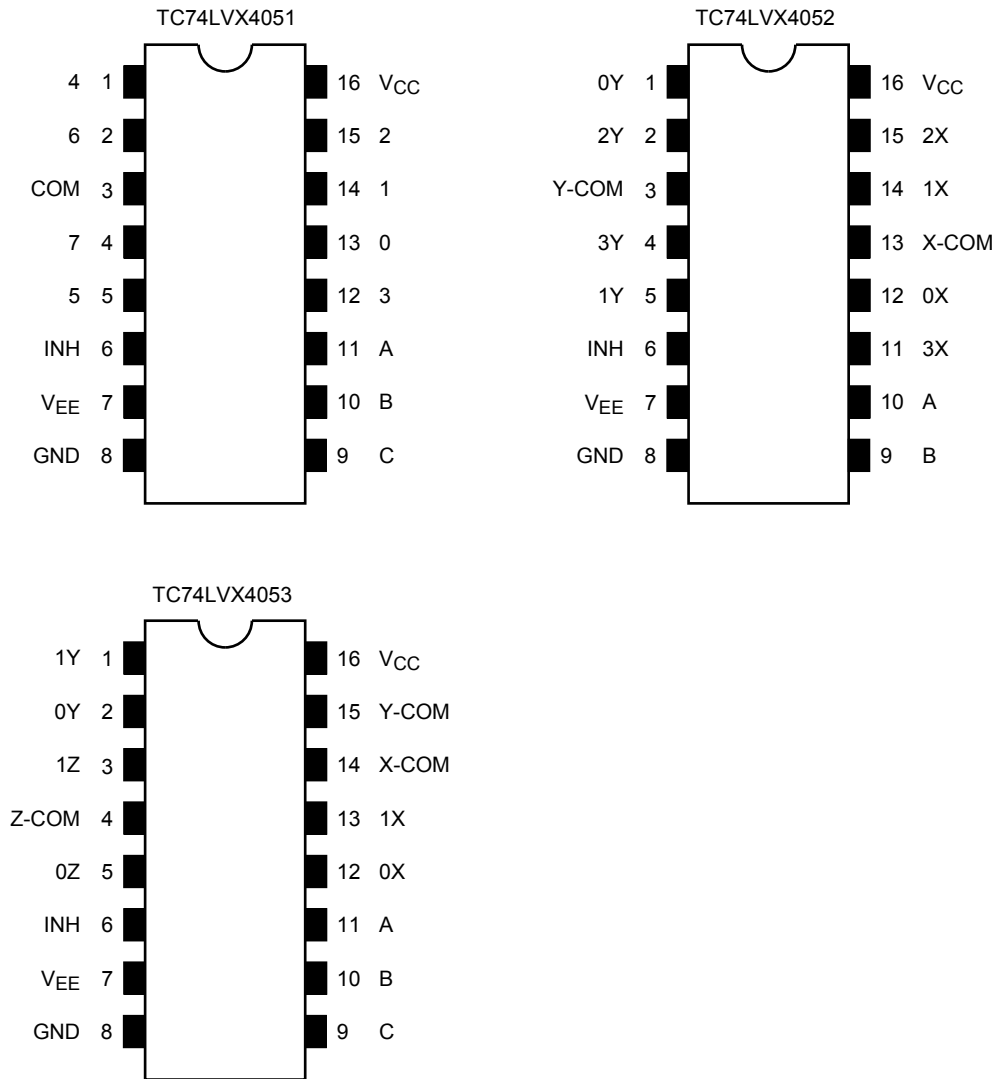


VSSOP16-P-0030-0.50

Weight

|                      |                 |
|----------------------|-----------------|
| SOP16-P-300-1.27A    | : 0.18 g (typ.) |
| TSSOP16-P-0044-0.65A | : 0.06 g (typ.) |
| VSSOP16-P-0030-0.50  | : 0.02 g (typ.) |

Pin Assignment (top view)



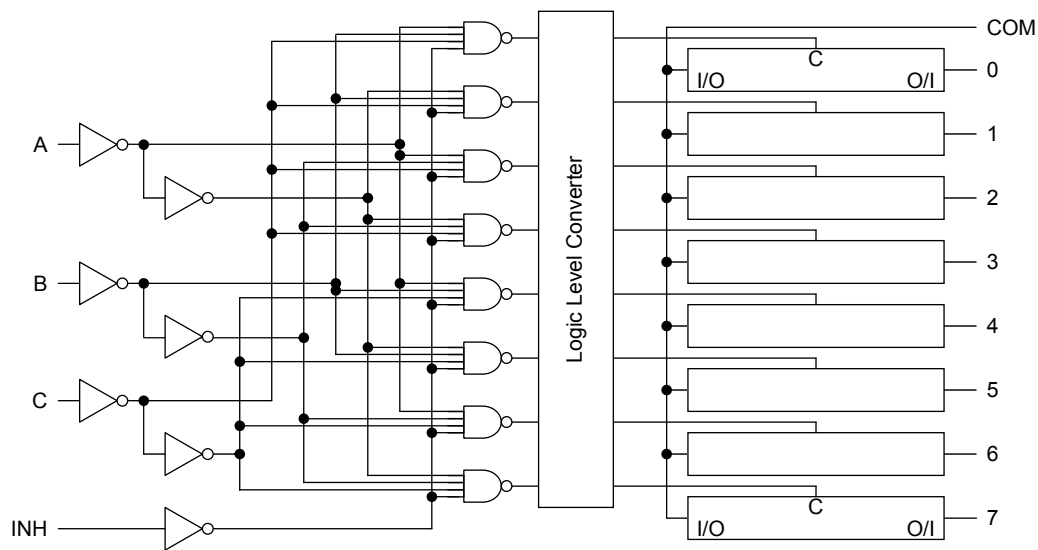
Truth Table

| Control Inputs |    |   |   | “ON” Channel |             |             |
|----------------|----|---|---|--------------|-------------|-------------|
| Inhibit        | C* | B | A | TC74LVX4051  | TC74LVX4052 | TC74LVX4053 |
| 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        |

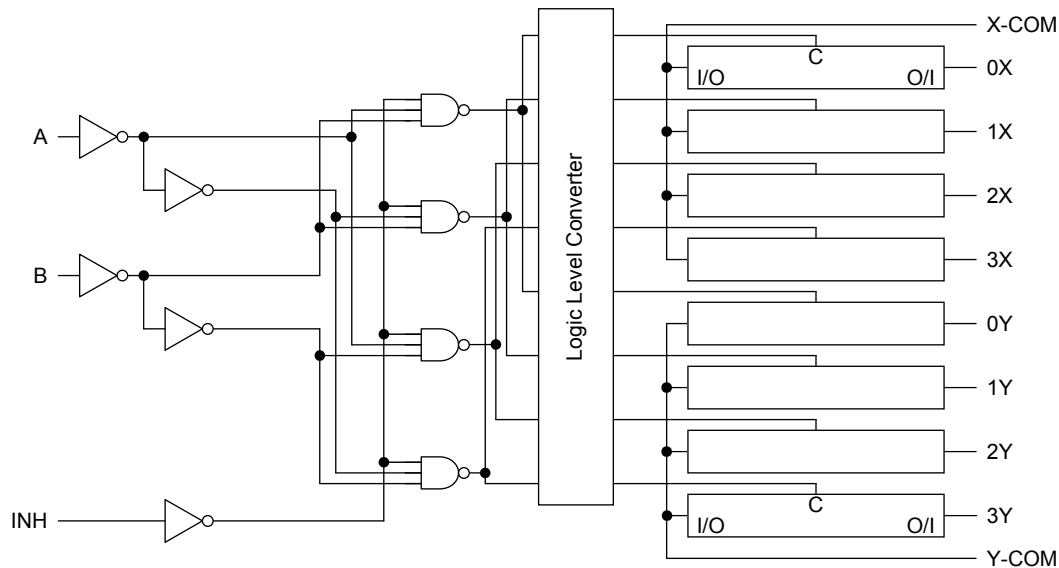
X: Don't care, \*: Except TC74LVX4052

**System Diagram**

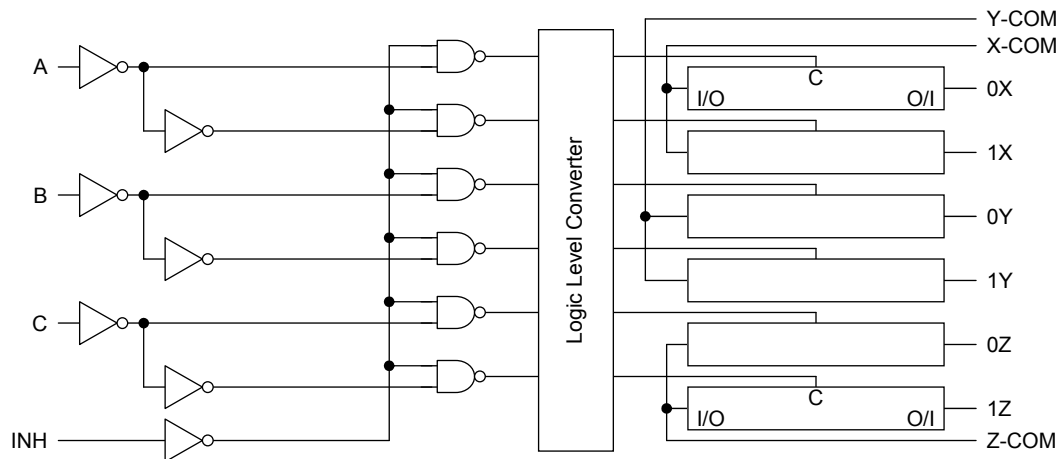
**TC74LVX4051**



**TC74LVX4052**



**TC74LVX4053**



**Absolute Maximum Ratings (Note)**

| Characteristics               | Symbol               | Rating                           | Unit |
|-------------------------------|----------------------|----------------------------------|------|
| Power supply voltage          | $V_{CC}$             | -0.5 to 7.0                      | V    |
|                               | $V_{CC}$ to $V_{EE}$ | -0.5 to 7.0                      |      |
| Control input voltage         | $V_{IN}$             | -0.5 to 7.0                      | V    |
| Switch I/O voltage            | $V_{I/O}$            | $V_{EE} - 0.5$ to $V_{CC} + 0.5$ | V    |
| Input diode current           | $I_{IK}$             | -20                              | mA   |
| I/O diode current             | $I_{IOK}$            | ±20                              | mA   |
| Switch through current        | $I_T$                | ±25                              | mA   |
| DC $V_{CC}$ or ground current | $I_{CC}$             | ±50                              | mA   |
| Power dissipation             | $P_D$                | 180                              | mW   |
| Storage temperature           | $T_{stg}$            | -65 to 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 to 6                               | V    |
|                          | $V_{EE}$             | -4 to 0                              |      |
|                          | $V_{CC}$ to $V_{EE}$ | 2 to 6                               |      |
| Input voltage            | $V_{IN}$             | 0 to 6.0                             | V    |
| Switch I/O voltage       | $V_{I/O}$            | $V_{EE}$ to $V_{CC}$                 | V    |
| Operating temperature    | $T_{opr}$            | -40 to 85                            | °C   |
| Input rise and fall time | $dt/dv$              | 0 to 100 ( $V_{CC} = 3.3 \pm 0.3$ V) | ns/V |
|                          |                      | 0 to 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  $V_{CC}$  or GND.

**Electrical Characteristics**
**DC Electrical Characteristics**

| Characteristics                                       |                  | Symbol                                                                                                                                       | Test Condition |     | Ta = 25°C           |                     |       | Ta = -40 to 85°C |      | Unit |
|-------------------------------------------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----|---------------------|---------------------|-------|------------------|------|------|
|                                                       |                  |                                                                                                                                              |                |     | V <sub>EE</sub> (V) | V <sub>CC</sub> (V) | Min   | Typ.             | Max  |      |
| Input voltage                                         | High-level       | V <sub>IH</sub>                                                                                                                              | —              |     |                     | 2.0                 | 1.5   | —                | —    | V    |
|                                                       |                  |                                                                                                                                              |                |     |                     | 3.0                 | 2.0   | —                | —    |      |
|                                                       |                  |                                                                                                                                              |                |     |                     | 4.5                 | 3.15  | —                | —    |      |
|                                                       |                  |                                                                                                                                              |                |     |                     | 6.0                 | 4.2   | —                | —    |      |
|                                                       | Low-level        | V <sub>IL</sub>                                                                                                                              | —              |     |                     | 2.0                 | —     | —                | 0.5  |      |
|                                                       |                  |                                                                                                                                              |                |     |                     | 3.0                 | —     | —                | 0.8  |      |
|                                                       |                  |                                                                                                                                              |                |     |                     | 4.5                 | —     | —                | 1.35 |      |
|                                                       |                  |                                                                                                                                              |                |     |                     | 6.0                 | —     | —                | 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    |
|                                                       |                  |                                                                                                                                              | GND            | 3.0 | —                   | 45                  | 86    | —                | 108  |      |
|                                                       |                  |                                                                                                                                              | GND            | 4.5 | —                   | 24                  | 37    | —                | 46   |      |
|                                                       |                  |                                                                                                                                              | -3.0           | 3.0 | —                   | 17                  | 26    | —                | 33   |      |
|                                                       |                  | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>I/O</sub> = V <sub>CC</sub> or V <sub>EE</sub><br>I <sub>I/O</sub> = 2 mA     | GND            | 2.0 | —                   | 28                  | 73    | —                | 84   |      |
|                                                       |                  |                                                                                                                                              | GND            | 3.0 | —                   | 22                  | 38    | —                | 44   |      |
|                                                       |                  |                                                                                                                                              | GND            | 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    |
|                                                       |                  |                                                                                                                                              | GND            | 3.0 | —                   | 5                   | 15    | —                | 20   |      |
|                                                       |                  |                                                                                                                                              | GND            | 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 ( $C_L = 50 \text{ pF}$ , Input: $t_r = t_f = 3 \text{ ns}$ , $GND = 0 \text{ V}$ )

| Characteristics                           | Symbol                 | Test Condition     |                     |                     | Ta = 25°C |      |     | Ta = -40 to 85°C |     | Unit |
|-------------------------------------------|------------------------|--------------------|---------------------|---------------------|-----------|------|-----|------------------|-----|------|
|                                           |                        |                    | V <sub>EE</sub> (V) | V <sub>CC</sub> (V) | Min       | Typ. | Max | Min              | Max |      |
| Phase difference between input and output | $\phi_{I/O}$           | 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                        | $t_{pZL}$<br>$t_{pZH}$ | 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                       | $t_{pLZ}$<br>$t_{pHZ}$ | 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               |     |      |
|                                           |                        | 4053               |                     |                     |           |      | 7   | 15               |     |      |
| SWITCH terminal capacitance               | C <sub>OS</sub>        | 4051               | Figure 2 (Note 2)   | -3.0                | 3.0       | —    | 6   | 13               | 13  | pF   |
|                                           |                        | 4052               |                     |                     |           |      | 6   | 13               |     |      |
|                                           |                        | 4053               |                     |                     |           |      | 6   | 13               |     |      |
| Feedthrough capacitance                   | C <sub>IOS</sub>       | 4051               | Figure 2 (Note 2)   | -3.0                | 3.0       | —    | 3   | 6                | 6   | pF   |
|                                           |                        | 4052               |                     |                     |           |      | 3   | 6                |     |      |
|                                           |                        | 4053               |                     |                     |           |      | 3   | 6                |     |      |
| Power dissipation capacitance             | C <sub>PD</sub>        | 4051               | Figure 2 (Note 3)   | GND                 | 6.0       | —    | 14  | —                | —   | pF   |
|                                           |                        | 4052               |                     |                     |           |      | 24  |                  |     |      |
|                                           |                        | 4053               |                     |                     |           |      | 18  |                  |     |      |

Note 1:  $R_L = 1 \text{ k}\Omega$

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.

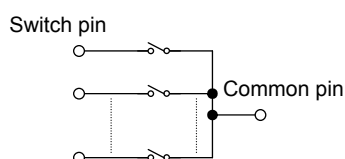
Average operating current can be obtained by the equation:

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

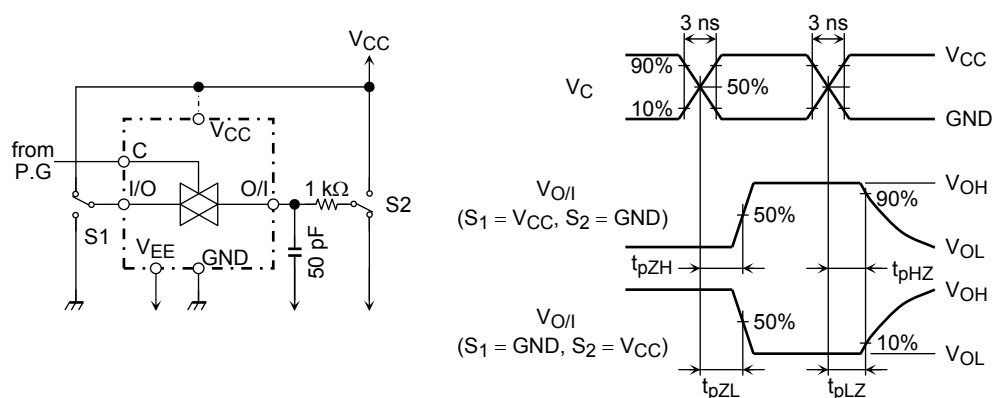
## Analog Switch Characteristics (GND = 0 V, Ta = 25°C) (Note)

| Characteristics                               | Symbol           | Test Condition                                                                                                                                                                                                                          |                                        | V <sub>EE</sub> (V) | V <sub>CC</sub> (V) | Typ.  | Unit |
|-----------------------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|---------------------|---------------------|-------|------|
|                                               |                  |                                                                                                                                                                                                                                         |                                        |                     |                     |       |      |
| Sine Wave Distortion<br>(T.H.D)               | —                | R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 50 pF,<br>f <sub>IN</sub> = 1 kHz                                                                                                                                                              | V <sub>IN</sub> = 2.0 V <sub>p-p</sub> | 0                   | 3.0                 | 0.100 | %    |
|                                               |                  |                                                                                                                                                                                                                                         | V <sub>IN</sub> = 4.0 V <sub>p-p</sub> | 0                   | 4.5                 | 0.030 |      |
|                                               |                  |                                                                                                                                                                                                                                         | V <sub>IN</sub> = 6.0 V <sub>p-p</sub> | -0.3                | 3.0                 | 0.020 |      |
| Frequency response<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>R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF,<br>f <sub>IN</sub> = 1 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<br>(switch OFF)      | —                | V <sub>IN</sub> is centered at (V <sub>CC</sub> - V <sub>EE</sub> )/2.<br>Adjust input for 0dBm.<br>R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF, f <sub>IN</sub> = 1 MHz, sine wave<br>Figure 4                                      |                                        | 0                   | 3.0                 | -45   | dB   |
|                                               |                  |                                                                                                                                                                                                                                         |                                        | 0                   | 4.5                 | -45   |      |
|                                               |                  |                                                                                                                                                                                                                                         |                                        | -3.0                | 3.0                 | -45   |      |
|                                               |                  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF, f <sub>IN</sub> = 1 MHz, sine wave                                                                                                                                                       |                                        | 0                   | 3.0                 | -60   |      |
|                                               |                  |                                                                                                                                                                                                                                         |                                        | 0                   | 4.5                 | -60   |      |
|                                               |                  |                                                                                                                                                                                                                                         |                                        | -3.0                | 3.0                 | -60   |      |
| Crosstalk<br>(control input to signal output) | —                | R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF, f <sub>IN</sub> = 1 MHz, square wave<br>(t <sub>r</sub> = t <sub>f</sub> = 6 ns)<br>Figure 5                                                                                            |                                        | 0                   | 3.0                 | 90    | mV   |
|                                               |                  |                                                                                                                                                                                                                                         |                                        | 0                   | 4.5                 | 150   |      |
|                                               |                  |                                                                                                                                                                                                                                         |                                        | -3.0                | 3.0                 | 120   |      |
| Crosstalk<br>(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, f <sub>IN</sub> = 1 MHz, sine wave<br>Figure 6                                                                                       |                                        | 0                   | 3.0                 | -45   | dB   |
|                                               |                  |                                                                                                                                                                                                                                         |                                        | 0                   | 4.5                 | -45   |      |
|                                               |                  |                                                                                                                                                                                                                                         |                                        | -3.0                | 3.0                 | -45   |      |

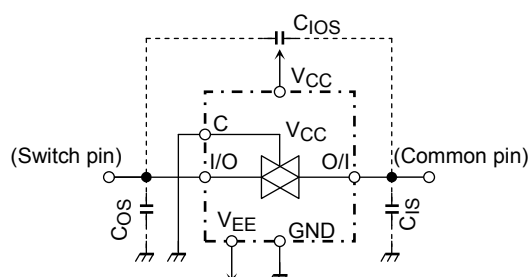
Note: These characteristics are determined by design of devices.



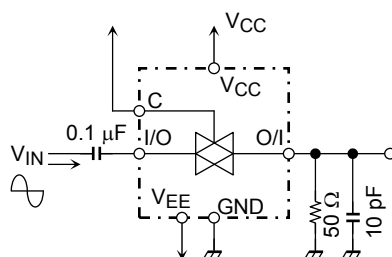
## AC Test Circuit



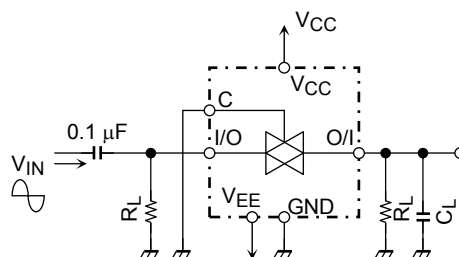
**Figure 1** t<sub>pLZ</sub>, t<sub>pHZ</sub>, t<sub>pZL</sub>, t<sub>pZH</sub>



**Figure 2** C<sub>10S</sub>, C<sub>1S</sub>, C<sub>0S</sub>

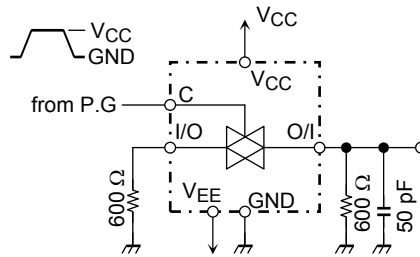


**Figure 3** Frequency Response (switch on)

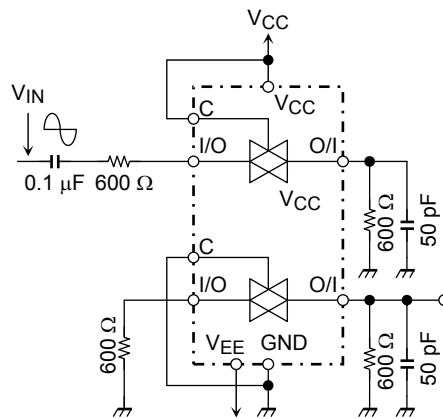


**Figure 4** Feedthrough





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

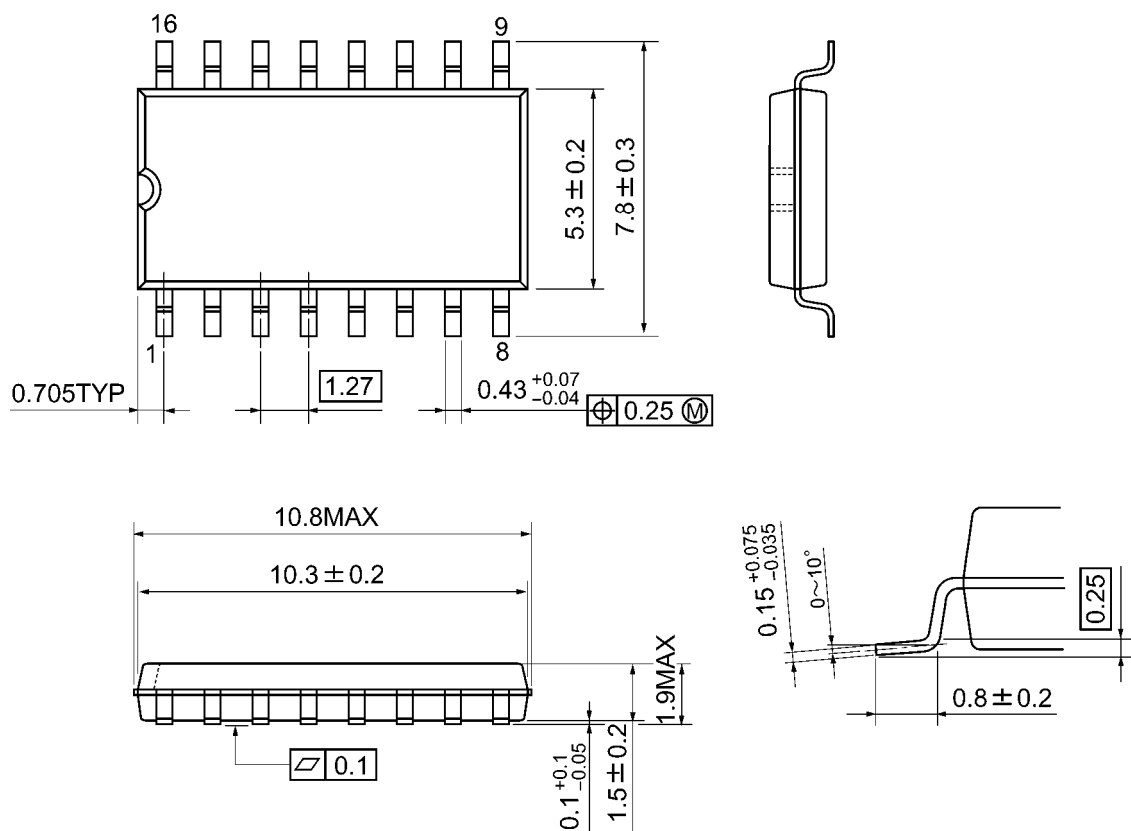


**Figure 6 Cross Talk (between any two switches)**

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm

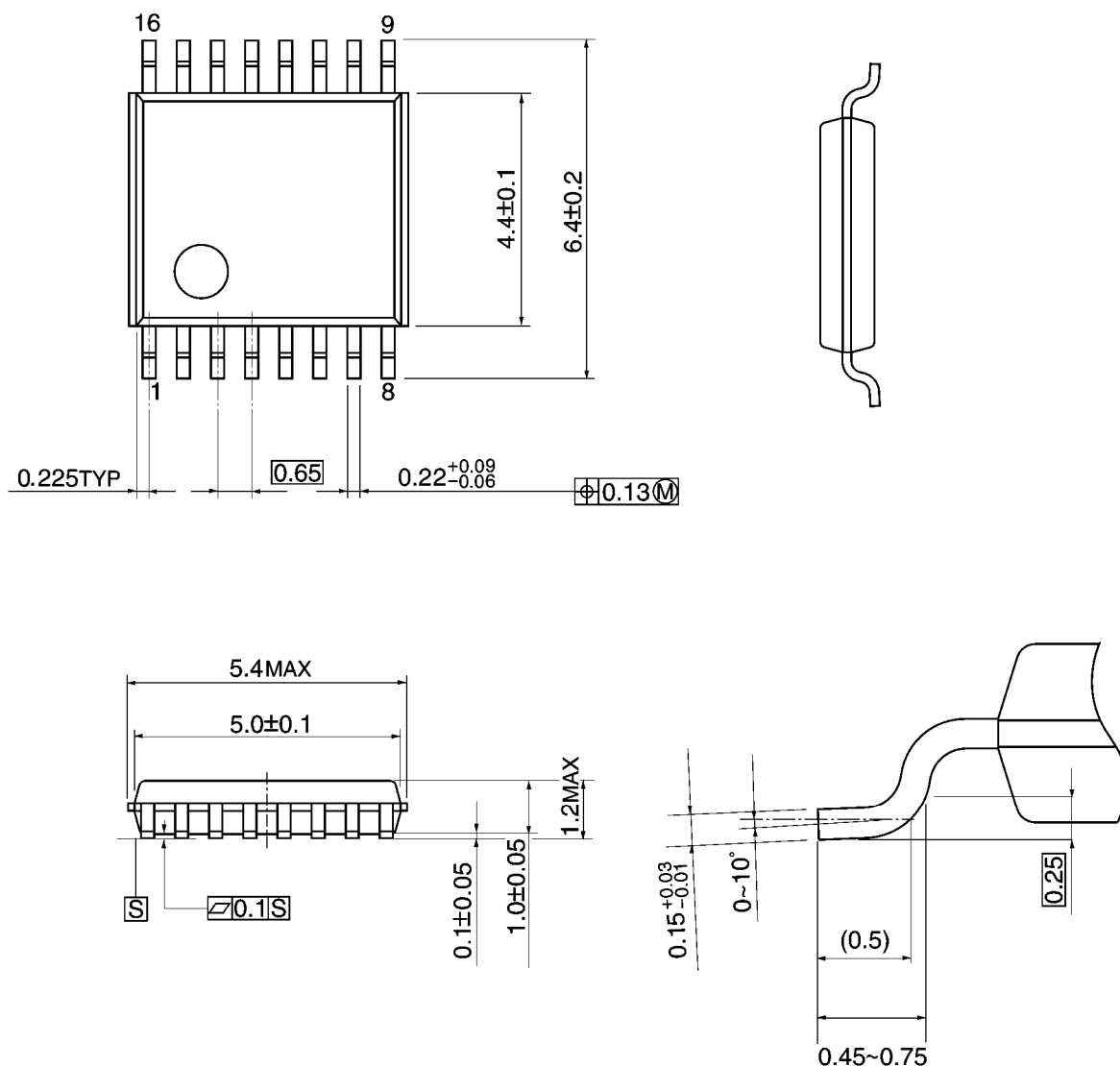


Weight: 0.18 g (typ.)

## Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm

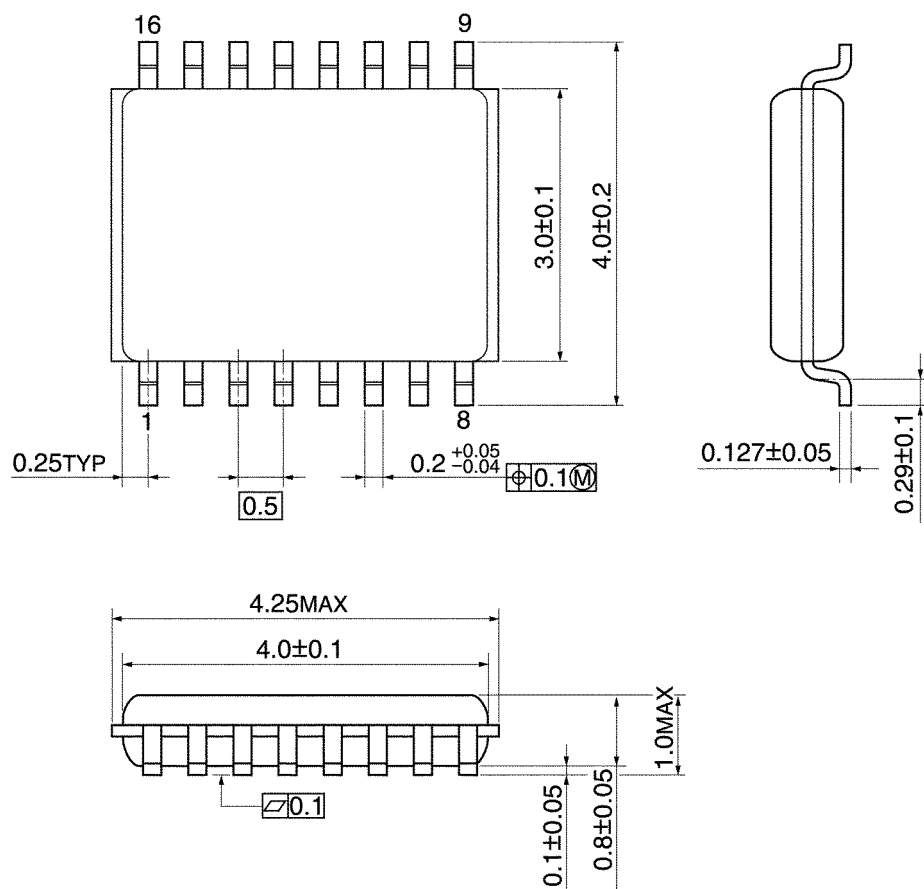


Weight: 0.06 g (typ.)

## Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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