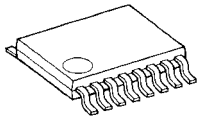
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74LVX4051FT, TC74LVX4052FT, TC74LVX4053FT

TC74LVX4051FT 8-Channel Analog Multiplexer/Demultiplexer

TC74LVX4052FT Dual 4-Channel Analog Multiplexer/Demultiplexer

TC74LVX4053FT Triple 2-Channel Analog Multiplexer/Demultiplexer



TSSOP16-P-0044-0.65

Weight: 0.06 g (typ.)

The TC74LVX4051/4052/4053FT 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 TC74LVX4051/4052/4053FT 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 V, GND = 0 V, and $V_{EE}$ = –3 V, signals between –3 V and +3 V can be switched from the logical circuit using a single 3 V power supply.

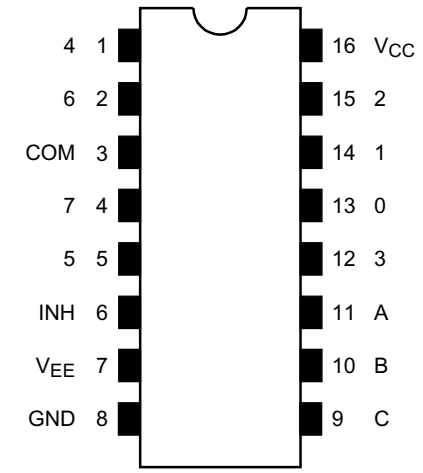
All input pins are equipped with a newly developed input protection circuit that avoids the need for a diode on the plus side (forward side from the input to the $V_{CC}$). As a result, for example, 5 V signals can be permitted on the inputs even when the power supply voltage to the circuits is off.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

## Features

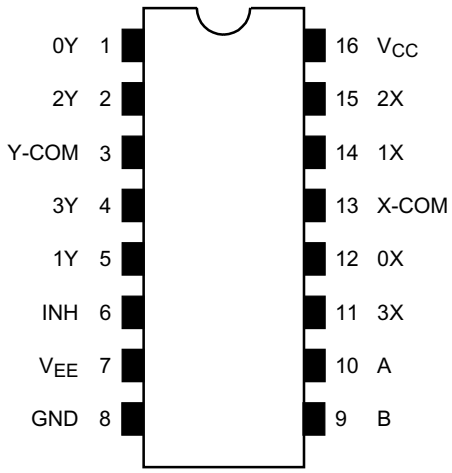
- Low ON resistance: $R_{on}$ = 22 Ω (typ.) ($V_{CC}$ – $V_{EE}$ = 3 V)
  $R_{on}$ = 15 Ω (typ.) ($V_{CC}$ – $V_{EE}$ = 6 V)
- High speed: tpd = 3 ns (typ.) ($V_{CC}$ = 3.0 V)
- Low power dissipation: $I_{CC}$ = 4 μA (max) (Ta = 25°C)
- Input level: $V_{IL}$ = 0.8 V (max) ($V_{CC}$ = 3 V)
  $V_{IH}$ = 2.0 V (min) ($V_{CC}$ = 3 V)
- Power down protection is provided on all control inputs
- Pin and function compatible with 74HC4051/4052/4053

## Pin Assignment (top view)

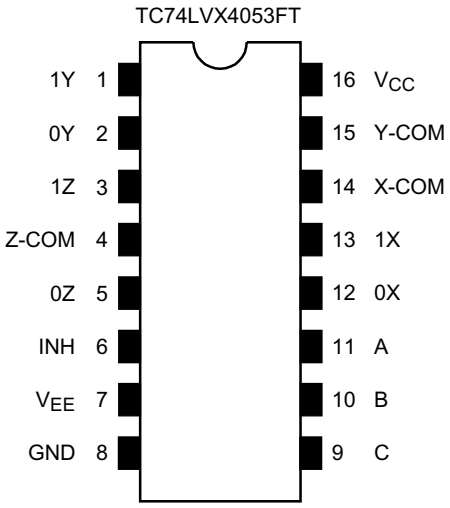
TC74LVX4051FT




TC74LVX4052FT




TC74LVX4053FT



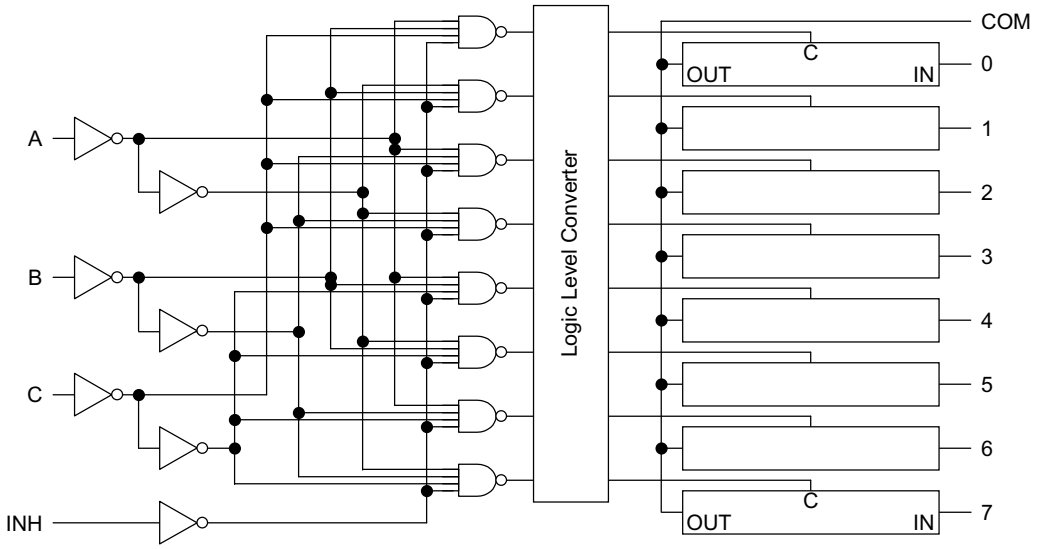

## Truth Table

| Control Inputs | | | | "ON" Channel | | |
|---|---|---|---|---|---|---|
| Inhibit | C* | B | A | LVX4051FT | LVX4052FT | LVX4053FT |
| 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 |

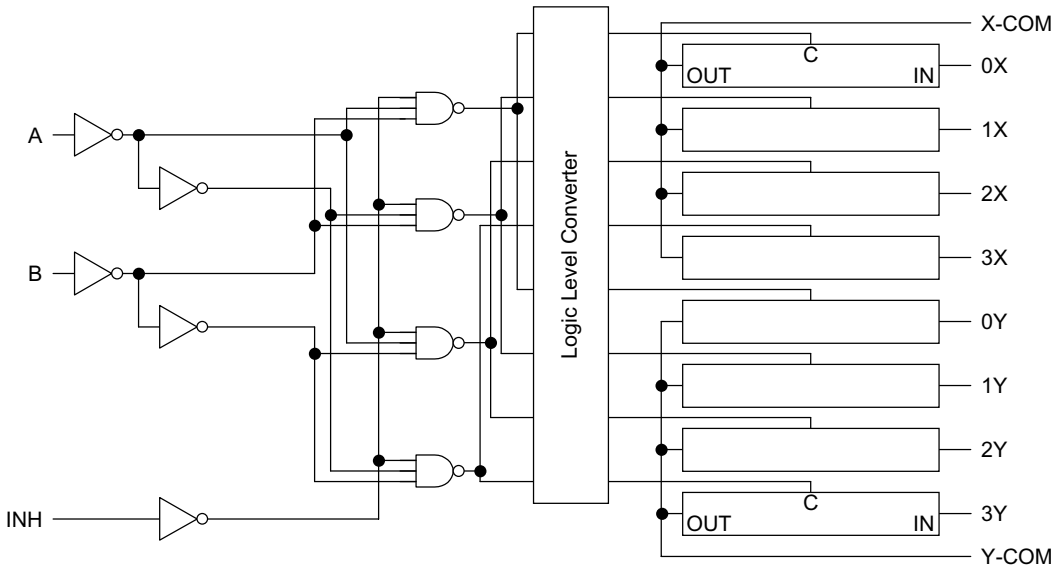
X: Don't care, *: Except LVX4052FT

## System Diagram

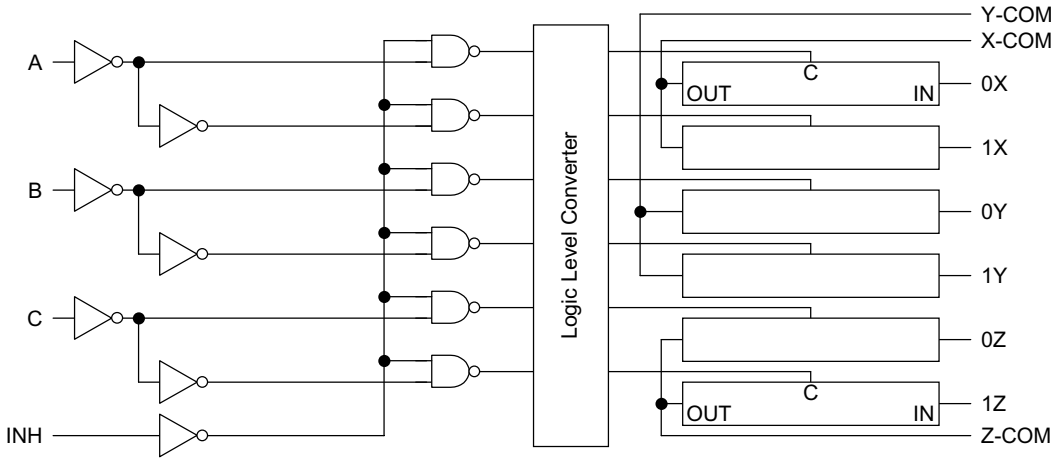
### TC74LVX4051FT




### TC74LVX4052FT




### TC74LVX4053FT



## Absolute Maximum Ratings

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power supply voltage | $V_{CC}$ | −0.5~7.0 | V |
| | $V_{CC}$~$V_{EE}$ | −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~$V_{CC}$ + 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 | $T_{stg}$ | −65~150 | °C |

## Recommended Operating Conditions

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

## Electrical Characteristics

## DC Electrical Characteristics

| Characteristics | | Symbol | Test Condition | | | Ta = 25°C | | | Ta = −40~85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{EE}$ (V) | $V_{CC}$ (V) | Min | Typ. | Max | Min | Max | |
| Input voltage | High-level | $V_{IH}$ | — | | 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 | $V_{IL}$ | — | | 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 | | $R_{ON}$ | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$V_{I/O}$ = $V_{CC}$ to $V_{EE}$<br>$I_{I/O}$ = 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 | |
| | | | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$V_{I/O}$ = $V_{CC}$ or $V_{EE}$<br>$I_{I/O}$ = 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 | | $\Delta R_{ON}$ | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$V_{I/O}$ = $V_{CC}$ to $V_{EE}$<br>$I_{I/O}$ = 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) | | $I_{OFF}$ | $V_{OS}$ = $V_{CC}$ or GND<br>$V_{IS}$ = GND to $V_{CC}$<br>$V_{IN}$ = $V_{IL}$ or $V_{IH}$ | GND | 3.0 | — | — | ±0.25 | — | ±2.5 | μA |
| | | | | −3.0 | 3.0 | — | — | ±0.5 | — | ±5.0 | |
| Input/Output leakage current (switch ON, output open) | | $I_{IN}$ | $V_{OS}$ = $V_{CC}$ or GND<br>$V_{IN}$ = $V_{IL}$ or $V_{IH}$ | GND | 3.0 | — | — | ±0.25 | — | ±2.5 | μA |
| | | | | −3.0 | 3.0 | — | — | ±0.5 | — | ±5.0 | |
| Control input current | | $I_{IN}$ | $V_{IN}$ = $V_{CC}$ or GND | GND | 6.0 | — | — | ±0.1 | — | ±0.1 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | GND | 3.0 | — | — | 4.0 | — | 40.0 | μA |
| | | | | −3.0 | 3.0 | — | — | 8.0 | — | 80.0 | |

## AC Electrical Characteristics ($C_L$ = 50 pF, Input: $t_r = t_f$ = 3 ns, GND = 0 V)

| Characteristics | Symbol | Test Condition | | | | Ta = 25°C | | | Ta = −40~85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{EE}$ (V) | $V_{CC}$ (V) | Min | Typ. | Max | Min | Max | |
| Phase difference between input and output | ϕI/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 | $t_{pZL}$ $t_{pZH}$ | 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 | $t_{pLZ}$ $t_{pHZ}$ | 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 | $C_{in}$ | All types (Note 2) | | — | — | — | 5 | 10 | — | 10 | pF |
| COMMON terminal capacitance | $C_{IS}$ | 4051 | Figure 2 (Note 2) | −3.0 | 3.0 | — | 11 | 25 | — | 25 | pF |
| | | 4052 | | | | | 9 | 20 | | 20 | |
| | | 4053 | | | | | 7 | 15 | | 15 | |
| SWITCH terminal capacitance | $C_{OS}$ | 4051 | Figure 2 (Note 2) | −3.0 | 3.0 | — | 6 | 13 | — | 13 | pF |
| | | 4052 | | | | | 6 | 13 | | 13 | |
| | | 4053 | | | | | 6 | 13 | | 13 | |
| Feedthrough capacitance | $C_{IOS}$ | 4051 | Figure 2 (Note 2) | −3.0 | 3.0 | — | 3 | 6 | — | 6 | pF |
| | | 4052 | | | | | 3 | 6 | | 6 | |
| | | 4053 | | | | | 3 | 6 | | 6 | |
| Power dissipation capacitance | $C_{PD}$ | 4051 | Figure 2 (Note 3) | GND | 6.0 | — | 14 | — | — | — | pF |
| | | 4052 | | | | | 24 | | | | |
| | | 4053 | | | | | 18 | | | | |

Note1: $R_L$ = 1 kΩ

Note2: $C_{in}$, $C_{IS}$, $C_{OS}$ and $C_{IOS}$ are guaranteed by the design.

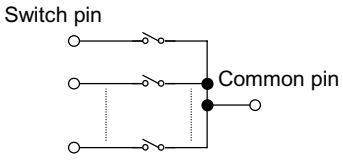
Note3: $C_{PD}$ is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.
Average operating current can be obtained by the equation:

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

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

| Characteristics | Symbol | Test Condition | | $V_{EE}$ (V) | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|---|---|
| Sine Wave Distortion (T.H.D) | | $R_L$ = 10 kΩ, $C_L$ = 50 pF, $f_{IN}$ = 1 kHz | $V_{IN}$ = 2.0 $V_{p-p}$ | 0 | 3.0 | 0.100 | % |
| | | | $V_{IN}$ = 4.0 $V_{p-p}$ | 0 | 4.5 | 0.030 | |
| | | | $V_{IN}$ = 6.0 $V_{p-p}$ | −0.3 | 3.0 | 0.020 | |
| Frequency response (switch ON) | $f_{max}$ | Adjust $f_{IN}$ voltage to obtain 0dBm at $V_{OS}$. Increase $f_{IN}$ frequency until dB meter reads −3dB. $R_L$ = 50 Ω, $C_L$ = 10 pF, $f_{IN}$ = 1 MHz, sine wave 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. Adjust input for 0dBm. $R_L$ = 600 Ω, $C_L$ = 50 pF, $f_{IN}$ = 1 MHz, sine wave Figure 4 | | 0 | 3.0 | −45 | dB |
| | | | | 0 | 4.5 | −45 | |
| | | | | −3.0 | 3.0 | −45 | |
| | | $R_L$ = 50 Ω, $C_L$ = 10 pF, $f_{IN}$ = 1 MHz, sine wave | | 0 | 3.0 | −60 | |
| | | | | 0 | 4.5 | −60 | |
| | | | | −3.0 | 3.0 | −60 | |
| Crosstalk (control input to signal output) | | $R_L$ = 600 Ω, $C_L$ = 50 pF, $f_{IN}$ = 1 MHz, square wave ($t_r$ = $t_f$ = 6 ns) 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. $R_L$ = 600 Ω, $C_L$ = 50 pF, $f_{IN}$ = 1 MHz, sine wave Figure 6 | | 0 | 3.0 | −45 | dB |
| | | | | 0 | 4.5 | −45 | |
| | | | | −3.0 | 3.0 | −45 | |

*: These characteristics are determined by design of devices.



**AC Test Circuit**

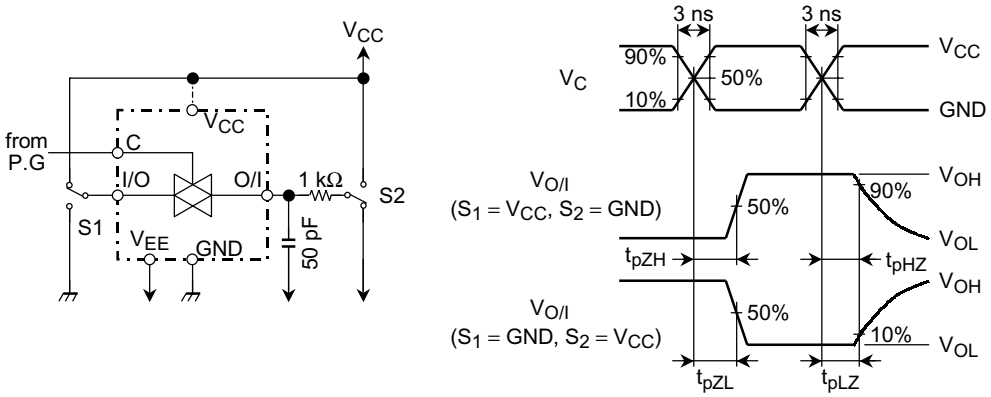



**Figure 1 $t_{pLZ}$, $t_{pHZ}$, $t_{pZL}$, $t_{pZH}$**

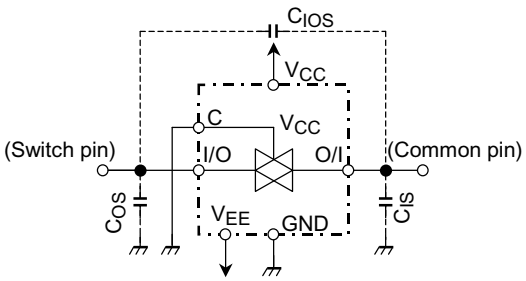



**Figure 2 $C_{IOS}$, $C_{IS}$, $C_{OS}$**

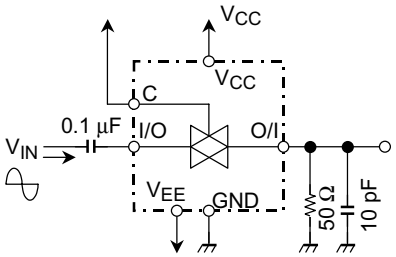



**Figure 3 Frequency Response (switch on)**

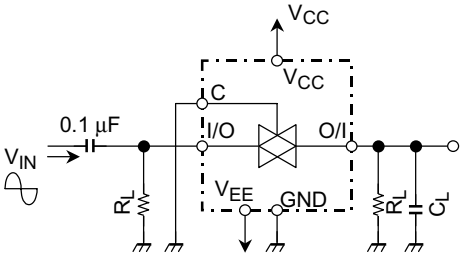



**Figure 4 Feedthrough**

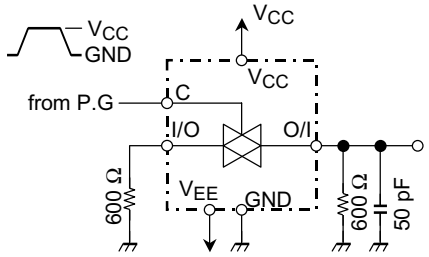



**Figure 5 Cross Talk (control input to output signal)**

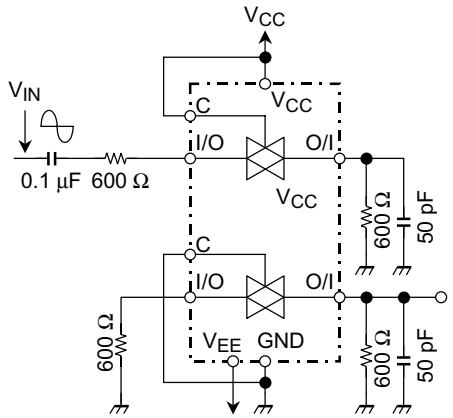
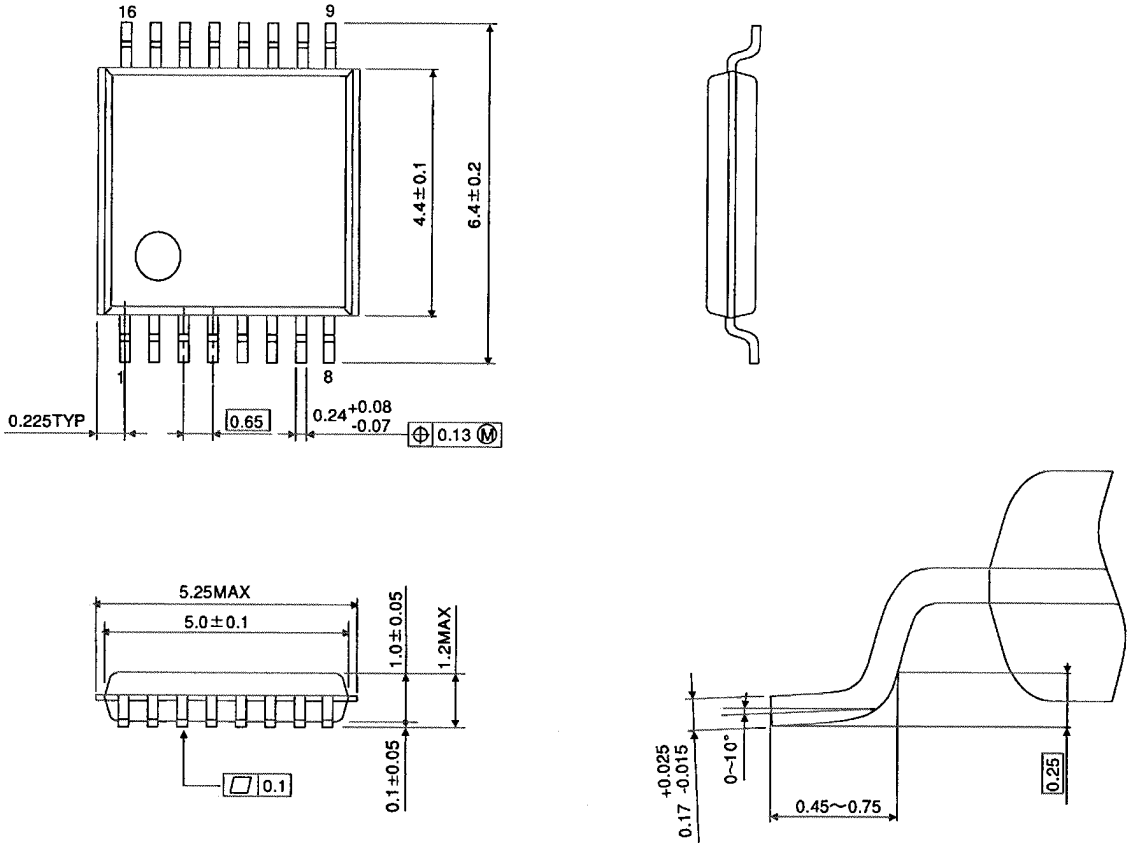



**Figure 6 Cross Talk (between any two switches)**

## Package Dimensions

TSSOP16-P-0044-0.65 Unit : mm




Weight: 0.06 g (typ.)