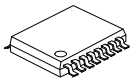
# U74LVX4053

**CMOS IC**

## Triple 2-Channel Analog Multiplexer/Demultiplexer



TSSOP-16

### ■ DESCRIPTION

The **U74LVX4053** is a high speed, low-voltage drive analog multiplexer/demultiplexer using silicon gate CMOS technology. In 3V and 5V systems these can achieve high-speed operation with the low power dissipation that is a feature of CMOS.

The **U74LVX4053** offer analog/digital signal selection as well as mixed signals wish a 4-Channel×2 configuration.

The switchses 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 $V_{CC}$=3V, GND=0V and $V_{EE}$=-3V, signals between -3V and +3V can be switched from the logical circuit using a signal 3V 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 (forword side from the input to the $V_{CC}$). As a result, for example, 5V 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 **U74LVX4053** can be used in a variety of applications, including in the system which has two power supplies, and in battery bachup circuits.

### ■ FEATURES

* Low ON resistance: $R_{ON}$=22Ω(Typ.)($V_{CC}$-$V_{EE}$=3V)
* $R_{ON}$=15Ω(Typ.)($V_{CC}$-$V_{EE}$=6V)
* High Speed: $t_{pd}$=3ns (Typ.)($V_{CC}$=3V)
* Low power Dissipation: $I_{CC}$=4μA (Max.)($T_A$=25°C)
* Input level: $V_{IL}$=0.8V(Max.)($V_{CC}$=3V)
  $V_{IH}$=2.0V(Min.)($V_{CC}$=3V)
* Power down protection is provided on all control inputs
* Pin and function compatible with U74HC4053

### ■ ORDERING INFORMATION

| Ordering Number | | Package | Packing |
|---|---|---|---|
| Lead Free | Halogen Free | | |
| U74LVX4053G-P16-R | U74LVX4053G-P16-R | TSSOP-16 | Tape Reel |

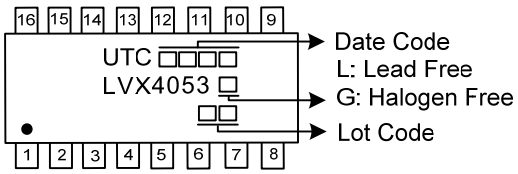
U74LVX4053G-P16-R

(1)Packing Type — (1) R: Tape Reel

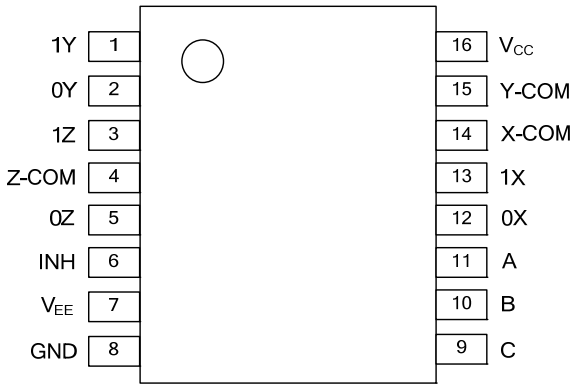
(2)Package Type — (2) P16: TSSOP-16

(3)Green Package — (3) G: Halogen Free and Lead Free, L: Lead Free

## ■ MARKING




## ■ PIN CONFIGURATION

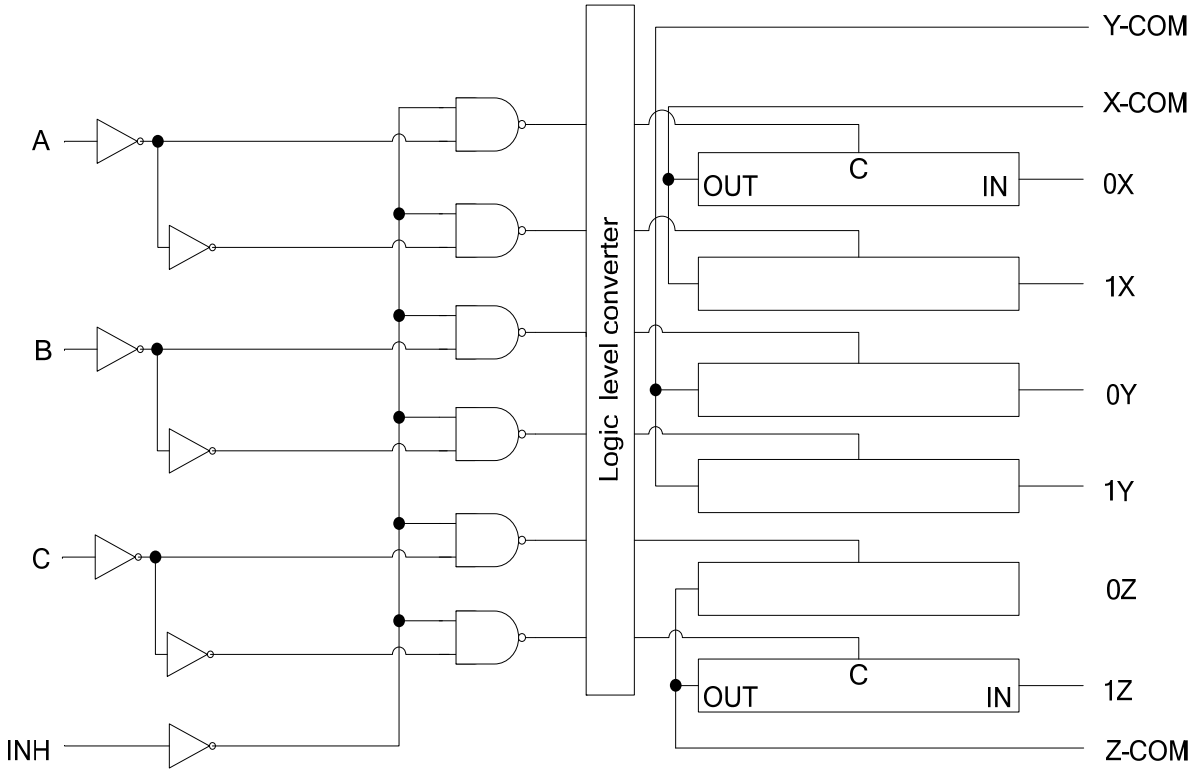



## ■ FUNCTION TABLE

| CONTROL INPUTS | | | | "ON" Channel |
|---|---|---|---|---|
| INH | C | B | A | LVX4053 |
| L | L | L | L | 0X,0Y,0Z |
| L | L | L | H | 1X,0Y,0Z |
| L | L | H | L | 0X,1Y,0Z |
| L | L | H | H | 1X,1Y,0Z |
| L | H | L | L | 0X,0Y,1Z |
| L | H | L | H | 1X,0Y,1Z |
| L | H | H | L | 0X,1Y,1Z |
| L | H | H | H | 1X,1Y,1Z |
| H | X | X | X | None |

Note: H: HIGH voltage level; L: LOW voltage level; X: Don't care

■ LOGIC DIAGRAM (positive logic)



## ■ ABSOLUTE MAXIMUM RATING

| PARAMETER | SYMBOL | RATINGS | 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 Vcc or ground current | $I_{CC}$ | ±50 | mA |
| Power dissipation | $P_D$ | 450 | mW |
| Operating Temperature | $T_{OPR}$ | -40 ~ +85 | °C |
| Storage Temperature | $T_{STG}$ | -65 ~ +150 | °C |

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

## ■ RECOMMENDED OPERATING CONDITIONS

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Power Supply Voltage | $V_{CC}$ | | 2.0 | | 6.0 | V |
| | $V_{EE}$ | | -4.0 | | 0 | |
| | $V_{CC}$~$V_{EE}$ | | 2.0 | | 6.0 | |
| Input Voltage | $V_{IN}$ | | 0 | | 6.0 | V |
| Switch I/O Voltage | $V_{I/O}$ | | $V_{EE}$ | | $V_{CC}$ | V |
| Input Rise and Fall time | dt/dv | $V_{CC}$=3.3V±0.3 | 0 | | 100 | ns/V |
| | | $V_{CC}$=5V±0.5 | 0 | | 20 | |

■ DC ELECTRICAL CHARACTERISTICS ($T_A$=25°C, unless otherwise specified)

| PARAMETER | | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| Input voltage | High-level | $V_{IH}$ | $V_{CC}$=2V | | 1.5 | | | V |
| | | | $V_{CC}$=3V | | 2.0 | | | |
| | | | $V_{CC}$=4.5V | | 3.15 | | | |
| | | | $V_{CC}$=6V | | 4.2 | | | |
| | Low-level | $V_{IL}$ | $V_{CC}$=2V | | | | 0.5 | |
| | | | $V_{CC}$=3V | | | | 0.8 | |
| | | | $V_{CC}$=4.5V | | | | 1.35 | |
| | | | $V_{CC}$=6V | | | | 1.8 | |
| ON resistance | | $R_{ON}$ | $V_{IN}$=$V_{IL}$ or $V_{IH}$<br>$V_{I/O}$=$V_{CC}$ to $V_{EE}$<br>$I_{I/O}$=2mA | $V_{CC}$=2V, $V_{EE}$=GND | | 200 | | Ω |
| | | | | $V_{CC}$=3V, $V_{EE}$=GND | | 45 | 86 | |
| | | | | $V_{CC}$=4.5V, $V_{EE}$=GND | | 24 | 37 | |
| | | | | $V_{CC}$=3V, $V_{EE}$= -3V | | 17 | 26 | |
| | | | $V_{IN}$=$V_{IL}$ or $V_{IH}$<br>$V_{I/O}$=$V_{CC}$ or $V_{EE}$<br>$I_{I/O}$=2mA | $V_{CC}$=2V, $V_{EE}$=GND | | 28 | 73 | |
| | | | | $V_{CC}$=3V, $V_{EE}$=GND | | 22 | 38 | |
| | | | | $V_{CC}$=4.5V, $V_{EE}$=GND | | 17 | 27 | |
| | | | | $V_{CC}$=3V, $V_{EE}$= -3V | | 15 | 24 | |
| 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>$I_{I/O}$=2mA | $V_{CC}$=2V, $V_{EE}$=GND | | 10 | 25 | Ω |
| | | | | $V_{CC}$=3V, $V_{EE}$=GND | | 5 | 15 | |
| | | | | $V_{CC}$=4.5V, $V_{EE}$=GND | | 5 | 13 | |
| | | | | $V_{CC}$=3V, $V_{EE}$= -3V | | 5 | 10 | |
| Input/Output Leakage Current(switch off) | | $I_{OFF}$ | $V_{OS}$=$V_{CC}$ or GND,<br>$V_{IS}$ =GND or $V_{CC}$,<br>$V_{IN}$=$V_{IH}$ OR $V_{IL}$ | $V_{CC}$=3V, $V_{EE}$= GND | | | ±0.25 | μA |
| | | | | $V_{CC}$=3V, $V_{EE}$= -3V | | | ±0.5 | |
| Quiescent Supply Current | | $I_{CC}$ | $V_{IN}$= $V_{CC}$ or GND | $V_{CC}$=3V, $V_{EE}$= GND | | | 4.0 | μA |
| | | | | $V_{CC}$=3V, $V_{EE}$= -3V | | | 8.0 | μA |
| Input/Output leakage current(switch on,output open) | | $I_{IN}$ | $V_{OS}$=$V_{CC}$ or GND,<br>$V_{IN}$=$V_{IH}$ or $V_{IL}$ | $V_{CC}$=3V, $V_{EE}$= GND | | | ±0.25 | μA |
| | | | | $V_{CC}$=3V, $V_{EE}$= -3V | | | ±0.5 | |
| Control input current | | $I_{IN}$ | $V_{IN}$= $V_{CC}$ or GND | $V_{CC}$=6V, $V_{EE}$=GND | | | ±0.1 | μA |

## ■ AC ELECTRICAL CHARACTERISTICS ($T_A$=25°C, Input $t_R/t_F$ =3ns, GND=0V, $C_L$=50pF)

See Fig. 1, Fig. 2 and Fig. 3 for test circuit and waveforms.

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Phase difference between input and output | $t_{PLH}/t_{PHL}$ | $V_{CC}$=2V, $V_{EE}$=GND | | 3.2 | 6.0 | ns |
| | | $V_{CC}$=3V, $V_{EE}$=GND | | 1.8 | 3.0 | |
| | | $V_{CC}$=4.5V, $V_{EE}$=GND | | 1.3 | 1.8 | |
| | | $V_{CC}$=3V, $V_{EE}$=-3V | | 1.1 | 1.3 | |
| Output enable time (Note 1) | $t_{PZL}/t_{PZH}$ | $V_{CC}$=2V, $V_{EE}$=GND | | 9 | 17 | ns |
| | | $V_{CC}$=3V, $V_{EE}$=GND | | 5.7 | 9 | |
| | | $V_{CC}$=4.5V, $V_{EE}$=GND | | 4.5 | 6 | |
| | | $V_{CC}$=3V, $V_{EE}$=-3V | | 5.8 | 8 | |
| Output disable time (Note 1) | $t_{PLZ}/t_{PHZ}$ | $V_{CC}$=2V, $V_{EE}$=GND | | 13.5 | 21 | ns |
| | | $V_{CC}$=3V, $V_{EE}$=GND | | 11.3 | 15 | |
| | | $V_{CC}$=4.5V, $V_{EE}$=GND | | 10.3 | 12 | |
| | | $V_{CC}$=3V, $V_{EE}$=-3V | | 10.9 | 13 | |
| Control input capacitance (Note 2) | $C_{IN}$ | | | 5 | 10 | pF |
| COMMON terminal capacitance (Note 2) | $C_{IS}$ | $V_{CC}$=3V, $V_{EE}$=-3V | | 7 | 15 | pF |
| SWITCH terminal capacitance (Note 2) | $C_{OS}$ | $V_{CC}$=3V, $V_{EE}$=-3V | | 6 | 13 | pF |
| Feedthrough capacitance (Note 2) | $C_{IOS}$ | $V_{CC}$=3V, $V_{EE}$=-3V | | 3 | 6 | pF |
| Power dissipation capacitance (Note 3) | $C_{PD}$ | $V_{CC}$=6V, $V_{EE}$=GND | | 18 | | pF |

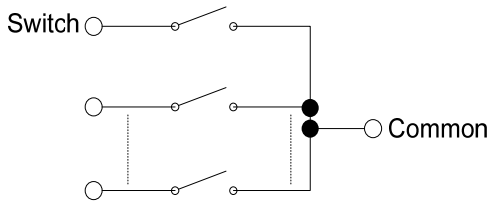
Note: 1. $R_L$=1k

2. $C_{IN}$, $C_{IS}$, $C_{OS}$ and $C_{IOS}$ are guaranteed by the design.
3. CPD 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.
   $I_{CC}(OPR)=C_{PD}\times V_{CC}\times f_{IN}+V_{CC}$

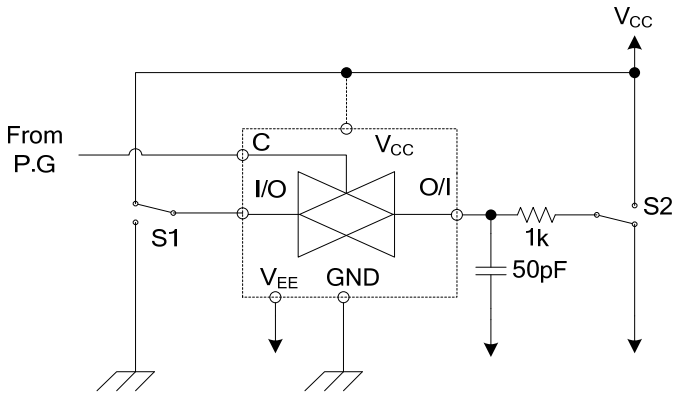
■ Analog Switch CHARACTERISTICS (GND=0V,$T_A$=25°C) (Note)

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Sine Wave Distortion | THD | $R_L$=10k, $C_L$=50pF, $f_{IN}$=1k | $V_{IN}$=2Vp-p, $V_{CC}$=3V, $V_{EE}$=0V | | 0.1 | | % |
| | | | $V_{IN}$=4Vp-p, $V_{CC}$=4.5V, $V_{EE}$=0V | | 0.03 | | |
| | | | $V_{IN}$=6Vp-p, $V_{CC}$=3V, $V_{EE}$=-0.3V | | 0.02 | | |
| Frequency response (switch on) | $f_{MAX}$ | Adjust fIN voltage to obtain 0dBm at $V_{OS}$. Increase fin frequency until dB meter reads -3dB. $R_L$=50Ω,$C_L$=10pF, $f_{IN}$=1MHz, sine wave (Figure 4) | $V_{CC}$=3V, $V_{EE}$=0V | | 200 | | MHz |
| | | | $V_{CC}$=4.5V, $V_{EE}$=0V | | 200 | | |
| | | | $V_{CC}$=3V, $V_{EE}$=-3V | | 200 | | |
| Feed through attenuation (switch off) | | $V_{IN}$ is centered at ($V_{CC}$-$V_{EE}$)/2. Adjust input for 0dBm. $R_L$=600Ω,$C_L$=50pF,$f_{IN}$=1MHz, sine wave (Figure 5) | $V_{CC}$=3V, $V_{EE}$=0V | | -45 | | dB |
| | | | $V_{CC}$=4.5V, $V_{EE}$=0V | | -45 | | |
| | | | $V_{CC}$=3V, $V_{EE}$=-3V | | -45 | | |
| | | $R_L$=50Ω,$C_L$=10pF,$f_{IN}$=1MHz, sine wave | $V_{CC}$=3V, $V_{EE}$=0V | | -60 | | |
| | | | $V_{CC}$=4.5V, $V_{EE}$=0V | | -60 | | |
| | | | $V_{CC}$=3V, $V_{EE}$=-3V | | -60 | | |
| Crosstalk (control input to signal output) | | $R_L$=600Ω,$C_L$=50pF,$f_{IN}$=1MHz, square wave($t_r$=$t_f$=6ns) (Figure 6) | $V_{CC}$=3V, $V_{EE}$=0V | | 90 | | mV |
| | | | $V_{CC}$=4.5V, $V_{EE}$=0V | | 150 | | |
| | | | $V_{CC}$=3V, $V_{EE}$=-3V | | 120 | | |
| Crosstalk (between any switches) | | Adjust $V_{IN}$ to obtain 0dBm at input. $R_L$=600Ω,$C_L$=50pF,$f_{IN}$=1MHz, sine wave (Figure 7) | $V_{CC}$=3V, $V_{EE}$=0V | | -45 | | dB |
| | | | $V_{CC}$=4.5V, $V_{EE}$=0V | | -45 | | |
| | | | $V_{CC}$=3V, $V_{EE}$=-3V | | -45 | | |

Note: These characteristics are determined by design of devices.



## TEST CIRCUIT AND WAVEFORMS




| TEST | S1 | S2 |
|---|---|---|
| $t_{PLH}/t_{PHL}$ | pulse | Open |
| $t_{PHZ}/t_{PZH}$ | $V_{CC}$ | GND |
| $t_{PLZ}/t_{PZL}$ | GND | $V_{CC}$ |

**Fig. 1 Load circuitry for switching times.**

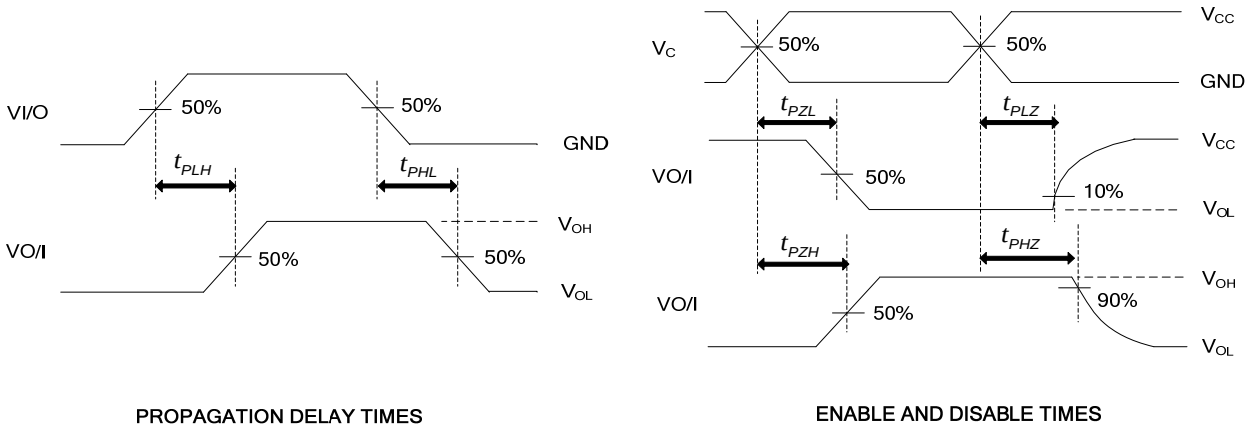



**Fig. 2 Propagation delay from input to output and enable, disable times.**

## ■ AC TEST CIRCUIT

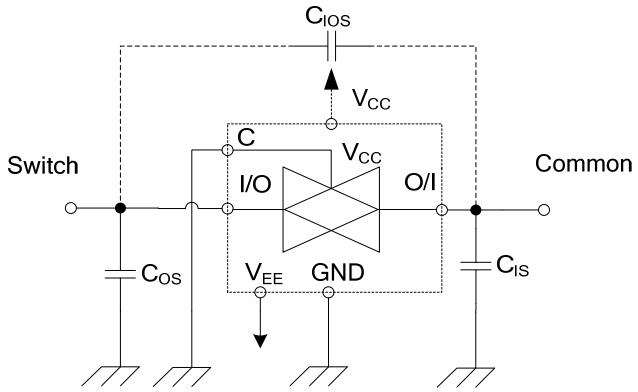



**Fig. 3 $C_{IOS}$, $C_{IS}$, $C_{OS}$**

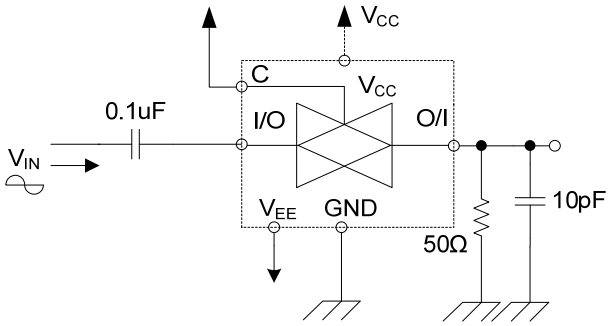



**Fig. 4 Frequency Response (switch on)**

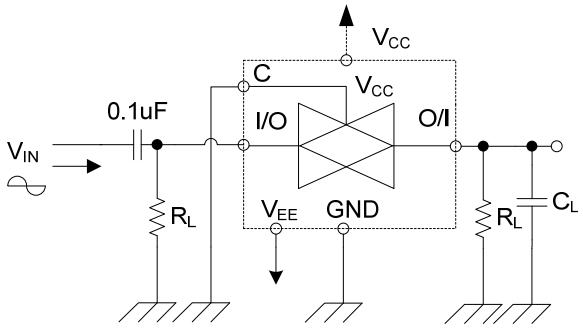



**Fig. 5 Feedthrough**

■ AC TEST CIRCUIT(Cont.)

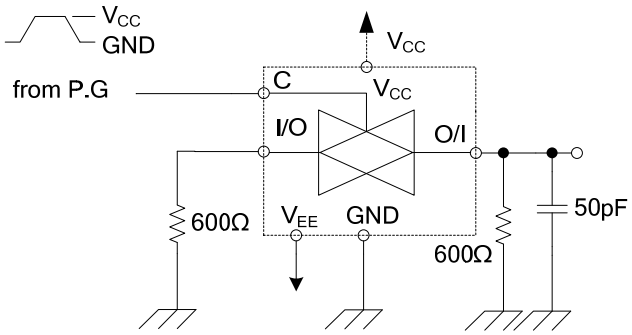



**Fig. 6 Cross Talk (control input to output signal)**

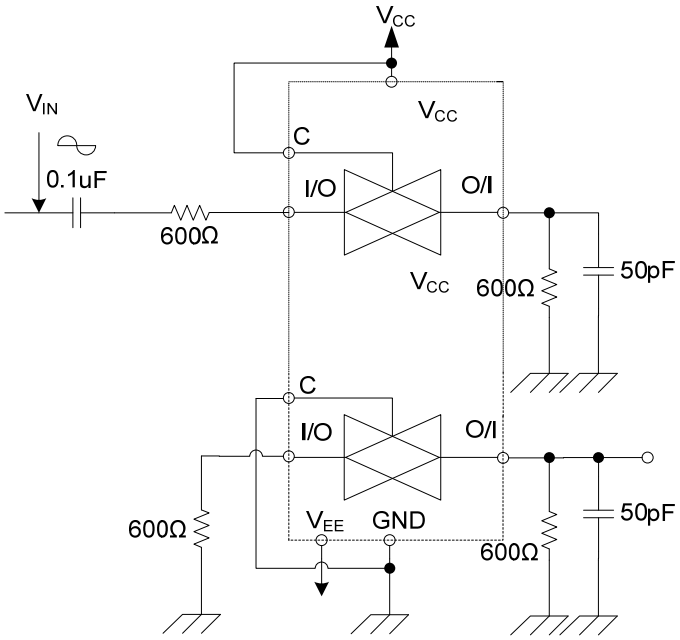



**Fig. 7 Cross Talk (between any two switches)**