

# 74HC4053D

## 1. Functional Description

- Triple 2-Channel Analog Multiplexer/Demultiplexer

## 2. General

The 74HC4053D 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 74HC4053D has a 2 channel  $\times$  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.

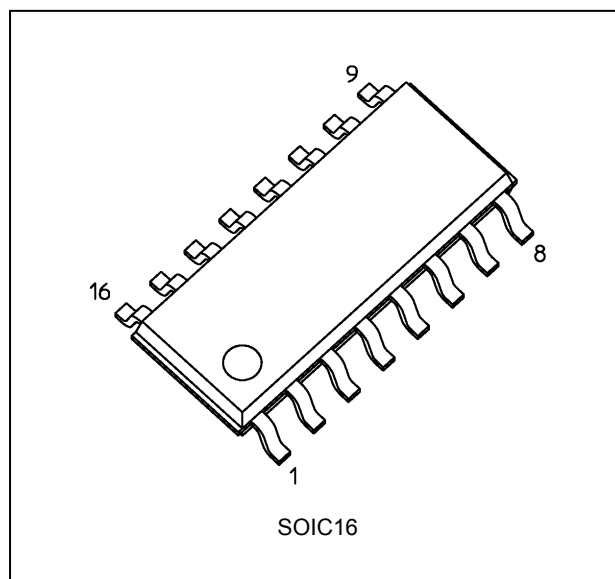
For example, in the case of  $V_{CC} = 5\text{ V}$ ,  $GND = 0\text{ V}$ ,  $V_{EE} = -5\text{ V}$ , signals between  $-5\text{ V}$  and  $+5\text{ V}$  can be switched from the logical circuit with a single power supply of  $5\text{ V}$ . As the ON-resistance of each switch is low, they can be connected to circuits with low input impedance.

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

## 3. Features

- (1) Low power dissipation:  $I_{CC} = 4.0\text{ }\mu\text{A}$  (max) ( $V_{CC} = 6.0\text{ V}$ ,  $V_{EE} = GND$ ,  $T_a = 25\text{ }^\circ\text{C}$ )
- (2) High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- (3) Low ON-resistance:  $R_{ON} = 50\text{ }\Omega$  (typ.) at  $V_{CC} - V_{EE} = 9\text{ V}$
- (4) High noise immunity: THD = 0.020 % (typ.) at  $V_{CC} - V_{EE} = 9\text{ V}$
- (5) Pin and function compatible with 4053B

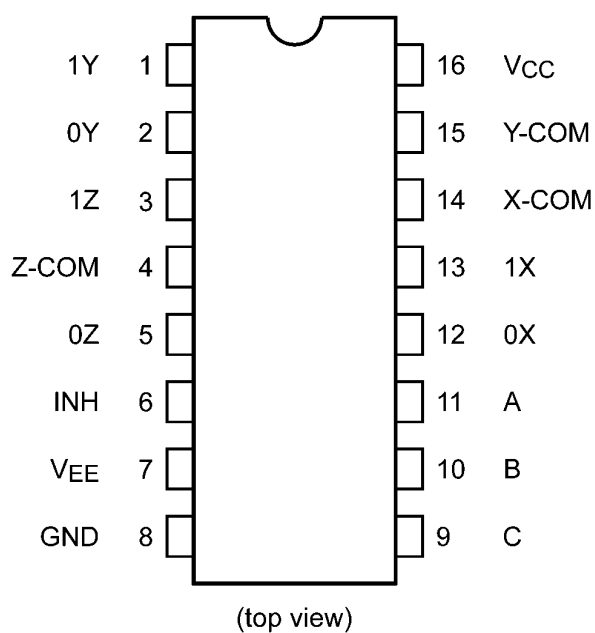
## 4. Packaging



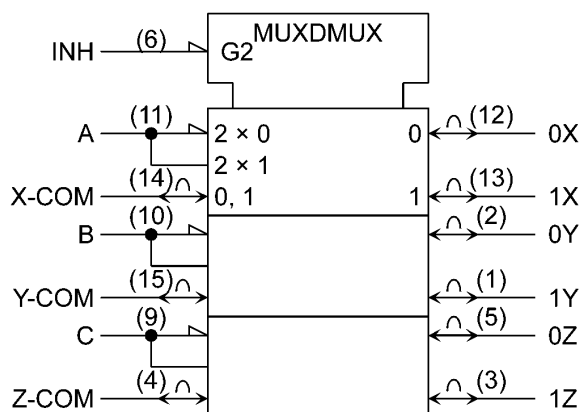
Start of commercial production

2016-08

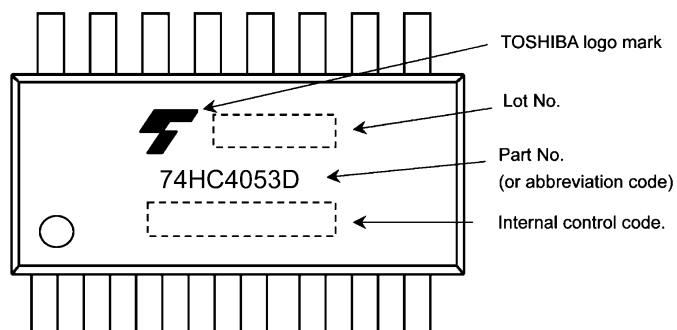
## 5. Pin Assignment



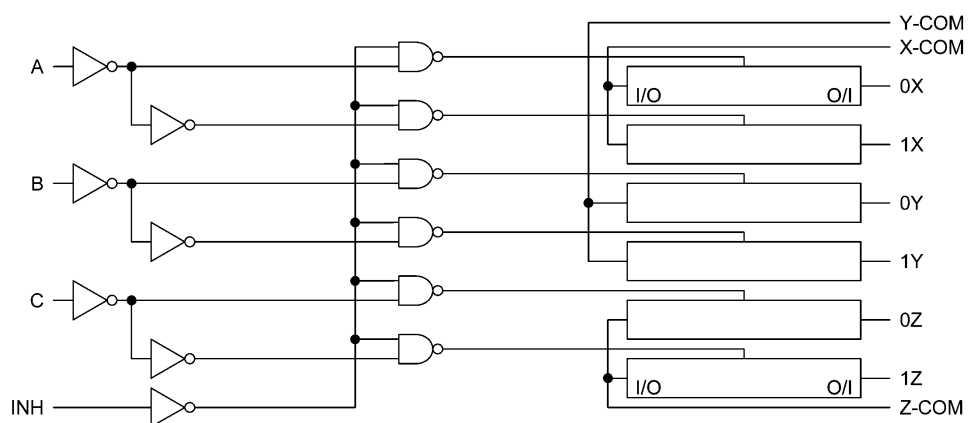
## 6. IEC Logic Symbol



## 7. Marking



## 8. System Diagram



## 9. Truth Table

Input Inhibit	Input C	Input B	Input A	ON Channel
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

X: Don't care

## 10. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	-0.5 to 7.0	V
	$V_{EE}$	-7.0 to 0	
	$V_{CC}-V_{EE}$	-0.5 to 13.0	
Input voltage	$V_{IN}$	-0.5 to $V_{CC} + 0.5$	V
Switch I/O voltage	$V_{I/O}$	$V_{EE} - 0.5$ to $V_{CC} + 0.5$	V
Input diode current	$I_{IK}$	$\pm 20$	mA
I/O diode current	$I_{I/OK}$	$\pm 20$	mA
Switch through current	$I_T$	$\pm 25$	mA
$V_{CC}$ /ground current	$I_{CC}$	$\pm 50$	mA
Power dissipation	$P_D$	500	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).

## 11. Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	2.0 to 6.0	V
	$V_{EE}$	-6.0 to 0	
	$V_{CC}-V_{EE}$	2.0 to 12.0	
Input voltage	$V_{IN}$	0 to $V_{CC}$	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 times	$t_r, t_f$	0 to 50	$\mu s$

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.

## 12. Electrical Characteristics

12.1. DC Characteristics (Unless otherwise specified,  $T_a = 25\text{ }^{\circ}\text{C}$ )

Characteristics	Symbol	Test Condition	$V_{EE}$ (V)	$V_{CC}$ (V)	Min	Typ.	Max	Unit
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	—	V
				4.5	3.15	—	—	
				6.0	4.20	—	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	—	0.50	V
				4.5	—	—	1.35	
				6.0	—	—	1.80	
ON-resistance	$R_{ON}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{IO} = V_{CC}$ to $V_{EE}$ $I_{IO} \leq 2\text{ mA}$	GND	4.5	—	85	180	$\Omega$
			-4.5	4.5	—	55	120	
			-6.0	6.0	—	50	100	
		$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{IO} = V_{CC}$ or $V_{EE}$ $I_{IO} \leq 2\text{ mA}$	GND	2.0	—	150	—	
			GND	4.5	—	70	150	
			-4.5	4.5	—	50	100	
Difference of ON-resistance between switches	$\Delta R_{ON}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{IO} = V_{CC}$ to $V_{EE}$ $I_{IO} \leq 2\text{ mA}$	GND	4.5	—	10	30	$\Omega$
			-4.5	4.5	—	5	12	
			-6.0	6.0	—	5	10	
Input/Output leakage current (Switch OFF)	$I_{OFF}$	$V_{OS} = V_{CC}$ or GND $V_{IS} = \text{GND}$ or $V_{CC}$ $V_{IN} = V_{IH}$ or $V_{IL}$	GND	6.0	—	—	$\pm 0.06$	$\mu\text{A}$
			-6.0	6.0	—	—	$\pm 0.1$	
Input/Output leakage current (Switch ON)	$I_{IO}$	$V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or $V_{IL}$	GND	6.0	—	—	$\pm 0.06$	$\mu\text{A}$
			-6.0	6.0	—	—	$\pm 0.1$	
Control input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND	GND	6.0	—	—	$\pm 0.1$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	GND	6.0	—	—	4.0	$\mu\text{A}$
			-6.0	6.0	—	—	8.0	

12.2. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $85\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Test Condition	$V_{EE}$ (V)	$V_{CC}$ (V)	Min	Max	Unit
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	V
				4.5	3.15	—	
				6.0	4.20	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V
				4.5	—	1.35	
				6.0	—	1.80	
ON-resistance	$R_{ON}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{I/O} = V_{CC}$ to $V_{EE}$ $I_{I/O} \leq 2\text{ mA}$	GND	4.5	—	225	$\Omega$
			-4.5	4.5	—	150	
			-6.0	6.0	—	125	
		$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{I/O} = V_{CC}$ or $V_{EE}$ $I_{I/O} \leq 2\text{ mA}$	GND	2.0	—	—	
			GND	4.5	—	190	
			-4.5	4.5	—	125	
Difference of ON-resistance between switches	$\Delta R_{ON}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{I/O} = V_{CC}$ to $V_{EE}$ $I_{I/O} \leq 2\text{ mA}$	GND	4.5	—	35	$\Omega$
			-4.5	4.5	—	15	
			-6.0	6.0	—	12	
Input/Output leakage current (Switch OFF)	$I_{OFF}$	$V_{OS} = V_{CC}$ or GND $V_{IS} = \text{GND}$ or $V_{CC}$ $V_{IN} = V_{IH}$ or $V_{IL}$	GND	6.0	—	$\pm 0.6$	$\mu\text{A}$
			-6.0	6.0	—	$\pm 1.0$	
Input/Output leakage current (Switch ON)	$I_{I/O}$	$V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or $V_{IL}$	GND	6.0	—	$\pm 0.6$	$\mu\text{A}$
			-6.0	6.0	—	$\pm 1.0$	
Control input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND	GND	6.0	—	$\pm 1.0$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	GND	6.0	—	40.0	$\mu\text{A}$
			-6.0	6.0	—	80.0	

## 12.3. AC Characteristics

(Unless otherwise specified,  $C_L = 50\text{ pF}$ ,  $T_a = 25\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6\text{ ns}$ )

Characteristics	Symbol	Test Condition	$V_{EE}$ (V)	$V_{CC}$ (V)	Min	Typ.	Max	Unit
Phase difference between input to output	$\phi_{I/O}$	—	GND	2.0	—	25	60	ns
			GND	4.5	—	6	12	
			GND	6.0	—	5	10	
			-4.5	4.5	—	4	—	
Output enable time	$t_{PZL}, t_{PZH}$	$R_L = 1\text{ k}\Omega$ Figure 1	GND	2.0	—	50	225	ns
			GND	4.5	—	14	45	
			GND	6.0	—	12	38	
			-4.5	4.5	—	14	—	
Output disable time	$t_{PLZ}, t_{PHZ}$	$R_L = 1\text{ k}\Omega$ Figure 1	GND	2.0	—	95	225	ns
			GND	4.5	—	30	45	
			GND	6.0	—	26	38	
			-4.5	4.5	—	26	—	
Control input capacitance	$C_{IN}$	—	—	—	—	5	10	pF
Common terminal capacitance	$C_{IS}$	Figure 2	-5.0	5.0	—	11	20	pF
Switch terminal capacitance	$C_{OS}$	Figure 2	-5.0	5.0	—	7	15	pF
Feedthrough capacitance	$C_{IOS}$	Figure 2	-5.0	5.0	—	0.75	2	pF
Power dissipation capacitance	$C_{PD}$	Figure 2 (Note 1)	GND	5.0	—	10	—	pF

Note 1:  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation.

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

## 12.4. AC Characteristics (Unless otherwise specified, $C_L = 50$ pF, $T_a = -40$ to $85$ °C, Input: $t_r = t_f = 6$ ns)

Characteristics	Symbol	Test Condition	$V_{EE}$ (V)	$V_{CC}$ (V)	Min	Max	Unit
Phase difference between input to output	$\phi_{I/O}$	—	GND	2.0	—	75	ns
			GND	4.5	—	15	
			GND	6.0	—	13	
			-4.5	4.5	—	—	
Output enable time	$t_{PZL}, t_{PZH}$	$R_L = 1$ k $\Omega$ Figure 1	GND	2.0	—	280	ns
			GND	4.5	—	56	
			GND	6.0	—	48	
			-4.5	4.5	—	—	
Output disable time	$t_{PLZ}, t_{PHZ}$	$R_L = 1$ k $\Omega$ Figure 1	GND	2.0	—	280	ns
			GND	4.5	—	56	
			GND	6.0	—	48	
			-4.5	4.5	—	—	
Control input capacitance	$C_{IN}$	—	—	—	—	10	pF
Common terminal capacitance	$C_{IS}$	Figure 2	-5.0	5.0	—	20	pF
Switch terminal capacitance	$C_{OS}$	Figure 2	-5.0	5.0	—	15	pF
Feedthrough capacitance	$C_{IOS}$	Figure 2	-5.0	5.0	—	2	pF

## 12.5. Analog Switch Characteristics ( $T_a = 25$ °C) (Note)

Characteristics	Symbol	Test Condition		V <sub>EE</sub> (V)	V <sub>CC</sub> (V)	Typ.	Unit
Sine Wave Distortion	THD	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 1 kHz	V <sub>IN</sub> = 4.0 V <sub>p-p</sub>	-2.25	2.25	0.025	%
			V <sub>IN</sub> = 8.0 V <sub>p-p</sub>	-4.5	4.5	0.020	
			V <sub>IN</sub> = 11.0 V <sub>p-p</sub>	-6.0	6.0	0.018	
Maximum frequency response	f <sub>MAX(I/O)</sub>	Adjust f <sub>IN</sub> voltage to obtain 0 dBm at V <sub>OS</sub> Increase f <sub>IN</sub> frequency until dB meter reads -3 dB R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF f <sub>IN</sub> = 1 MHz, sine wave Figure 3	(Note 1)	-2.25	2.25	120	MHz
			(Note 2)			95	
			(Note 1)	-4.5	4.5	190	
			(Note 2)			150	
			(Note 1)	-6.0	6.0	200	
			(Note 2)			190	
Feed through attenuation (switch OFF)	FTH	V <sub>IN</sub> is centered at (V <sub>CC</sub> - V <sub>EE</sub> )/2 Adjust input for 0 dBm. R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF, f <sub>IN</sub> = 1 MHz, sine wave Figure 4		-2.25	2.25	-50	dB
				-4.5	4.5	-50	
				-6.0	6.0	-50	
Crosstalk (control input to signal output)	X <sub>talk</sub>	R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF, f <sub>IN</sub> = 1 MHz, square wave (t <sub>r</sub> = t <sub>f</sub> = 6 ns) Figure 5		-2.25	2.25	60	mV
				-4.5	4.5	140	
				-6.0	6.0	200	
Crosstalk (between any switches)	X <sub>talk</sub>	Adjust V <sub>IN</sub> to obtain 0 dBm at input. R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF, f <sub>IN</sub> = 1 MHz, sine wave Figure 6		-2.25	2.25	-50	dB
				-4.5	4.5	-50	
				-6.0	6.0	-50	

Note: These characteristics are determined by design of devices.

Note 1: Input COMMON terminal, and measured at SWITCH terminal.

Note 2: Input SWITCH terminal, and measured at COMMON terminal.

# 13. AC Test Circuit

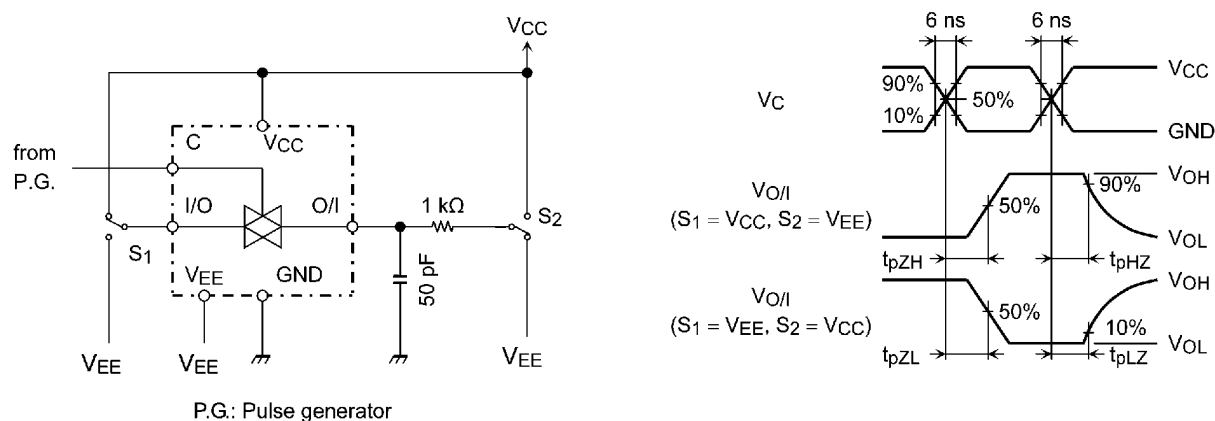


Figure 1  $t_{PLZ}$ ,  $t_{PHZ}$ ,  $t_{PZL}$ ,  $t_{PZH}$

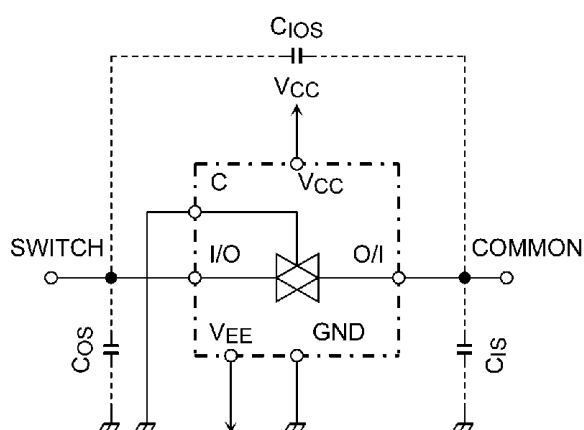


Figure 2  $C_{ios}$ ,  $C_{is}$ ,  $C_{os}$

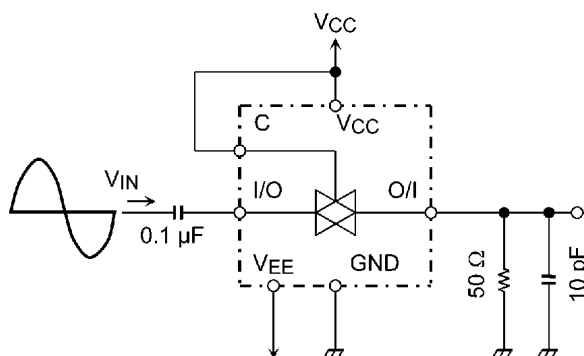


Figure 3 Frequency Response

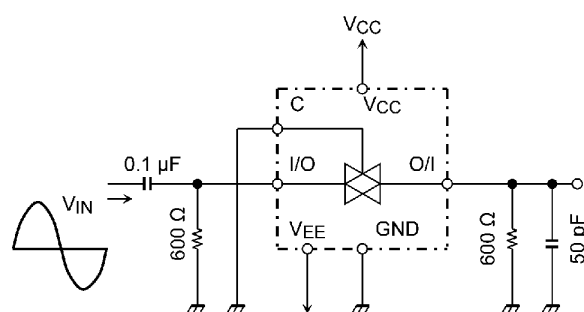
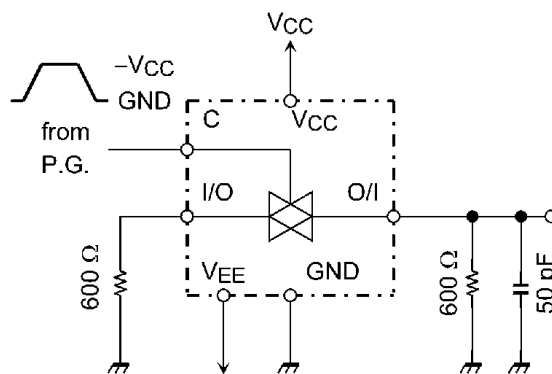


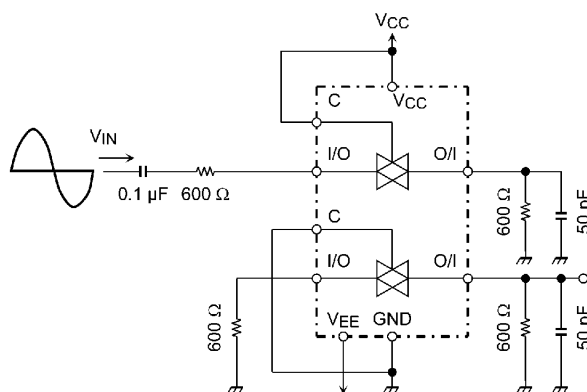
Figure 4 Feedthrough Attenuation





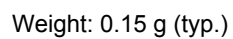
P.G.: Pulse generator

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



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

## Unit: mm



Package Name(s)
Nickname: SOIC16

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