

# 74HCT4053D

## 1. Functional Description

- Triple 2-Channel Analog Multiplexer/Demultiplexer

## 2. General

The 74HCT4053D 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.

This device may be used as a level converter for interfacing TTL or NMOS to High Speed CMOS. This inputs are compatible with TTL, NMOS and CMOS output voltage levels.

The 74HCT4053D has a 2 channel × 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 V. As the ON-resistance of each switch is low, they can be connected to circuits with low input impedance.

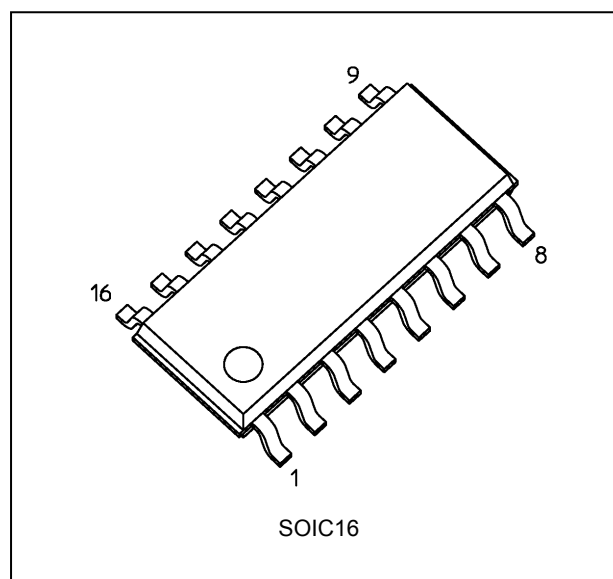
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

## 3. Features

- (1) Wide operating temperature range:  $T_{opr} = -40$  to  $125\text{ }^{\circ}\text{C}$  (Note 1)
- (2) Low power dissipation:  $I_{CC} = 4.0\text{ }\mu\text{A}$  (max) ( $V_{CC} = 5.5\text{ V}$ ,  $V_{EE} = GND$ ,  $T_a = 25\text{ }^{\circ}\text{C}$ )
- (3) Compatible with TTL output:  $V_{IH} = 2.0\text{ V}$  (min),  $V_{IL} = 0.8\text{ V}$  (max)
- (4) Wide interfacing ability: LSTTL, NMOS, CMOS
- (5) Low ON-resistance:  $R_{ON} = 50\text{ }\Omega$  (typ.) at  $V_{CC} - V_{EE} = 9\text{ V}$
- (6) High degree of linearity: THD = 0.020 % (typ.) at  $V_{CC} - V_{EE} = 9\text{ V}$
- (7) Pin and function compatible with 4053B

Note 1: Operating Range spec of  $T_{opr} = -40\text{ }^{\circ}\text{C}$  to  $125\text{ }^{\circ}\text{C}$  is applicable only for the products which manufactured after July 2020.

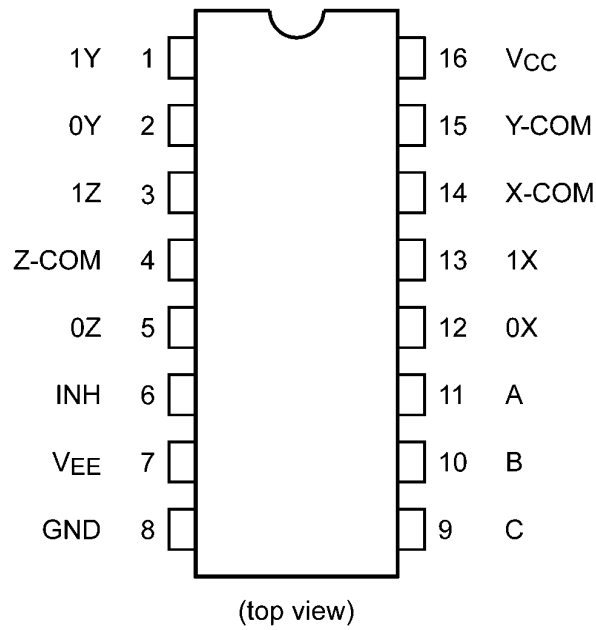
## 4. Packaging



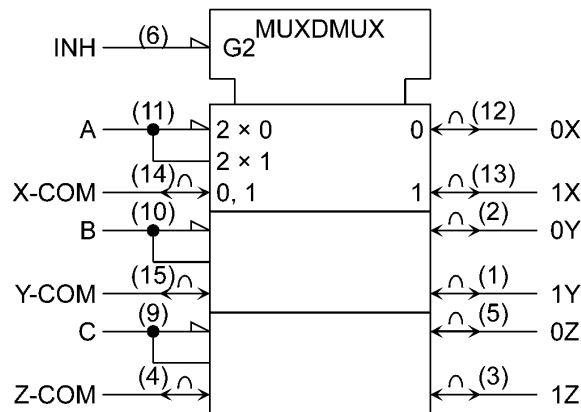
Start of commercial production

2020-07

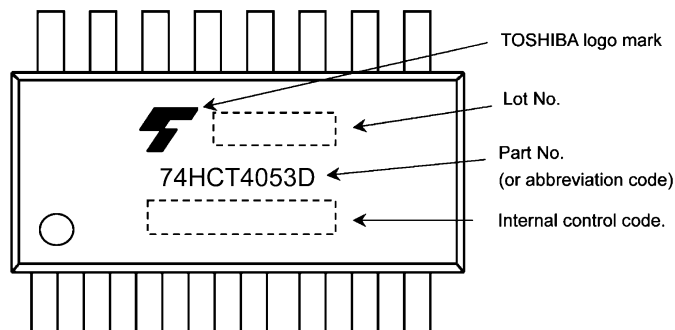
### 5. Pin Assignment



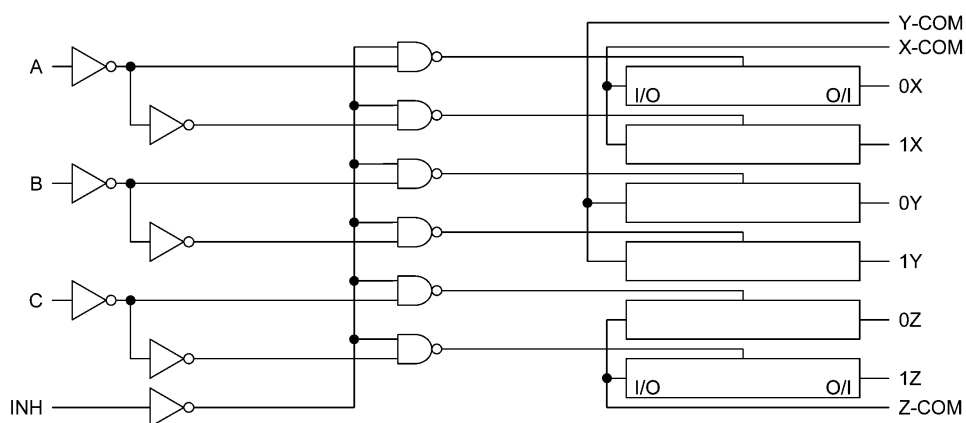
### 6. IEC Logic Symbol



### 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	Note	Rating	Unit
Supply voltage	$V_{CC}$		-0.5 to 13.0	V
	$V_{CC}-V_{EE}$		-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	$P_D$	(Note 1)	500	mW
Storage temperature	$T_{stg}$		-65 to 150	$^{\circ}C$

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).

Note 1:  $P_D$  derates linearly with  $-8$  mW/ $^{\circ}C$  above  $85$   $^{\circ}C$ .

### 11. Operating Ranges (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	$V_{CC}$		4.5 to 5.5	V
	$V_{EE}$		-7.5 to 0	
	$V_{CC}-V_{EE}$		4.5 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	$T_{opr}$	(Note 1)	-40 to 125	$^{\circ}C$
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.

Note 1: Operating Range spec of  $T_{opr} = -40$   $^{\circ}C$  to  $125$   $^{\circ}C$  is applicable only for the products which manufactured after July 2020.

### 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	$V_{IH}$	—		4.5 to 5.5	2.0	—	—	V
Low-level input voltage	$V_{IL}$	—		4.5 to 5.5	—	—	0.8	V
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	—	85	180	$\Omega$
			-4.5	4.5	—	55	120	
			-5.5	5.5	—	50	110	
		$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{I/O} = V_{CC}$ or $V_{EE}$ $I_{I/O} \leq 2\text{ mA}$	GND	4.5	—	70	150	
			-4.5	4.5	—	50	100	
			-5.5	5.5	—	45	90	
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	—	10	30	$\Omega$
			-4.5	4.5	—	5	12	
			-5.5	5.5	—	5	11	
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	5.5	—	—	$\pm 0.06$	$\mu\text{A}$
			-5.5	5.5	—	—	$\pm 0.1$	
Input/Output leakage current (Switch ON)	$I_{I/O}$	$V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or $V_{IL}$	GND	5.5	—	—	$\pm 0.06$	$\mu\text{A}$
			-5.5	5.5	—	—	$\pm 0.1$	
Control input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND	GND	5.5	—	—	$\pm 0.1$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	GND	5.5	—	—	4.0	$\mu\text{A}$
			-5.5	5.5	—	—	8.0	
	$I_{CC}$	Per input: $V_{IN} = 0.5\text{ V}$ or $2.4\text{ V}$ Other input: $V_{CC}$ or GND	GND	5.5	—	—	2.0	mA

#### 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	$V_{IH}$	—		4.5 to 5.5	2.0	—	V
Low-level input voltage	$V_{IL}$	—		4.5 to 5.5	—	0.8	V
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	
			-5.5	5.5	—	140	
		$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{I/O} = V_{CC}$ or $V_{EE}$ $I_{I/O} \leq 2\text{ mA}$	GND	4.5	—	190	
			-4.5	4.5	—	125	
			-5.5	5.5	—	115	
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	
			-5.5	5.5	—	14	
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	5.5	—	$\pm 0.6$	$\mu\text{A}$
			-5.5	5.5	—	$\pm 1.0$	
Input/Output leakage current (Switch ON)	$I_{I/O}$	$V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or $V_{IL}$	GND	5.5	—	$\pm 0.6$	$\mu\text{A}$
			-5.5	5.5	—	$\pm 1.0$	
Control input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND	GND	5.5	—	$\pm 1.0$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	GND	5.5	—	40.0	$\mu\text{A}$
			-5.5	5.5	—	80.0	
	$I_{CC}$	Per input: $V_{IN} = 0.5\text{ V}$ or $2.4\text{ V}$ Other input: $V_{CC}$ or GND	GND	5.5	—	2.9	mA

### 12.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125$ °C)

Characteristics	Symbol	Test Condition	$V_{EE}$ (V)	$V_{CC}$ (V)	Min	Max	Unit
High-level input voltage	$V_{IH}$	—		4.5 to 5.5	2.0	—	V
Low-level input voltage	$V_{IL}$	—		4.5 to 5.5	—	0.8	V
ON-resistance	$R_{ON}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{I/O} = V_{CC}$ to $V_{EE}$ $I_{I/O} \leq 2$ mA	GND	4.5	—	255	$\Omega$
			-4.5	4.5	—	170	
			-5.5	5.5	—	160	
		$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{I/O} = V_{CC}$ or $V_{EE}$ $I_{I/O} \leq 2$ mA	GND	4.5	—	220	
			-4.5	4.5	—	145	
			-5.5	5.5	—	135	
Difference of ON-resistance between switches	$\Delta R_{ON}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{I/O} = V_{CC}$ to $V_{EE}$ $I_{I/O} \leq 2$ mA	GND	4.5	—	35	$\Omega$
			-4.5	4.5	—	15	
			-5.5	5.5	—	14	
Input/Output leakage current (Switch OFF)	$I_{OFF}$	$V_{OS} = V_{CC}$ or GND $V_{IS} = GND$ to $V_{CC}$ $V_{IN} = V_{IH}$ or $V_{IL}$	GND	5.5	—	$\pm 3.0$	$\mu A$
			-5.5	5.5	—	$\pm 5.0$	
Input/Output leakage current (Switch ON)	$I_{I/O}$	$V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or $V_{IL}$	GND	5.5	—	$\pm 3.0$	$\mu A$
			-5.5	5.5	—	$\pm 5.0$	
Control input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND	GND	5.5	—	$\pm 1.0$	$\mu A$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	GND	5.5	—	80.0	$\mu A$
			-5.5	5.5	—	160.0	
		Per input: $V_{IN} = 0.5$ V or 2.4 V Other input: $V_{CC}$ or GND	GND	5.5	—	2.9	mA

Note: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after July 2020.

### 12.4. AC Characteristics

(Unless otherwise specified,  $C_L = 50$  pF,  $T_a = 25$  °C, Input:  $t_r = t_f = 6$  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	4.5	—	6	12	ns
			GND	5.5	—	5	11	
Output enable time	$t_{PZL}, t_{PZH}$	$R_L = 1$ k $\Omega$ Figure 1	GND	4.5	—	33	60	ns
			GND	5.5	—	26	45	
Output disable time	$t_{PLZ}, t_{PHZ}$	$R_L = 1$ k $\Omega$ Figure 1	GND	4.5	—	45	65	ns
			GND	5.5	—	37	59	
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.

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

### 12.5. 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	4.5	—	15	ns
			GND	5.5	—	13	
Output enable time	$t_{PZL}, t_{PZH}$	$R_L = 1$ k $\Omega$ Figure 1	GND	4.5	—	63	ns
			GND	5.5	—	57	
Output disable time	$t_{PLZ}, t_{PHZ}$	$R_L = 1$ k $\Omega$ Figure 1	GND	4.5	—	81	ns
			GND	5.5	—	73	
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

### 12.6. AC Characteristics (Note) (Unless otherwise specified, $C_L = 50$ pF, $T_a = -40$ to $125$ °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	4.5	—	17	ns
			GND	5.5	—	14	
Output enable time	$t_{PZL}, t_{PZH}$	$R_L = 1$ k $\Omega$ Figure 1	GND	4.5	—	65	ns
			GND	5.5	—	65	
Output disable time	$t_{PLZ}, t_{PHZ}$	$R_L = 1$ k $\Omega$ Figure 1	GND	4.5	—	92	ns
			GND	5.5	—	82	
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

Note: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after July 2020.

### 12.7. Analog Switch Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ ) (Note)

Characteristics	Symbol	Test Condition	$V_{EE}$ (V)	$V_{CC}$ (V)	Typ.	Unit	
Sine Wave Distortion	THD	$R_L = 10\text{ k}\Omega$ , $C_L = 50\text{ pF}$ $f_{IN} = 1\text{ kHz}$	$V_{IN} = 8.0\text{ V}_{p-p}$	-4.5	4.5	0.020	%
			$V_{IN} = 11.0\text{ V}_{p-p}$	-5.5	5.5	0.019	
Maximum frequency response	$f_{MAX(I/O)}$	Adjust $f_{IN}$ voltage to obtain 0 dBm at $V_{OS}$ Increase $f_{IN}$ frequency until dB meter reads -3 dB $R_L = 50\text{ }\Omega$ , $C_L = 10\text{ pF}$ $f_{IN} = 1\text{ MHz}$ , sine wave Figure 3	(Note 1)	-4.5	4.5	190	MHz
			(Note 2)			150	
			(Note 1)	-5.5	5.5	200	
			(Note 2)			180	
Feed through attenuation (switch OFF)	FTH	$V_{IN}$ is centered at $(V_{CC} - V_{EE})/2$ Adjust input for 0 dBm. $R_L = 600\text{ }\Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , sine wave Figure 4	-4.5	4.5	-50	dB	
			-5.5	5.5	-50		
Crosstalk (control input to signal output)	$X_{talk}$	$R_L = 600\text{ }\Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , square wave ( $t_r = t_f = 6\text{ ns}$ ) Figure 5	-4.5	4.5	140	mV	
			-5.5	5.5	180		
Crosstalk (between any switches)	$X_{talk}$	Adjust $V_{IN}$ to obtain 0 dBm at input. $R_L = 600\text{ }\Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , sine wave Figure 6	-4.5	4.5	-50	dB	
			-5.5	5.5	-50		
	$X_{talk}$	$R_L = 50\text{ }\Omega$ , $C_L = 15\text{ pF}$ , $f_{IN} = 100\text{ KHz}$ , $V_{SWITCH} = 1\text{ V}_{RMS}$ Figure 6	-4.5	4.5	-90	dB	

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

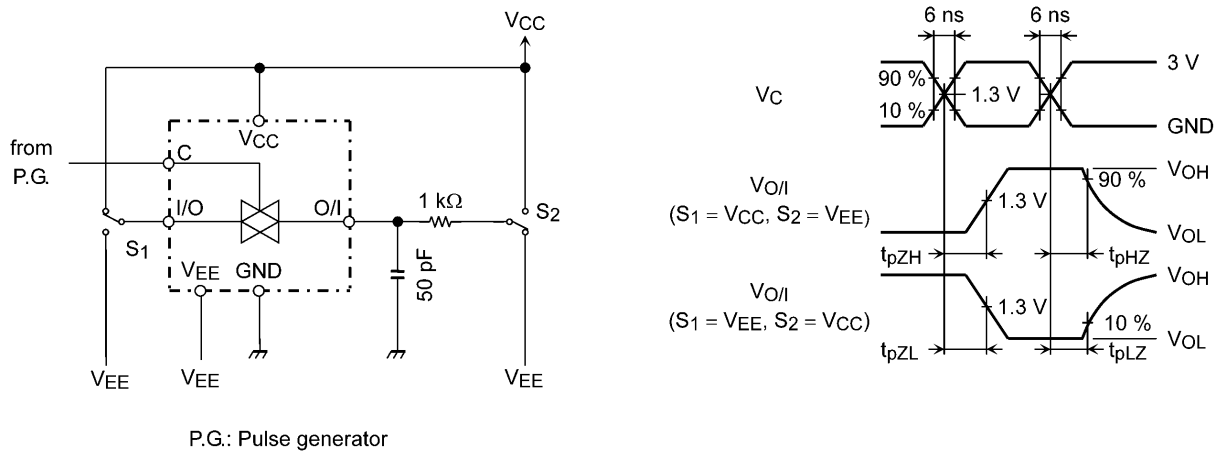


Figure 1  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

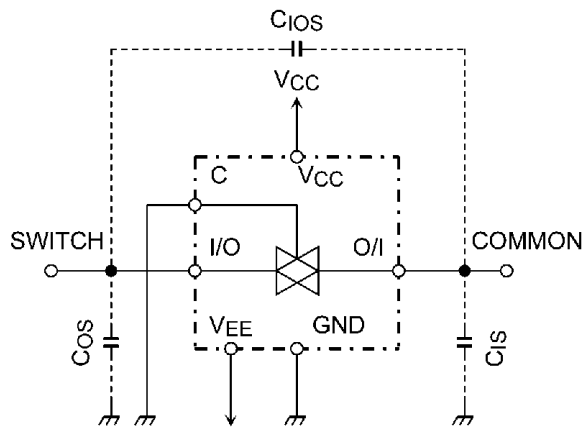


Figure 2  $C_{ios}$ ,  $C_{is}$ ,  $C_{os}$

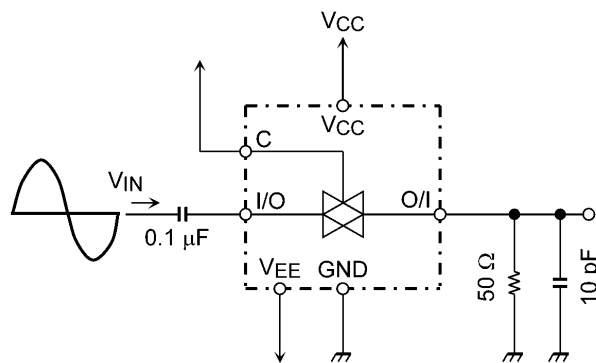
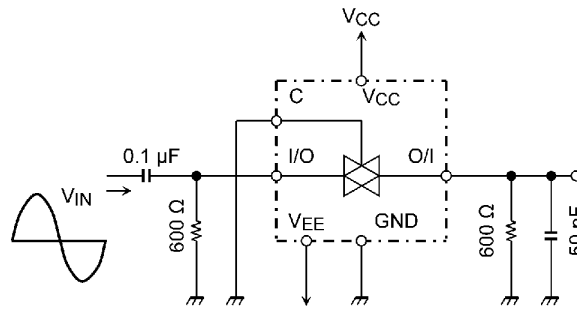
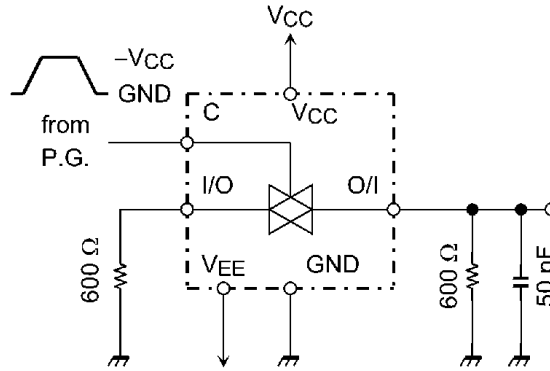


Figure 3 Frequency Response

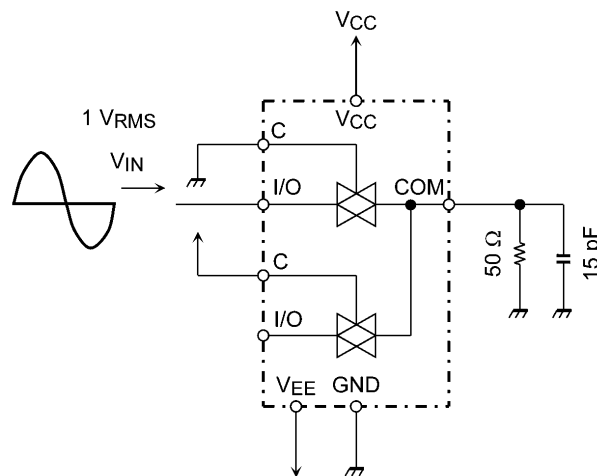
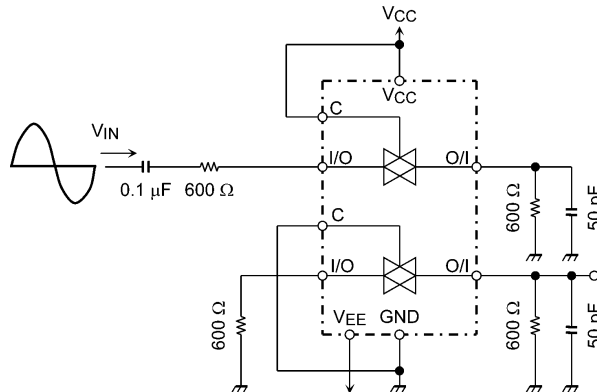


**Figure 4 Feedthrough Attenuation**



P.G.: Pulse generator

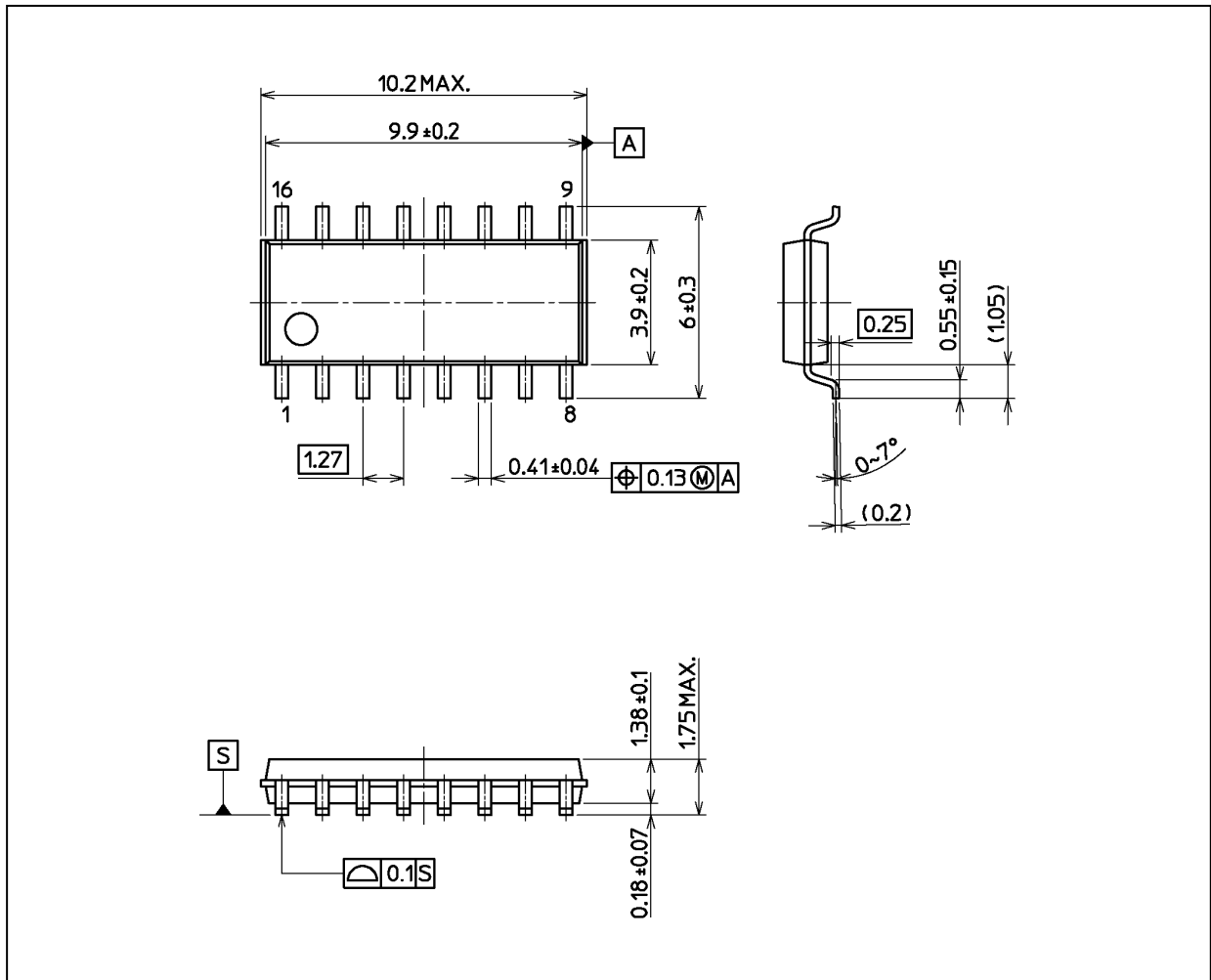
**Figure 5 Cross Talk (control input to output signal)**



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

## Package Dimensions

Unit: mm



Weight: 0.15 g (typ.)

Package Name(s)
Nickname: SOIC16

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