

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

**TC74VHC4051AF,TC74VHC4051AFT,TC74VHC4051AFK**  
**TC74VHC4052AF,TC74VHC4052AFT,TC74VHC4052AFK**  
**TC74VHC4053AF,TC74VHC4053AFT,TC74VHC4053AFK**

TC74VHC4051AF/AFT/AFK

8-Channel Analog Multiplexer/Demultiplexer

TC74VHC4052AF/AFT/AFK

Dual 4-Channel Analog Multiplexer/Demultiplexer

TC74V4053AF/AFT/AFK

Triple 2-Channel Analog Multiplexer/Demultiplexer

The TC74VHC4051A/4052A/4053A 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.

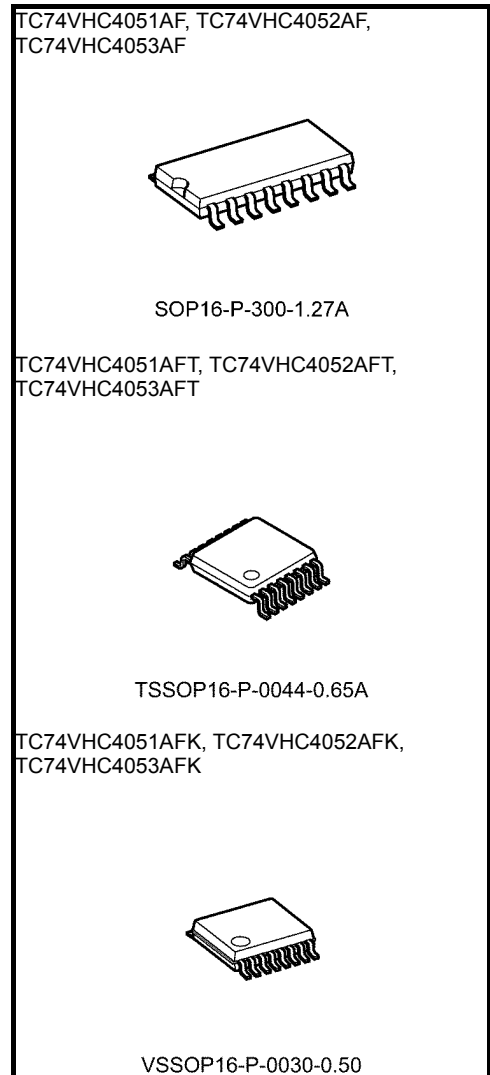
The TC74VHC4051A/4052A/4053A offer analog/digital signal selection as well as mixed signals. The 4051A has an 8-channel configuration, the 4052A has an 4-channel × 2 configuration, and the 4053A has a 2-channel × 3 configuration.

The switches for each channel are turned ON by the control pin digital signals.

All control inputs 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<sub>CC</sub>). As a result, for example, 5.5 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 TC74VHC4051A/4052A/4053A can be used in a variety of applications, including in the system which has two power supplies, and in battery backup circuits.

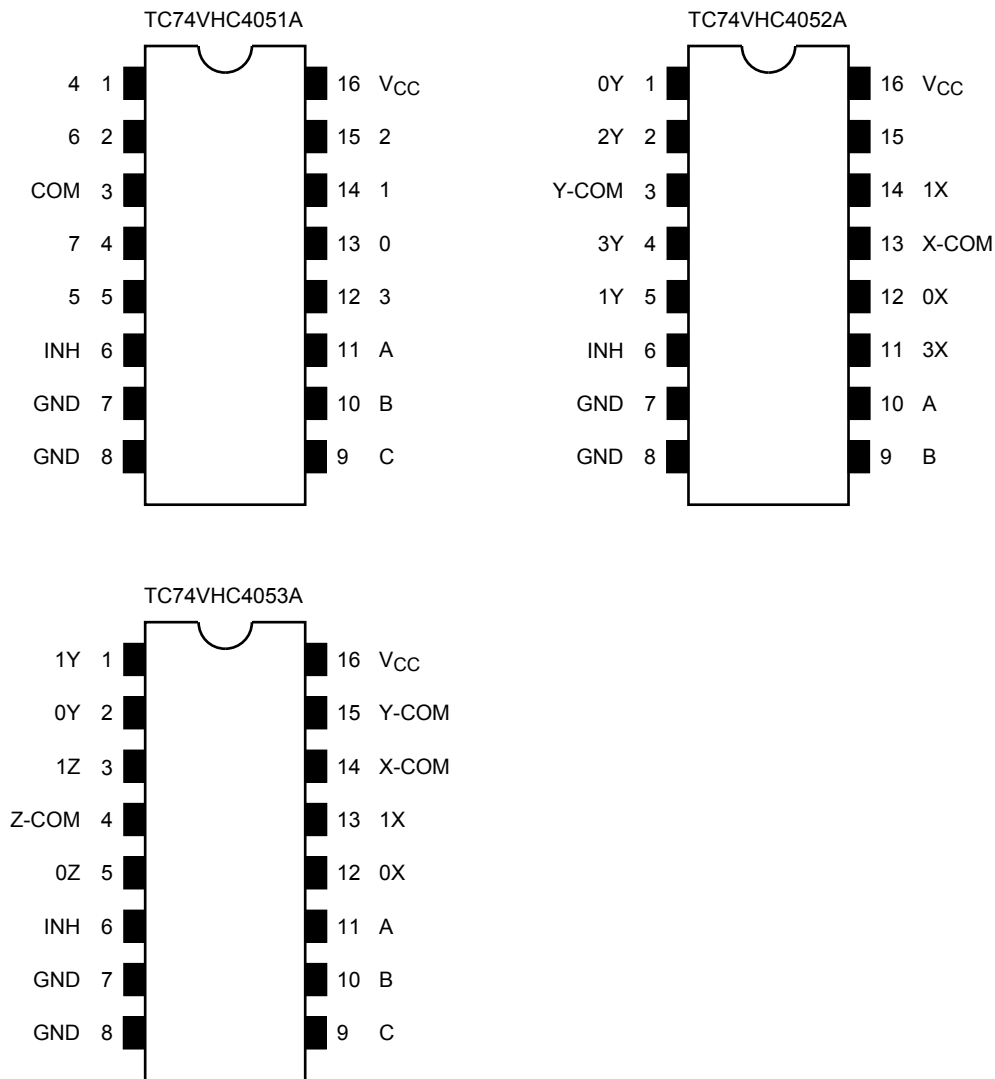
## Features

- Low ON resistance: R<sub>on</sub> = 45Ω (typ.) (V<sub>CC</sub> = 3 V)  
R<sub>on</sub> = 24Ω (typ.) (V<sub>CC</sub> = 4.5 V)
- Low power dissipation: I<sub>CC</sub> = 2.0 μA (max) (T<sub>a</sub> = 25°C)
- Input level: V<sub>IL</sub> = 0.8V (max) (V<sub>CC</sub> = 3 V)  
V<sub>IH</sub> = 2.0V (min) (V<sub>CC</sub> = 3 V)
- Power down protection is provided on all control inputs



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)



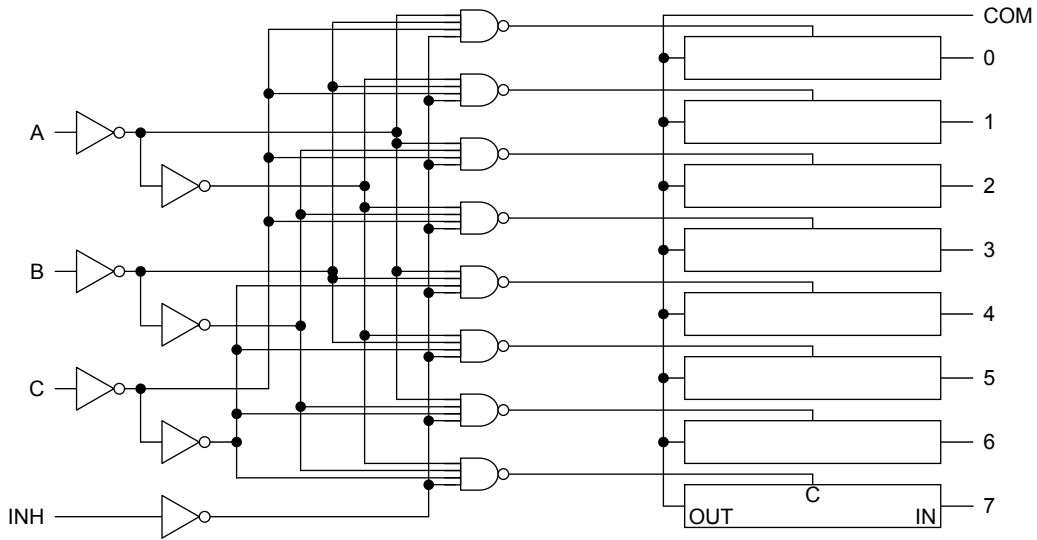
## Truth Table

Control Inputs				"ON" Channel		
Inhibit	C*	B	A	VHC4051A	VHC4052A	VHC4053A
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

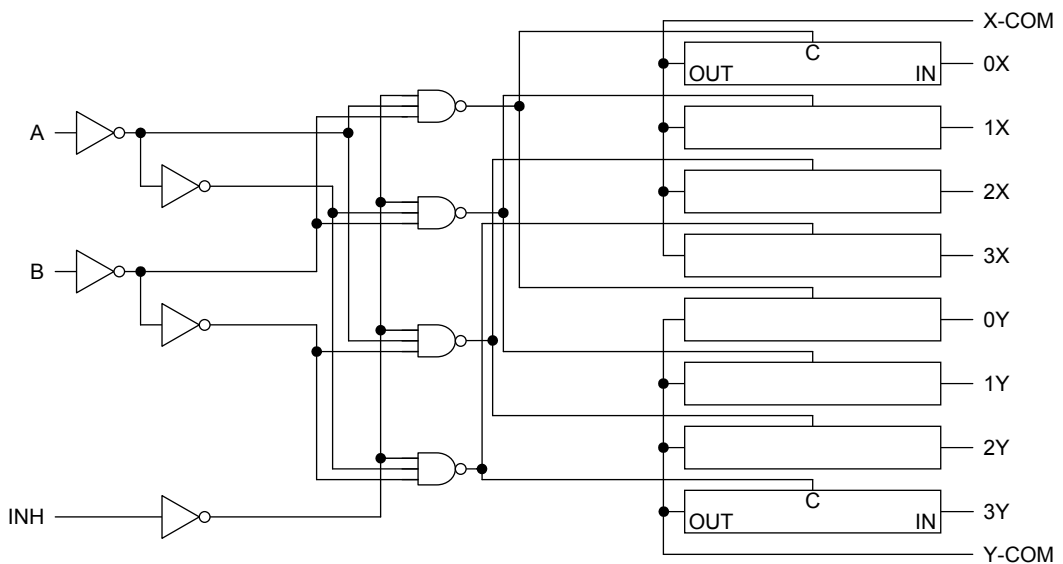
X: Don't care, \*: Except VHC4052AFT

## System Diagram

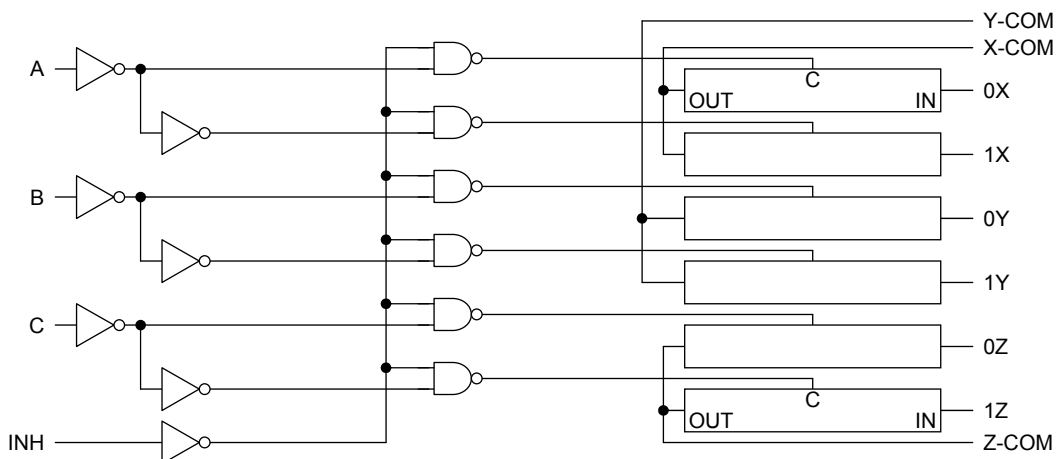
### TC74VHC4051A



### TC74VHC4052A



### TC74VHC4053A



## Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	-0.5~7.0	V
Control input voltage	$V_{IN}$	-0.5~7.0	V
Switch I/O voltage	$V_{I/O}$	-0.5~ $V_{CC} + 0.5$	V
Input diode current	$I_{IK}$	-20	mA
I/O diode current	$I_{I/OK}$	±25	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

Note : Exceeding any of the absolute maximum ratings, even briefly, may 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 Range (Note)

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	2~5.5	V
Input voltage	$V_{IN}$	0~5.5	V
Switch I/O voltage	$V_{I/O}$	0~ $V_{CC}$	V
Operating temperature	$T_{opr}$	-40~85	°C
Input rise and fall time	dt/dv	0~200 ( $V_{CC} = 2.5 \pm 0.2$ V)	ns/V
		0~100 ( $V_{CC} = 3.3 \pm 0.3$ V)	
		0~20 ( $V_{CC} = 5 \pm 0.5$ V)	

Note: The operating ranges must be maintained to ensure the normal operation of the device. Unused control inputs must be tied to either  $V_{CC}$  or GND.

## Electrical Characteristics

### DC Electrical Characteristics

Characteristics		Symbol	Test Condition	Ta = 25°C			Ta = -40~85°C		Unit	
				V <sub>CC</sub> (V)	Min	Typ.	Max	Min		Max
Input voltage	High-level	V <sub>IH</sub>	—	2.0	1.5	—	—	1.5	—	V
				3.0	2.0	—	—	2.0	—	
				4.5	3.15	—	—	3.15	—	
				5.5	3.85	—	—	3.85	—	
	Low-level	V <sub>IL</sub>	—	2.0	—	—	0.5	—	0.5	
				3.0	—	—	0.8	—	0.8	
				4.5	—	—	1.35	—	1.35	
				5.5	—	—	1.65	—	1.65	
ON resistance	R <sub>ON</sub>	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>I/O</sub> = V <sub>CC</sub> to GND I <sub>I/O</sub> = 2 mA	2.3	—	200	—	—	—	Ω	
			3.0	—	45	86	—	108		
			4.5	—	24	37	—	46		
			2.3	—	28	73	—	84		
			3.0	—	22	38	—	44		
			4.5	—	17	27	—	31		
Difference of ON resistance between switches	ΔR <sub>ON</sub>	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>I/O</sub> = V <sub>CC</sub> to GND I <sub>I/O</sub> = 2 mA	2.3	—	10	25	—	35	Ω	
			3.0	—	5	15	—	20		
			4.5	—	5	13	—	18		
Input/Output leakage current (switch OFF)	I <sub>OFF</sub>	V <sub>OS</sub> = V <sub>CC</sub> or GND V <sub>IS</sub> = GND to V <sub>CC</sub> V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub>	5.5	—	—	±0.1	—	±1.0	μA	
Input/Output leakage current (switch ON, output open)	I <sub>I/O</sub>	V <sub>OS</sub> = V <sub>CC</sub> or GND V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub>	5.5	—	—	±0.1	—	±1.0	μA	
Control input current	I <sub>IN</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	5.5	—	—	±0.1	—	±1.0	μA	
Quiescent supply current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	5.5	—	—	2.0	—	20.0	μA	

## AC Electrical Characteristics (Input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40~85°C		Unit	
				VCC (V)	Min	Typ.	Max	Min		Max
Phase difference between input and output	$\phi$ I/O	CL = 15 pF RL = 1 kΩ	Figure 1	2.5±0.2	—	1.2	10	—	16	ns
				3.3±0.3	—	0.8	6	—	10	
				5.0±0.5	—	0.3	4	—	7	
		CL = 50 pF RL = 1 kΩ		2.5±0.2	—	2.6	12	—	18	
				3.3±0.3	—	1.5	9	—	12	
				5.0±0.5	—	0.6	6	—	8	
Output enable time	tpZL tpZH	CL = 15 pF RL = 1 kΩ	Figure 1	2.5±0.2	—	3.3	15	—	20	ns
				3.3±0.3	—	2.3	11	—	15	
				5.0±0.5	—	1.6	7	—	10	
		CL = 50 pF RL = 1 kΩ		2.5±0.2	—	4.2	25	—	32	
				3.3±0.3	—	3.0	18	—	22	
				5.0±0.5	—	2.1	12	—	16	
Output disable time	tpLZ tpHZ	CL = 15 pF RL = 1 kΩ	Figure 1	2.5±0.2	—	6	15	—	23	ns
				3.3±0.3	—	4.5	11	—	15	
				5.0±0.5	—	3.2	7	—	10	
		CL = 50 pF RL = 1 kΩ		2.5±0.2	—	9.6	25	—	32	
				3.3±0.3	—	7.2	18	—	22	
				5.0±0.5	—	5.1	12	—	16	
Control input capacitance	CIN	All types	—	—	3	—	—	10	pF	
COMMON terminal capacitance	CIS	4051A	Figure 2	—	—	23.4	—	—	—	pF
		4052A				13.1				
		4053A				8.2				
SWITCH terminal capacitance	COS	4051A	Figure 2	—	—	5.7	—	—	—	pF
		4052A				5.6				
		4053A				5.6				
Feedthrough capacitance	CIOS	4051A	Figure 2	—	—	0.5	—	—	—	pF
		4052A				0.5				
		4053A				0.5				
Power dissipation capacitance	CPD	4051A	Figure 2 (Note)	—	—	15	—	—	—	pF
		4052A				24				
		4053A				12				

Note: CPD is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.

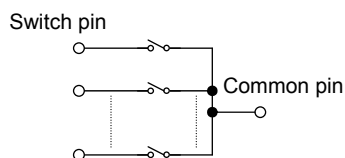
Average operating current can be obtained by the equation:

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

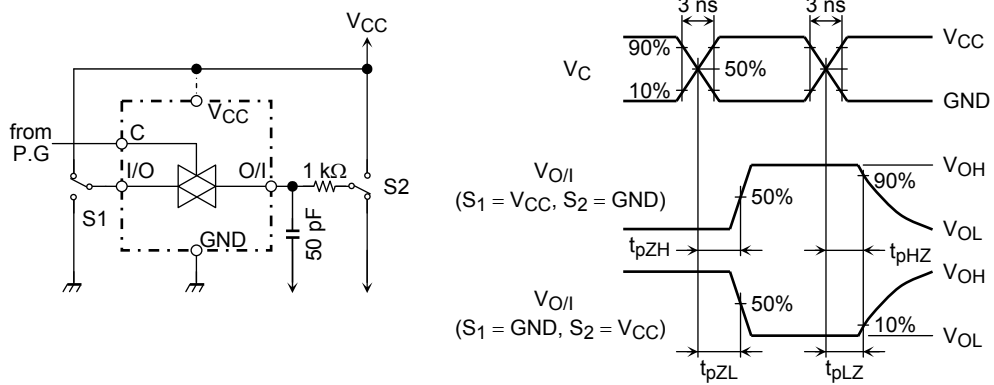
## Analog Switch Characteristics (Ta = 25°C) (Note)

Characteristics	Test Condition		Typ.	Unit	
		V <sub>CC</sub> (V)			
Sine Wave Distortion (T.H.D)	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 50 pF, f <sub>IN</sub> = 1 kHz	V <sub>IN</sub> = 2.0 V <sub>p-p</sub>	3.0	0.1	%
		V <sub>IN</sub> = 4.0 V <sub>p-p</sub>	4.5	0.03	
Frequency response (switch ON)	V <sub>IN</sub> is centered at (V <sub>CC</sub> /2). Adjust input for 0dBm. Increase f <sub>IN</sub> frequency until dB meter reads -3dB. R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF, sine wave Figure 3	4051A	3.0	150	MHz
		4052A		200	
		4053A		240	
		4051A	4.5	180	
		4052A		230	
		4053A		280	
Feed through attenuation (switch OFF)	V <sub>IN</sub> is centered at (V <sub>CC</sub> /2). Adjust input for 0dBm. R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF, f <sub>IN</sub> = 1 MHz, sine wave Figure 4		3.0	-45	dB
			4.5	-45	
		R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF, f <sub>IN</sub> = 1 MHz, sine wave	3.0	-65	
			4.5	-65	
Crosstalk (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 (t <sub>r</sub> = t <sub>f</sub> = 6 ns) Figure 5		3.0	60	mV
			4.5	100	
Crosstalk (between any switches)	V <sub>IN</sub> is centered at (V <sub>CC</sub> /2). Adjust input for 0dBm. R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF, f <sub>IN</sub> = 1 MHz, sine wave Figure 6		3.0	-45	dB
			4.5	-45	

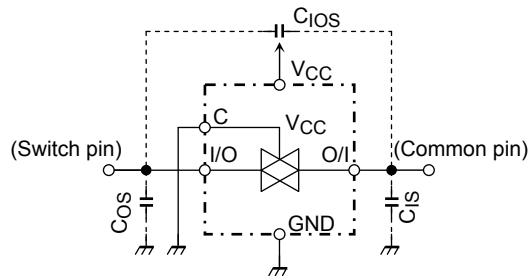
Note: These characteristics are determined by design of devices.



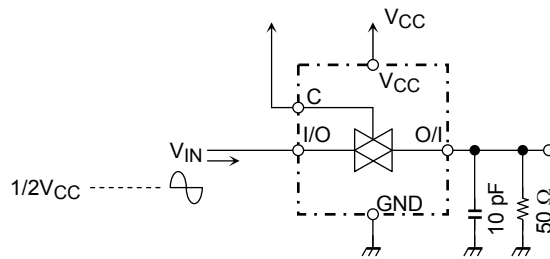
**AC Test Circuit**



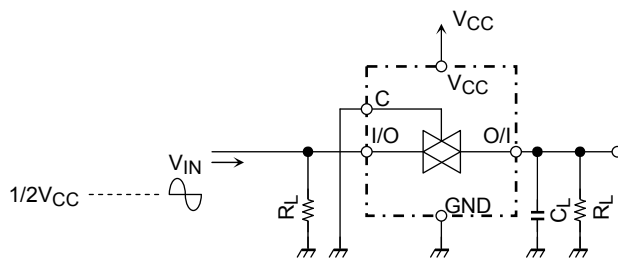
**Figure 1  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$**



**Figure 2  $C_{1os}$ ,  $C_{1s}$ ,  $C_{1b}$**

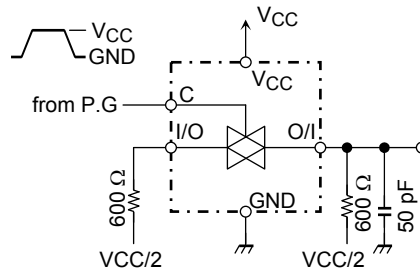


**Figure 3 Frequency Response (switch on)**

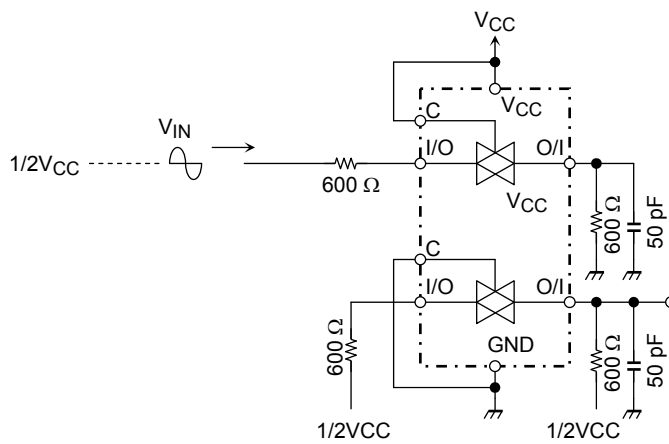


**Figure 4 Feedthrough**





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

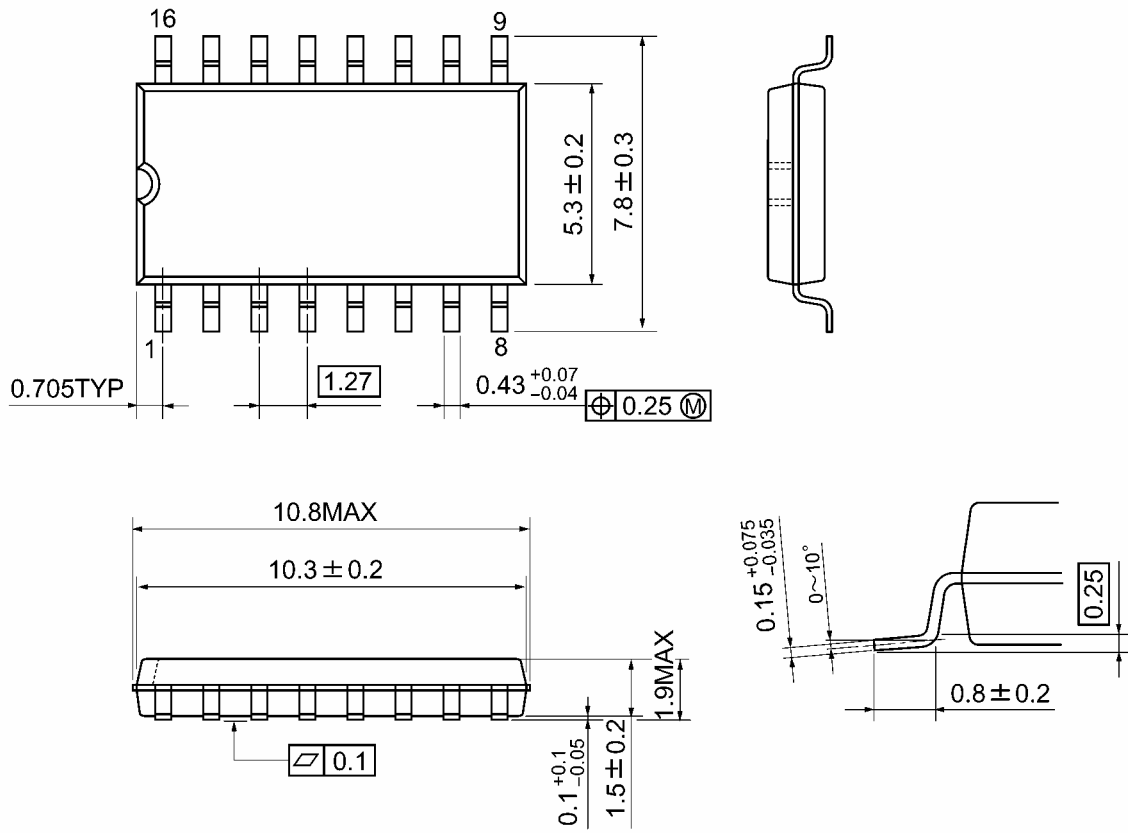


**Figure 6 Cross Talk (between any two switches)**

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm

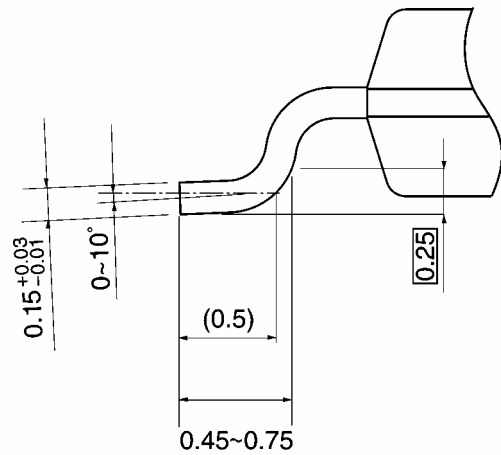
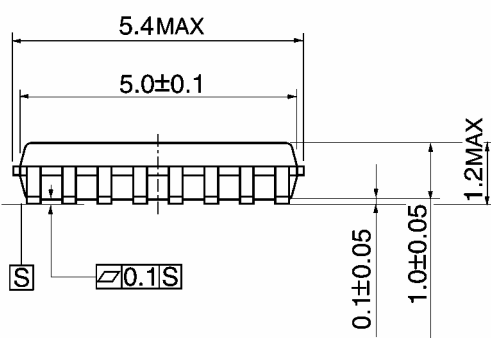
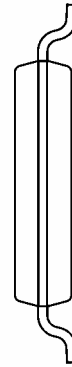
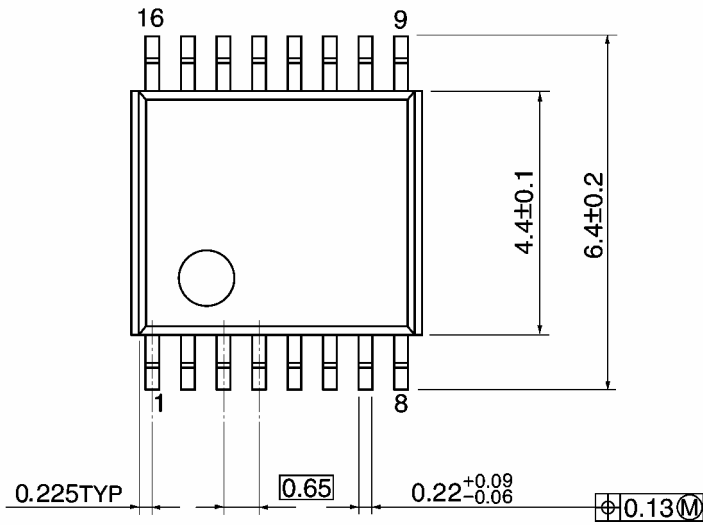


Weight: 0.18 g (typ.)

**Package Dimensions**

TSSOP16-P-0044-0.65A

Unit: mm

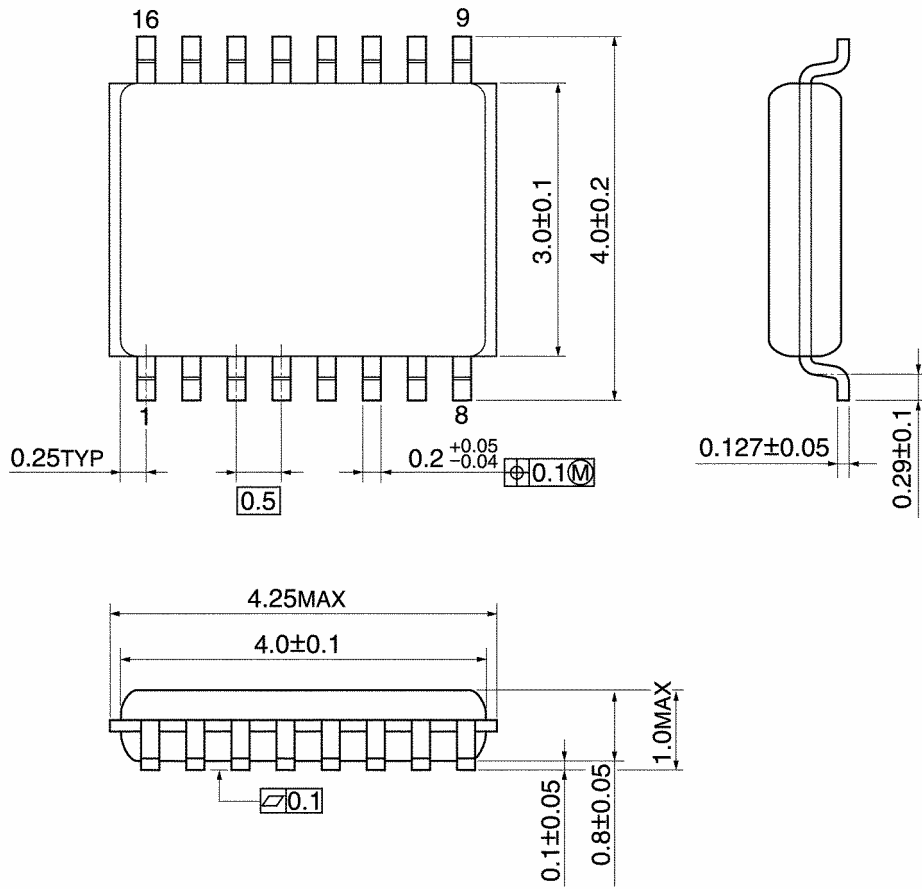


Weight: 0.06 g (typ.)

**Package Dimensions**

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

**RESTRICTIONS ON PRODUCT USE**

20070701-EN

- The information contained herein is subject to change without notice.
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.  
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc.
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document shall not be used or embedded to any downstream products of which manufacture, use and/or sale are prohibited under any applicable laws and regulations.
- Please contact your sales representative for product-by-product details in this document regarding RoHS compatibility. Please use these products in this document in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances. Toshiba assumes no liability for damage or losses occurring as a result of noncompliance with applicable laws and regulations.