

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.

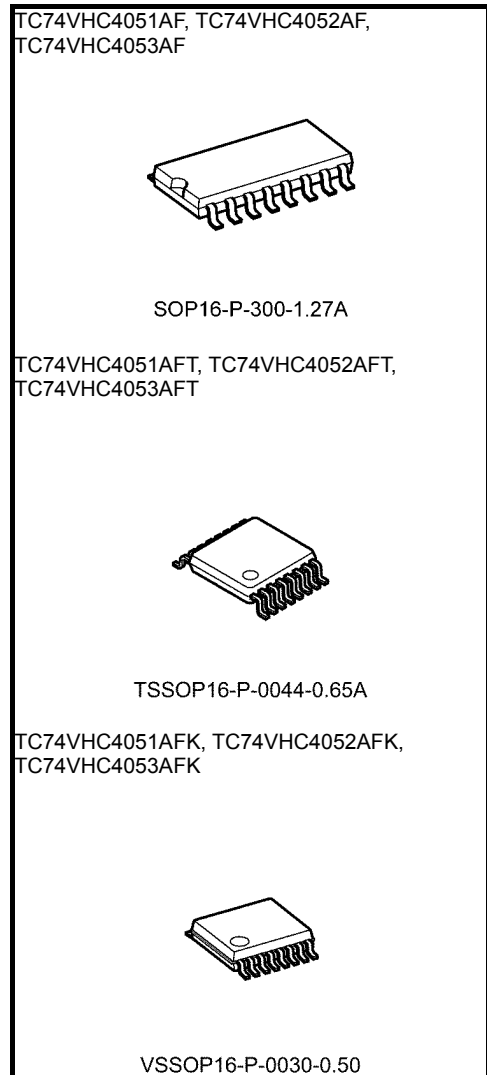
The TC74VHC4051A/4052A/4053A offer analog/digital signal selection as well as mixed signals. The 4051A has an 8-channel configuration, the 4052A has an 4-channel × 2 configuration, and the 4053A has a 2-channel × 3 configuration.

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



TC74VHC4051AF, TC74VHC4052AF,  
TC74VHC4053AF

SOP16-P-300-1.27A

TC74VHC4051AFT, TC74VHC4052AFT,  
TC74VHC4053AFT

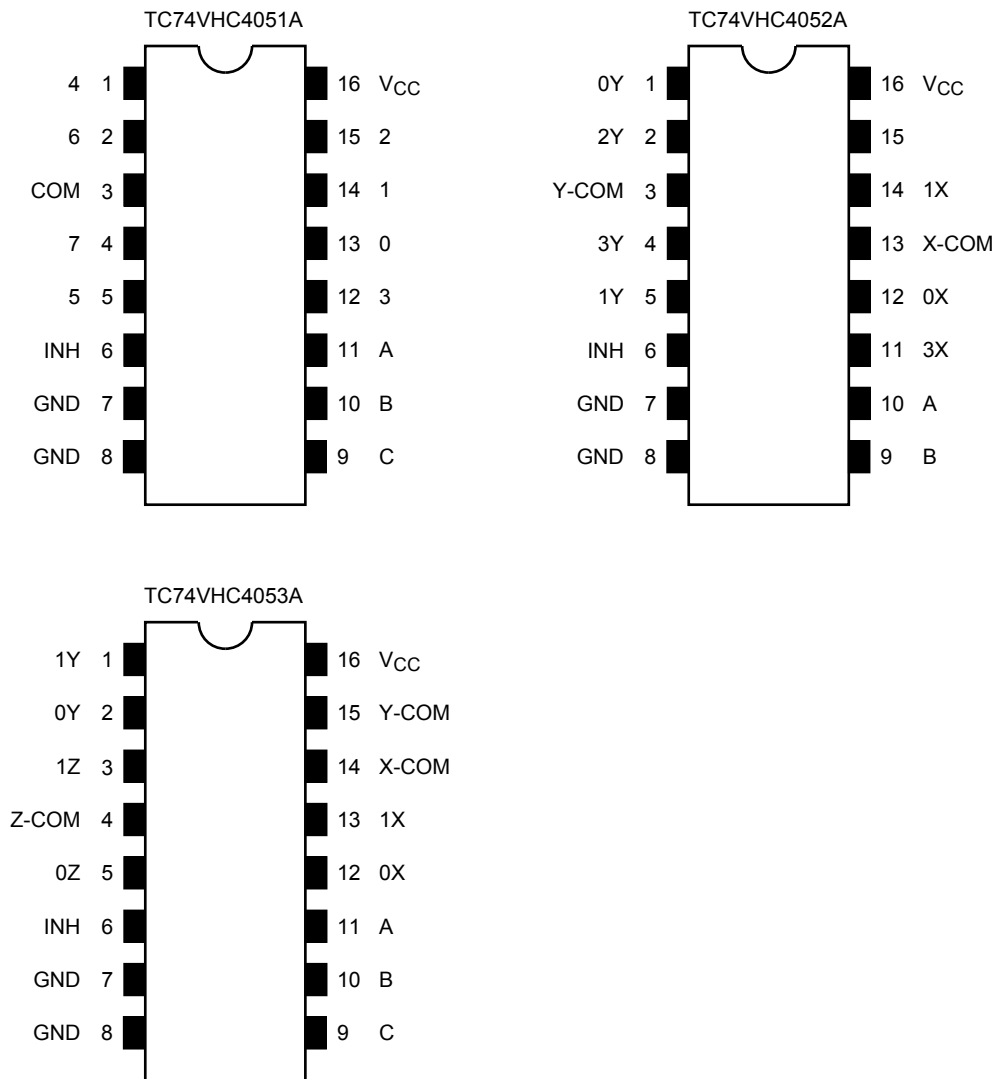
TSSOP16-P-0044-0.65A

TC74VHC4051AFK, TC74VHC4052AFK,  
TC74VHC4053AFK

VSSOP16-P-0030-0.50

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)



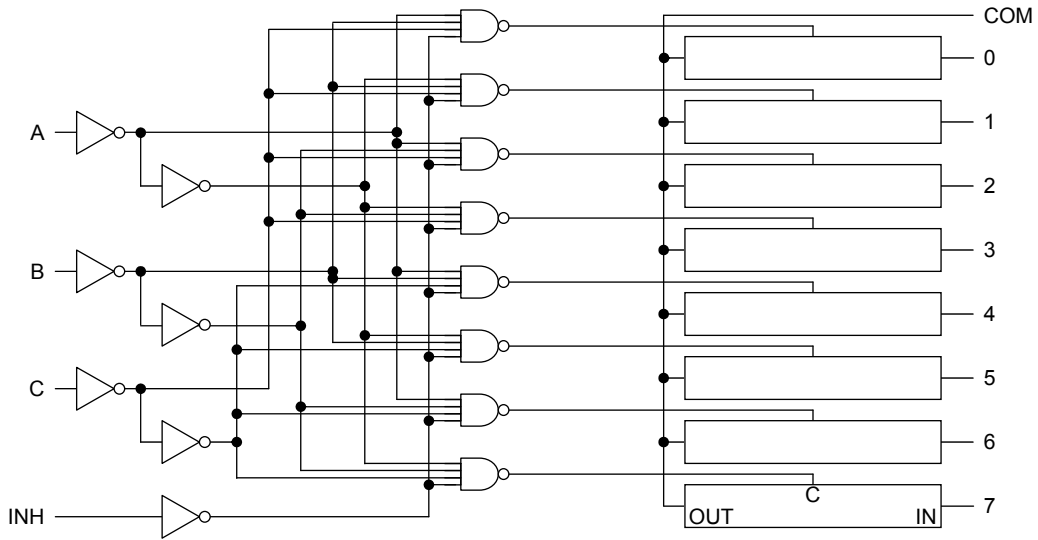
## Truth Table

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

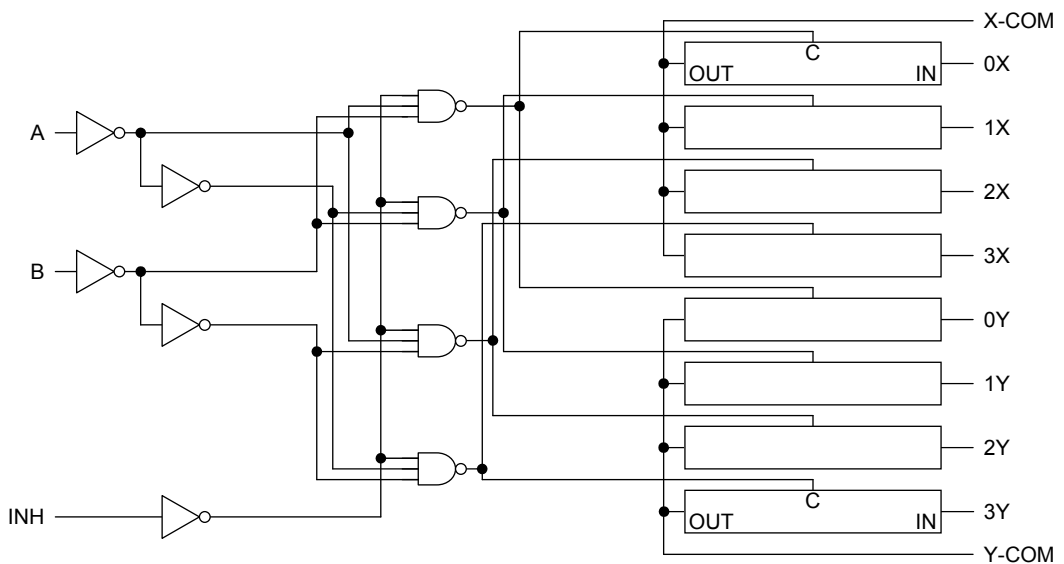
X: Don't care, \*: Except VHC4052AFT

## System Diagram

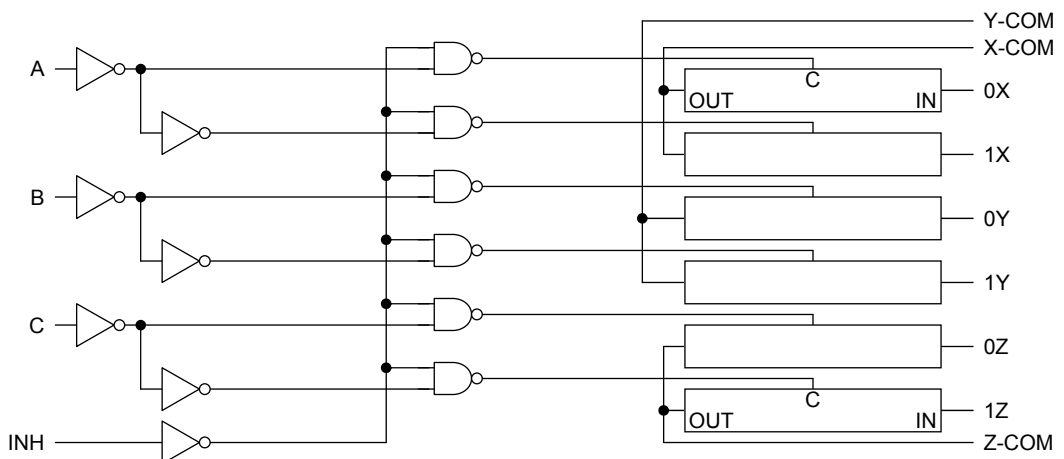
### TC74VHC4051A



### 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	$I_{IOK}$	±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		
				V <sub>CC</sub> (V)	Min	Typ.	Max	Min		Max	
Phase difference between input and output	$\phi$ /O	C <sub>L</sub> = 15 pF R <sub>L</sub> = 1 k $\Omega$	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		
		C <sub>L</sub> = 50 pF R <sub>L</sub> = 1 k $\Omega$	Figure 1	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	$t_{pZL}$ $t_{pZH}$	C <sub>L</sub> = 15 pF R <sub>L</sub> = 1 k $\Omega$	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		
		C <sub>L</sub> = 50 pF R <sub>L</sub> = 1 k $\Omega$	Figure 1	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	$t_{pLZ}$ $t_{pHZ}$	C <sub>L</sub> = 15 pF R <sub>L</sub> = 1 k $\Omega$	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		
		C <sub>L</sub> = 50 pF R <sub>L</sub> = 1 k $\Omega$	Figure 1	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	C <sub>IN</sub>	All types		—	—	3	—	—	10	pF	
COMMON terminal capacitance	C <sub>IS</sub>	4051A 4052A 4053A	Figure 2	—	—	23.4	—	—	—	—	pF
						13.1					
						8.2					
SWITCH terminal capacitance	C <sub>OS</sub>	4051A 4052A 4053A	Figure 2	—	—	5.7	—	—	—	—	pF
						5.6					
						5.6					
Feedthrough capacitance	C <sub>IOS</sub>	4051A 4052A 4053A	Figure 2	—	—	0.5	—	—	—	—	pF
						0.5					
						0.5					
Power dissipation capacitance	C <sub>PD</sub>	4051A 4052A 4053A	Figure 2 (Note)	—	—	15	—	—	—	—	pF
						24					
						12					

Note: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.

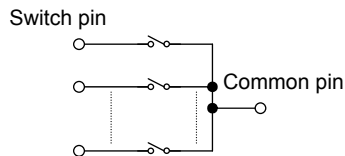
Average operating current can be obtained by the equation:

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

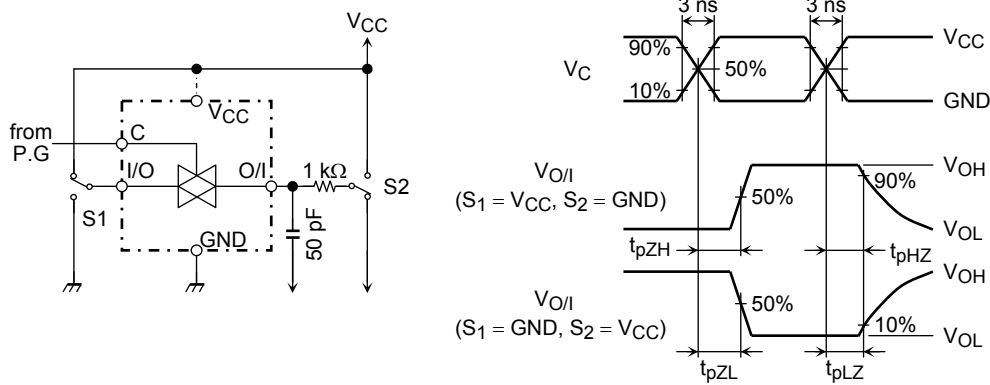
## Analog Switch Characteristics (Ta = 25°C) (Note)

Characteristics	Test Condition		V <sub>CC</sub> (V)	Typ.	Unit
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	

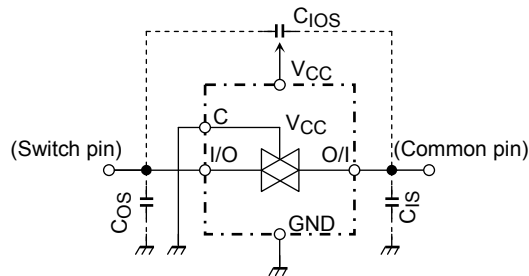
Note: These characteristics are determined by design of devices.



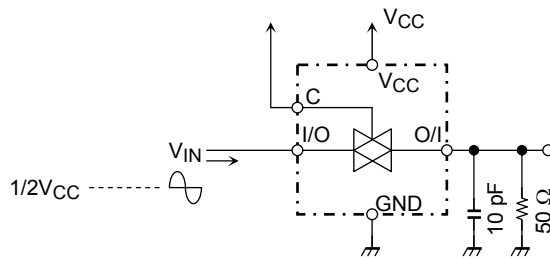
**AC Test Circuit**



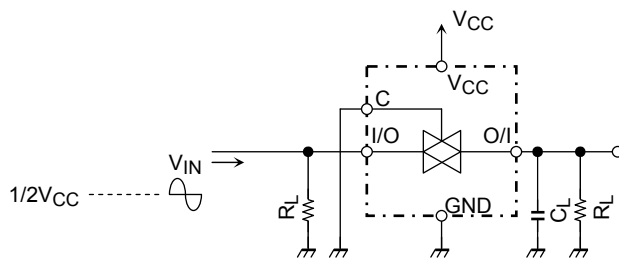
**Figure 1**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$



**Figure 2**  $C_{10S}$ ,  $C_{1S}$ ,  $C_{0S}$

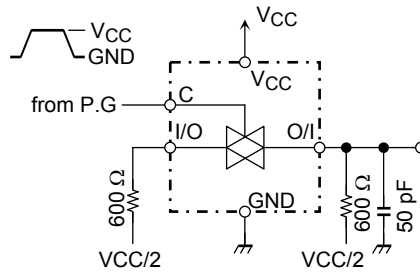


**Figure 3** Frequency Response (switch on)

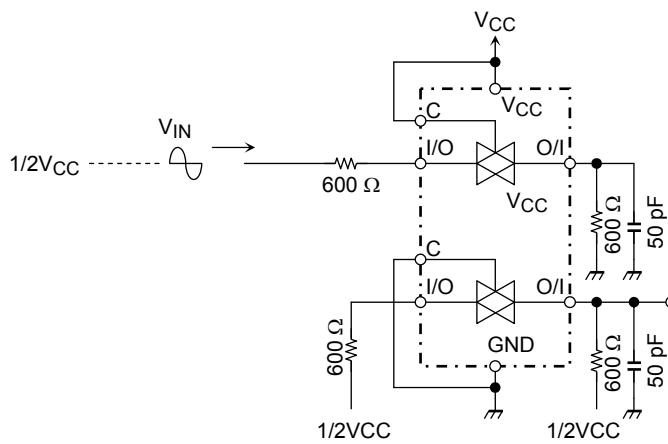


**Figure 4** Feedthrough





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

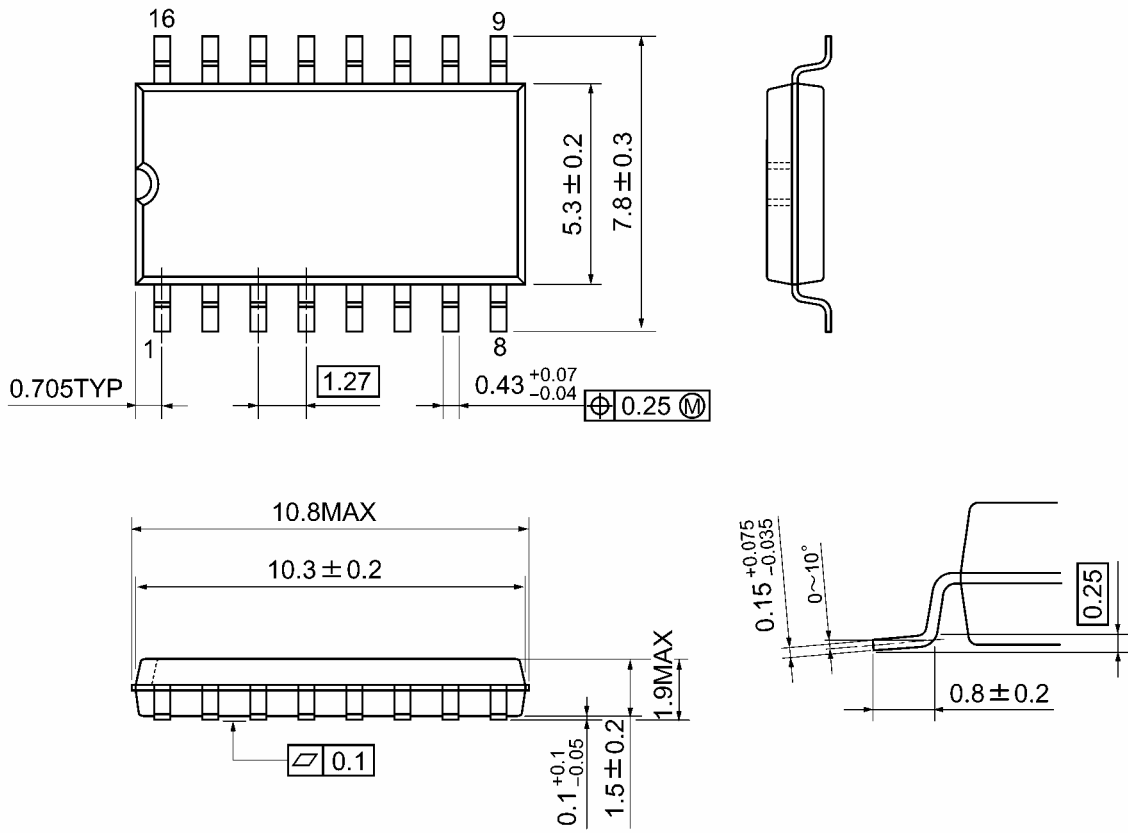


**Figure 6 Cross Talk (between any two switches)**

**Package Dimensions**

SOP16-P-300-1.27A

Unit: mm

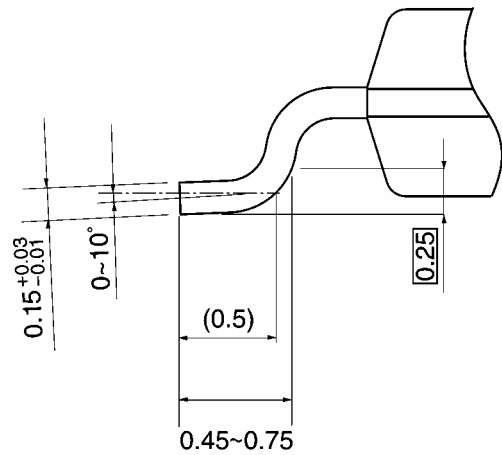
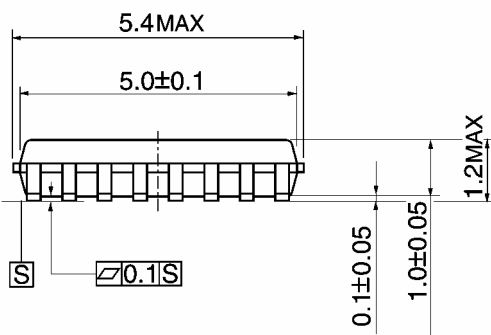
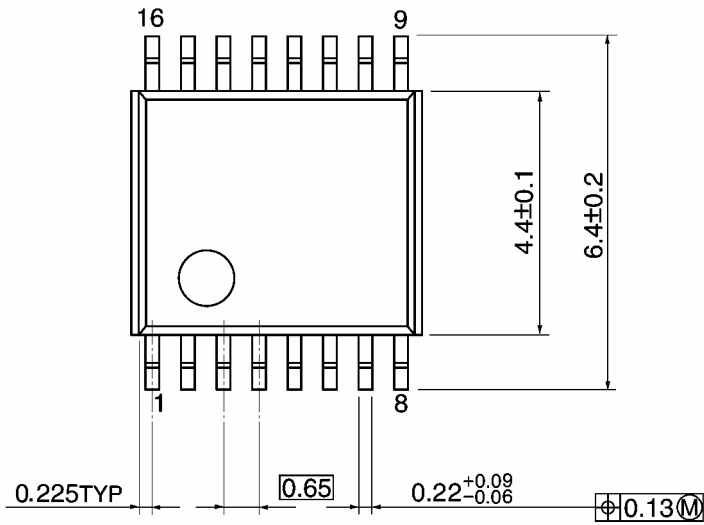


Weight: 0.18 g (typ.)

**Package Dimensions**

TSSOP16-P-0044-0.65A

Unit: mm

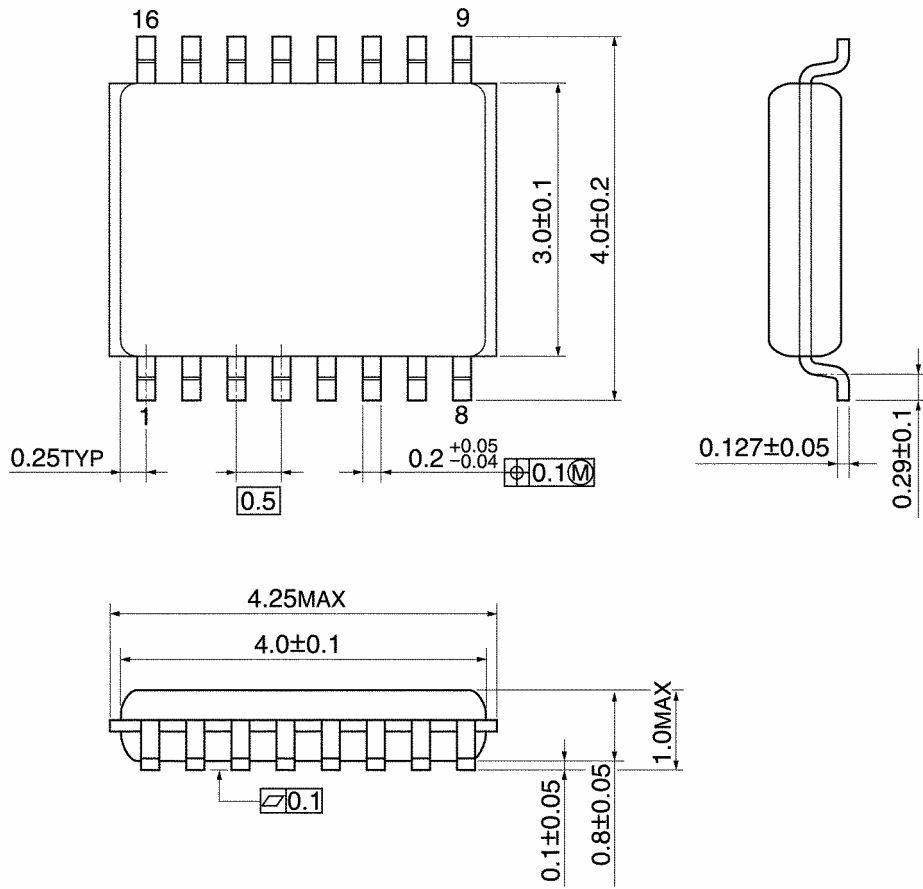


Weight: 0.06 g (typ.)

## Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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20070701-EN

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