

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  $\times$  2 configuration, and the 4053A has a 2-channel  $\times$  3 configuration.

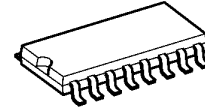
The switches for each channel are turned ON by the control pin digital signals.

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 VCC). 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

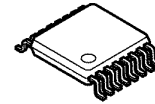
- Low ON resistance:  $R_{on} = 45\Omega$  (typ.) ( $V_{CC} = 3\text{ V}$ )  
 $R_{on} = 24\Omega$  (typ.) ( $V_{CC} = 4.5\text{ V}$ )
- Low power dissipation:  $I_{CC} = 2.0\text{ }\mu\text{A}$  (max) ( $T_a = 25^\circ\text{C}$ )
- Input level:  $V_{IL} = 0.8\text{ V}$  (max) ( $V_{CC} = 3\text{ V}$ )  
 $V_{IH} = 2.0\text{ V}$  (min) ( $V_{CC} = 3\text{ V}$ )
- Power down protection is provided on all control inputs

TC74VHC4051AF, TC74VHC4052AF,  
TC74VHC4053AF



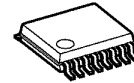
SOP16-P-300-1.27A

TC74VHC4051AFT, TC74VHC4052AFT,  
TC74VHC4053AFT



TSSOP16-P-0044-0.65A

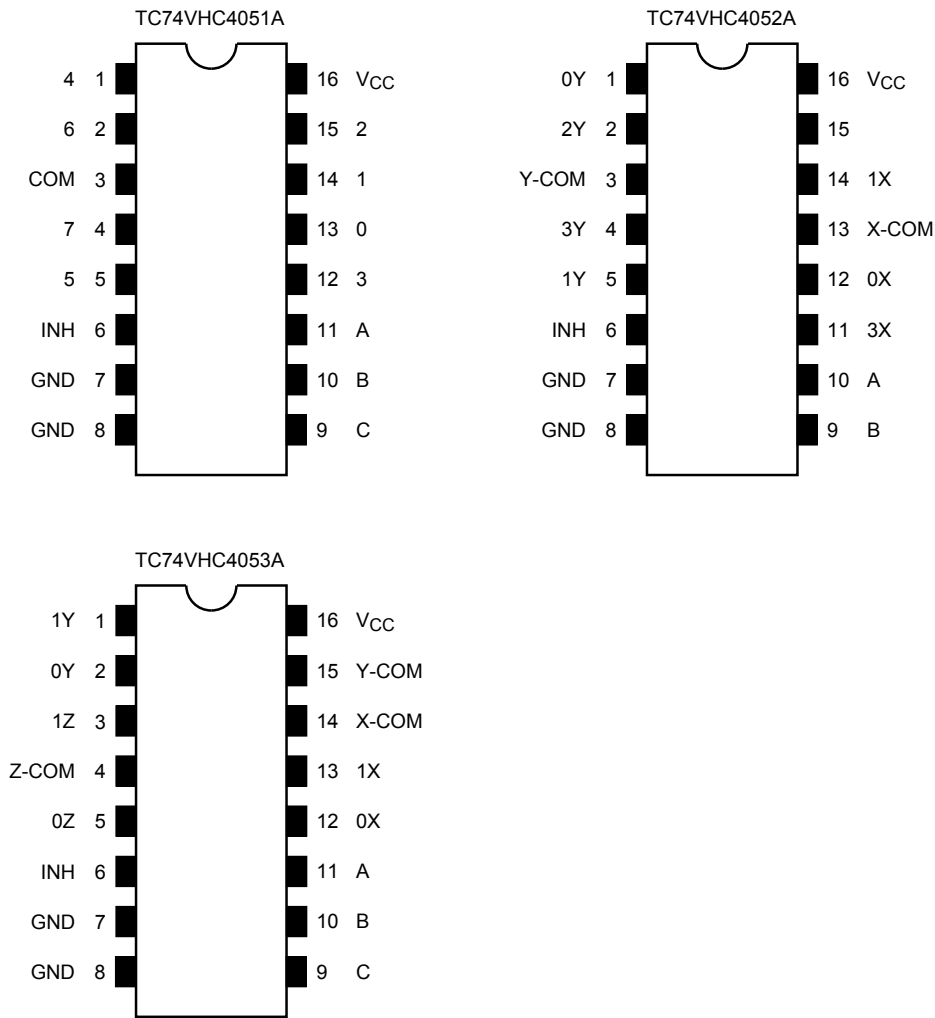
TC74VHC4051AFK, TC74VHC4052AFK,  
TC74VHC4053AFK



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)



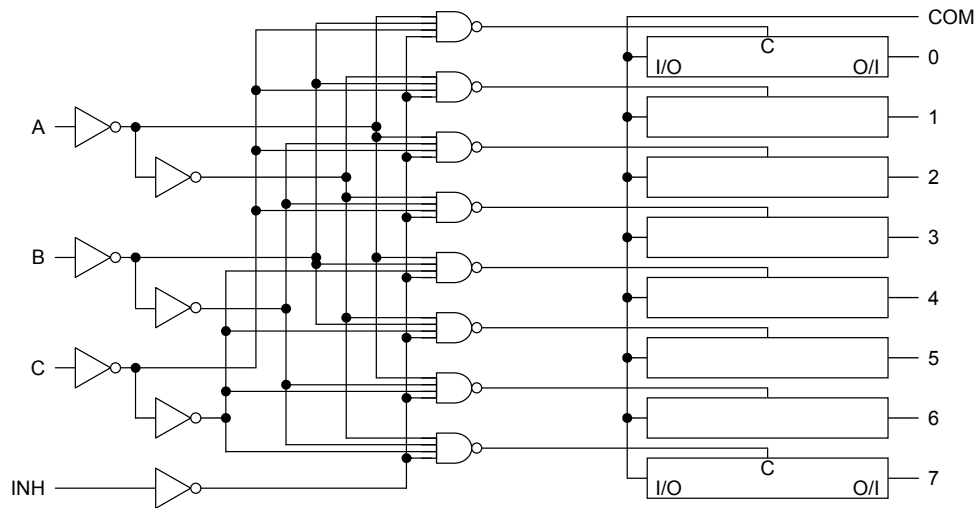
Truth Table

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

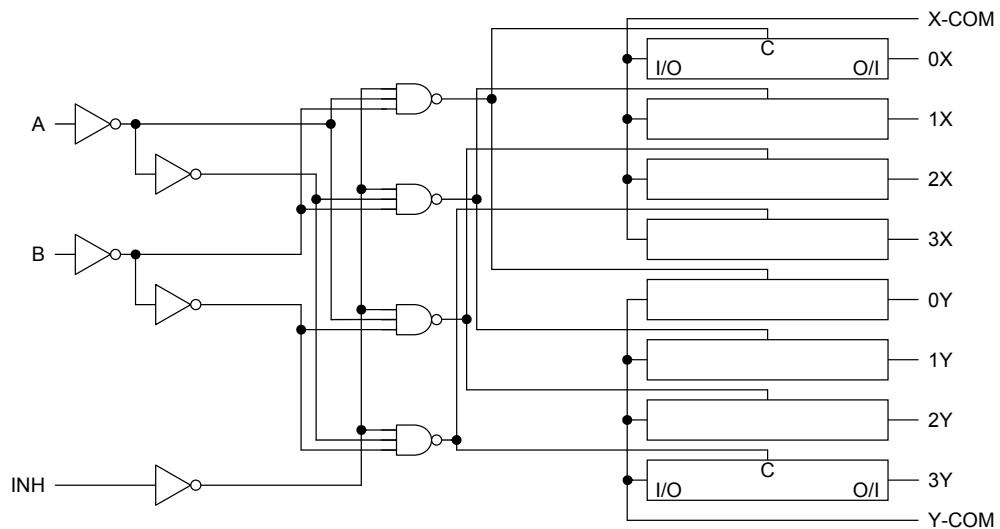
X: Don't care, \*: Except VHC4052A

## System Diagram

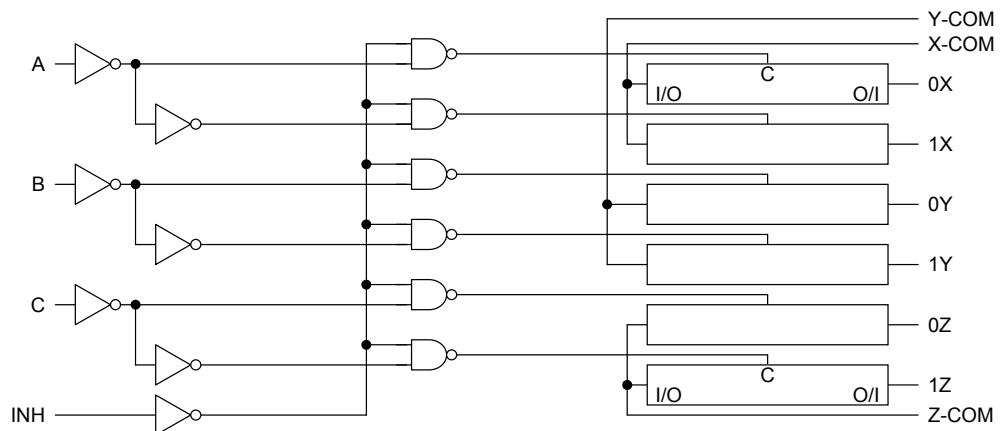
### TC74VHC4051A



### TC74VHC4052A



### TC74VHC4053A



**Absolute Maximum Ratings (Note)**

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	-0.5 to 7.0	V
Control input voltage	$V_{IN}$	-0.5 to 7.0	V
Switch I/O voltage	$V_{I/O}$	- 0.5 to $V_{CC} + 0.5$	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 to 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 to 5.5	V
Input voltage	$V_{IN}$	0 to 5.5	V
Switch I/O voltage	$V_{I/O}$	0 to $V_{CC}$	V
Operating temperature	$T_{opr}$	-40 to 85	°C
Input rise and fall time	dt/dv	0 to 200 ( $V_{CC} = 2.5 \pm 0.2$ V)	ns/V
		0 to 100 ( $V_{CC} = 3.3 \pm 0.3$ V)	
		0 to 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 to 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	
			V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>I/O</sub> = V <sub>CC</sub> or GND I <sub>I/O</sub> = 2 mA	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:  $t_r = t_f = 3 \text{ ns}$ )**

Characteristics	Symbol	Test Condition		Ta = 25°C				Ta = −40 to 85°C		Unit		
				V <sub>CC</sub> (V)	Min	Typ.	Max	Min	Max			
Phase difference between input and output	φ <sub>I/O</sub>	C <sub>L</sub> = 15 pF R <sub>L</sub> = 1 kΩ		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 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	t <sub>pZL</sub> t <sub>pZH</sub>	C <sub>L</sub> = 15 pF R <sub>L</sub> = 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	
		C <sub>L</sub> = 50 pF R <sub>L</sub> = 1 kΩ		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 <sub>pLZ</sub> t <sub>pHZ</sub>	C <sub>L</sub> = 15 pF R <sub>L</sub> = 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	
		C <sub>L</sub> = 50 pF R <sub>L</sub> = 1 kΩ		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	Figure 2	—	—	23.4	—	—	—	pF		
		4052A				13.1						
		4053A				8.2						
SWITCH terminal capacitance	C <sub>OS</sub>	4051A	Figure 2	—	—	5.7	—	—	—	pF		
		4052A				5.6						
		4053A				5.6						
Feedthrough capacitance	C <sub>IOS</sub>	4051A	Figure 2	—	—	0.5	—	—	—	pF		
		4052A				0.5						
		4053A				0.5						
Power dissipation capacitance	C <sub>PD</sub>	4051A	Figure 2 (Note)	—	—	15	—	—	—	pF		
		4052A				24						
		4053A				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.

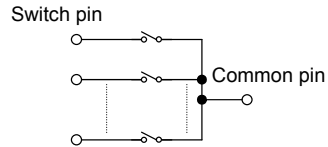
Average operating current can be obtained by the equation:

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

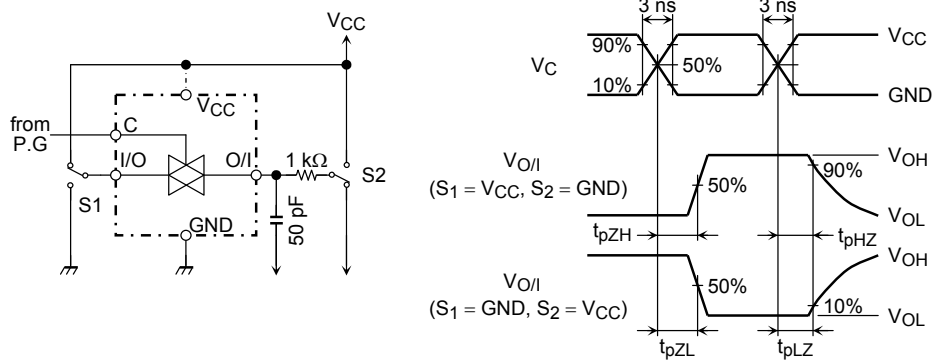
**Analog Switch Characteristics (Ta = 25°C) (Note)**

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	

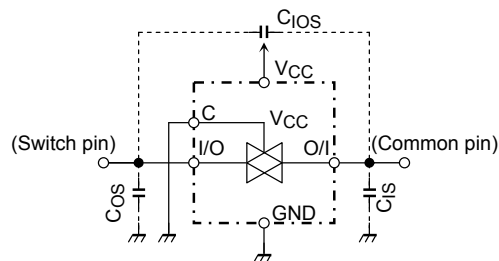
Note: These characteristics are determined by design of devices.



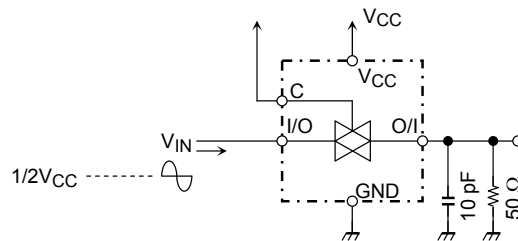
## AC Test Circuit



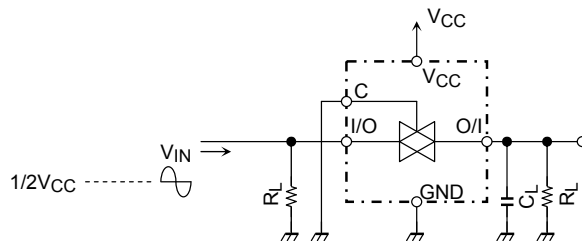
**Figure 1**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$



**Figure 2**  $C_{1OS}$ ,  $C_{1S}$ ,  $C_{2OS}$

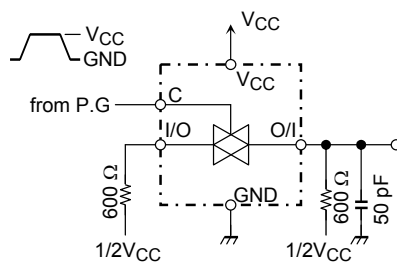


**Figure 3** Frequency Response (switch on)

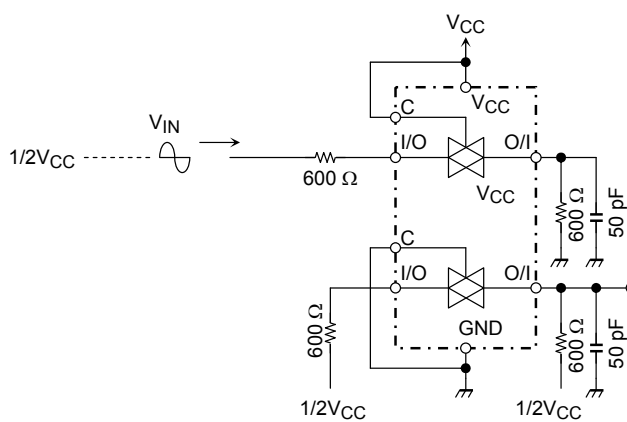


**Figure 4** Feedthrough





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

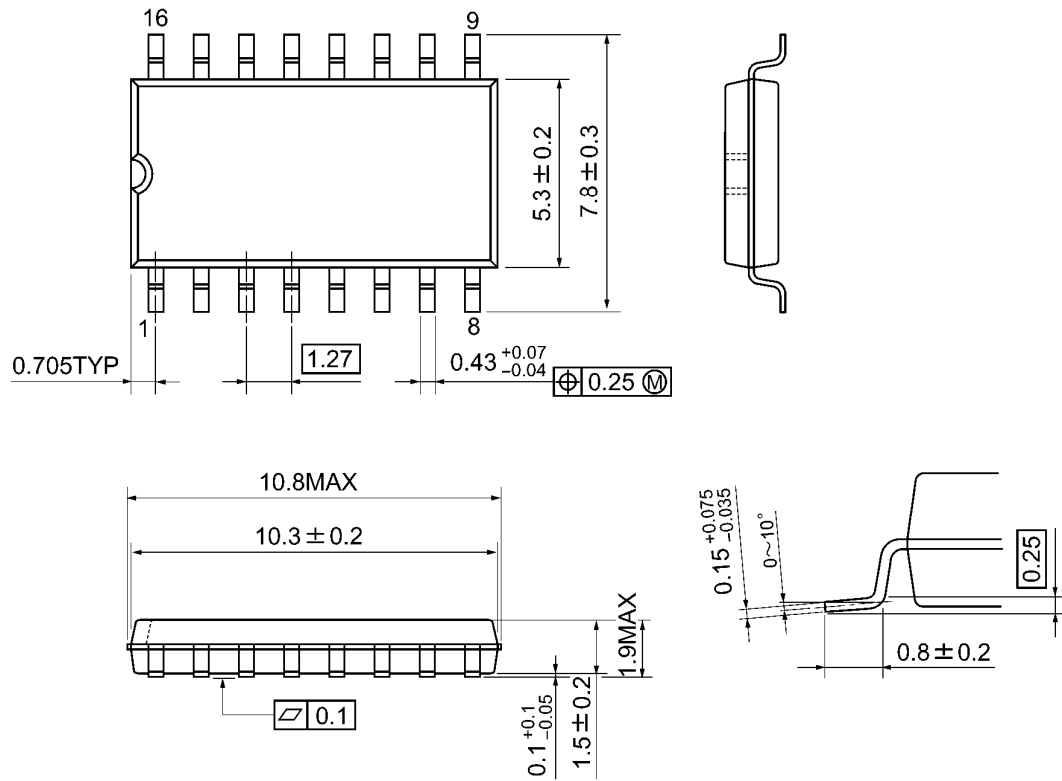


**Figure 6 Cross Talk (between any two switches)**

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm

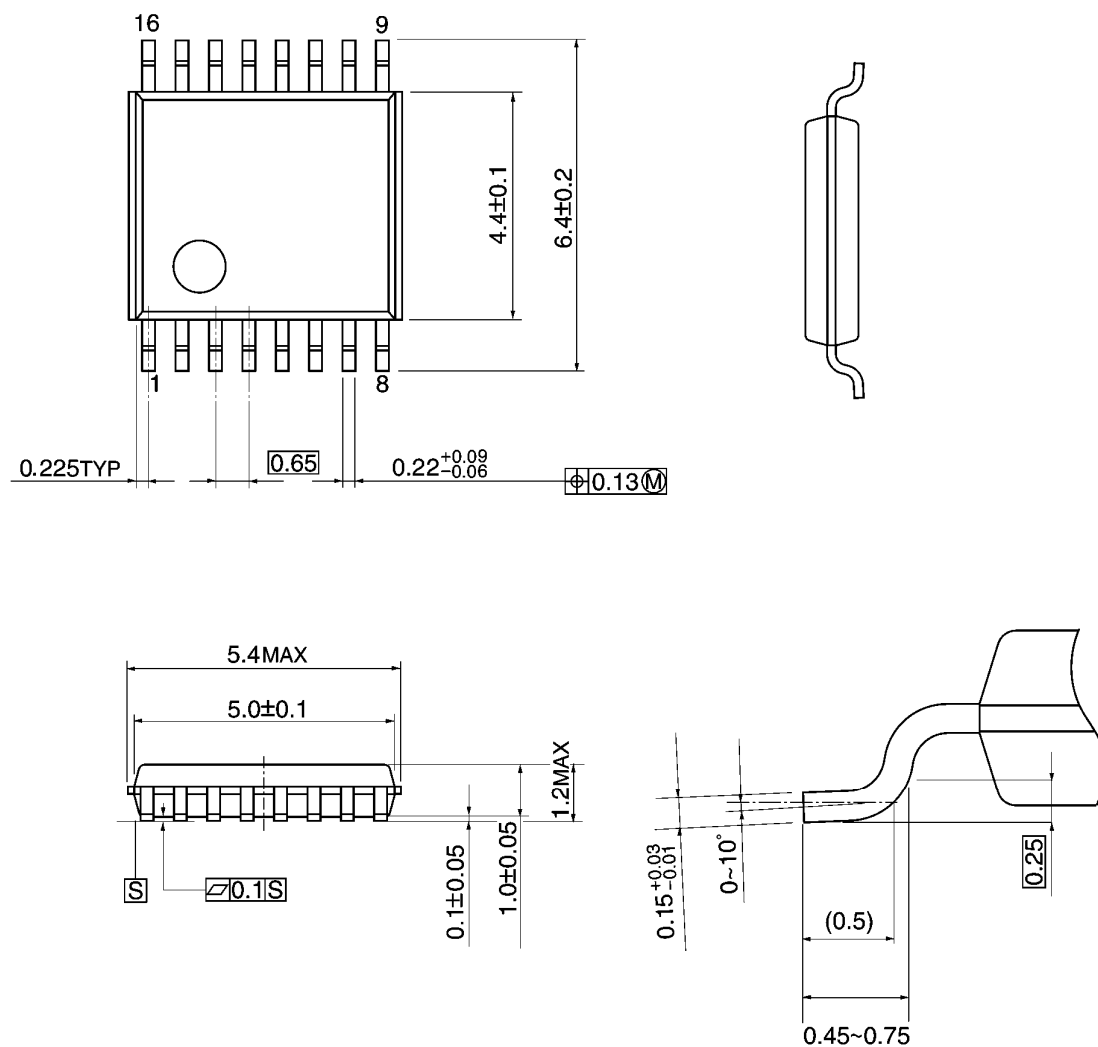


Weight: 0.18 g (typ.)

## Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm

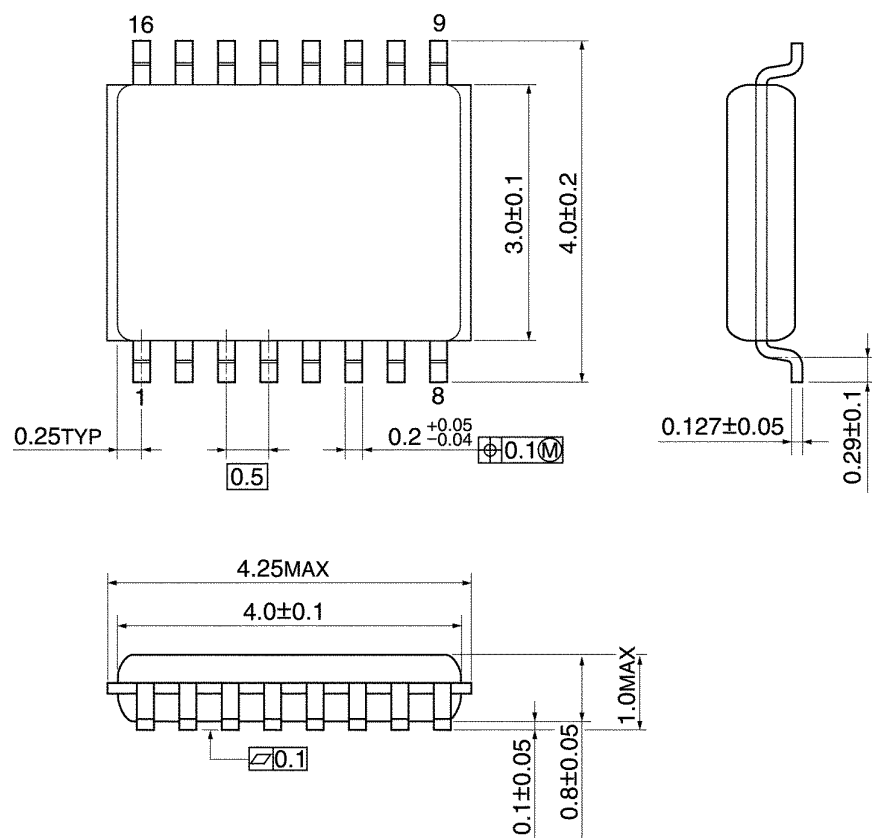


Weight: 0.06 g (typ.)

## Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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20070701-EN GENERAL

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