

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74HC4051AP, TC74HC4051AF, TC74HC4051AFT TC74HC4052AP, TC74HC4052AF, TC74HC4052AFT TC74HC4053AP, TC74HC4053AF, TC74HC4053AFN, TC74HC4053AFT

### TC74HC4051AP/AF/AFT

8-Channel Analog Multiplexer/Demultiplexer

### TC74HC4052AP/AF/AFT

Dual 4-Channel Analog Multiplexer/Demultiplexer

### TC74HC4053AP/AF/AFN/AFT

Triple 2-Channel Analog Multiplexer/Demultiplexer

The TC74HC4051A/4052A/4053A 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 TC74HC4051A has an 8 channel configuration, the TC74HC4052A has a 4 channel × 2 configuration and the TC74HC4053A 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<sub>CC</sub> – V<sub>EE</sub>) can then be switched by the small logical amplitude (V<sub>CC</sub> – GND) control signal.

For example, in the case of V<sub>CC</sub> = 5 V, GND = 0 V, V<sub>EE</sub> = -5 V, signals between -5 V and +5 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.

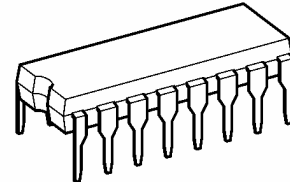
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

### Features

- High speed: t<sub>pd</sub> = 15 ns (typ.) at V<sub>CC</sub> = 5 V, V<sub>EE</sub> = 0 V
- Low power dissipation: I<sub>CC</sub> = 4 μA (max) at T<sub>a</sub> = 25°C
- High noise immunity: V<sub>NIH</sub> = V<sub>NIL</sub> = 28% V<sub>CC</sub> (min)
- Low ON resistance: R<sub>ON</sub> = 50 Ω (typ.) at V<sub>CC</sub> – V<sub>EE</sub> = 9 V
- High noise immunity: THD = 0.02% (typ.) at V<sub>CC</sub> – V<sub>EE</sub> = 9 V
- Pin and function compatible with 4051/4052/4053B

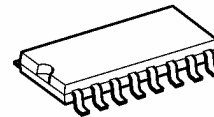
Note: xxxFN (JEDEC SOP) is not available in Japan.

TC74HC4051AP, TC74HC4052AP, TC74HC4053AP



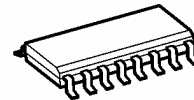
DIP16-P-300-2.54A

TC74HC4051AF, TC74HC4052AF, TC74HC4053AF



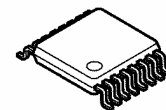
SOP16-P-300-1.27A

TC74HC4053AFN



SOL16-P-150-1.27

TC74HC4051AFT, TC74HC4052AFT, TC74HC4053AFT

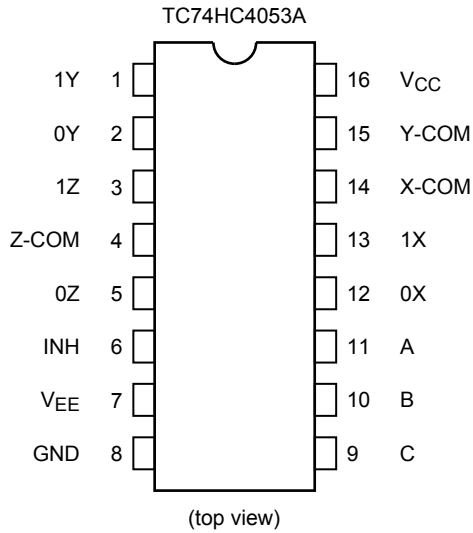
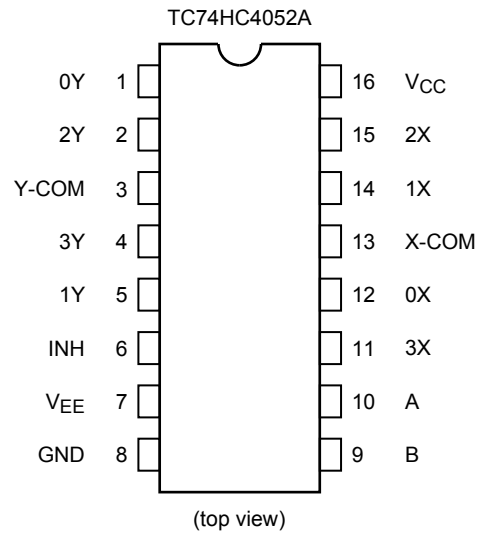
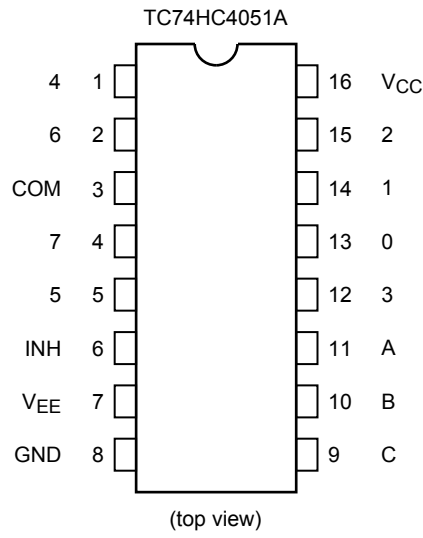


TSSOP16-P-0044-0.65A

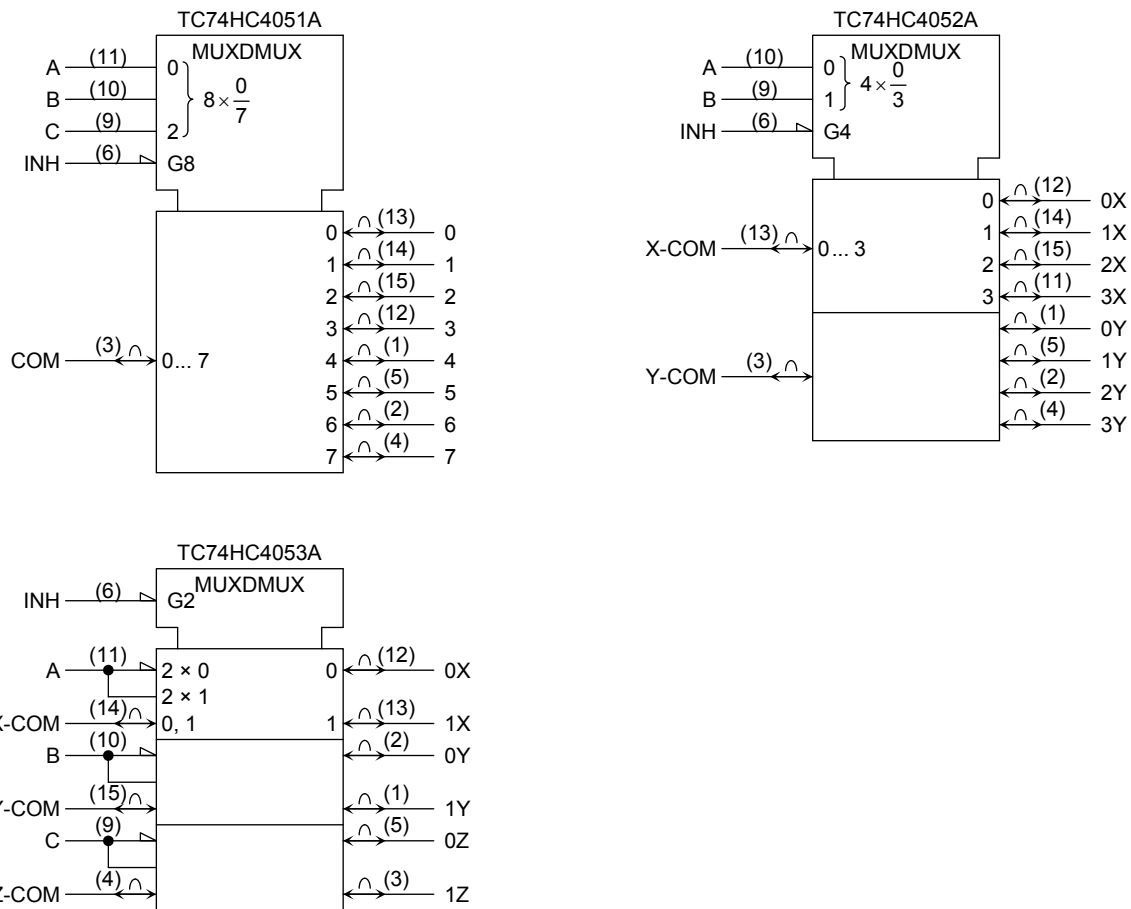
### Weight

DIP16-P-300-2.54A	: 1.00 g (typ.)
SOP16-P-300-1.27A	: 0.18 g (typ.)
SOL16-P-150-1.27	: 0.13 g (typ.)
TSSOP16-P-0044-0.65A	: 0.06 g (typ.)

**Pin Assignment**



## IEC Logic Symbol



## Truth Table

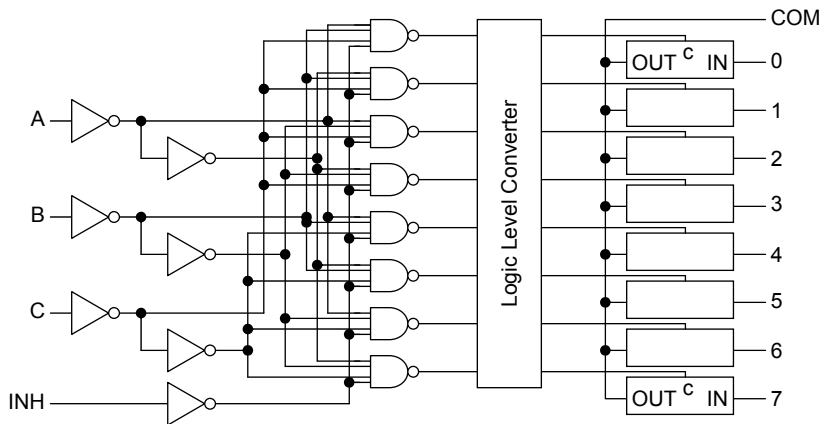
Control Inputs				"ON" Channel		
Inhibit	C*	B	A	HC4051A	HC4052A	HC4053A
L	L	L	L	0	0X, 0Y	0X, 0Y, 0Z
L	L	L	H	1	1X, 1Y	1X, 0Y, 0Z
L	L	H	L	2	2X, 2Y	0X, 1Y, 0Z
L	L	H	H	3	3X, 3Y	1X, 1Y, 0Z
L	H	L	L	4	—	0X, 0Y, 1Z
L	H	L	H	5	—	1X, 0Y, 1Z
L	H	H	L	6	—	0X, 1Y, 1Z
L	H	H	H	7	—	1X, 1Y, 1Z
H	X	X	X	None	None	None

X: Don't care

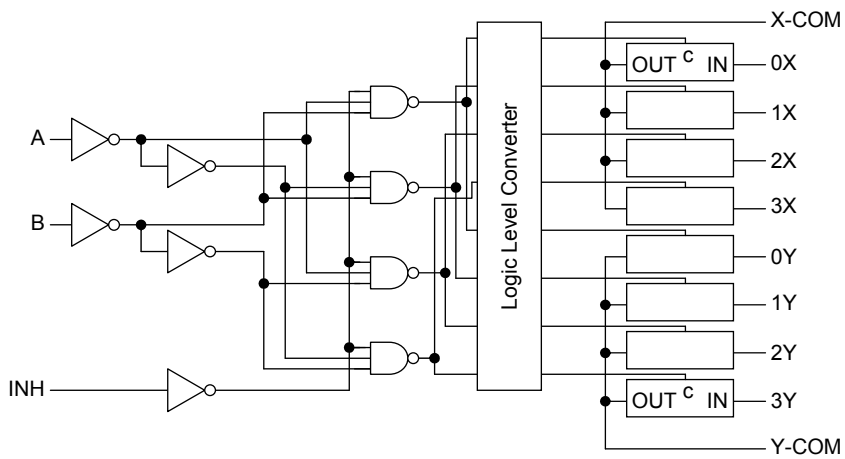
\*: Except HC4052A

**System Diagram**

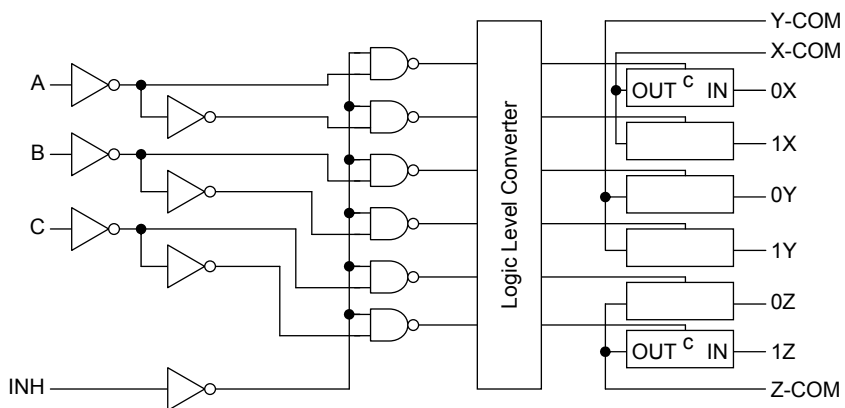
**TC74HC4051A**



**TC74HC4052A**



**TC74HC4053A**



## Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Supply voltage range	$V_{CC}$	-0.5 to 7	V
Supply voltage range	$V_{CC}-V_{EE}$	-0.5 to 13	V
Control 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
Control input diode current	$I_{ICK}$	$\pm 20$	mA
I/O diode current	$I_{OK}$	$\pm 20$	mA
Switch through current	$I_T$	$\pm 25$	mA
DC $V_{CC}$ or ground current	$I_{CC}$	$\pm 50$	mA
Power dissipation	$P_D$	500 (DIP) (Note 2)/180 (SOP, TSSOP)	mW
Storage temperature	$T_{stg}$	-65 to 150	$^{\circ}C$

Note 1: 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 2: 500 mW in the range of  $T_a = -40$  to  $65^{\circ}C$ . From  $T_a = 65$  to  $85^{\circ}C$  a derating factor of  $-10$  mW/ $^{\circ}C$  should be applied up to 300 mW.

## Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage range	$V_{CC}$	2 to 6	V
Supply voltage range	$V_{EE}$	-6 to 0	V
Supply voltage range	$V_{CC}-V_{EE}$	2 to 12	V
Control 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	$^{\circ}C$
Control input rise and fall time	$t_r, t_f$	0 to 1000 ( $V_{CC} = 2.0$ V) 0 to 500 ( $V_{CC} = 4.5$ V) 0 to 400 ( $V_{CC} = 6.0$ V)	ns

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 Characteristics**

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40 to 85°C		Unit	
		V <sub>EE</sub> (V)	V <sub>CC</sub> (V)	Min	Typ.	Max	Min	Max		
High-level control input voltage	V <sub>IHC</sub>	—	—	2.0	1.50	—	—	1.50	—	V
				4.5	3.15	—	—	3.15	—	
				6.0	4.20	—	—	4.20	—	
Low-level control input voltage	V <sub>ILC</sub>	—	—	2.0	—	—	0.50	—	0.50	V
				4.5	—	—	1.35	—	1.35	
				6.0	—	—	1.80	—	1.80	
ON resistance	R <sub>ON</sub>	V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub> V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub> I <sub>I/O</sub> ≤ 2 mA	GND	4.5	—	85	180	—	225	Ω
			-4.5	4.5	—	55	120	—	150	
			-6.0	6.0	—	50	100	—	125	
		GND	V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub> V <sub>I/O</sub> = V <sub>CC</sub> or V <sub>EE</sub> I <sub>I/O</sub> ≤ 2 mA	2.0	—	150	—	—	—	
			4.5	—	70	150	—	190		
			-4.5	4.5	—	50	100	—	125	
-6.0	6.0	—	45	80	—	100				
Difference of ON resistance between switches	ΔR <sub>ON</sub>	V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub> V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub> I <sub>I/O</sub> ≤ 2 mA	GND	4.5	—	10	30	—	35	Ω
			-4.5	4.5	—	5	12	—	15	
			-6.0	6.0	—	5	10	—	12	
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 or V <sub>CC</sub> V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub>	GND	6.0	—	—	±60	—	±600	nA
			-6.0	6.0	—	—	±100	—	±1000	
Switch input leakage current (switch on)	I <sub>IZ</sub>	V <sub>OS</sub> = V <sub>CC</sub> or GND V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub>	GND	6.0	—	—	±60	—	±600	nA
			-6.0	6.0	—	—	±100	—	±1000	
Control input current	I <sub>IN</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	GND	6.0	—	—	±0.1	—	±1.0	μA
Quiescent supply current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	GND	6.0	—	—	4.0	—	40.0	μA
			-6.0	6.0	—	—	8.0	—	80.0	

## AC Characteristics (C<sub>L</sub> = 50 pF, input: t<sub>r</sub> = t<sub>f</sub> = 6 ns, GND = 0 V)

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40 to 85°C		Unit	
				V <sub>EE</sub> (V)	V <sub>CC</sub> (V)	Min	Typ.	Max		Min
Phase difference between input and output	φ <sub>I/O</sub>	All types	GND	2.0	—	25	60	—	75	ns
			GND	4.5	—	6	12	—	15	
			GND	6.0	—	5	10	—	13	
			-4.5	4.5	—	4	—	—	—	
Output enable time	t <sub>pZL</sub> t <sub>pZH</sub>	4051 (Note 1)	GND	2.0	—	64	225	—	280	ns
			GND	4.5	—	18	45	—	56	
			GND	6.0	—	15	38	—	48	
			-4.5	4.5	—	18	—	—	—	
		4052 (Note 1)	GND	2.0	—	64	225	—	280	
			GND	4.5	—	18	45	—	56	
			GND	6.0	—	15	38	—	48	
			-4.5	4.5	—	18	—	—	—	
		4053 (Note 1)	GND	2.0	—	50	225	—	280	
			GND	4.5	—	14	45	—	56	
			GND	6.0	—	12	38	—	48	
			-4.5	4.5	—	14	—	—	—	
Output disable time	t <sub>pLZ</sub> t <sub>pHZ</sub>	4051 (Note 1)	GND	2.0	—	100	250	—	315	ns
			GND	4.5	—	33	50	—	63	
			GND	6.0	—	28	43	—	54	
			-4.5	4.5	—	29	—	—	—	
		4052 (Note 1)	GND	2.0	—	100	250	—	315	
			GND	4.5	—	33	50	—	63	
			GND	6.0	—	28	43	—	54	
			-4.5	4.5	—	29	—	—	—	
		4053 (Note 1)	GND	2.0	—	95	225	—	280	
			GND	4.5	—	30	45	—	56	
			GND	6.0	—	26	38	—	48	
			-4.5	4.5	—	26	—	—	—	
Control input capacitance	C <sub>IN</sub>	All types	—	—	—	5	10	—	10	pF
COMMON terminal capacitance	C <sub>IS</sub>	4051	—	—	—	36	70	—	70	pF
		4052	-5.0	5.0	—	19	40	—	40	
		4053	—	—	—	11	20	—	20	
SWITCH terminal capacitance	C <sub>OS</sub>	4051	—	—	—	7	15	—	15	pF
		4052	-5.0	5.0	—	7	15	—	15	
		4053	—	—	—	7	15	—	15	
Feedthrough capacitance	C <sub>IOS</sub>	4051	—	—	—	0.95	2	—	2	pF
		4052	-5.0	5.0	—	0.85	2	—	2	
		4053	—	—	—	0.75	2	—	2	
Power dissipation capacitance	C <sub>PD</sub>	4051	—	—	—	70	—	—	—	pF
		4052 (Note 2)	GND	5.0	—	71	—	—	—	
		4053	—	—	—	67	—	—	—	

Note 1: R<sub>L</sub> = 1 kΩ

Note 2: 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 (GND = 0 V, Ta = 25°C) (Note 1)

Characteristics	Symbol	Test Condition			Typ.	Unit					
			V <sub>EE</sub> (V)	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> = 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					
Frequency response (switch on)	f <sub>max</sub>	Adjust f <sub>IN</sub> voltage to obtain 0dBm at V <sub>OS</sub> Increase f <sub>IN</sub> frequency until dB meter reads -3dB R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF f <sub>IN</sub> = 1 MHz, sine wave	All (Note 2)	-2.25	2.25	120	MHz				
			4051 (Note 3)			45					
			4052			70					
			4053	95	-4.5	4.5		All (Note 2)	190		
			4051 (Note 3)	70							
			4052	110							
			4053	150	-6.0	6.0		All (Note 2)	200		
			4051 (Note 3)	85							
			4052	140							
			4053	190							
			Feed through attenuation (switch off)		V <sub>IN</sub> is centered at (V <sub>CC</sub> - V <sub>EE</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			-2.25	2.25	-50	dB
								-4.5	4.5	-50	
	-6.0	6.0				-50					
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)		-2.25	2.25	60	mV				
				-4.5	4.5	140					
				-6.0	6.0	200					
Crosstalk (between any switches)		Adjust V <sub>IN</sub> to obtain 0dBm at input R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 1 MHz, sine wave		-2.25	2.25	-50	dB				
				-4.5	4.5	-50					
				-6.0	6.0	-50					

Note 1: These characteristics are determined by design of devices.

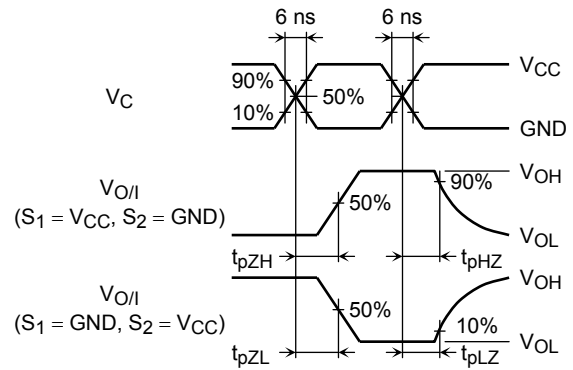
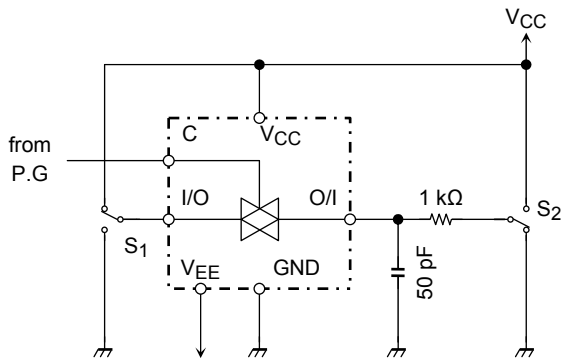
Note 2: Input COMMON terminal, and measured at SWITCH terminal.

Note 3: Input SWITCH terminal, and measured at COMMON terminal.

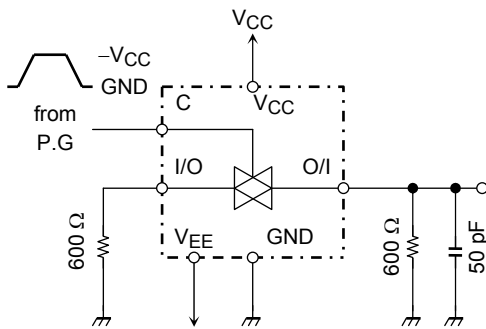


**Switching Characteristics Test Circuits**

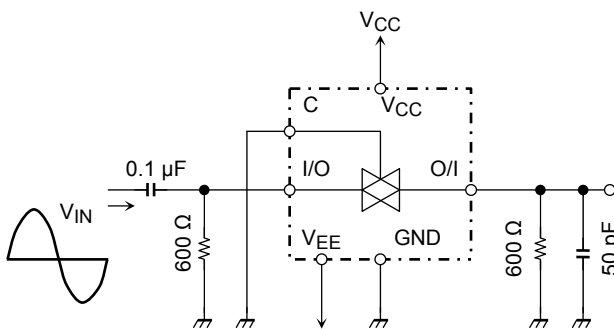
**1.  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$**



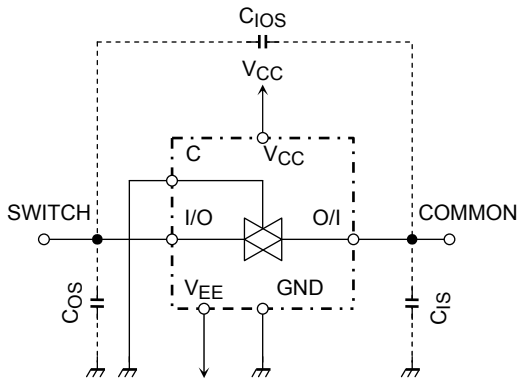
**2. Cross Talk (control input-switch output)  $f_{IN} = 1$  MHz duty = 50%  $t_r = t_f = 6$  ns**



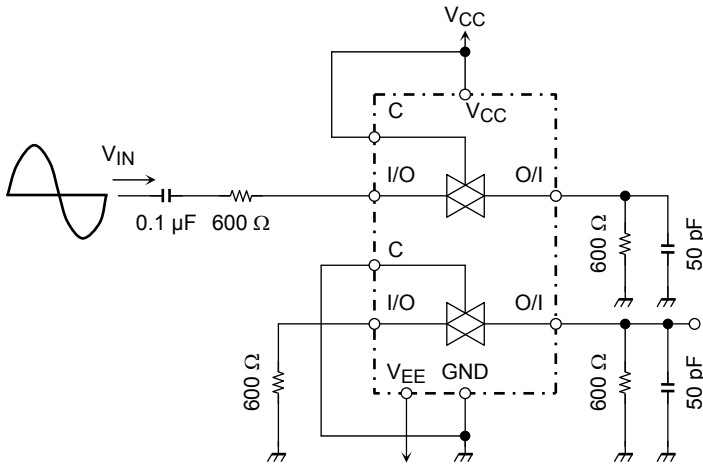
**3. Feedthrough Attenuation**



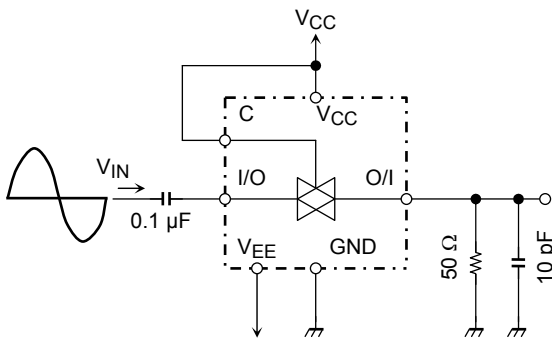
**4. C<sub>IOS</sub>, C<sub>IS</sub>, C<sub>OS</sub>**



**5. Cross Talk (between any two switches)**



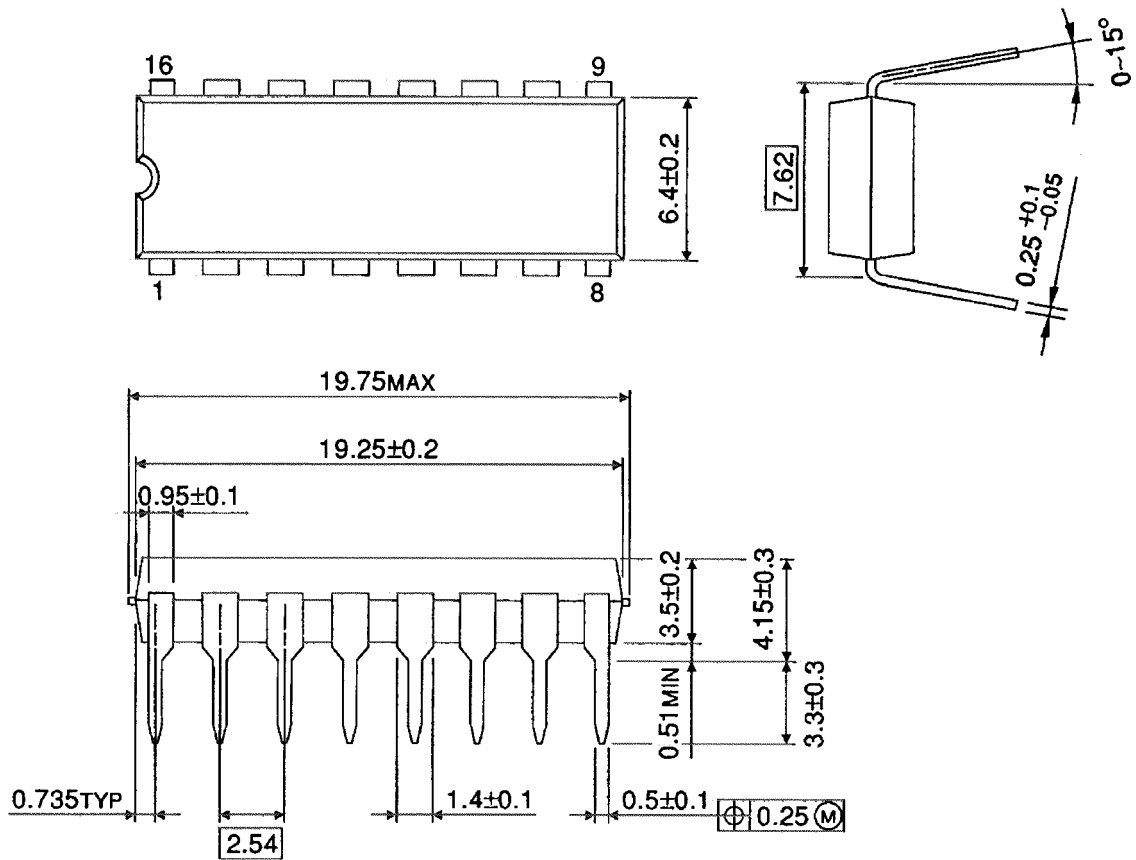
**6. Frequency Response (switch on)**



**Package Dimensions**

DIP16-P-300-2.54A

Unit : mm

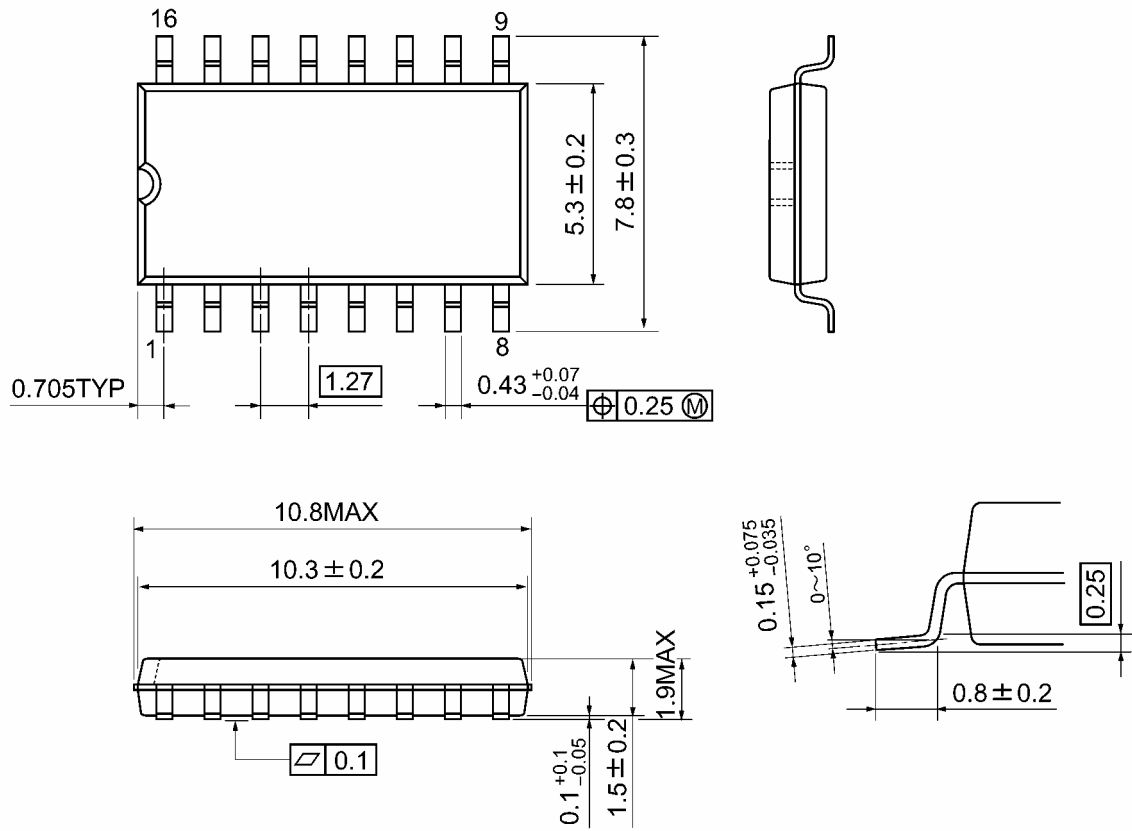


Weight: 1.00 g (typ.)

**Package Dimensions**

SOP16-P-300-1.27A

Unit: mm

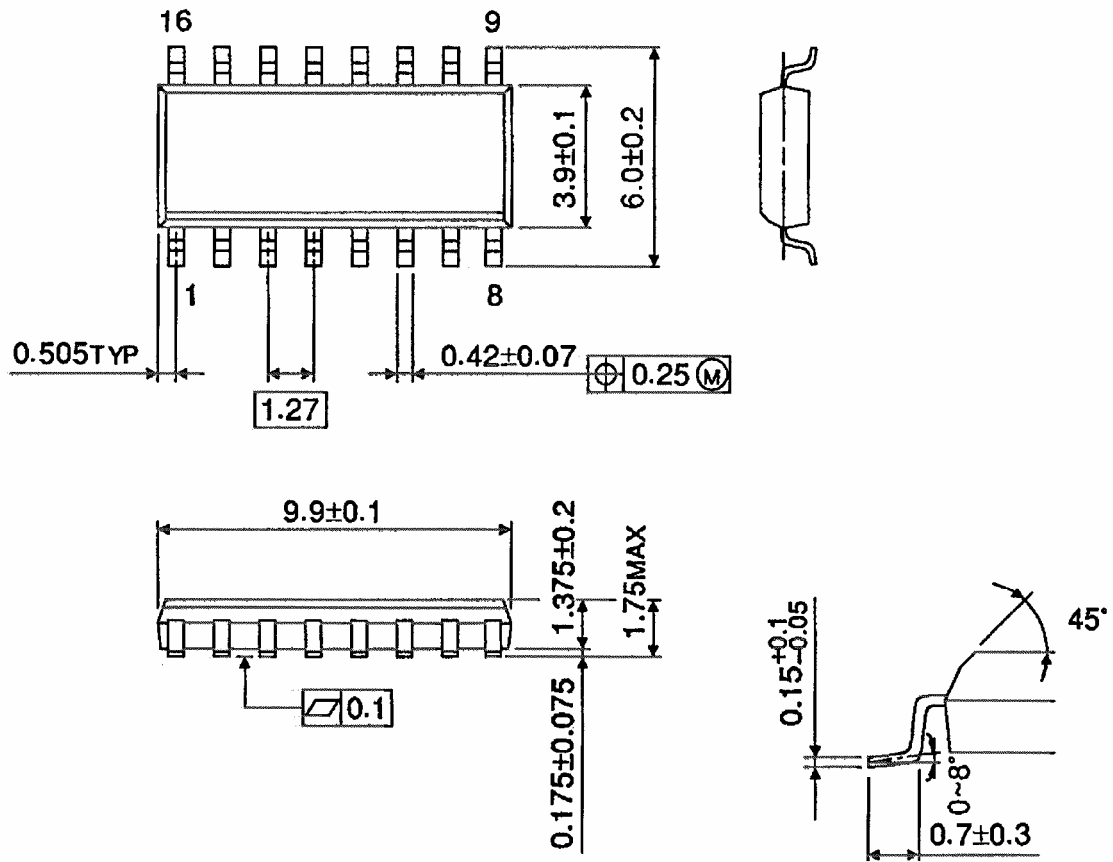


Weight: 0.18 g (typ.)

Package Dimensions (Note)

SOL16-P-150-1.27

Unit : mm



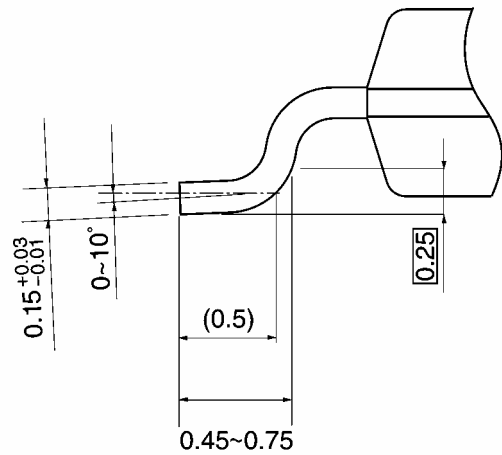
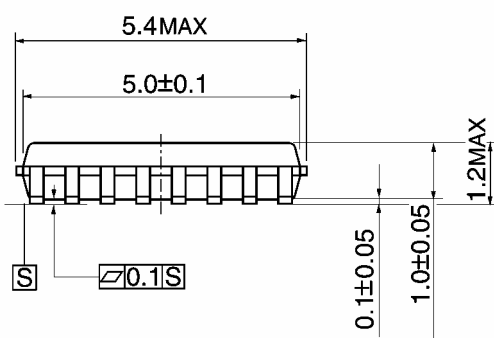
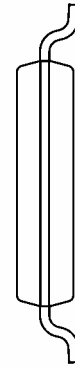
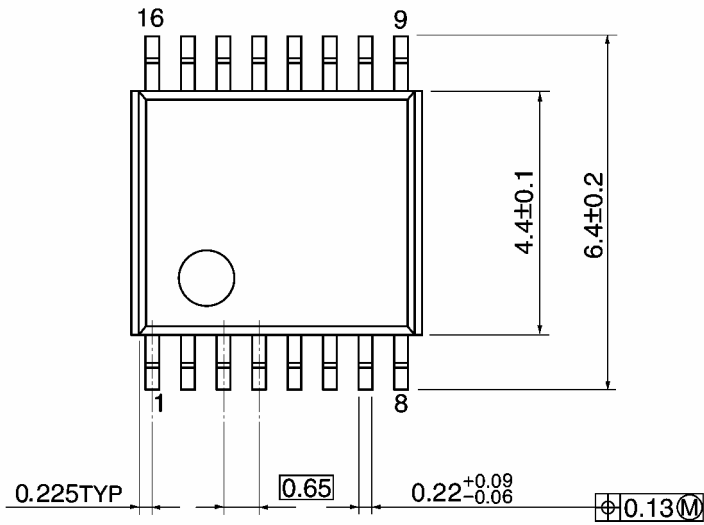
Note: This package is not available in Japan.

Weight: 0.13 g (typ.)

**Package Dimensions**

TSSOP16-P-0044-0.65A

Unit: mm



Weight: 0.06 g (typ.)

**RESTRICTIONS ON PRODUCT USE**

20070701-EN GENERAL

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