

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

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

TC74HC4051AP/AF/AFT

8-Channel Analog  
 Multiplexer/Demultiplexer

TC74HC4052AP/AF/AFT

Dual 4-Channel Analog  
 Multiplexer/Demultiplexer

TC74HC4053AP/AF/AFT

Triple 2-Channel Analog  
 Multiplexer/Demultiplexer

The TC74HC4051A/4052A/4053A are high speed CMOS ANALOG MULTIPLEXER/DEMUTIPLEXER 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.

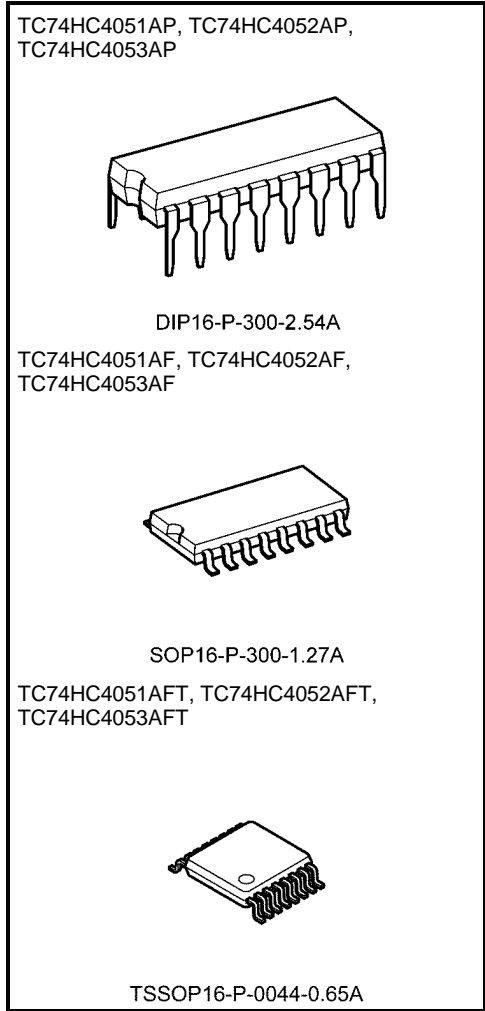
The digital signal to the control terminal turns "ON" the corresponding switch of each channel a large amplitude signal (VCC - VEE) can then be switched by the small logical amplitude (VCC - GND) control signal.

For example, in the case of VCC = 5 V, GND = 0 V, VEE = -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

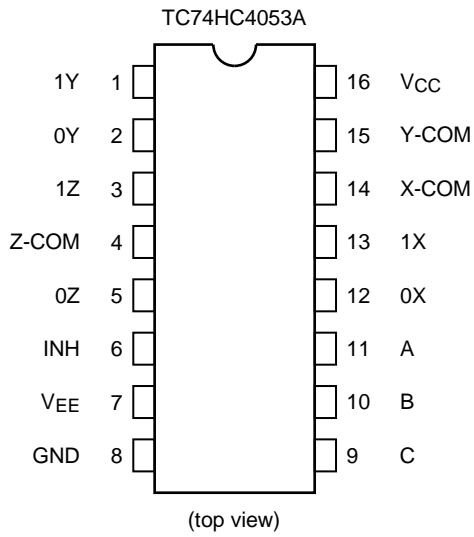
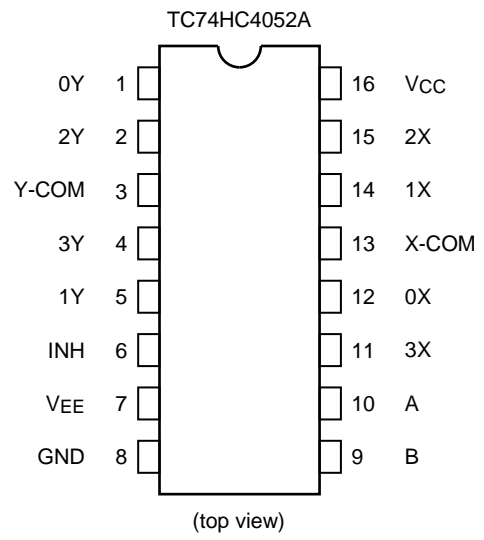
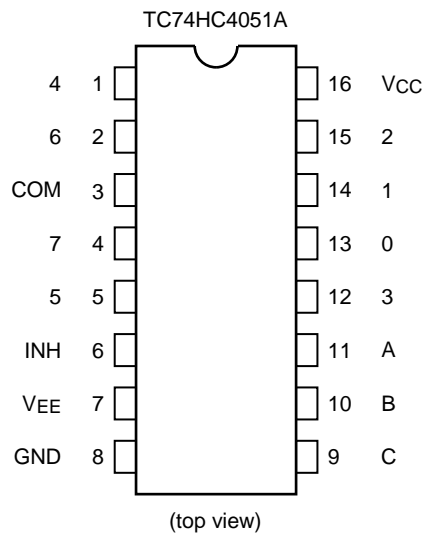
- High speed: t<sub>pd</sub> = 15 ns (typ.) at VCC = 5 V, VEE = 0 V
- Low power dissipation: ICC = 4 μA (max) at Ta = 25°C
- High noise immunity: V<sub>NIH</sub> = V<sub>NIL</sub> = 28% VCC (min)
- Low ON resistance: RON = 50 Ω (typ.) at VCC - VEE = 9 V
- High noise immunity: THD = 0.02% (typ.) at VCC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



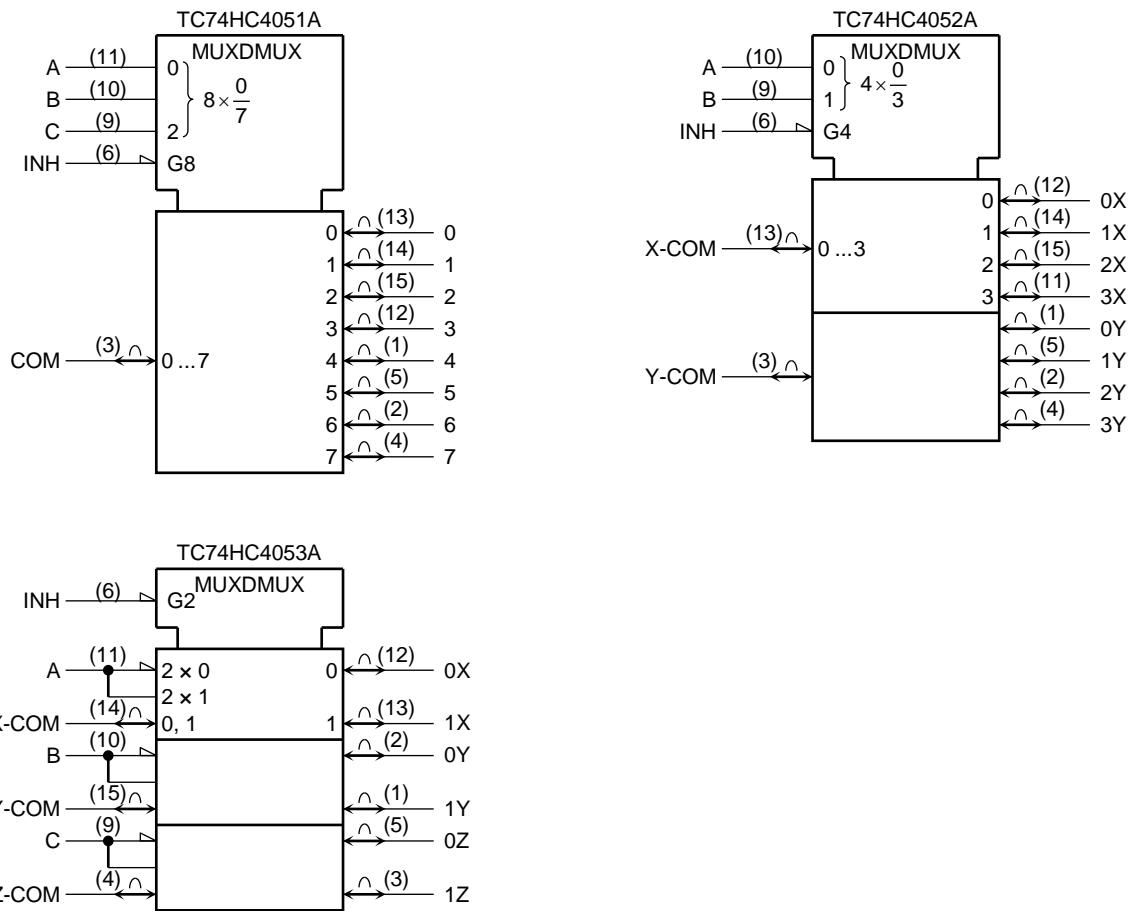
Weight	
DIP16-P-300-2.54A	: 1.00 g (typ.)
SOP16-P-300-1.27A	: 0.18 g (typ.)
TSSOP16-P-0044-0.65A	: 0.06 g (typ.)

Start of commercial production  
 1986-05

## Pin Assignment



## IEC Logic Symbol



## Truth Table

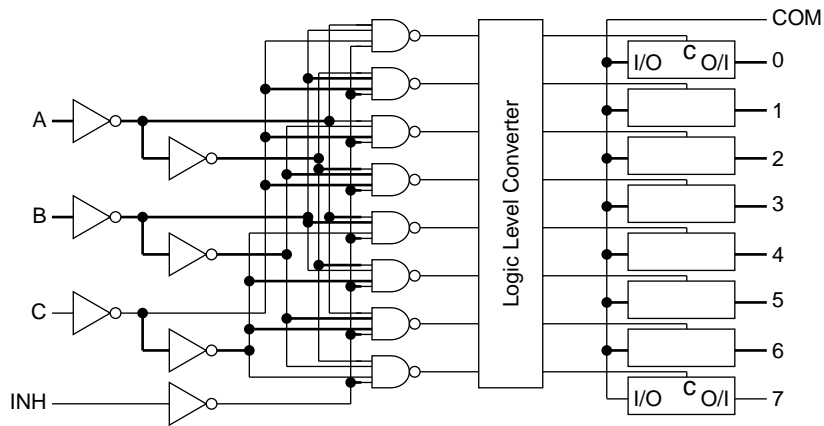
Control Inputs				"ON" Channel		
Inhibit	C*	B	A	HC4051A	HC4052A	HC4053A
L	L	L	L	0	0X, 0Y	0X, 0Y, 0Z
L	L	L	H	1	1X, 1Y	1X, 0Y, 0Z
L	L	H	L	2	2X, 2Y	0X, 1Y, 0Z
L	L	H	H	3	3X, 3Y	1X, 1Y, 0Z
L	H	L	L	4	—	0X, 0Y, 1Z
L	H	L	H	5	—	1X, 0Y, 1Z
L	H	H	L	6	—	0X, 1Y, 1Z
L	H	H	H	7	—	1X, 1Y, 1Z
H	X	X	X	None	None	None

X: Don't care

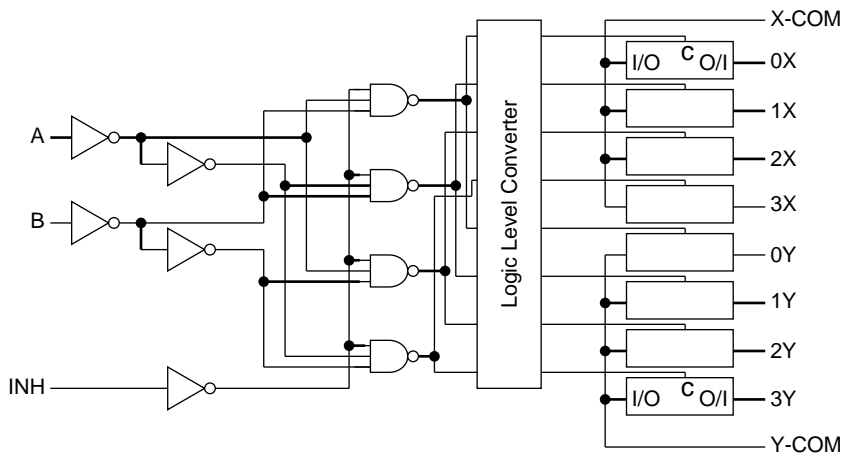
\*: Except HC4052A

**System Diagram**

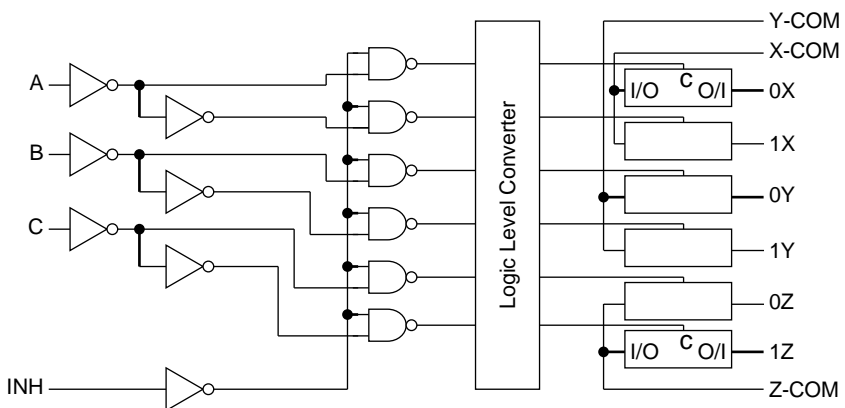
**TC74HC4051A**



**TC74HC4052A**



**TC74HC4053A**



## Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Supply voltage range	V <sub>CC</sub>	-0.5 to 7	V
Supply voltage range	V <sub>CC</sub> -V <sub>EE</sub>	-0.5 to 13	V
Control input voltage	V <sub>IN</sub>	-0.5 to V <sub>CC</sub> + 0.5	V
Switch I/O voltage	V <sub>I/O</sub>	V <sub>EE</sub> - 0.5 to V <sub>CC</sub> + 0.5	V
Control input diode current	I <sub>CK</sub>	±20	mA
I/O diode current	I <sub>IOK</sub>	±20	mA
Switch through current	I <sub>T</sub>	±25	mA
DC V <sub>CC</sub> or ground current	I <sub>CC</sub>	±50	mA
Power dissipation	P <sub>D</sub>	500 (DIP) (Note 2)/180 (SOP/TSSOP)	mW
Storage temperature	T <sub>stg</sub>	-65 to 150	°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<sub>a</sub> = -40 to 65°C. From T<sub>a</sub> = 65 to 85°C a derating factor of -10 mW/°C should be applied up to 300 mW.

## Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage range	V <sub>CC</sub>	2 to 6	V
Supply voltage range	V <sub>EE</sub>	-6 to 0	V
Supply voltage range	V <sub>CC</sub> -V <sub>EE</sub>	2 to 12	V
Control input voltage	V <sub>IN</sub>	0 to V <sub>CC</sub>	V
Switch I/O voltage	V <sub>I/O</sub>	V <sub>EE</sub> to V <sub>CC</sub>	V
Operating temperature	T <sub>opr</sub>	-40 to 85	°C
Control input rise and fall time	t <sub>r</sub> , t <sub>f</sub>	0 to 1000 (V <sub>CC</sub> = 2.0 V) 0 to 500 (V <sub>CC</sub> = 4.5 V) 0 to 400 (V <sub>CC</sub> = 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<sub>CC</sub> 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	
		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	GND	2.0	—	150	—	—	—	
			GND	4.5	—	70	150	—	190	
			-4.5	4.5	—	50	100	—	125	
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, output open)	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	—	—	
-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 (CL = 50 pF, input: tr = tf = 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>	4051A (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	—	—	—	
		4052A (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	—	—	—	
		4053A (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>	4051A (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	—	—	—	
		4052A (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	—	—	—	
		4053A (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>	4051A	—	—	—	36	70	—	70	pF
		4052A	-5.0	5.0	—	19	40	—	40	
		4053A	—	—	—	11	20	—	20	
SWITCH terminal capacitance	C <sub>OS</sub>	4051A	—	—	—	7	15	—	15	pF
		4052A	-5.0	5.0	—	7	15	—	15	
		4053A	—	—	—	7	15	—	15	
Feedthrough capacitance	C <sub>IOS</sub>	4051A	—	—	—	0.95	2	—	2	pF
		4052A	-5.0	5.0	—	0.85	2	—	2	
		4053A	—	—	—	0.75	2	—	2	
Power dissipation capacitance	CPD	4051A (Note 2)	—	—	—	70	—	—	—	pF
		4052A (Note 2)	GND	5.0	—	71	—	—	—	
		4053A (Note 2)	—	—	—	67	—	—	—	

Note 1: R<sub>L</sub> = 1 kΩ

Note 2: 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:

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

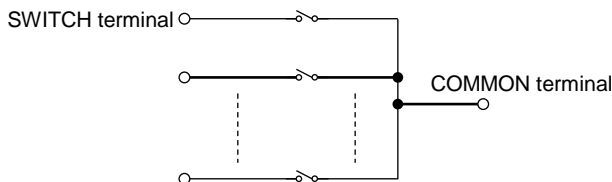
## Analog Switch Characteristics (GND = 0 V, Ta = 25°C) (Note 1)

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, V <sub>IN</sub> = 4.0 V <sub>p-p</sub>	-2.25	2.25	0.025	%	
		C <sub>L</sub> = 50 pF, V <sub>IN</sub> = 8.0 V <sub>p-p</sub>	-4.5	4.5	0.020		
		f <sub>IN</sub> = 1 kHz, 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
			4051A (Note 3)			45	
			4052A (Note 3)			70	
			4053A (Note 3)			95	
			All (Note 2)	-4.5	4.5	190	
			4051A (Note 3)			70	
			4052A (Note 3)			110	
			4053A (Note 3)			150	
			All (Note 2)	-6.0	6.0	200	
			4051A (Note 3)			85	
			4052A (Note 3)			140	
			4053A (Note 3)			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.

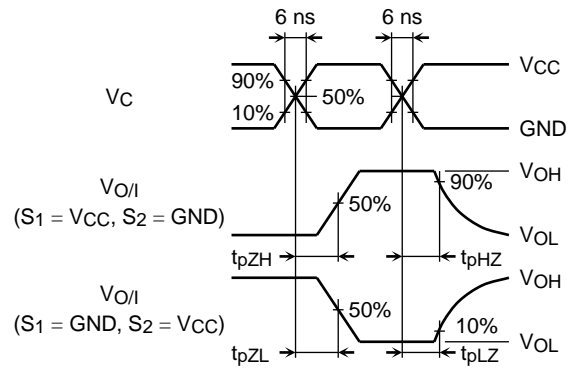
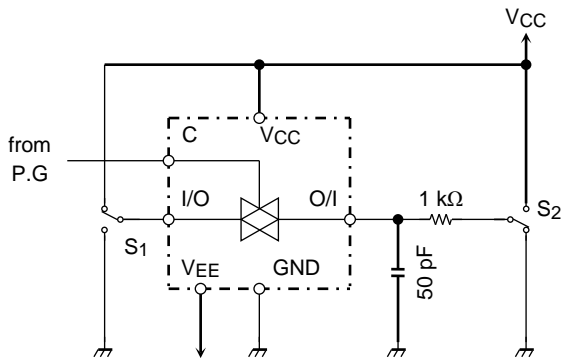
Note 3: Input SWITCH terminal, and measured at COMMON terminal.



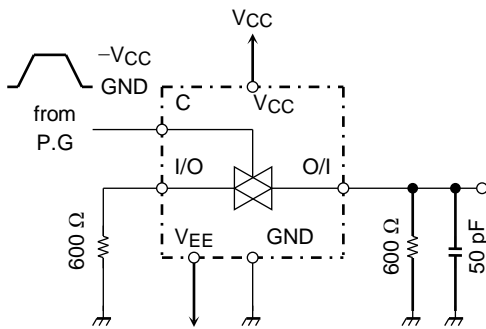


**Switching Characteristics Test Circuits**

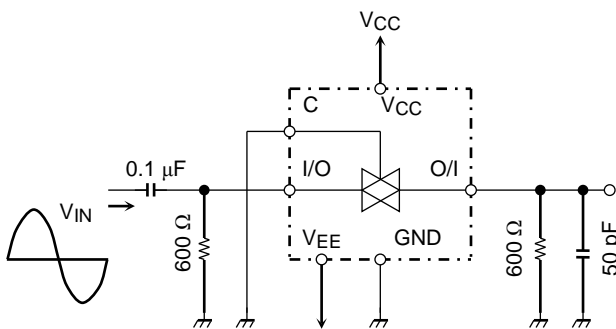
**1.  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$**



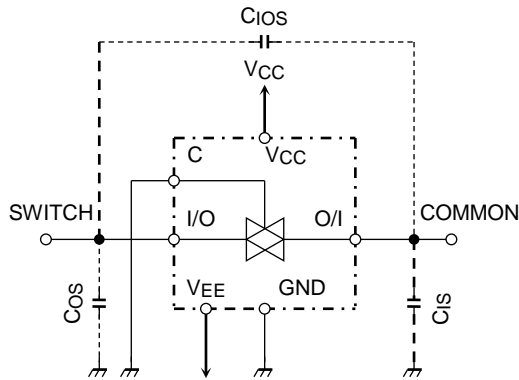
**2. Cross Talk (control input-switch output)  $f_{IN} = 1$  MHz duty = 50%  $t_r = t_f = 6$  ns**



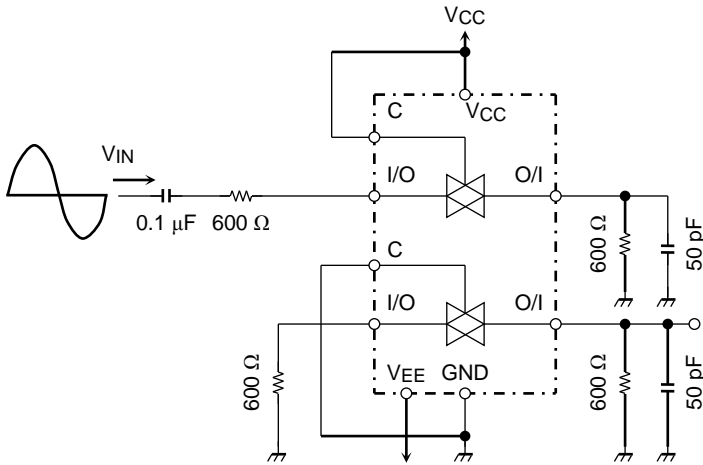
**3. Feedthrough Attenuation**



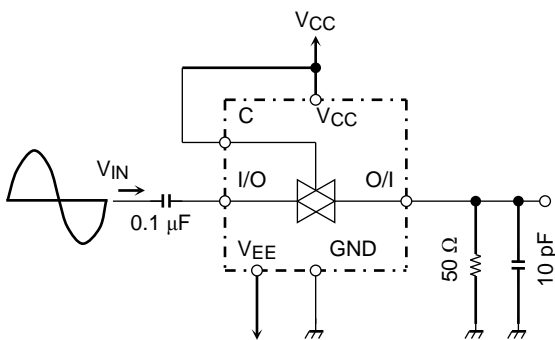
**4. Cios, Cis, Cos**



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



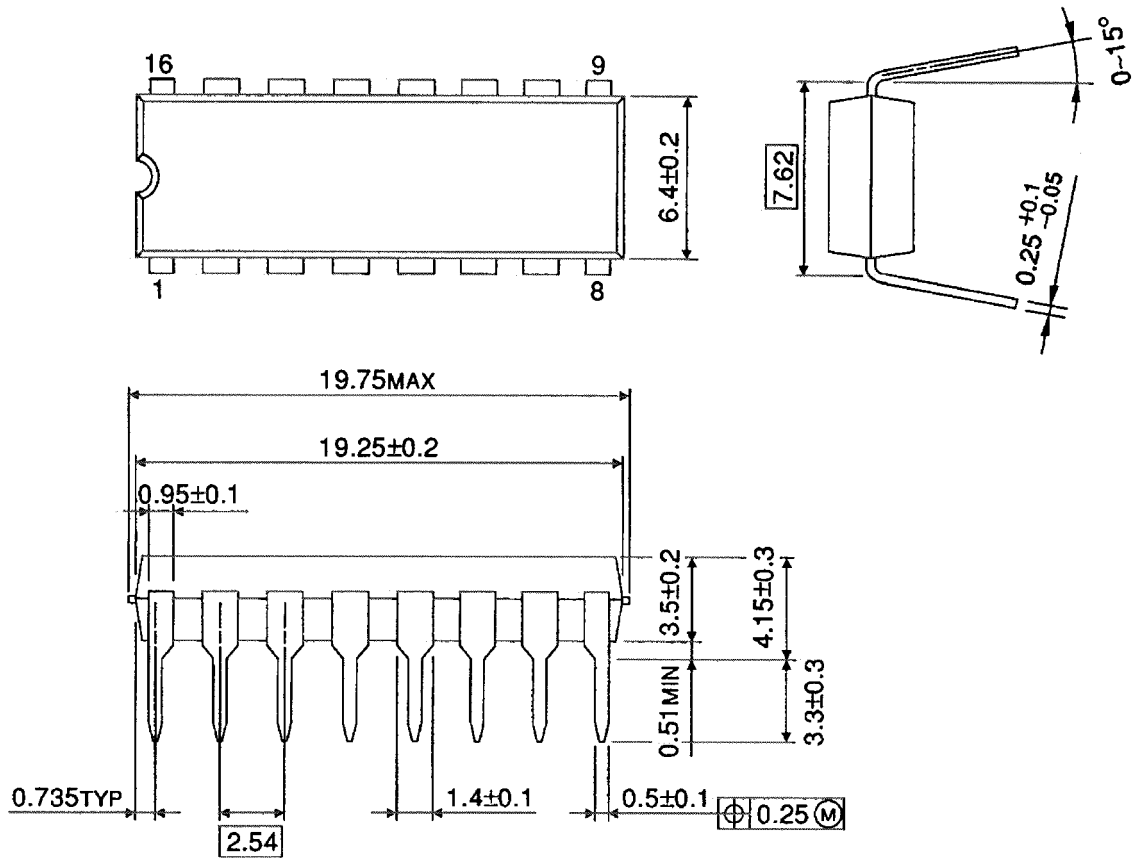
**6. Frequency Response (switch on)**



**Package Dimensions**

DIP16-P-300-2.54A

Unit : mm

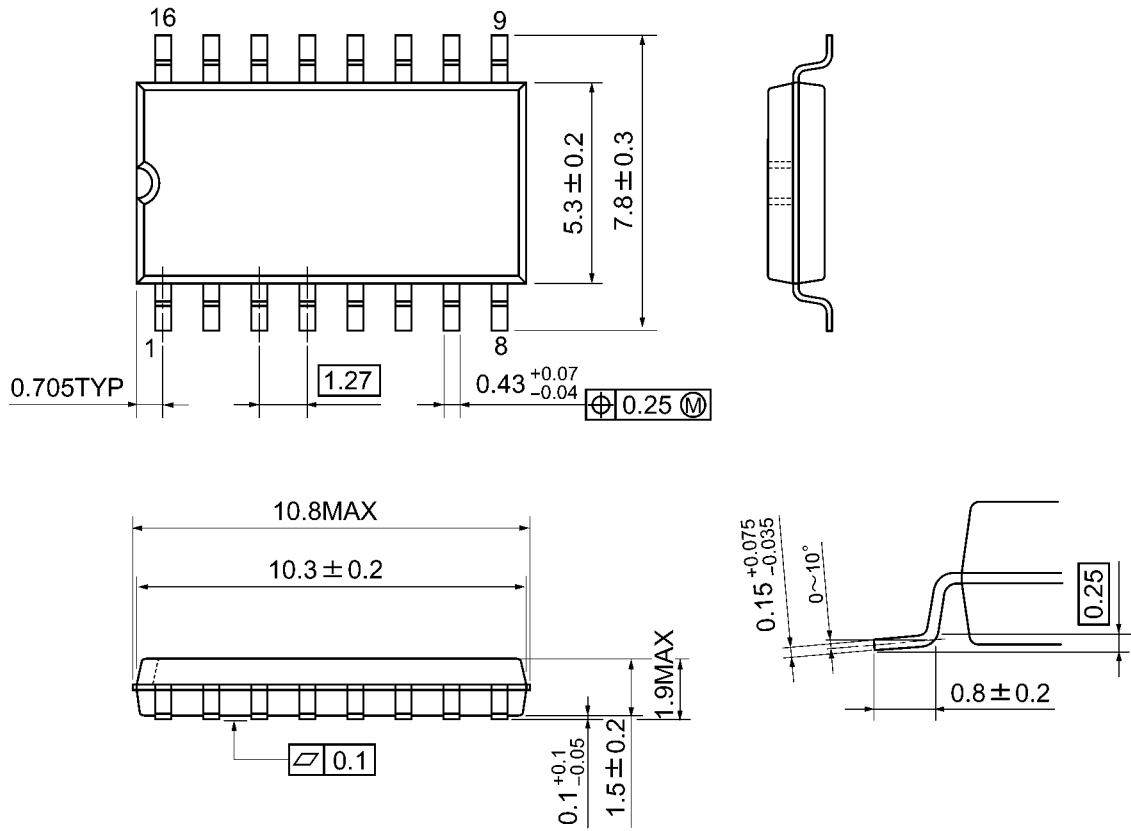


Weight: 1.00 g (typ.)

**Package Dimensions**

SOP16-P-300-1.27A

Unit: mm

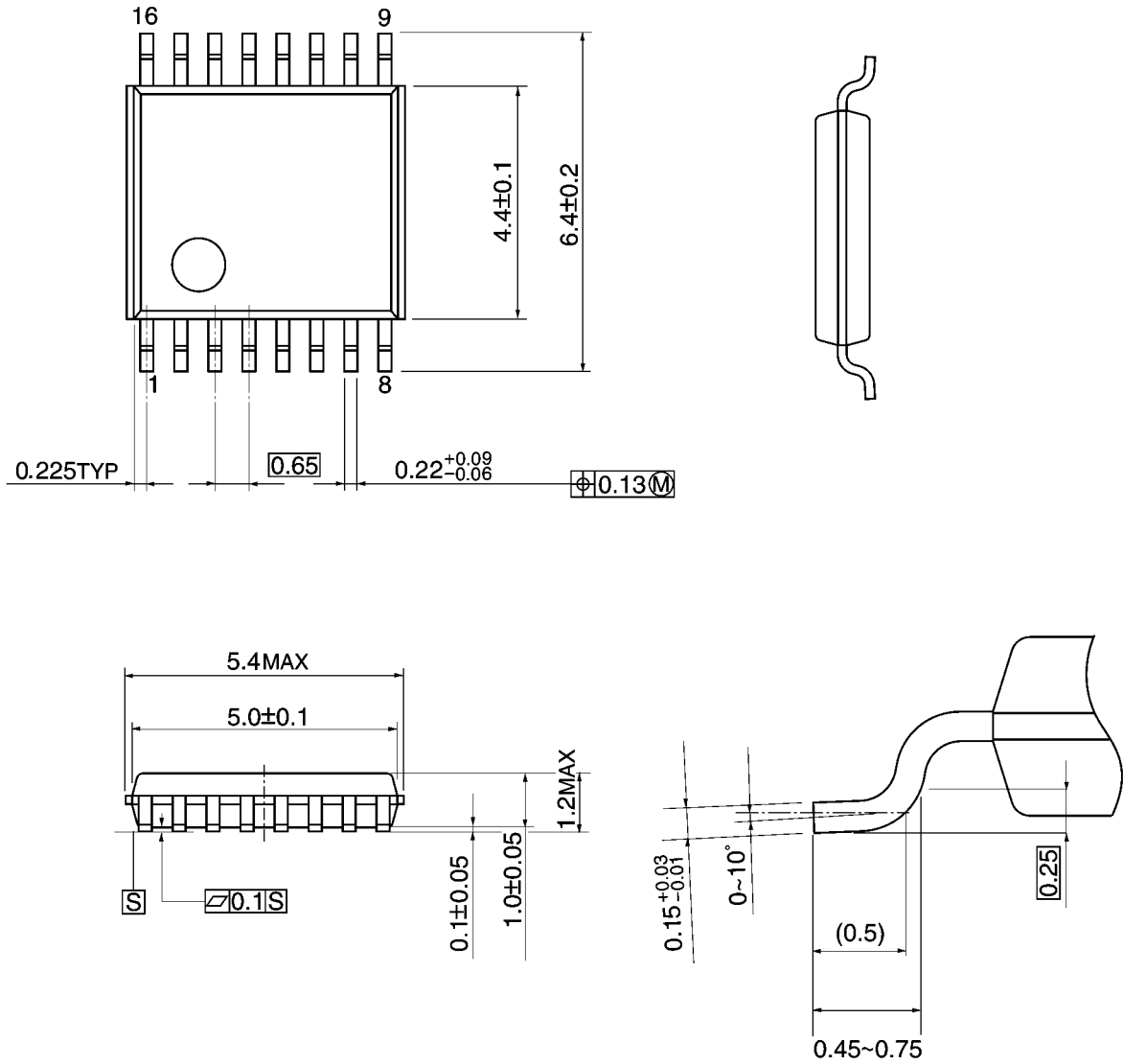


Weight: 0.18 g (typ.)

## Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm



Weight: 0.06 g (typ.)

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