

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 ( $V_{CC} - V_{EE}$ ) can then be switched by the small logical amplitude ( $V_{CC} - GND$ ) control signal.

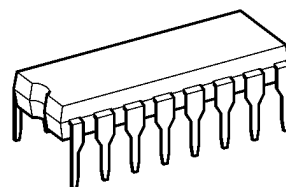
For example, in the case of  $V_{CC} = 5\text{ V}$ ,  $GND = 0\text{ V}$ ,  $V_{EE} = -5\text{ V}$ , signals between  $-5\text{ V}$  and  $+5\text{ V}$  can be switched from the logical circuit with a single power supply of  $5\text{ V}$ . As the ON-resistance of each switch is low, they can be connected to circuits with low input impedance.

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

### Features

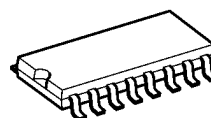
- High speed:  $t_{pd} = 15\text{ ns}$  (typ.) at  $V_{CC} = 5\text{ V}$ ,  $V_{EE} = 0\text{ V}$
- Low power dissipation:  $I_{CC} = 4\text{ }\mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- Low ON resistance:  $R_{ON} = 50\text{ }\Omega$  (typ.) at  $V_{CC} - V_{EE} = 9\text{ V}$
- High noise immunity:  $THD = 0.02\%$  (typ.) at  $V_{CC} - V_{EE} = 9\text{ V}$
- Pin and function compatible with 4051/4052/4053B

TC74HC4051AP, TC74HC4052AP,  
TC74HC4053AP



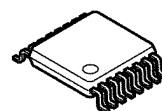
DIP16-P-300-2.54A

TC74HC4051AF, TC74HC4052AF,  
TC74HC4053AF



SOP16-P-300-1.27A

TC74HC4051AFT, TC74HC4052AFT,  
TC74HC4053AFT



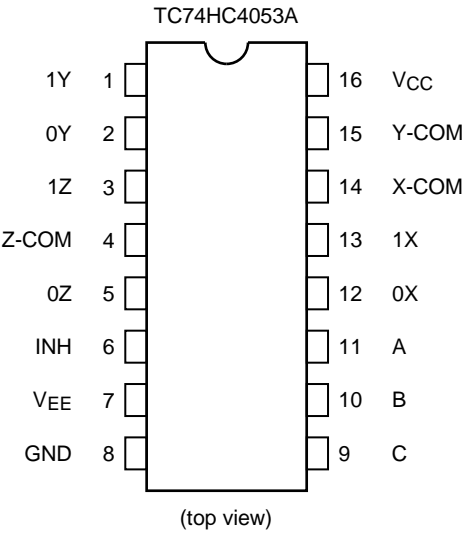
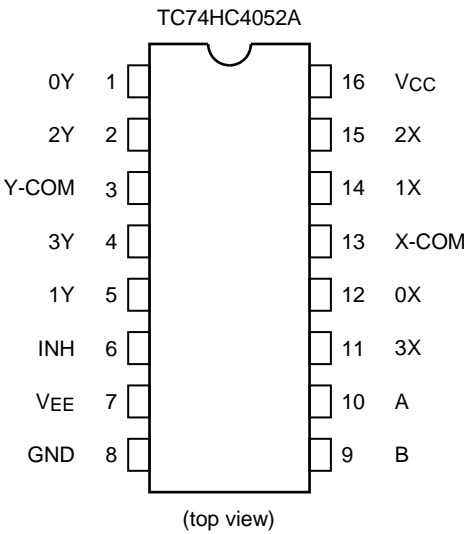
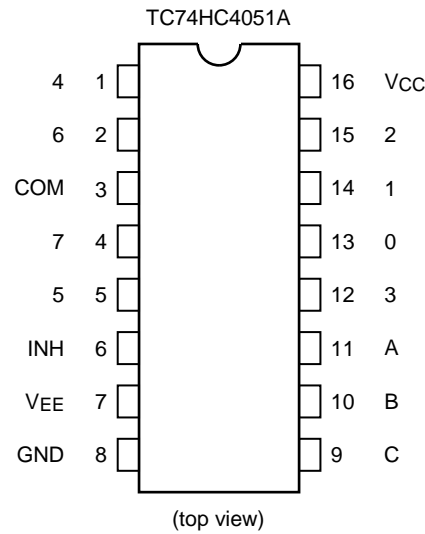
TSSOP16-P-0044-0.65A

Weight

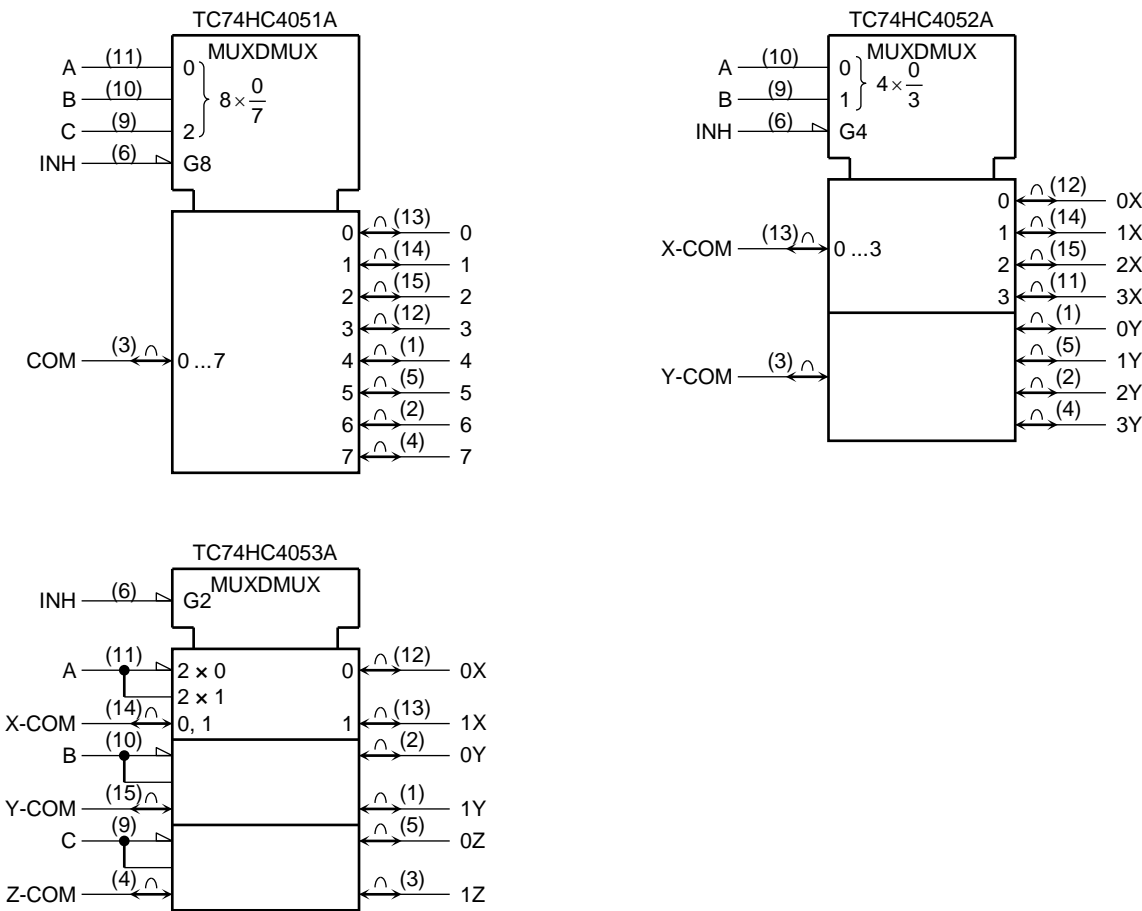
DIP16-P-300-2.54A	: 1.00 g (typ.)
SOP16-P-300-1.27A	: 0.18 g (typ.)
TSSOP16-P-0044-0.65A	: 0.06 g (typ.)

Start of commercial production  
1986-05

**Pin Assignment**



IEC Logic Symbol



Truth Table

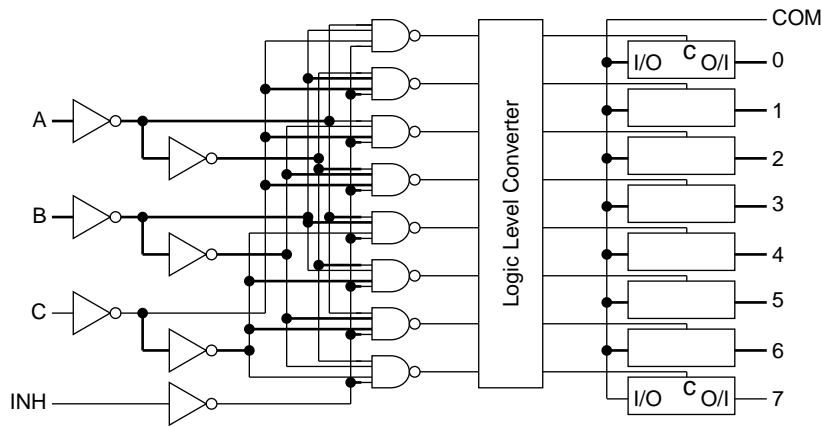
Control Inputs				“ON” Channel		
Inhibit	C*	B	A	HC4051A	HC4052A	HC4053A
L	L	L	L	0	0X, 0Y	0X, 0Y, 0Z
L	L	L	H	1	1X, 1Y	1X, 0Y, 0Z
L	L	H	L	2	2X, 2Y	0X, 1Y, 0Z
L	L	H	H	3	3X, 3Y	1X, 1Y, 0Z
L	H	L	L	4	—	0X, 0Y, 1Z
L	H	L	H	5	—	1X, 0Y, 1Z
L	H	H	L	6	—	0X, 1Y, 1Z
L	H	H	H	7	—	1X, 1Y, 1Z
H	X	X	X	None	None	None

X: Don't care

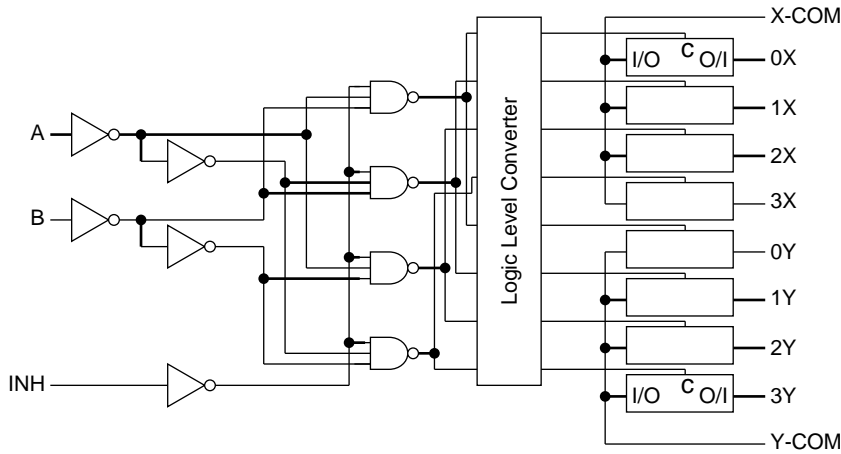
\*: Except HC4052A

**System Diagram**

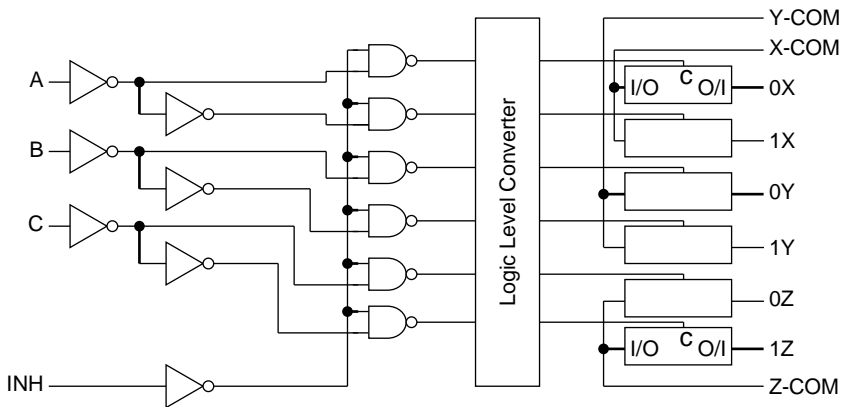
**TC74HC4051A**



**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>I/O</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 4.5 6.0	1.50 3.15 4.20	— — —	— — —	1.50 3.15 4.20	— — —	V
Low-level control input voltage	V <sub>ILC</sub>	—			2.0 4.5 6.0	— — —	— — —	0.50 1.35 1.80	— — —	0.50 1.35 1.80	V
ON resistance	R <sub>ON</sub>	V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub>	GND	4.5	—	85	180	—	225	Ω	
		V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub>	-4.5	4.5	—	55	120	—	150		
		I <sub>I/O</sub> ≤ 2 mA	-6.0	6.0	—	50	100	—	125		
		V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub>	GND	2.0	—	150	—	—	—		
		V <sub>I/O</sub> = V <sub>CC</sub> or V <sub>EE</sub>	GND	4.5	—	70	150	—	190		
		I <sub>I/O</sub> ≤ 2 mA	-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>	GND	4.5	—	10	30	—	35	Ω	
		V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub>	-4.5	4.5	—	5	12	—	15		
		I <sub>I/O</sub> ≤ 2 mA	-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	6.0 6.0	— —	— —	±60 ±100	— —	±600 ±1000	nA	
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	— —	— —	±60 ±100	— —	±600 ±1000	nA	
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	6.0 6.0	— —	— —	4.0 8.0	— —	40.0 80.0	μA	

## 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
			VEE (V)	VCC (V)	Min	Typ.	Max	Min	Max	
Phase difference between input and output	ϕI/O	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	tpZL tpZH	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	tpLZ tpHZ	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	CIN	All types	—	—	—	5	10	—	10	pF
COMMON terminal capacitance	CIS	4051A			—	36	70	—	70	pF
		4052A	-5.0	5.0	—	19	40	—	40	
		4053A			—	11	20	—	20	
SWITCH terminal capacitance	COS	4051A			—	7	15	—	15	pF
		4052A	-5.0	5.0	—	7	15	—	15	
		4053A			—	7	15	—	15	
Feedthrough capacitance	CIOS	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: RL = 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:

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

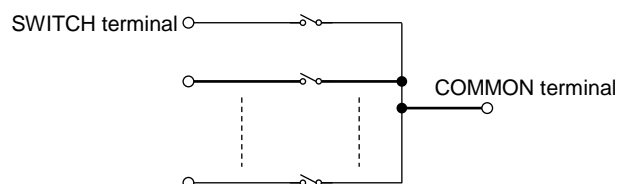
## Analog Switch Characteristics (GND = 0 V, Ta = 25°C) (Note 1)

Characteristics	Symbol	Test Condition				Typ.	Unit	
				VEE (V)	VCC (V)			
Sine wave distortion (T.H.D)		RL = 10 kΩ,		VIN = 4.0 VP-P	-2.25	2.25	0.025	%
		CL = 50 pF		VIN = 8.0 VP-P	-4.5	4.5	0.020	
		fIN = 1 kHz		VIN = 11.0 VP-P	-6.0	6.0	0.018	
Frequency response (switch on)	fmax	Adjust fIN voltage to obtain 0dBm at VOS  Increase fIN frequency until dB meter reads -3dB  RL = 50 Ω, CL = 10 pF  fIN = 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)		VIN is centered at (VCC - VEE)/2		-2.25	2.25	-50	dB	
		Adjust input for 0dBm		-4.5	4.5	-50		
		RL = 600 Ω, CL = 50 pF		-6.0	6.0	-50		
		fIN = 1 MHz, sine wave						
Crosstalk (control input to signal output)		RL = 600 Ω, CL = 50 pF		-2.25	2.25	60	mV	
		fIN = 1 MHz, square wave (tr = tr = 6 ns)		-4.5	4.5	140		
				-6.0	6.0	200		
Crosstalk (between any switches)		Adjust VIN to obtain 0dBm at input		-2.25	2.25	-50	dB	
		RL = 600 Ω, CL = 50 pF		-4.5	4.5	-50		
		fIN = 1 MHz, sine wave		-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.

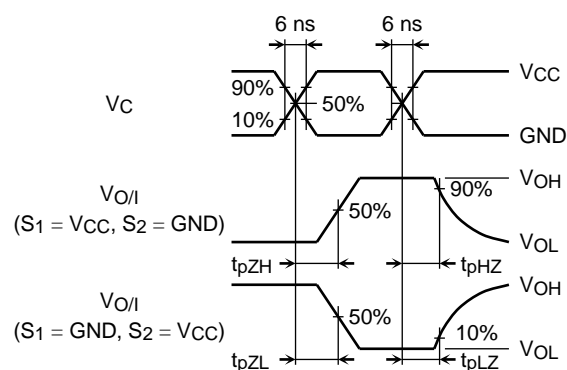
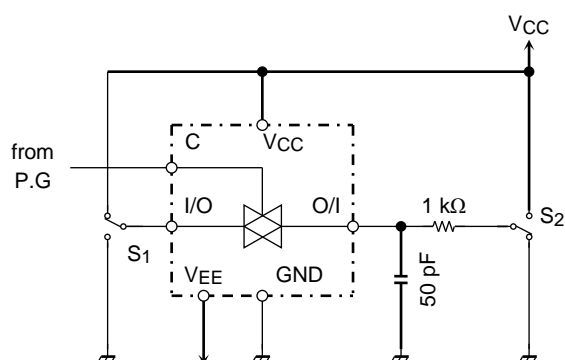
Note 3: Input SWITCH terminal, and measured at COMMON terminal.



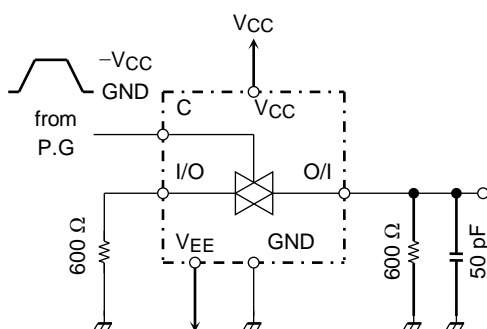


## Switching Characteristics Test Circuits

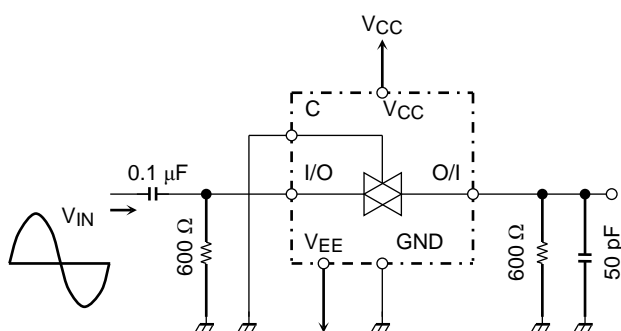
### 1. $tp_{LZ}$ , $tp_{HZ}$ , $tp_{ZL}$ , $tp_{ZH}$



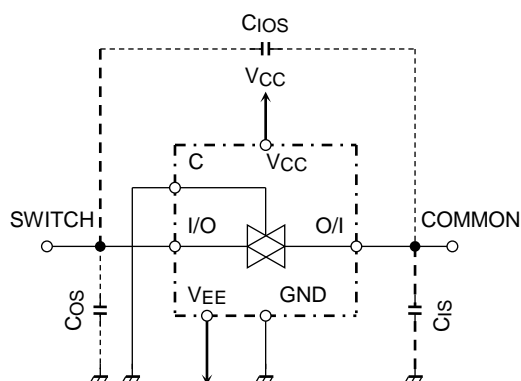
### 2. Cross Talk (control input-switch output) $f_{IN} = 1$ MHz duty = 50% $t_r = t_f = 6$ ns



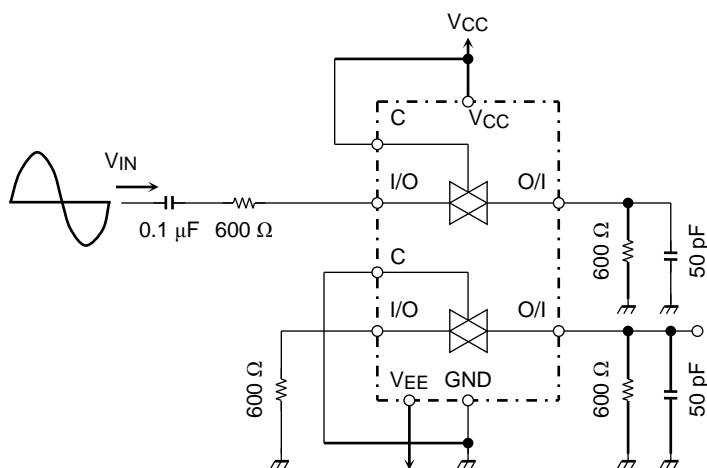
### 3. Feedthrough Attenuation



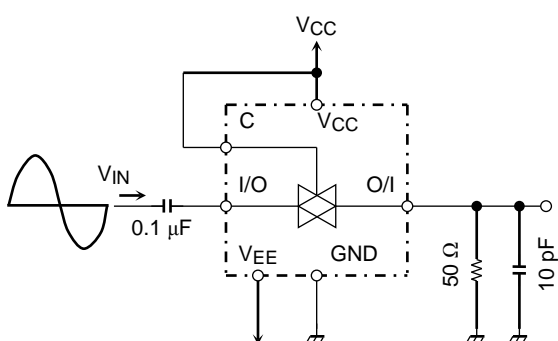
## 4. Cios, Cis, Cos



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



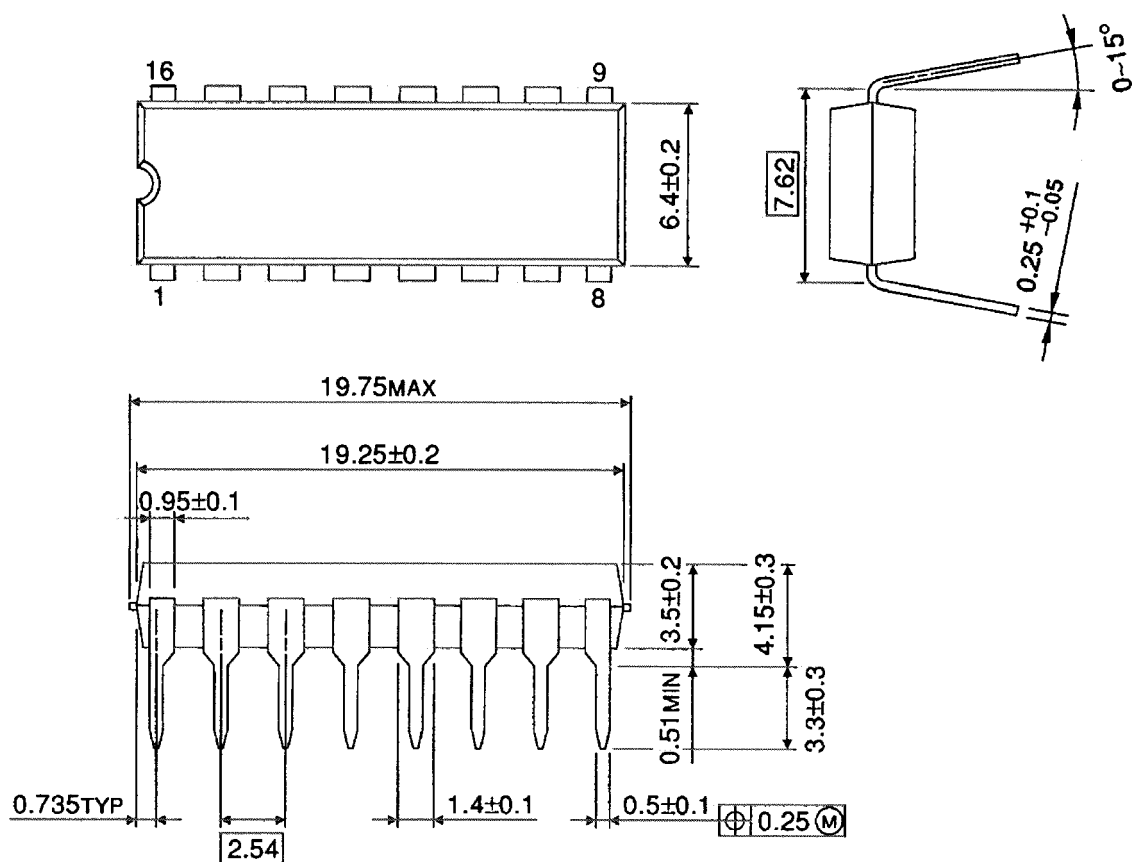
## 6. Frequency Response (switch on)



## Package Dimensions

DIP16-P-300-2.54A

Unit : mm

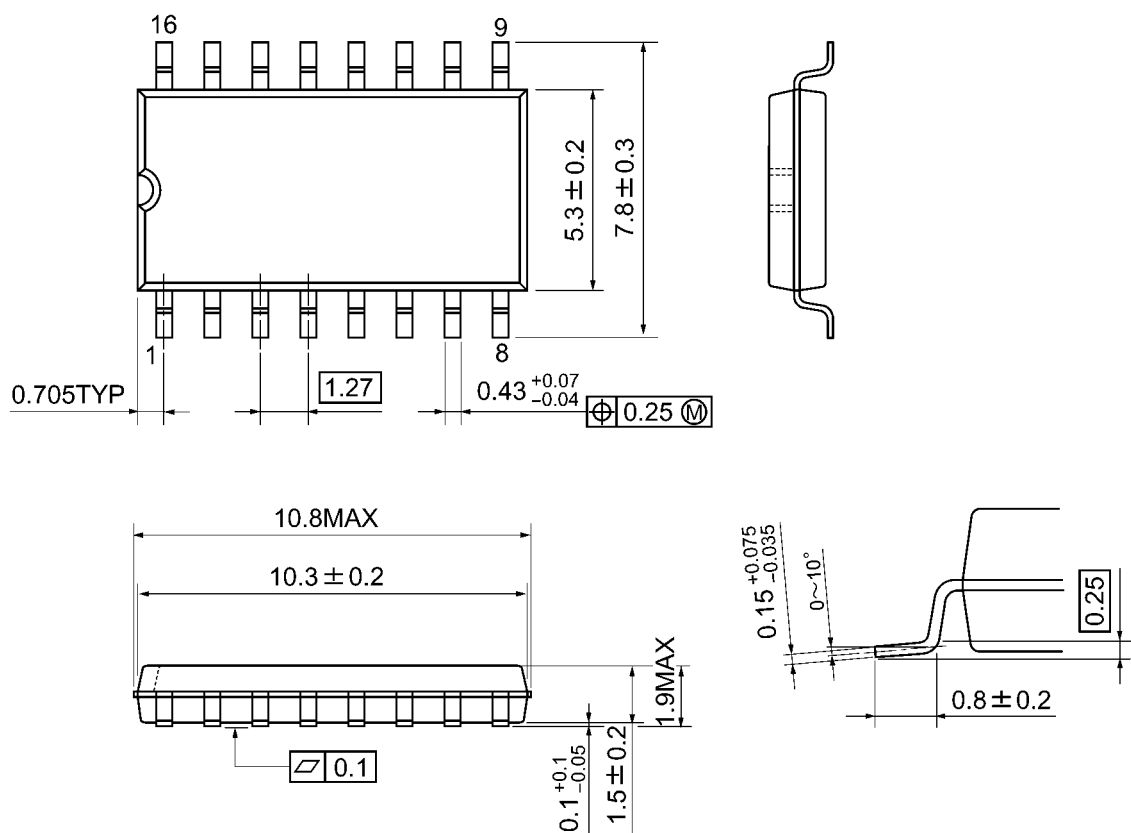


Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm

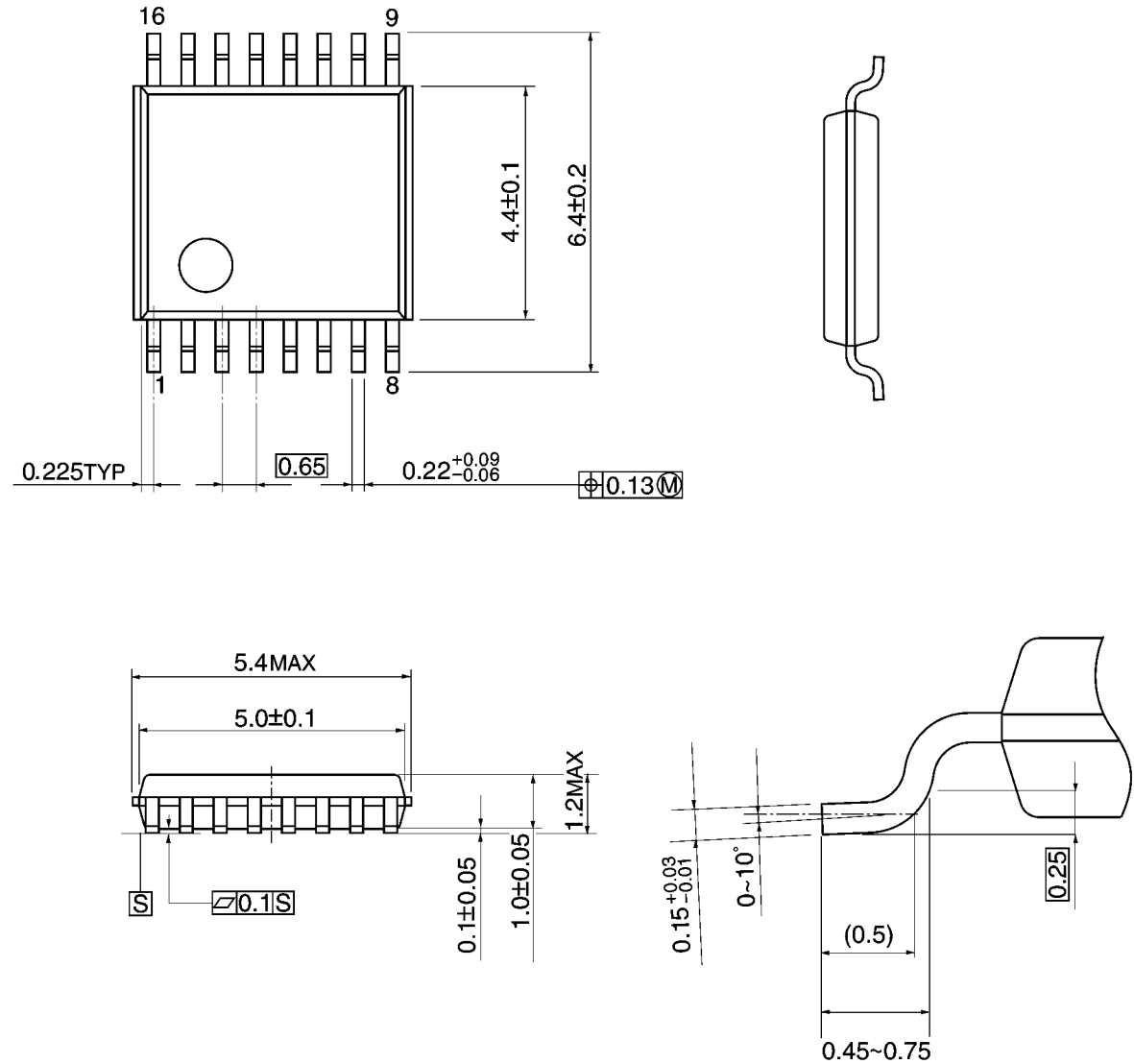


Weight: 0.18 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm



Weight: 0.06 g (typ.)

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