

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74HCT4053AF, TC74HCT4053AFT

### Triple 2-Channel Analog Multiplexer/Demultiplexer

The TC74HCT4053A 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.

This device may be used as a level converter for interfacing TTL or NMOS to High Speed CMOS. This inputs are compatible with TTL, NMOS and CMOS output voltage levels.

The TC74HCT4053A 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.

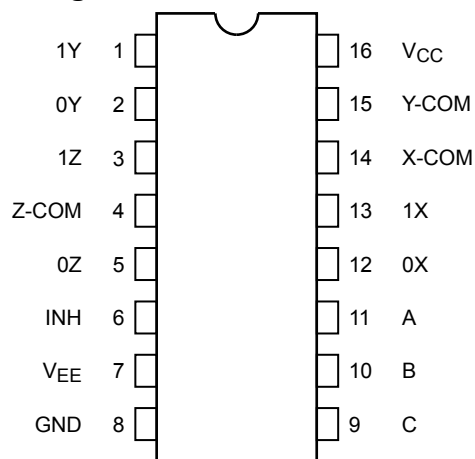
For example, in the case of  $V_{CC} = 5\text{ V}$ ,  $GND = 0\text{ V}$ ,  $V_{EE} = -5\text{ V}$ , signals between  $-5\text{ V}$  and  $+5\text{ V}$  can be switched from the logical circuit with a single power supply of 5 V. As the ON-resistance of each switch is low, they can be connected to circuits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

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

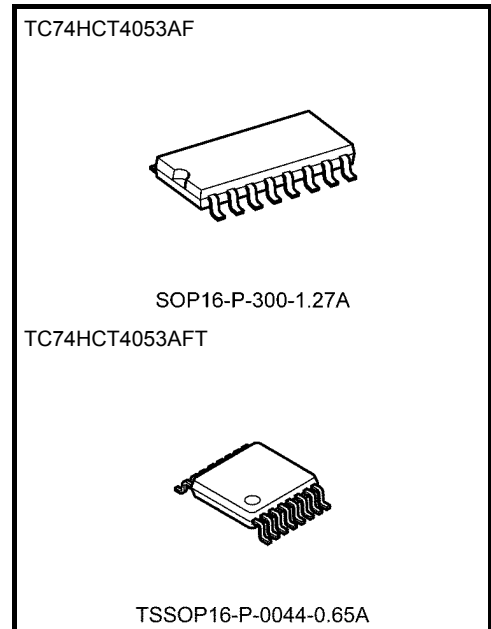
### Features

- High speed:  $t_{pd} = 30\text{ ns}$  (typ.) at  $V_{CC} = 5\text{ V}$   
 $V_{EE} = 0\text{ V}$
- Low power dissipation:  $I_{CC} = 4\text{ }\mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- Compatible with TTL output:  $V_{IH} = 2.0\text{ V}$  (min)  
 $V_{IL} = 0.8\text{ V}$  (max)
- Wide interfacing ability: LSTTL, NMOS, CMOS
- 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 4053B

### Pin Assignment



(top view)



Weight

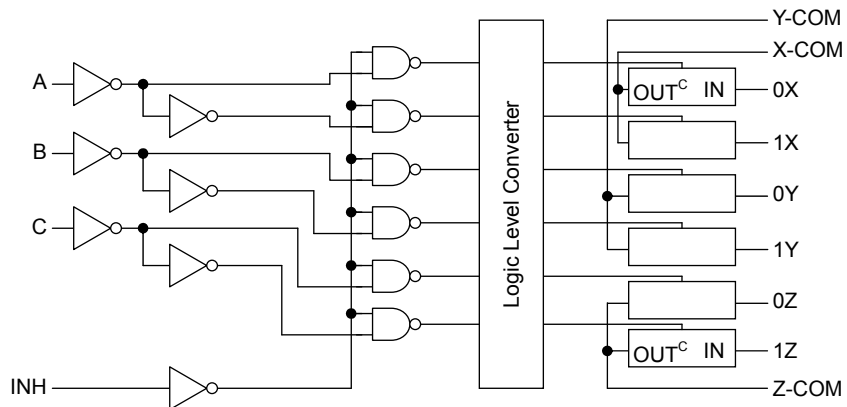
SOP16-P-300-1.27A : 0.18 g (typ.)  
TSSOP16-P-0044-0.65A : 0.06 g (typ.)

## Truth Table

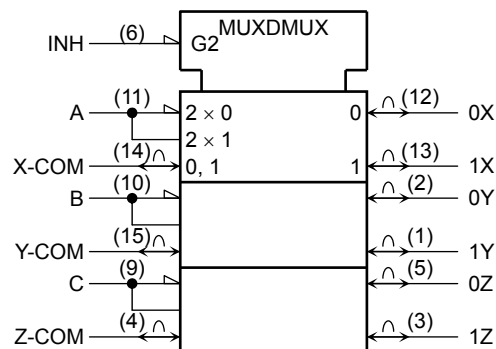
Control Inputs				"ON" Channel
Inhibit	C	B	A	HCT4053A
L	L	L	L	0X, 0Y, 0Z
L	L	L	H	1X, 0Y, 0Z
L	L	H	L	0X, 1Y, 0Z
L	L	H	H	1X, 1Y, 0Z
L	H	L	L	0X, 0Y, 1Z
L	H	L	H	1X, 0Y, 1Z
L	H	H	L	0X, 1Y, 1Z
L	H	H	H	1X, 1Y, 1Z
H	X	X	X	NONE

X: Don't care

## System Diagram



## IEC Logic Symbol



**Absolute Maximum Ratings (Note)**

Characteristics	Symbol	Rating	Unit
Supply voltage range	$V_{CC}$	-0.5 to 13	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	$I_{I/O}$	$\pm 20$	mA
Switch through current	$I_T$	$\pm 25$	mA
DC $V_{CC}$ or ground current	$I_{CC}$	$\pm 50$	mA
Power dissipation	$P_D$	180	mW
Storage temperature	$T_{stg}$	-65 to 150	°C

Note: 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).

**Operating Ranges (Note)**

Characteristics	Symbol	Rating	Unit
Supply voltage range	$V_{CC}$	4.5 to 12	V
Supply voltage range	$V_{EE}$	-7.5 to 0	V
Supply voltage range	$V_{CC} - V_{EE}$	4.5 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	°C
Control input rise and fall time	$t_r, t_f$	0 to 500	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>		4.5 to 5.5 9.0	2.0 2.5	— —	— —	2.0 2.5	— —	V	
Low-level control input voltage	V <sub>ILC</sub>		4.5 to 5.5 9.0	— —	— —	0.8 0.8	— —	0.8 0.8	V	
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	
			-5.5	5.5	—	50	110	—	140	
			GND	9.0	—	55	120	—	150	
		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	4.5	—	70	150	—	190	
			-4.5	4.5	—	50	100	—	125	
			-5.5	5.5	—	45	90	—	115	
			GND	9.0	—	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	
			-5.5	5.5	—	5	11	—	14	
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	5.5	—	—	±60	—	±600	nA
			-5.5	5.5	—	—	±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	5.5	—	—	±60	—	±600	nA
			-5.5	5.5	—	—	±100	—	±1000	
Control input current	I <sub>IN</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	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	GND	5.5	—	—	4.0	—	40.0	μA
			-5.5	5.5	—	—	8.0	—	80.0	
	I <sub>C</sub>	Per input: V <sub>IN</sub> = 0.5 V or 2.4 V Other input: V <sub>CC</sub> or GND	GND	5.5	—	—	2.0	—	2.9	mA

## AC Characteristics ( $C_L = 50 \text{ pF}$ , Input $t_r = t_f = 6 \text{ ns}$ , 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	$\phi_{I/O}$		GND	4.5	—	6	12	—	15	ns
			GND	5.5	—	5	11	—	14	
			GND	9.0	—	4	—	—	—	
Output enable time	$t_{pZL}$ $t_{pZH}$	(Note 1)	GND	4.5	—	33	50	—	63	ns
			GND	5.5	—	26	45	—	57	
			GND	9.0	—	17	—	—	—	
Output disable time	$t_{pLZ}$ $t_{pHZ}$	(Note 1)	GND	4.5	—	45	65	—	81	ns
			GND	5.5	—	37	59	—	73	
			GND	9.0	—	26	—	—	—	
Control input capacitance	$C_{in}$		—	—	—	5	10	—	10	pF
COMMON terminal capacitance	$C_{IS}$		-5.0	5.0	—	11	20	—	20	pF
SWITCH terminal capacitance	$C_{OS}$		-5.0	5.0	—	7	15	—	15	pF
Feedthrough capacitance	$C_{IOS}$		-5.0	5.0	—	0.75	2	—	2	pF
Power dissipation capacitance	$C_{PD}$	(Note 2)	GND	5.0	—	67	—	—	—	pF

Note 1  $R_L = 1 \text{ k}\Omega$

Note 2:  $C_{PD}$  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 (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> = 8.0 V <sub>p-p</sub>	-4.5	4.5	0.020	%
		C <sub>L</sub> = 50 pF	V <sub>IN</sub> = 11.0 V <sub>p-p</sub>	-5.5	5.5	0.019	
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	(Note 2)	-4.5	4.5	190	MHz
			(Note 3)	-4.5	4.5	150	
		R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF f <sub>IN</sub> = 1 MHz, Sine wave	(Note 2)	-5.5	5.5	200	
			(Note 3)	-5.5	5.5	180	
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		-4.5	4.5	-50	dB
				-5.5	5.5	-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)		-4.5	4.5	140	mV
				-5.5	5.5	180	
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		-4.5	4.5	-50	dB
				-5.5	5.5	-50	
		R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 15 pF f <sub>IN</sub> = 100 kHz, V <sub>SWITCH</sub> = 1 V <sub>RMS</sub>		-4.5	4.5	-90	dB

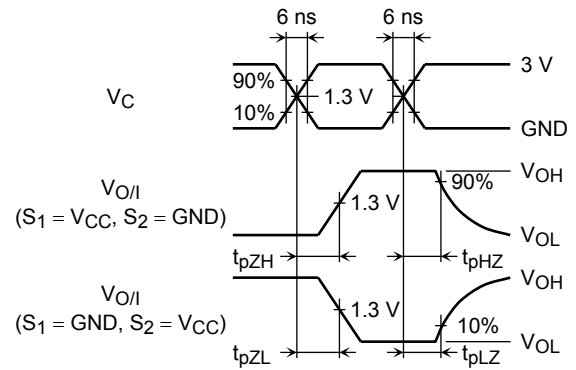
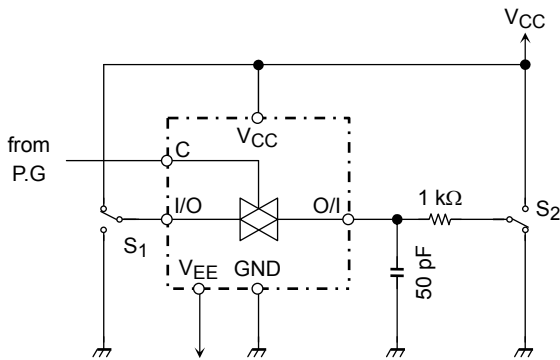
Note 1: These characteristics are determined by design of devices.

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

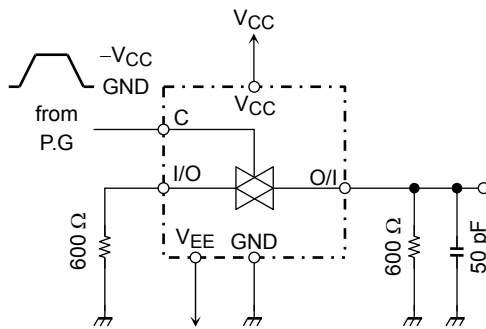
Note 3: Input SWITCH terminal, and measured at COMMON terminal.

## Switching Characteristics Test Circuits

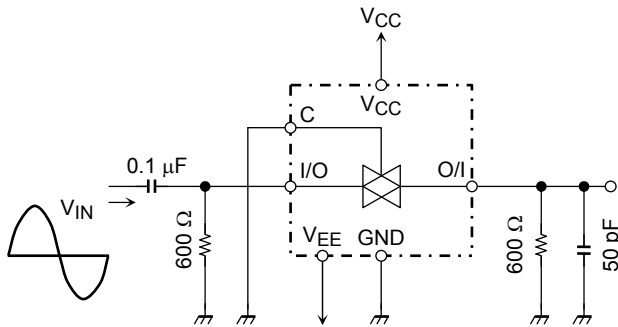
### 1. $t_{pLZ}$ , $t_{pHZ}$ , $t_{pZL}$ , $t_{pZH}$



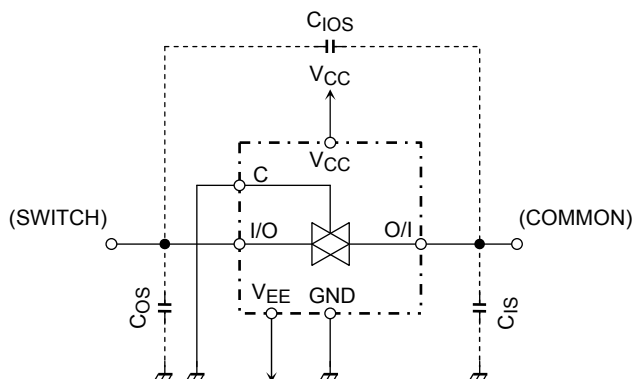
### 2. Cross Talk (control input – switch output) $f_{IN} = 1 \text{ MHz}$ duty = 50% $t_r = t_f = 6 \text{ ns}$



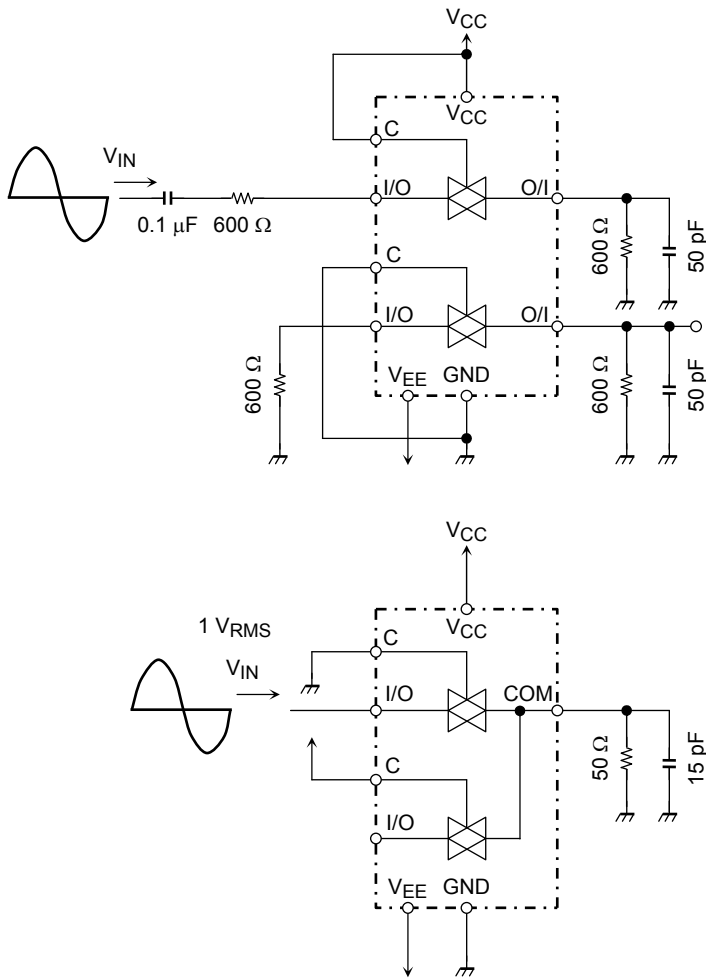
### 3. Feedthrough Attenuation



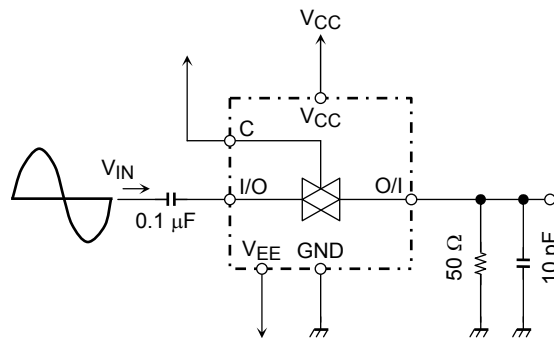
### 4. $C_{IOS}$ , $C_{IS}$ , $C_{OS}$



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



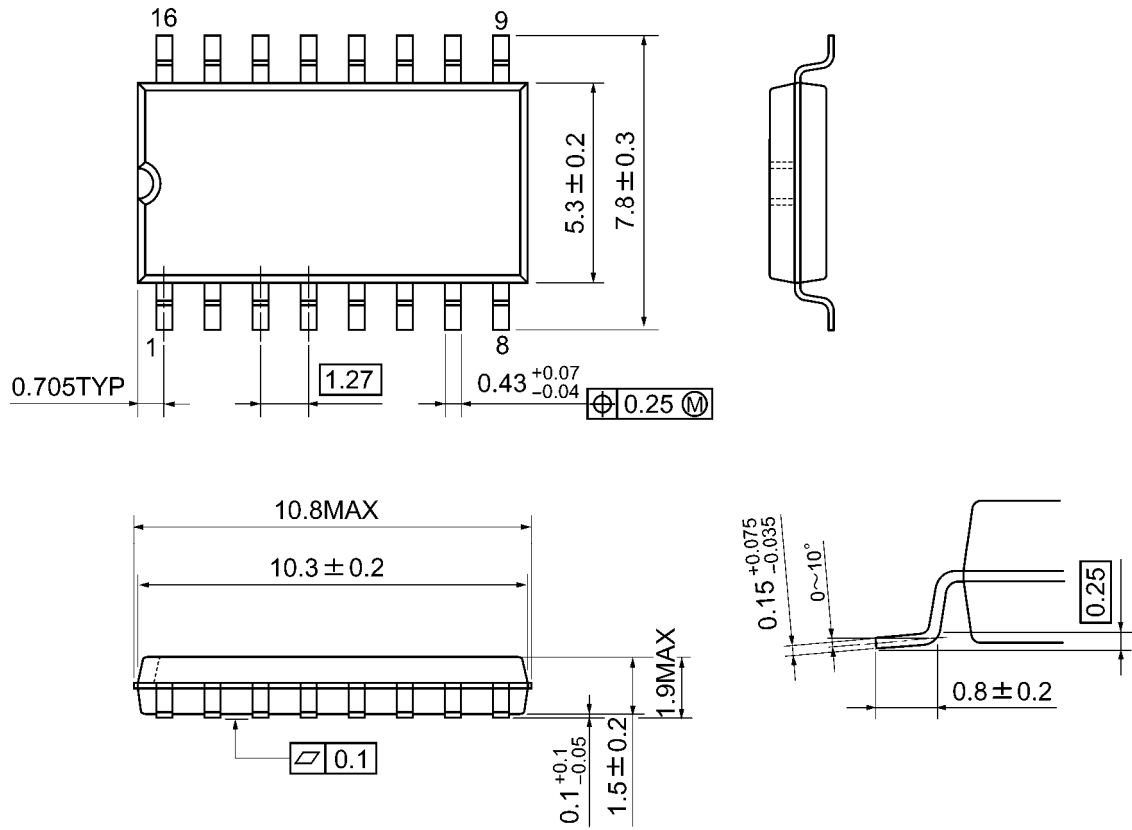
**6. Frequency Response (switch ON)**



## Package Dimensions

SOP16-P-300-1.27A

Unit: mm

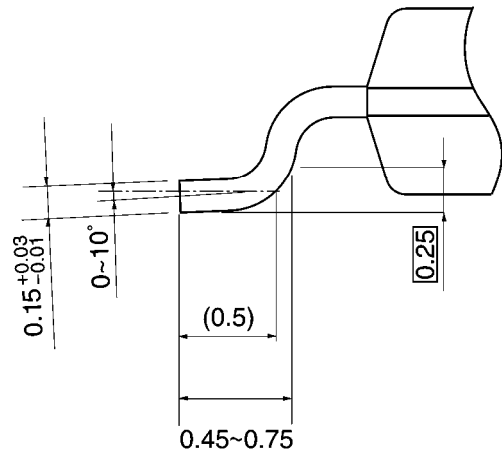
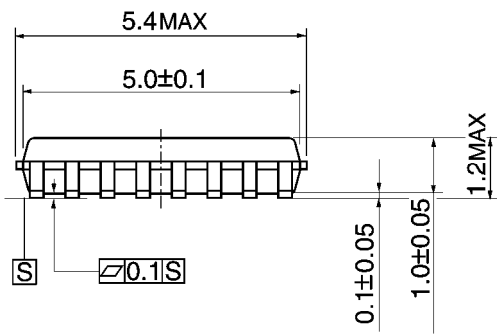
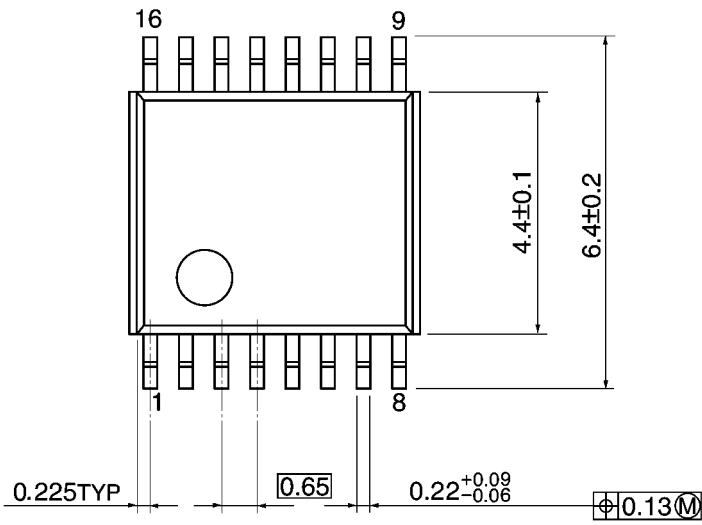


Weight: 0.18 g (typ.)

**Package Dimensions**

TSSOP16-P-0044-0.65A

Unit: mm



Weight: 0.06 g (typ.)

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