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^2MOS 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 V, GND = 0 V, V_{EE} = −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.

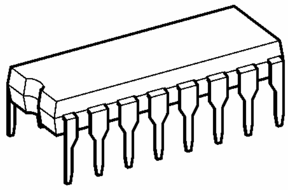
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

Features

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

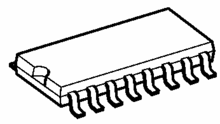
Note: xxxFN (JEDEC SOP) is not available in Japan.

TC74HC4051AP, TC74HC4052AP, TC74HC4053AP



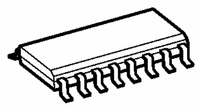
DIP16-P-300-2.54A

TC74HC4051AF, TC74HC4052AF, TC74HC4053AF



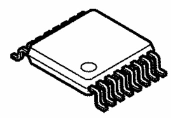
SOP16-P-300-1.27A

TC74HC4053AFN



SOL16-P-150-1.27

TC74HC4051AFT, TC74HC4052AFT, TC74HC4053AFT



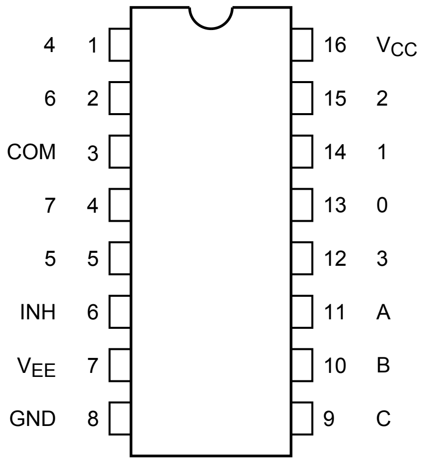
TSSOP16-P-0044-0.65A

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.)

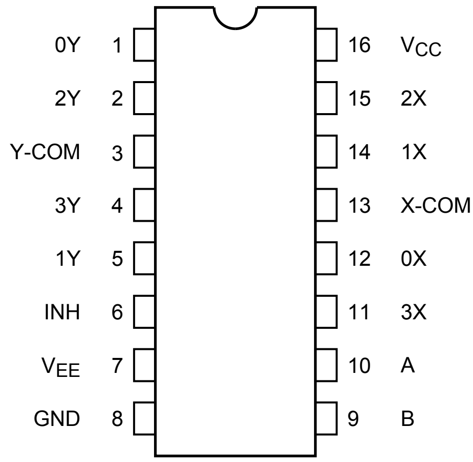
Pin Assignment

TC74HC4051A



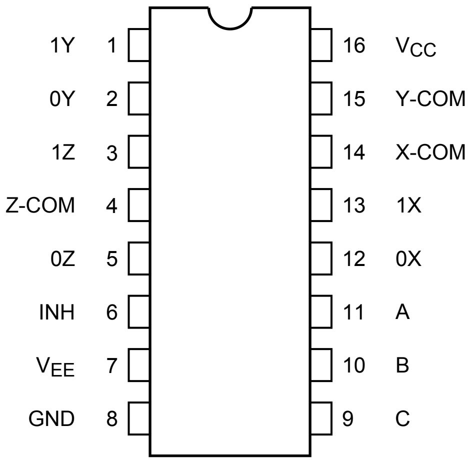
(top view)

TC74HC4052A



(top view)

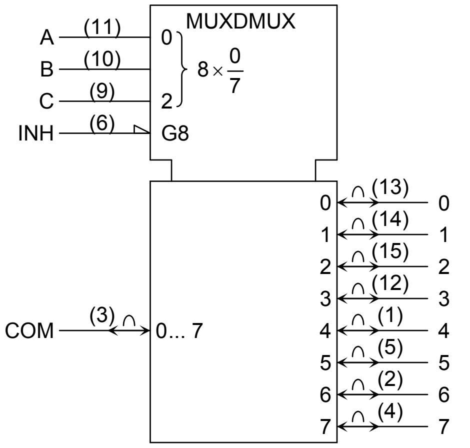
TC74HC4053A



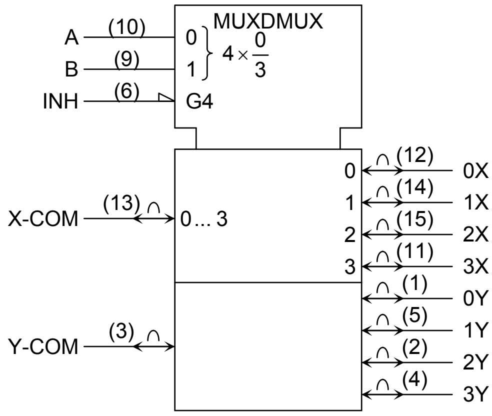
(top view)

IEC Logic Symbol

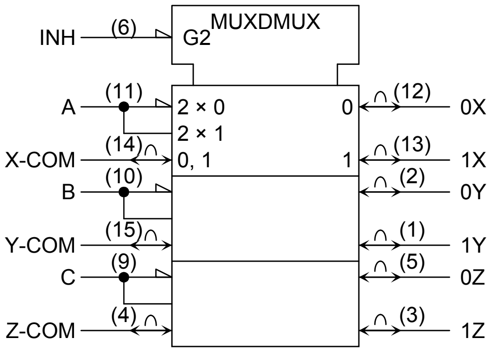
TC74HC4051A



TC74HC4052A



TC74HC4053A



Truth Table

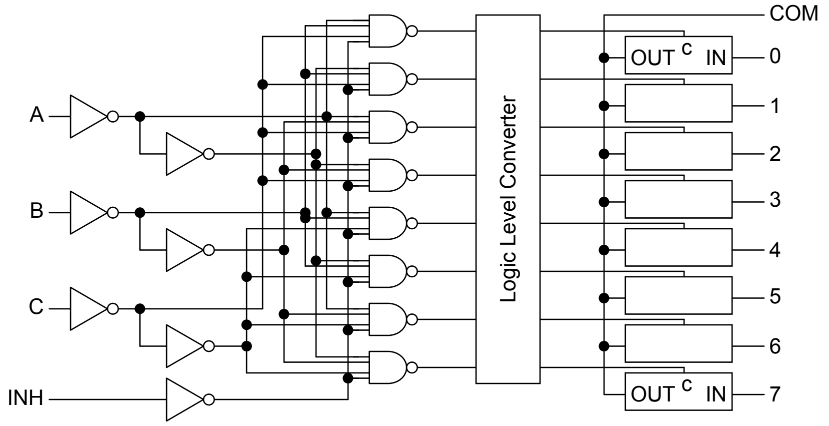
Control Inputs				"ON" Channel		
Inhibit	C*	B	A	HC4051A	HC4052A	HC4053A
L	L	L	L	0	0X, 0Y	0X, 0Y, 0Z
L	L	L	H	1	1X, 1Y	1X, 0Y, 0Z
L	L	H	L	2	2X, 2Y	0X, 1Y, 0Z
L	L	H	H	3	3X, 3Y	1X, 1Y, 0Z
L	H	L	L	4	—	0X, 0Y, 1Z
L	H	L	H	5	—	1X, 0Y, 1Z
L	H	H	L	6	—	0X, 1Y, 1Z
L	H	H	H	7	—	1X, 1Y, 1Z
H	X	X	X	None	None	None

X: Don't care

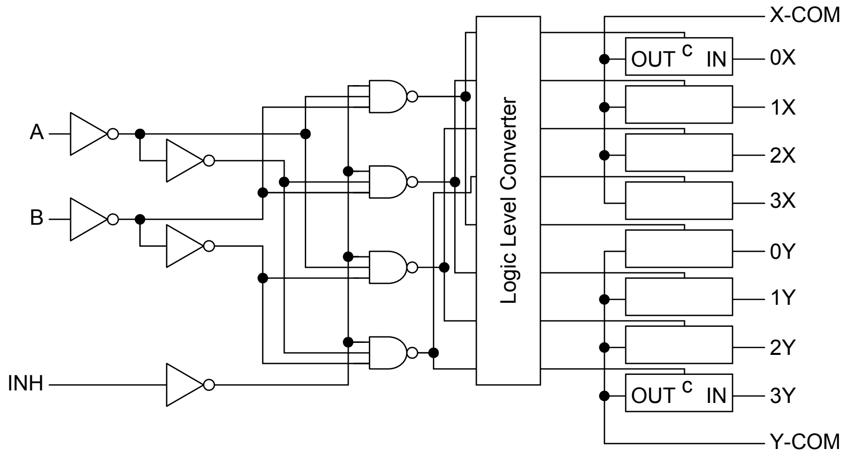
*: Except HC4052A

System Diagram

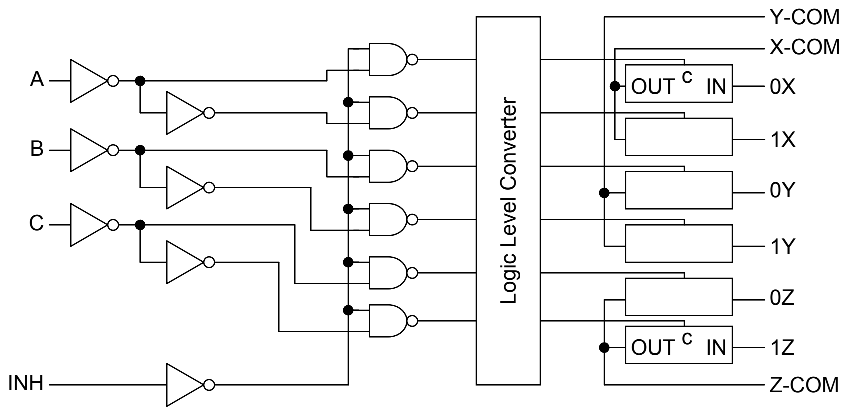
TC74HC4051A



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}	±20	mA
I/O diode current	I_{OK}	±20	mA
Switch through current	I_T	±25	mA
DC V_{CC} or ground current	I_{CC}	±50	mA
Power dissipation	P_D	500 (DIP) (Note 2)/180 (SOP, TSSOP)	mW
Storage temperature	T_{stg}	−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 Ta = −40 to 65°C. From Ta = 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_{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	°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 VCC or GND.

Electrical Characteristics

DC Characteristics

Characteristics	Symbol	Test Condition	V_{EE} (V)	V_{CC} (V)	Ta = 25°C Min	Typ.	Max	Ta = –40 to 85°C Min	Max	Unit
High-level control input voltage	V_{IHC}	—		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_{ILC}	—		2.0	—	—	0.50	—	0.50	V
				4.5	—	—	1.35	—	1.35	
				6.0	—	—	1.80	—	1.80	
ON resistance	R_{ON}	$V_{IN} = V_{ILC}$ or V_{IHC}	GND	4.5	—	85	180	—	225	Ω
		$V_{I/O} = V_{CC}$ to V_{EE}	–4.5	4.5	—	55	120	—	150	
		$I_{I/O} \leq 2$ mA	–6.0	6.0	—	50	100	—	125	
		$V_{IN} = V_{ILC}$ or V_{IHC} $V_{I/O} = V_{CC}$ or V_{EE} $I_{I/O} \leq 2$ mA	GND	2.0	—	150	—	—	—	
			GND	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_{ON}	$V_{IN} = V_{ILC}$ or V_{IHC}	GND	4.5	—	10	30	—	35	Ω
		$V_{I/O} = V_{CC}$ to V_{EE}	–4.5	4.5	—	5	12	—	15	
		$I_{I/O} \leq 2$ mA	–6.0	6.0	—	5	10	—	12	
Input/output leakage current (switch off)	I_{OFF}	$V_{OS} = V_{CC}$ or GND V_{IS} = GND or V_{CC} $V_{IN} = V_{ILC}$ or V_{IHC}	GND	6.0	—	—	±60	—	±600	nA
			–6.0	6.0	—	—	±100	—	±1000	
Switch input leakage current (switch on)	I_{IZ}	$V_{OS} = V_{CC}$ or GND	GND	6.0	—	—	±60	—	±600	nA
		$V_{IN} = V_{ILC}$ or V_{IHC}	–6.0	6.0	—	—	±100	—	±1000	
Control input current	I_{IN}	$V_{IN} = V_{CC}$ or GND	GND	6.0	—	—	±0.1	—	±1.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	GND	6.0	—	—	4.0	—	40.0	μA
			–6.0	6.0	—	—	8.0	—	80.0	

AC Characteristics (C_L = 50 pF, input: $t_r = t_f$ = 6 ns, GND = 0 V)

Characteristics	Symbol	Test Condition			Ta = 25°C			Ta = –40 to 85°C		Unit
			V_{EE} (V)	V_{CC} (V)	Min	Typ.	Max	Min	Max	
Phase difference between input and output	$\varphi_{I/O}$	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	t_{pZL} t_{pZH}	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_{pLZ} t_{pHZ}	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_{IN}	All types	—	—	—	5	10	—	10	pF
COMMON terminal capacitance	C_{IS}	4051	–5.0	5.0	—	36	70	—	70	pF
		4052			—	19	40	—	40	
		4053			—	11	20	—	20	
SWITCH terminal capacitance	C_{OS}	4051	–5.0	5.0	—	7	15	—	15	pF
		4052			—	7	15	—	15	
		4053			—	7	15	—	15	
Feedthrough capacitance	C_{IOS}	4051	–5.0	5.0	—	0.95	2	—	2	pF
		4052			—	0.85	2	—	2	
		4053			—	0.75	2	—	2	
Power dissipation capacitance	C_{PD}	4051	GND	5.0	—	70	—	—	—	pF
		4052 (Note 2)			—	71	—	—	—	
		4053			—	67	—	—	—	

Note 1: R_L = 1 kΩ

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:

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

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

Characteristics	Symbol	Test Condition		V_{EE} (V)	V_{CC} (V)	Typ.	Unit
Sine wave distortion (T.H.D)		R_L = 10 kΩ, C_L = 50 pF, f_{IN} = 1 kHz	V_{IN} = 4.0 $V_{p\text{-}p}$	−2.25	2.25	0.025	%
			V_{IN} = 8.0 $V_{p\text{-}p}$	−4.5	4.5	0.020	
			V_{IN} = 11.0 $V_{p\text{-}p}$	−6.0	6.0	0.018	
Frequency response (switch on)	f_{max}	Adjust f_{IN} voltage to obtain 0dBm at V_{OS} Increase f_{IN} frequency until dB meter reads −3dB R_L = 50 Ω, C_L = 10 pF f_{IN} = 1 MHz, sine wave	All (Note 2)	−2.25	2.25	120	MHz
			4051 (Note 3)			45	
			4052			70	
			4053			95	
			All (Note 2)	−4.5	4.5	190	
			4051 (Note 3)			70	
			4052			110	
			4053			150	
			All (Note 2)	−6.0	6.0	200	
			4051 (Note 3)			85	
			4052			140	
			4053			190	
Feed through attenuation (switch off)		V_{IN} is centered at $(V_{CC} - V_{EE})/2$ Adjust input for 0dBm R_L = 600 Ω, C_L = 50 pF f_{IN} = 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_L = 600 Ω, C_L = 50 pF f_{IN} = 1 MHz, square wave (t_r = t_f = 6 ns)		−2.25	2.25	60	mV
				−4.5	4.5	140	
				−6.0	6.0	200	
Crosstalk (between any switches)		Adjust V_{IN} to obtain 0dBm at input R_L = 600 Ω, C_L = 50 pF f_{IN} = 1 MHz, sine wave		−2.25	2.25	−50	dB
				−4.5	4.5	−50	
				−6.0	6.0	−50	

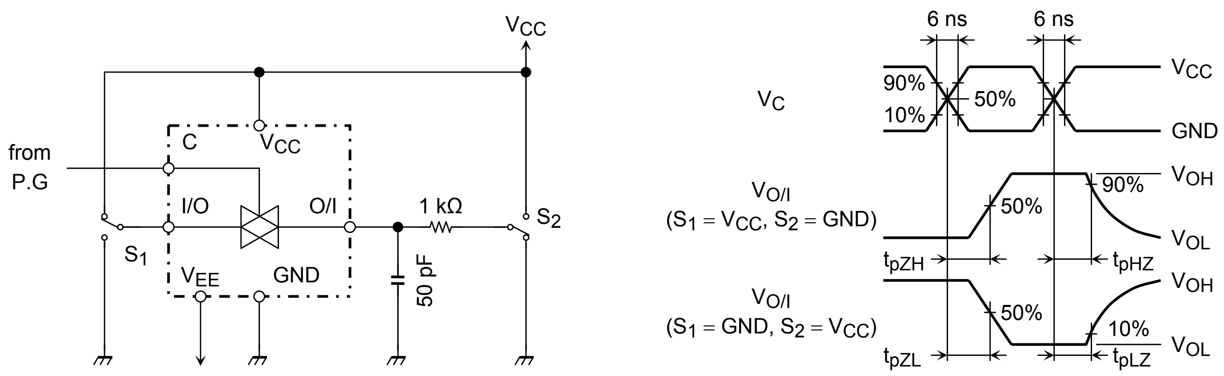
Note 1: These characteristics are determined by design of devices.

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

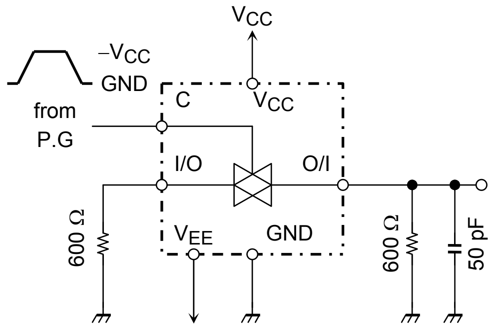
Note 3: Input SWITCH terminal, and measured at COMMON terminal.

Switching Characteristics Test Circuits

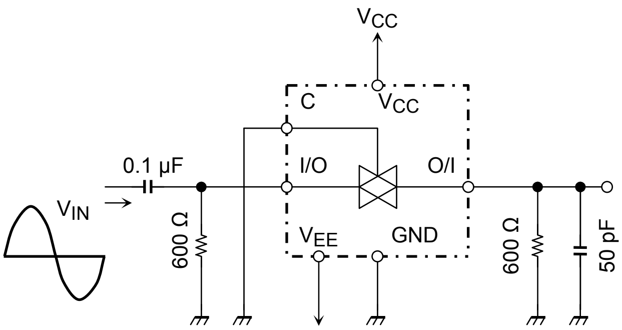
1. t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}



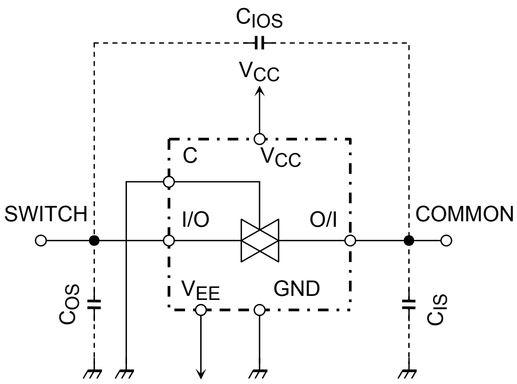
2. Cross Talk (control input-switch output) $f_{IN} = 1$ MHz duty = 50% $t_r = t_f = 6$ ns



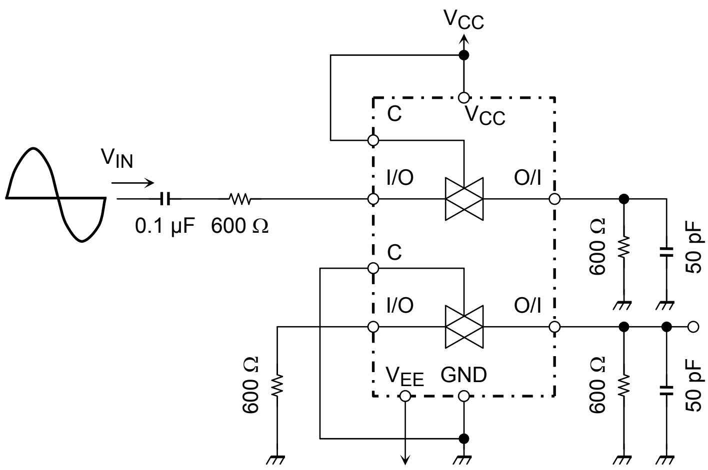
3. Feedthrough Attenuation



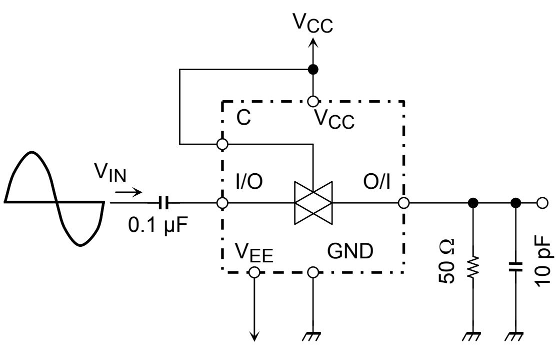
4. C_{IOS}, C_{IS}, C_{OS}



5. Cross Talk (between any two switches)



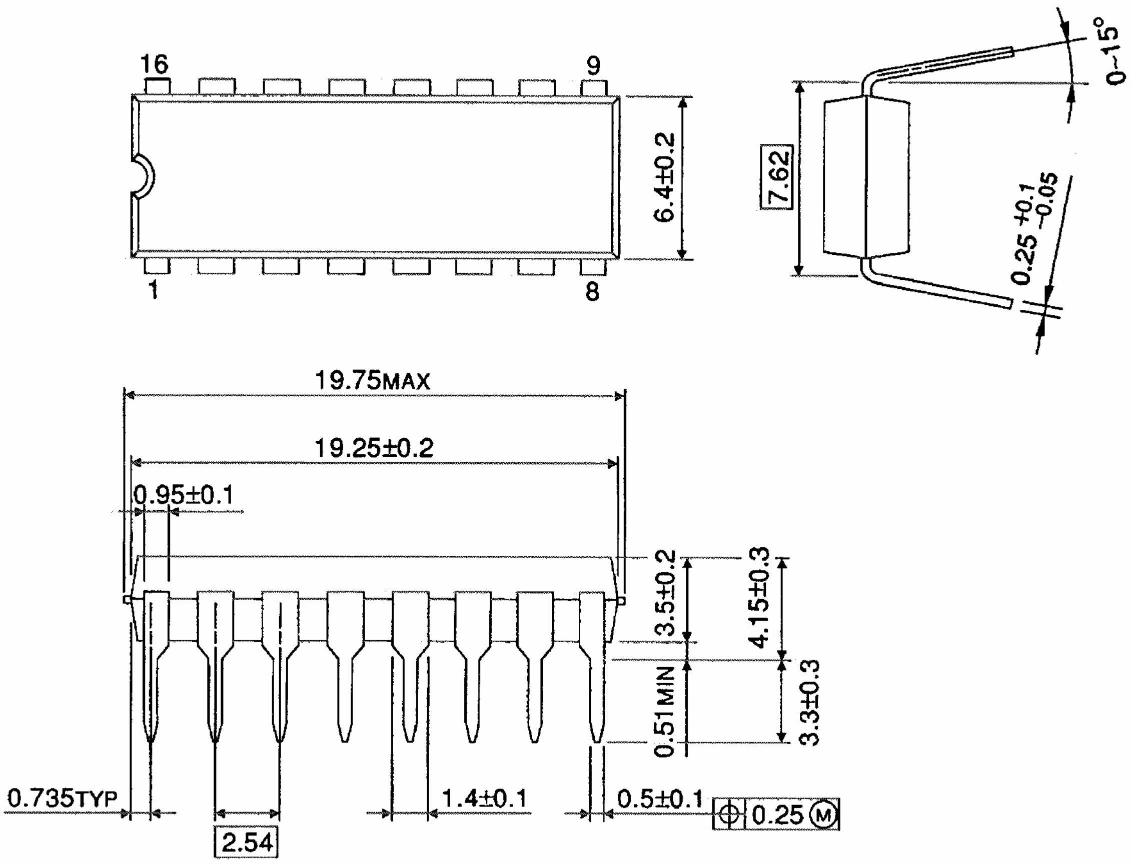
6. Frequency Response (switch on)



Package Dimensions

DIP16-P-300-2.54A

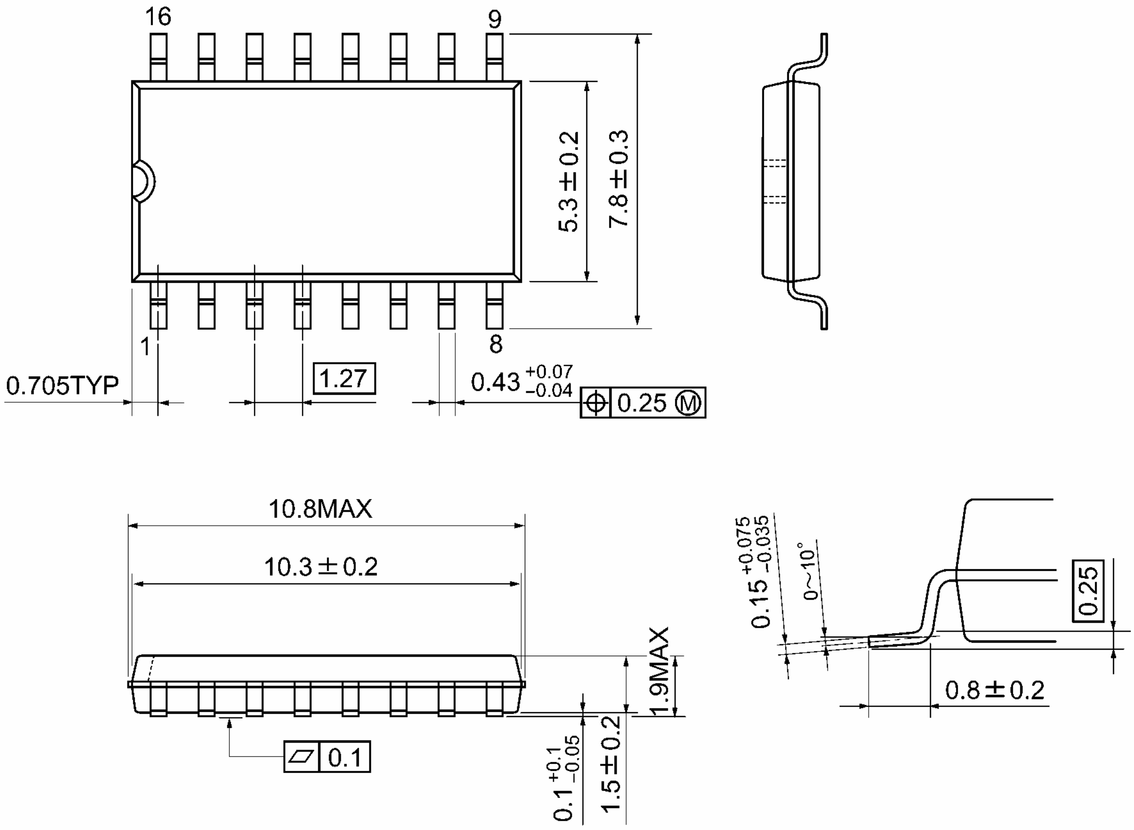
Unit : mm



Weight: 1.00 g (typ.)

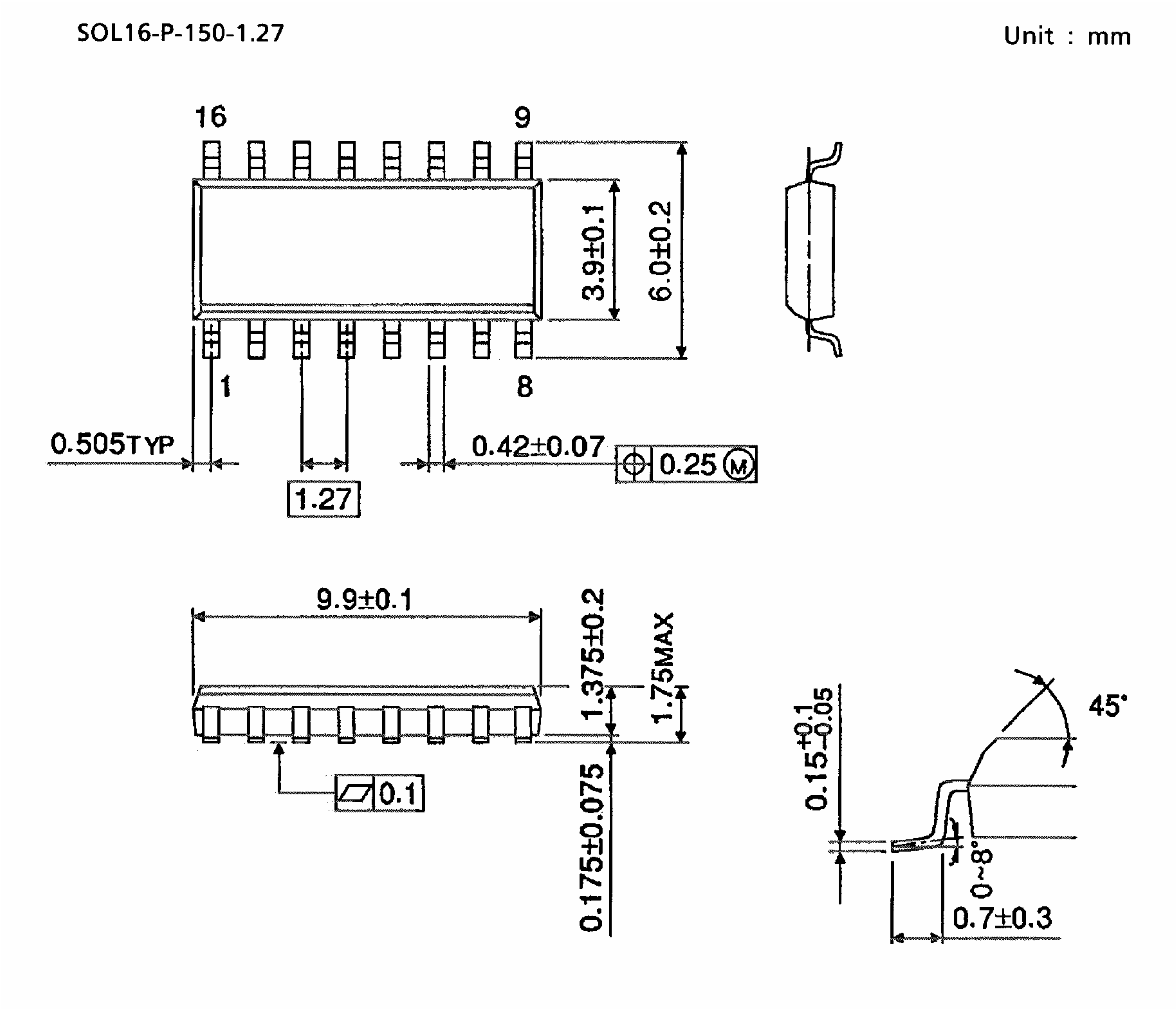
Package Dimensions

SOP16-P-300-1.27A Unit: mm



Weight: 0.18 g (typ.)

Package Dimensions (Note)



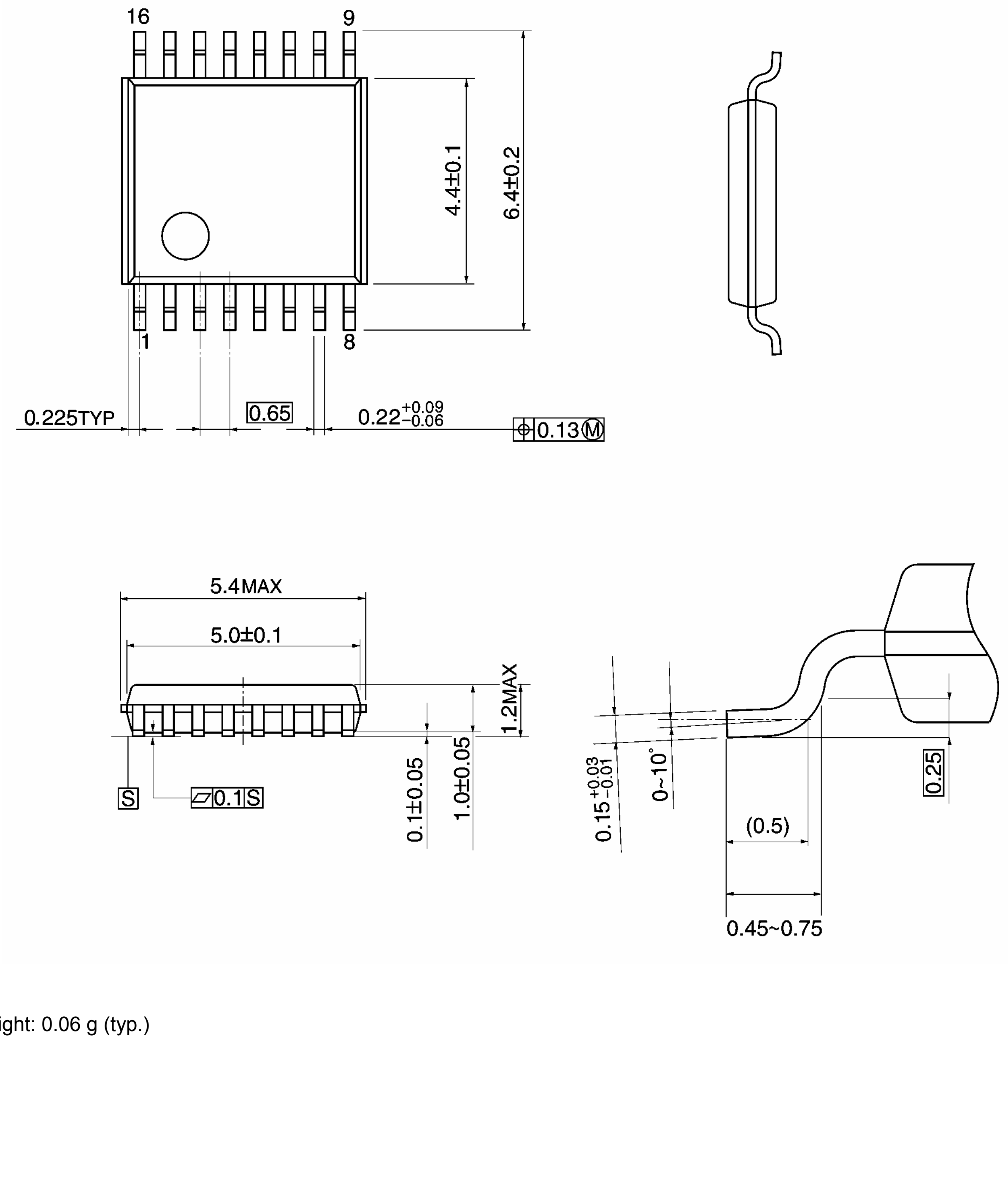
Note: This package is not available in Japan.

Weight: 0.13 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm



Weight: 0.06 g (typ.)