

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/DEMUTIPLEXER fabricated with silicon gate C²MOS 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 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.

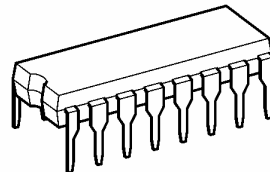
Features

- High speed: $t_{pd} = 15\text{ ns}$ (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

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

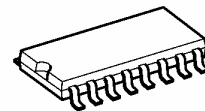
Note: xxxFN (JEDEC SOP) is not available in Japan.

TC74HC4051AP, TC74HC4052AP,
TC74HC4053AP

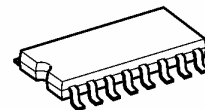


DIP16-P-300-2.54A

TC74HC4051AF, TC74HC4052AF,
TC74HC4053AF

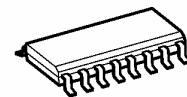


SOP16-P-300-1.27A



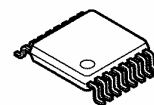
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TC74HC4053AFN



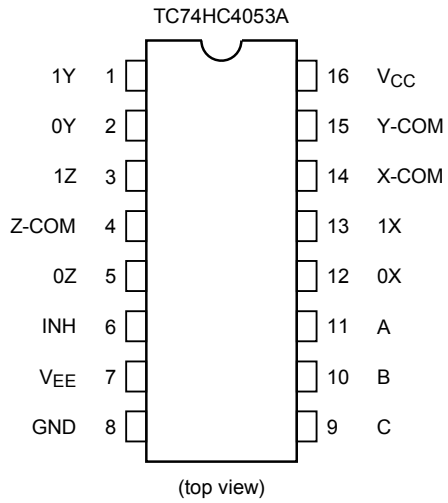
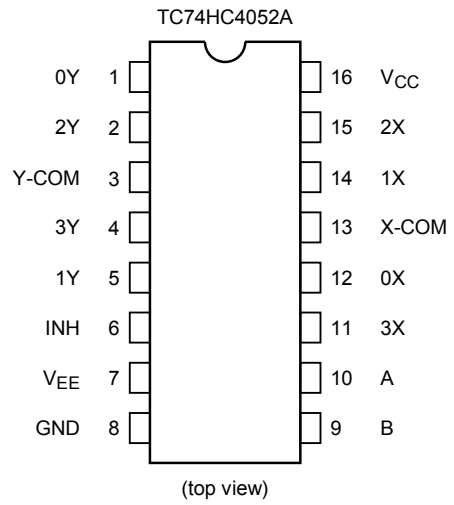
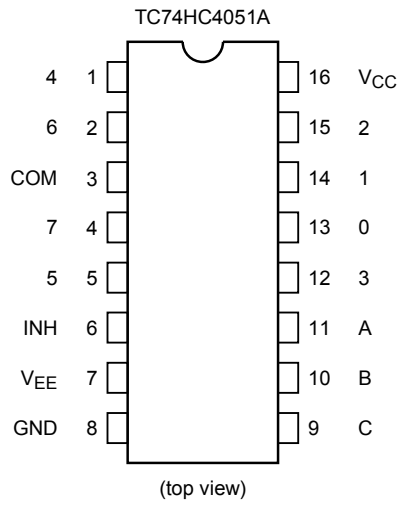
SOL16-P-150-1.27

TC74HC4051AFT, TC74HC4052AFT,
TC74HC4053AFT

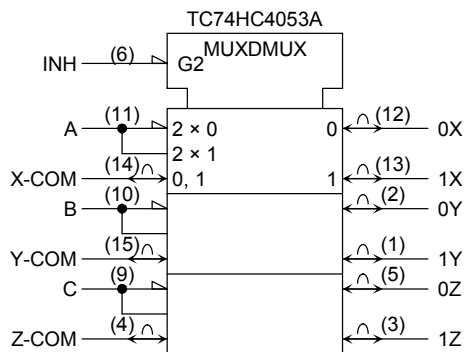
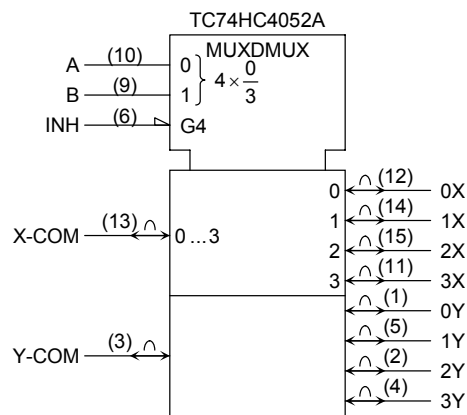
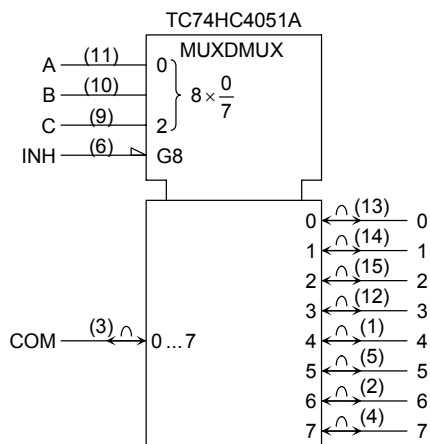


TSSOP16-P-0044-0.65A

Pin Assignment



IEC Logic Symbol



Truth Table

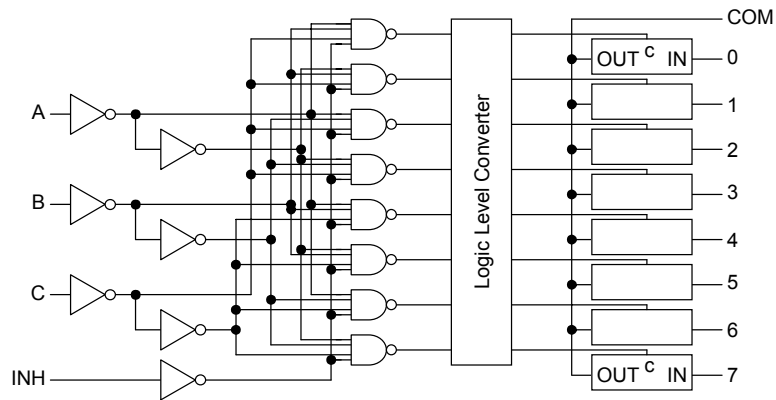
| Control Inputs | | | | "ON" Channel | | |
|----------------|----|---|---|--------------|---------|------------|
| Inhibit | C* | B | A | HC4051A | HC4052A | HC4053A |
| L | L | L | L | 0 | 0X, 0Y | 0X, 0Y, 0Z |
| L | L | L | H | 1 | 1X, 1Y | 1X, 0Y, 0Z |
| L | L | H | L | 2 | 2X, 2Y | 0X, 1Y, 0Z |
| 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

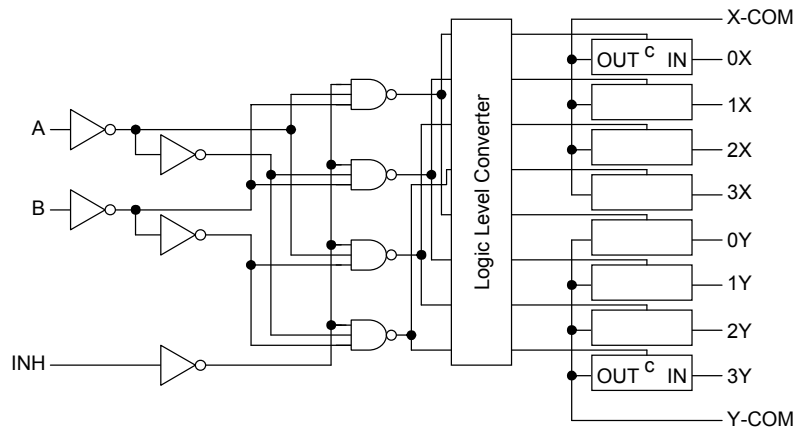
*: Except HC4052A

System Diagram

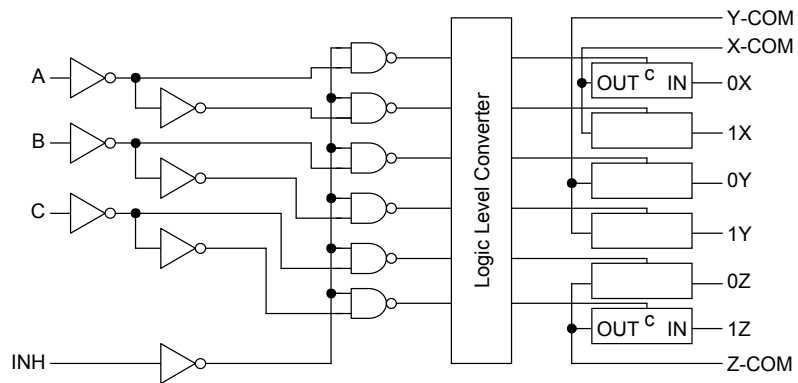
TC74HC4051A



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} | ± 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.

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

Recommended Operating Conditions (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 recommended operating conditions are required to ensure the normal operation of the device. Unused inputs must be tied to either VCC or GND.

Electrical Characteristics

DC Characteristics

| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | Ta = -40 to 85°C | | Unit | |
|--|------------------|--|---------------------|-----------|------|-----|------------------|------|-------|----|
| | | V _{EE} (V) | V _{CC} (V) | Min | Typ. | Max | Min | Max | | |
| 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} V _{I/O} = V _{CC} to V _{EE} I _{I/O} ≤ 2 mA | GND | 4.5 | — | 85 | 180 | — | 225 | Ω |
| | | | -4.5 | 4.5 | — | 55 | 120 | — | 150 | |
| | | | -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} ≤ 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 _{ON} | V _{IN} = V _{ILC} or V _{IHC} V _{I/O} = V _{CC} to V _{EE} I _{I/O} ≤ 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 _{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 V _{IN} = V _{ILC} or V _{IHC} | GND | 6.0 | — | — | ±60 | — | ±600 | nA |
| | | | -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 |
| Phase difference between input and output | φ _{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 | — | — | — | 36 | 70 | — | 70 | pF |
| | | 4052 | -5.0 | 5.0 | — | 19 | 40 | — | 40 | |
| | | 4053 | — | — | — | 11 | 20 | — | 20 | |
| SWITCH terminal capacitance | C _{OS} | 4051 | — | — | — | 7 | 15 | — | 15 | pF |
| | | 4052 | -5.0 | 5.0 | — | 7 | 15 | — | 15 | |
| | | 4053 | — | — | — | 7 | 15 | — | 15 | |
| Feedthrough capacitance | C _{IOS} | 4051 | — | — | — | 0.95 | 2 | — | 2 | pF |
| | | 4052 | -5.0 | 5.0 | — | 0.85 | 2 | — | 2 | |
| | | 4053 | — | — | — | 0.75 | 2 | — | 2 | |
| Power dissipation capacitance | C _{PD} | 4051 | — | — | — | 70 | — | — | — | pF |
| | | 4052 (Note 2) | GND | 5.0 | — | 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 | | Typ. | Unit | | |
|---|------------------|---|---|-------|------|-------|-----|
| | | V _{EE} (V) | V _{CC} (V) | | | | |
| Sine wave distortion (T.H.D) | | R _L = 10 kΩ, C _L = 50 pF f _{IN} = 1 kHz | V _{IN} = 4.0 V _{p-p} | -2.25 | 2.25 | 0.025 | % |
| | | | V _{IN} = 8.0 V _{p-p} | -4.5 | 4.5 | 0.020 | |
| | | | V _{IN} = 11.0 V _{p-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 | |

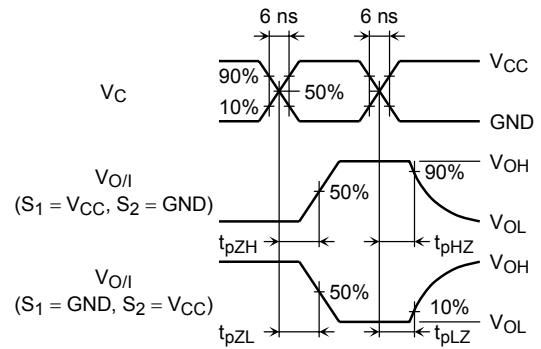
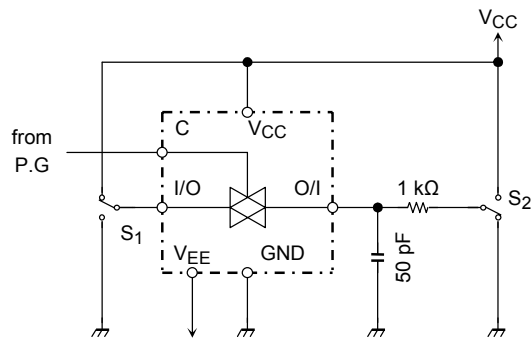
Note 1: These characteristics are determined by design of devices.

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

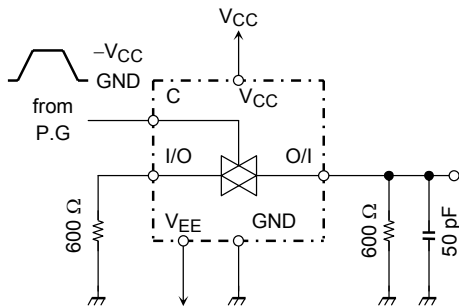
Note 3: Input SWITCH terminal, and measured at COMMON terminal.

Switching Characteristics Test Circuits

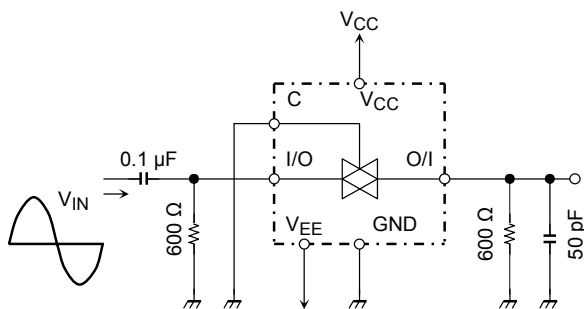
1. t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}



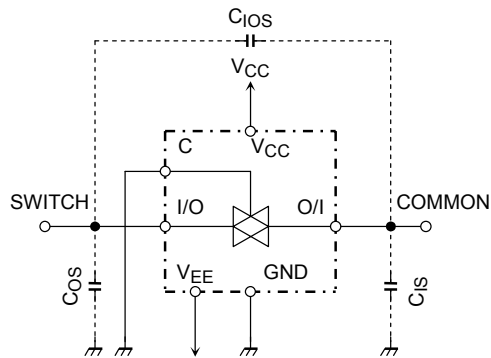
2. Cross Talk (control input-switch output) $f_{IN} = 1$ MHz duty = 50% $t_r = t_f = 6$ ns



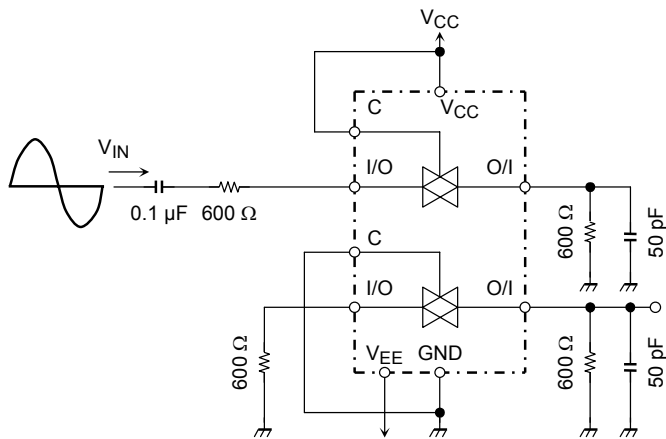
3. Feedthrough Attenuation



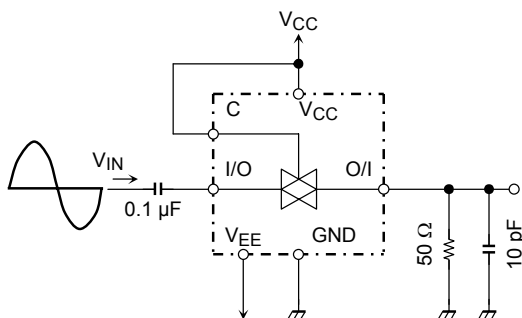
4. C_{IOS} , C_{IS} , C_{OS}



5. Cross Talk (between any two switches)



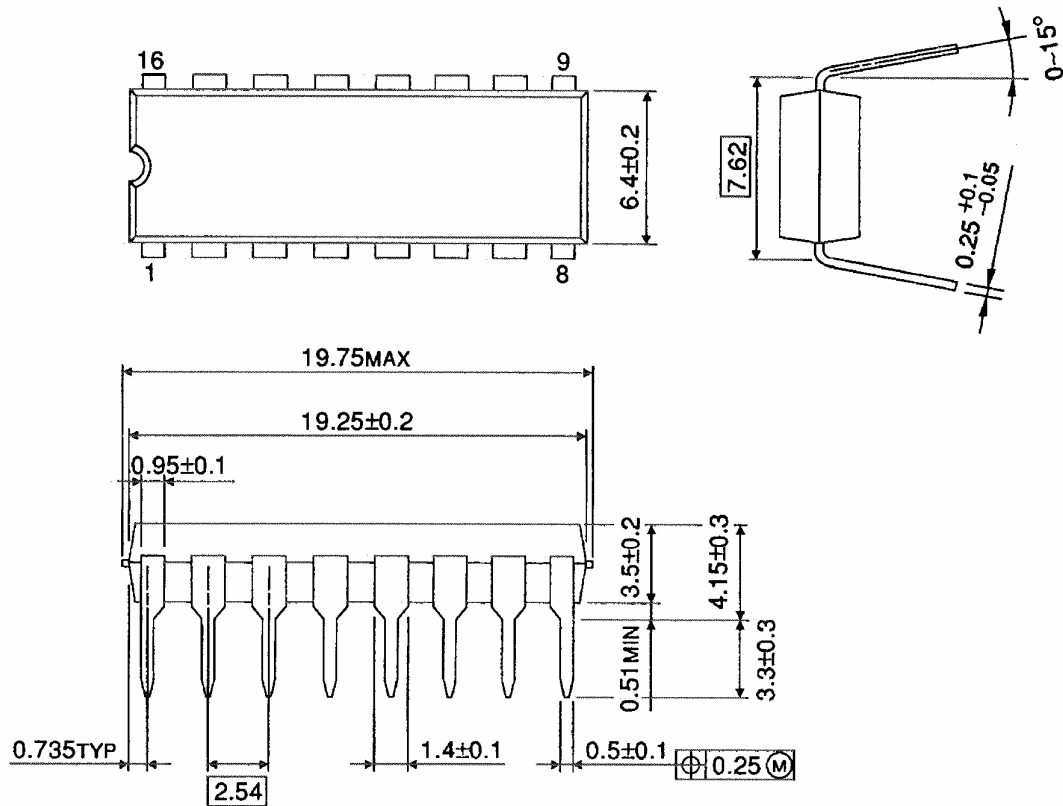
6. Frequency Response (switch on)



Package Dimensions

DIP16-P-300-2.54A

Unit : mm

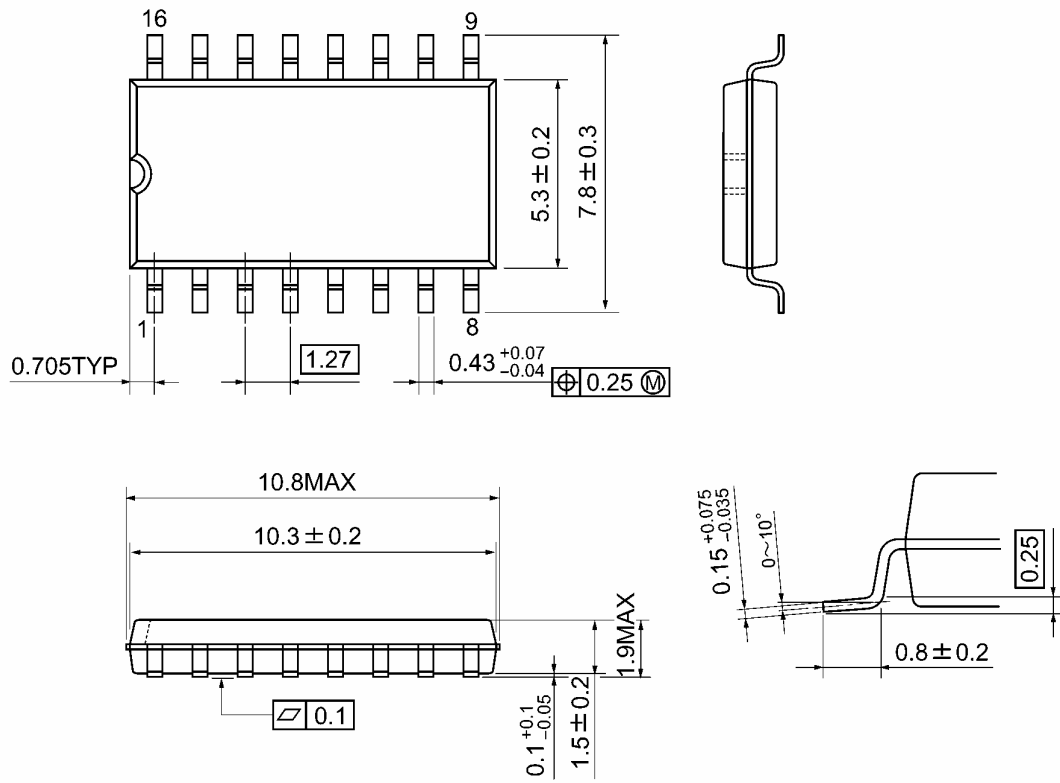


Weight: 1.00 g (typ.)

Package Dimensions

SOP16-P-300-1.27A

Unit: mm

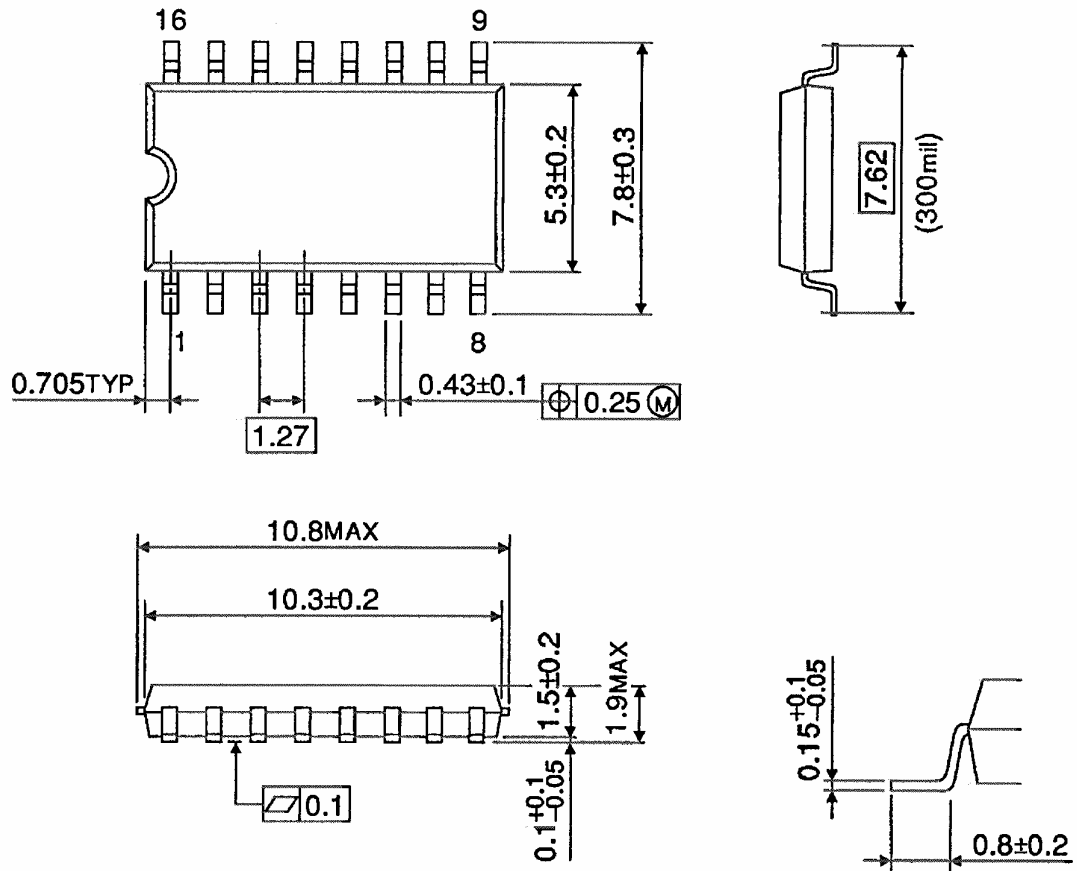


Weight: 0.18 g (typ.)

Package Dimensions

SOP16-P-300-1.27

Unit : mm

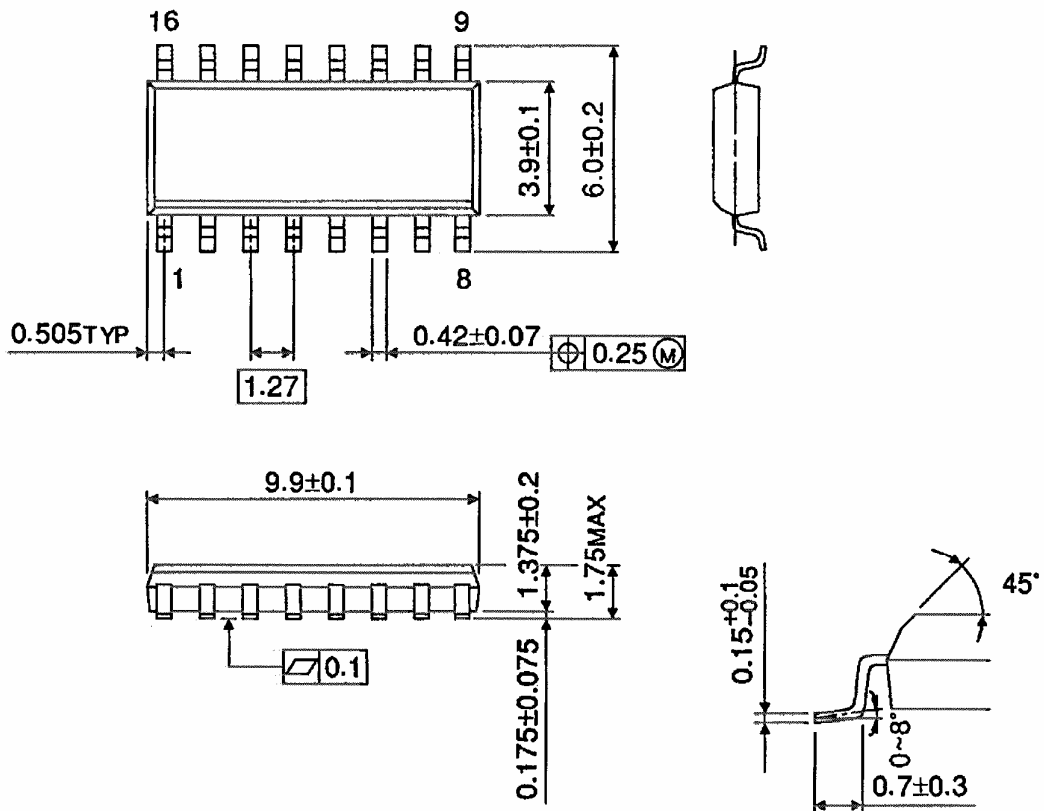


Weight: 0.18 g (typ.)

Package Dimensions (Note)

SOL16-P-150-1.27

Unit : mm



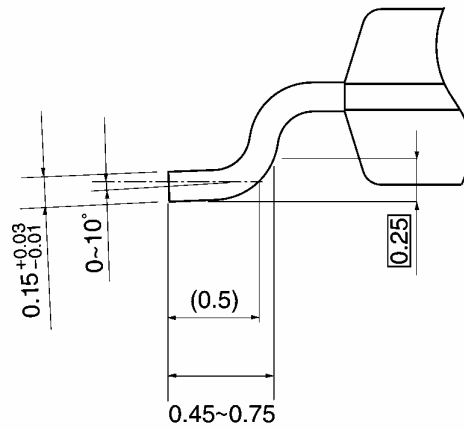
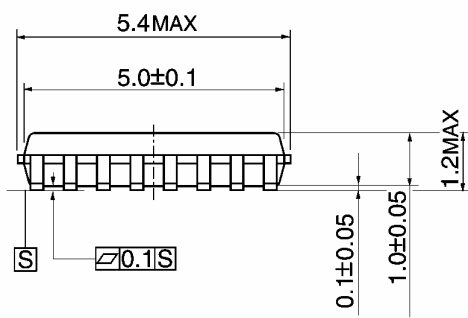
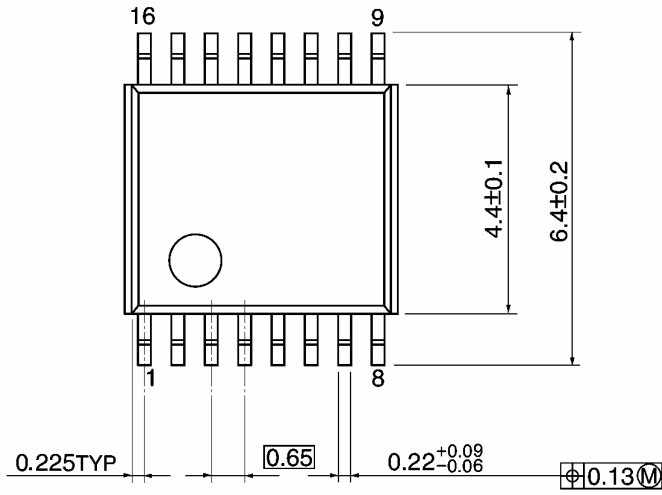
Note: This package is not available in Japan.

Weight: 0.13 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm



Weight: 0.06 g (typ.)

Note: Lead (Pb)-Free Packages**DIP16-P-300-2.54A SOP16-P-300-1.27A SOL16-P-150-1.27 TSSOP16-P-0044-0.65A****RESTRICTIONS ON PRODUCT USE**

060116EBA

- The information contained herein is subject to change without notice. 021023_D
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc. 021023_A
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