

74HC4053D

1. Functional Description

- Triple 2-Channel Analog Multiplexer/Demultiplexer

2. General

The 74HC4053D are high speed CMOS ANALOG MULTIPLEXER/DEMULTIPLEXER fabricated with silicon gate C²MOS technology. They achieve the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The 74HC4053D 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.

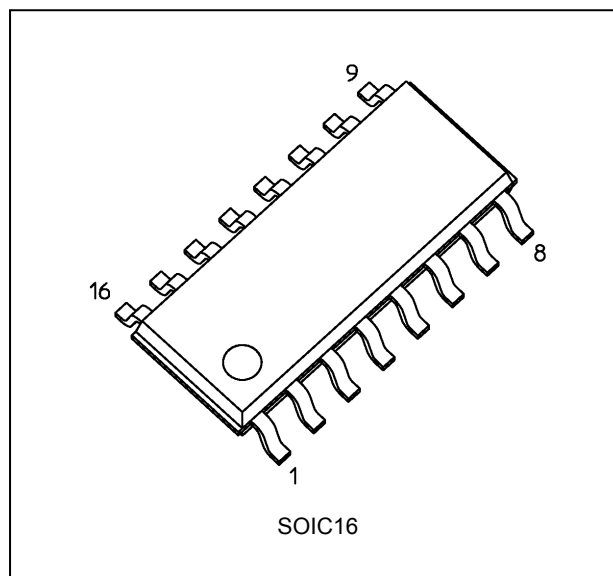
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

3. Features

- (1) Wide operating temperature range: $T_{opr} = -40$ to $125\text{ }^{\circ}\text{C}$ (Note 1)
- (2) Low power dissipation: $I_{CC} = 4.0\text{ }\mu\text{A}$ (max) ($V_{CC} = 6.0\text{ V}$, $V_{EE} = GND$, $T_a = 25\text{ }^{\circ}\text{C}$)
- (3) High noise immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (min)
- (4) Low ON-resistance: $R_{ON} = 50\text{ }\Omega$ (typ.) at $V_{CC} - V_{EE} = 9\text{ V}$
- (5) High degree of linearity: THD = 0.020 % (typ.) at $V_{CC} - V_{EE} = 9\text{ V}$
- (6) Pin and function compatible with 4053B

Note 1: Operating Range spec of $T_{opr} = -40\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$ is applicable only for the products which manufactured after July 2020.

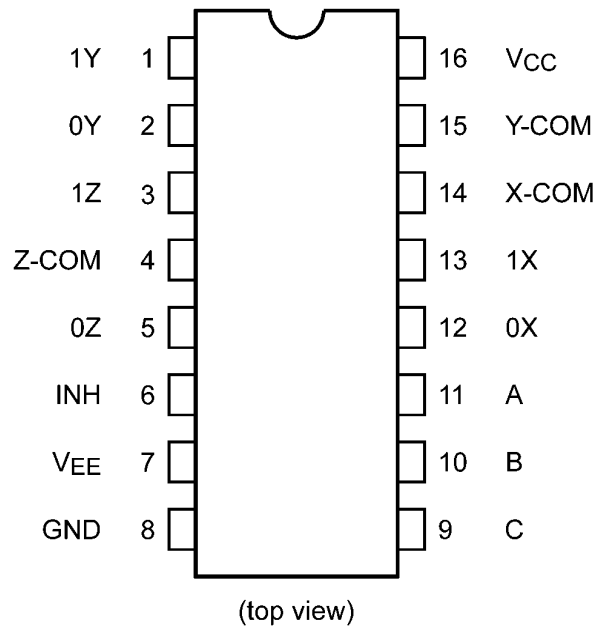
4. Packaging



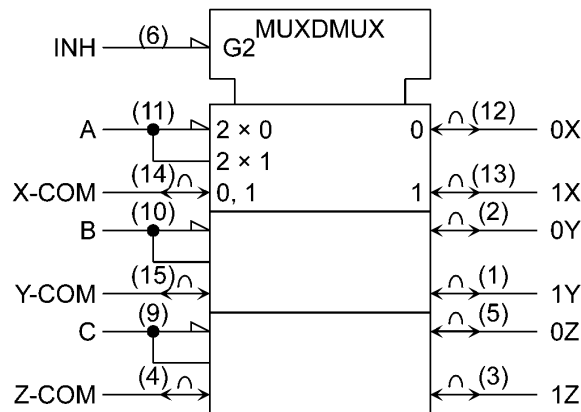
Start of commercial production

2020-07

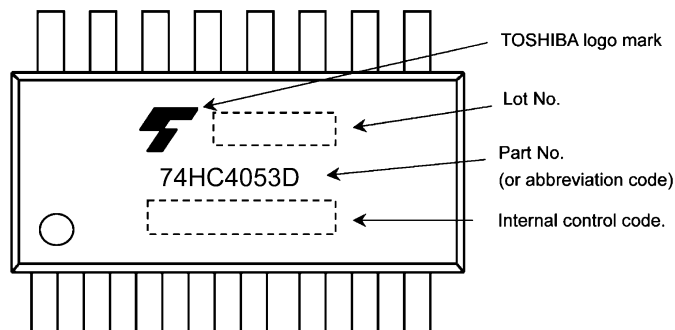
5. Pin Assignment



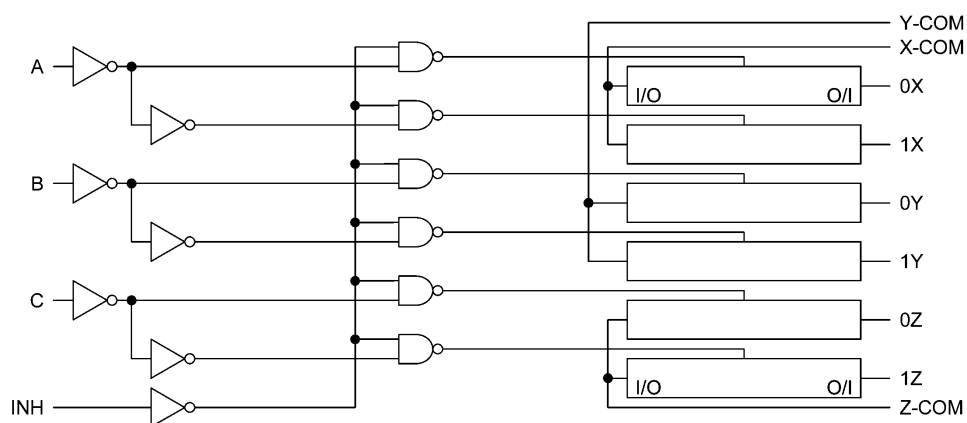
6. IEC Logic Symbol



7. Marking



8. System Diagram



9. Truth Table

| Input Inhibit | Input C | Input B | Input A | ON Channel |
|---------------|---------|---------|---------|------------|
| 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

10. Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|--------------------------|-----------------|----------|----------------------------------|--------------------|
| Supply voltage | V_{CC} | | -0.5 to 7.0 | V |
| | V_{EE} | | -7.0 to 0 | |
| | $V_{CC}-V_{EE}$ | | -0.5 to 13.0 | |
| 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 |
| Input diode current | I_{IK} | | ± 20 | mA |
| I/O diode current | $I_{I/OK}$ | | ± 20 | mA |
| Switch through current | I_T | | ± 25 | mA |
| V_{CC} /ground current | I_{CC} | | ± 50 | mA |
| Power dissipation | P_D | (Note 1) | 500 | mW |
| Storage temperature | T_{stg} | | -65 to 150 | $^{\circ}\text{C}$ |

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).

Note 1: P_D derates linearly with -8 mW/ $^{\circ}\text{C}$ above 85 $^{\circ}\text{C}$.

11. Operating Ranges (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---------------------------|-----------------|----------|----------------------|--------------------|
| Supply voltage | V_{CC} | | 2.0 to 6.0 | V |
| | V_{EE} | | -6.0 to 0 | |
| | $V_{CC}-V_{EE}$ | | 2.0 to 12.0 | |
| 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} | (Note 1) | -40 to 125 | $^{\circ}\text{C}$ |
| Input rise and fall times | t_r, t_f | | 0 to 50 | μs |

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either V_{CC} or GND.

Note 1: Operating Range spec of $T_{opr} = -40\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$ is applicable only for the products which manufactured after July 2020.

12. Electrical Characteristics

12.1. DC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

| Characteristics | Symbol | Test Condition | V_{EE} (V) | V_{CC} (V) | Min | Typ. | Max | Unit |
|--|-----------------|--|--------------|--------------|------|------|------------|---------------|
| High-level input voltage | V_{IH} | — | | 2.0 | 1.50 | — | — | V |
| | | | | 4.5 | 3.15 | — | — | |
| | | | | 6.0 | 4.20 | — | — | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | — | 0.50 | V |
| | | | | 4.5 | — | — | 1.35 | |
| | | | | 6.0 | — | — | 1.80 | |
| ON-resistance | R_{ON} | $V_{IN} = V_{IH}$ or V_{IL} $V_{IO} = V_{CC}$ to V_{EE} $I_{IO} \leq 2\text{ mA}$ | GND | 4.5 | — | 85 | 180 | Ω |
| | | | -4.5 | 4.5 | — | 55 | 120 | |
| | | | -6.0 | 6.0 | — | 50 | 100 | |
| | | $V_{IN} = V_{IH}$ or V_{IL} $V_{IO} = V_{CC}$ or V_{EE} $I_{IO} \leq 2\text{ mA}$ | GND | 2.0 | — | 150 | — | |
| | | | GND | 4.5 | — | 70 | 150 | |
| | | | -4.5 | 4.5 | — | 50 | 100 | |
| Difference of ON-resistance between switches | ΔR_{ON} | $V_{IN} = V_{IH}$ or V_{IL} $V_{IO} = V_{CC}$ to V_{EE} $I_{IO} \leq 2\text{ mA}$ | GND | 4.5 | — | 10 | 30 | Ω |
| | | | -4.5 | 4.5 | — | 5 | 12 | |
| | | | -6.0 | 6.0 | — | 5 | 10 | |
| Input/Output leakage current (Switch OFF) | I_{OFF} | $V_{OS} = V_{CC}$ or GND $V_{IS} = \text{GND}$ or V_{CC} $V_{IN} = V_{IH}$ or V_{IL} | GND | 6.0 | — | — | ± 0.06 | μA |
| | | | -6.0 | 6.0 | — | — | ± 0.1 | |
| Input/Output leakage current (Switch ON) | I_{IO} | $V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or V_{IL} | GND | 6.0 | — | — | ± 0.06 | μA |
| | | | -6.0 | 6.0 | — | — | ± 0.1 | |
| Control input leakage current | I_{IN} | $V_{IN} = V_{CC}$ or GND | GND | 6.0 | — | — | ± 0.1 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | GND | 6.0 | — | — | 4.0 | μA |
| | | | -6.0 | 6.0 | — | — | 8.0 | |

12.2. DC Characteristics (Unless otherwise specified, $T_a = -40$ to 85 °C)

| Characteristics | Symbol | Test Condition | V_{EE} (V) | V_{CC} (V) | Min | Max | Unit | |
|--|-----------------|---|--|--------------|------|-----------|----------|-----|
| High-level input voltage | V_{IH} | — | | 2.0 | 1.50 | — | V | |
| | | | | 4.5 | 3.15 | — | | |
| | | | | 6.0 | 4.20 | — | | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | 0.50 | V | |
| | | | | 4.5 | — | 1.35 | | |
| | | | | 6.0 | — | 1.80 | | |
| ON-resistance | R_{ON} | $V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to V_{EE} $I_{I/O} \leq 2$ mA | GND | 4.5 | — | 225 | Ω | |
| | | | | -4.5 | 4.5 | 150 | | |
| | | | | -6.0 | 6.0 | 125 | | |
| | | | $V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ or V_{EE} $I_{I/O} \leq 2$ mA | GND | 2.0 | — | | — |
| | | | | | 4.5 | — | | 190 |
| | | | | | -4.5 | 4.5 | | 125 |
| Difference of ON-resistance between switches | ΔR_{ON} | $V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to V_{EE} $I_{I/O} \leq 2$ mA | GND | 4.5 | — | 35 | Ω | |
| | | | | -4.5 | 4.5 | 15 | | |
| | | | | -6.0 | 6.0 | 12 | | |
| Input/Output leakage current (Switch OFF) | I_{OFF} | $V_{OS} = V_{CC}$ or GND $V_{IS} = GND$ or V_{CC} $V_{IN} = V_{IH}$ or V_{IL} | GND | 6.0 | — | ± 0.6 | μA | |
| | | | | -6.0 | 6.0 | ± 1.0 | | |
| Input/Output leakage current (Switch ON) | $I_{I/O}$ | $V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or V_{IL} | GND | 6.0 | — | ± 0.6 | μA | |
| | | | | -6.0 | 6.0 | ± 1.0 | | |
| Control input leakage current | I_{IN} | $V_{IN} = V_{CC}$ or GND | GND | 6.0 | — | ± 1.0 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | GND | 6.0 | — | 40.0 | μA | |
| | | | | -6.0 | 6.0 | 80.0 | | |

12.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to 125 °C)

| Characteristics | Symbol | Test Condition | V_{EE} (V) | V_{CC} (V) | Min | Max | Unit |
|--|-----------------|---|--------------|--------------|------|-----------|----------|
| High-level input voltage | V_{IH} | — | | 2.0 | 1.50 | — | V |
| | | | | 4.5 | 3.15 | — | |
| | | | | 6.0 | 4.20 | — | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | 0.5 | V |
| | | | | 4.5 | — | 1.35 | |
| | | | | 6.0 | — | 1.8 | |
| ON-resistance | R_{ON} | $V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to V_{EE} $I_{I/O} \leq 2$ mA | GND | 4.5 | — | 255 | Ω |
| | | | -4.5 | 4.5 | — | 170 | |
| | | | -6.0 | 6.0 | — | 145 | |
| | | $V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ or V_{EE} $I_{I/O} \leq 2$ mA | GND | 2.0 | — | — | Ω |
| | | | GND | 4.5 | — | 220 | |
| | | | -4.5 | 4.5 | — | 145 | |
| Difference of ON-resistance between switches | ΔR_{ON} | $V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to V_{EE} $I_{I/O} \leq 2$ mA | GND | 4.5 | — | 35 | Ω |
| | | | -4.5 | 4.5 | — | 15 | |
| | | | -6.0 | 6.0 | — | 12 | |
| Input/Output leakage current (Switch OFF) | I_{OFF} | $V_{OS} = V_{CC}$ or GND $V_{IS} = GND$ or V_{CC} $V_{IN} = V_{IH}$ or V_{IL} | GND | 6.0 | — | ± 3.0 | μA |
| | | | -6.0 | 6.0 | — | ± 5.0 | |
| Input/Output leakage current (Switch ON) | $I_{I/O}$ | $V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or V_{IL} | GND | 6.0 | — | ± 3.0 | μA |
| | | | -6.0 | 6.0 | — | ± 5.0 | |
| Control input leakage current | I_{IN} | $V_{IN} = V_{CC}$ or GND | GND | 6.0 | — | ± 1.0 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | GND | 6.0 | — | 80.0 | μA |
| | | | -6.0 | 6.0 | — | 160.0 | |

Note: Operating Range spec of $T_{opr} = -40$ °C to 125 °C is applicable only for the products which manufactured after July 2020.

12.4. AC Characteristics

(Unless otherwise specified, $C_L = 50 \text{ pF}$, $T_a = 25 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

| Characteristics | Symbol | Test Condition | V_{EE} (V) | V_{CC} (V) | Min | Typ. | Max | Unit |
|--|--------------------|---------------------------------------|--------------|--------------|-----|------|-----|------|
| Phase difference between input to output | $\varphi_{I/O}$ | — | GND | 2.0 | — | 25 | 60 | ns |
| | | | GND | 4.5 | — | 6 | 12 | |
| | | | GND | 6.0 | — | 5 | 10 | |
| | | | -4.5 | 4.5 | — | 4 | — | |
| Output enable time | t_{PZL}, t_{PZH} | $R_L = 1 \text{ k}\Omega$ Figure 1 | GND | 2.0 | — | 50 | 225 | ns |
| | | | GND | 4.5 | — | 14 | 45 | |
| | | | GND | 6.0 | — | 12 | 38 | |
| | | | -4.5 | 4.5 | — | 14 | — | |
| Output disable time | t_{PLZ}, t_{PHZ} | $R_L = 1 \text{ k}\Omega$ Figure 1 | GND | 2.0 | — | 95 | 225 | ns |
| | | | GND | 4.5 | — | 30 | 45 | |
| | | | GND | 6.0 | — | 26 | 38 | |
| | | | -4.5 | 4.5 | — | 26 | — | |
| Control input capacitance | C_{IN} | — | — | — | — | 5 | 10 | pF |
| Common terminal capacitance | C_{IS} | Figure 2 | -5.0 | 5.0 | — | 11 | 20 | pF |
| Switch terminal capacitance | C_{OS} | Figure 2 | -5.0 | 5.0 | — | 7 | 15 | pF |
| Feedthrough capacitance | C_{IOS} | Figure 2 | -5.0 | 5.0 | — | 0.75 | 2 | pF |
| Power dissipation capacitance | C_{PD} | Figure 2 (Note 1) | GND | 5.0 | — | 10 | — | pF |

Note 1: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation.

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

12.5. AC Characteristics

(Unless otherwise specified, $C_L = 50 \text{ pF}$, $T_a = -40 \text{ to } 85 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

| Characteristics | Symbol | Test Condition | V_{EE} (V) | V_{CC} (V) | Min | Max | Unit |
|--|--------------------|---------------------------------------|--------------|--------------|-----|-----|------|
| Phase difference between input to output | $\varphi_{I/O}$ | — | GND | 2.0 | — | 75 | ns |
| | | | GND | 4.5 | — | 15 | |
| | | | GND | 6.0 | — | 13 | |
| | | | -4.5 | 4.5 | — | — | |
| Output enable time | t_{PZL}, t_{PZH} | $R_L = 1 \text{ k}\Omega$ Figure 1 | GND | 2.0 | — | 280 | ns |
| | | | GND | 4.5 | — | 56 | |
| | | | GND | 6.0 | — | 48 | |
| | | | -4.5 | 4.5 | — | — | |
| Output disable time | t_{PLZ}, t_{PHZ} | $R_L = 1 \text{ k}\Omega$ Figure 1 | GND | 2.0 | — | 280 | ns |
| | | | GND | 4.5 | — | 56 | |
| | | | GND | 6.0 | — | 48 | |
| | | | -4.5 | 4.5 | — | — | |
| Control input capacitance | C_{IN} | — | — | — | — | 10 | pF |
| Common terminal capacitance | C_{IS} | Figure 2 | -5.0 | 5.0 | — | 20 | pF |
| Switch terminal capacitance | C_{OS} | Figure 2 | -5.0 | 5.0 | — | 15 | pF |
| Feedthrough capacitance | C_{IOS} | Figure 2 | -5.0 | 5.0 | — | 2 | pF |

12.6. AC Characteristics (Note)

(Unless otherwise specified, $C_L = 50 \text{ pF}$, $T_a = -40 \text{ to } 125 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

| Characteristics | Symbol | Test Condition | V_{EE} (V) | V_{CC} (V) | Min | Max | Unit |
|--|--------------------|---------------------------------------|--------------|--------------|-----|-----|------|
| Phase difference between input to output | $\varphi_{I/O}$ | — | GND | 2.0 | — | 85 | ns |
| | | | GND | 4.5 | — | 17 | |
| | | | GND | 6.0 | — | 15 | |
| | | | -4.5 | 4.5 | — | — | |
| Output enable time | t_{PZL}, t_{PZH} | $R_L = 1 \text{ k}\Omega$ Figure 1 | GND | 2.0 | — | 320 | ns |
| | | | GND | 4.5 | — | 64 | |
| | | | GND | 6.0 | — | 55 | |
| | | | -4.5 | 4.5 | — | — | |
| Output disable time | t_{PLZ}, t_{PHZ} | $R_L = 1 \text{ k}\Omega$ Figure 1 | GND | 2.0 | — | 320 | ns |
| | | | GND | 4.5 | — | 64 | |
| | | | GND | 6.0 | — | 55 | |
| | | | -4.5 | 4.5 | — | — | |
| Control input capacitance | C_{IN} | — | — | — | — | 10 | pF |
| Common terminal capacitance | C_{IS} | Figure 2 | -5.0 | 5.0 | — | 20 | pF |
| Switch terminal capacitance | C_{OS} | Figure 2 | -5.0 | 5.0 | — | 15 | pF |
| Feedthrough capacitance | C_{IOS} | Figure 2 | -5.0 | 5.0 | — | 2 | pF |

Note: Operating Range spec of $T_{opr} = -40 \text{ }^\circ\text{C}$ to $125 \text{ }^\circ\text{C}$ is applicable only for the products which manufactured after July 2020.

12.7. Analog Switch Characteristics ($T_a = 25 \text{ }^\circ\text{C}$) (Note)

| Characteristics | Symbol | Test Condition | V_{EE} (V) | V_{CC} (V) | Typ. | Unit | |
|--|----------------|--|---------------------------------|--------------|------|-------|-----|
| Sine Wave Distortion | THD | $R_L = 10 \text{ k}\Omega$, $C_L = 50 \text{ pF}$ $f_{IN} = 1 \text{ kHz}$ | $V_{IN} = 4.0 \text{ V}_{p-p}$ | -2.25 | 2.25 | 0.025 | % |
| | | | $V_{IN} = 8.0 \text{ V}_{p-p}$ | -4.5 | 4.5 | 0.020 | |
| | | | $V_{IN} = 11.0 \text{ V}_{p-p}$ | -6.0 | 6.0 | 0.018 | |
| Maximum frequency response | $f_{MAX(I/O)}$ | Adjust f_{IN} voltage to obtain 0 dBm at V_{OS} Increase f_{IN} frequency until dB meter reads -3 dB $R_L = 50 \text{ }\Omega$, $C_L = 10 \text{ pF}$ $f_{IN} = 1 \text{ MHz}$, sine wave Figure 3 | (Note 1) | -2.25 | 2.25 | 120 | MHz |
| | | | (Note 2) | — | — | 95 | |
| | | | (Note 1) | -4.5 | 4.5 | 190 | |
| | | | (Note 2) | — | — | 150 | |
| | | | (Note 1) | -6.0 | 6.0 | 200 | |
| Feed through attenuation (switch OFF) | FTH | V_{IN} is centered at $(V_{CC} - V_{EE})/2$ Adjust input for 0 dBm. $R_L = 600 \text{ }\Omega$, $C_L = 50 \text{ pF}$, $f_{IN} = 1 \text{ MHz}$, sine wave Figure 4 | -2.25 | 2.25 | -50 | dB | |
| | | | -4.5 | 4.5 | -50 | | |
| | | | -6.0 | 6.0 | -50 | | |
| Crosstalk (control input to signal output) | X_{talk} | $R_L = 600 \text{ }\Omega$, $C_L = 50 \text{ pF}$, $f_{IN} = 1 \text{ MHz}$, square wave ($t_r = t_f = 6 \text{ ns}$) Figure 5 | -2.25 | 2.25 | 60 | mV | |
| | | | -4.5 | 4.5 | 140 | | |
| | | | -6.0 | 6.0 | 200 | | |
| Crosstalk (between any switches) | X_{talk} | Adjust V_{IN} to obtain 0 dBm at input. $R_L = 600 \text{ }\Omega$, $C_L = 50 \text{ pF}$, $f_{IN} = 1 \text{ MHz}$, sine wave Figure 6 | -2.25 | 2.25 | -50 | dB | |
| | | | -4.5 | 4.5 | -50 | | |
| | | | -6.0 | 6.0 | -50 | | |

Note: These characteristics are determined by design of devices.

Note 1: Input COMMON terminal, and measured at SWITCH terminal.

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

13. AC Test Circuit

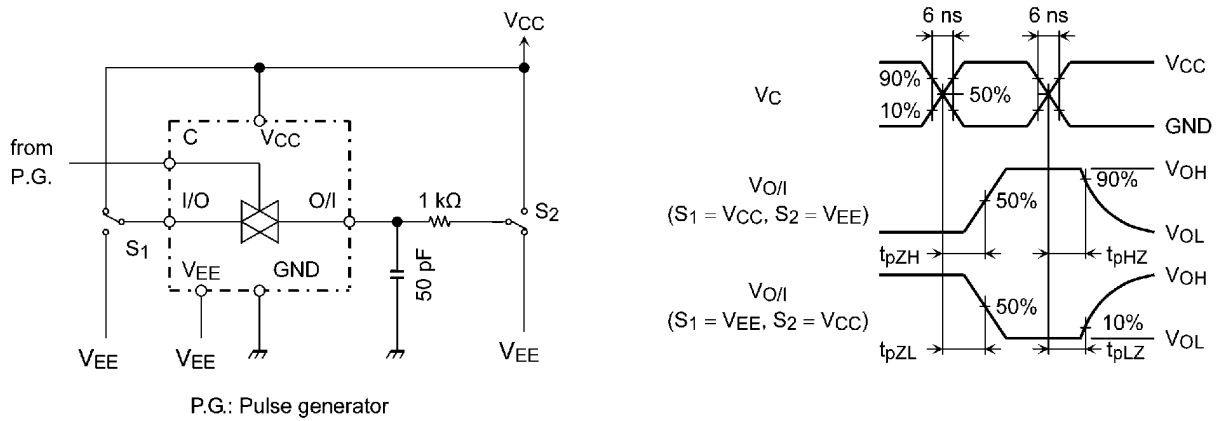


Figure 1 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

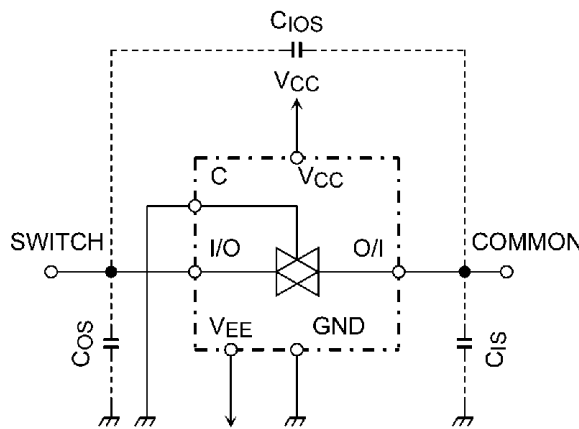


Figure 2 C_{IOS} , C_{IS} , C_{OS}

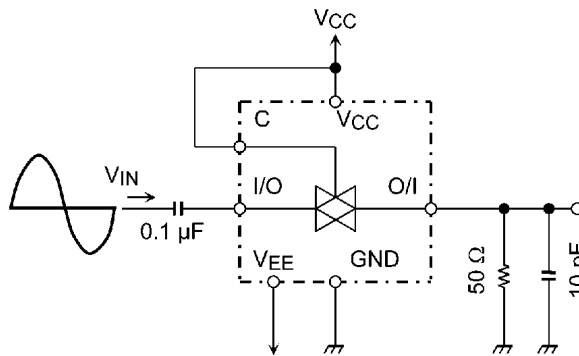


Figure 3 Frequency Response

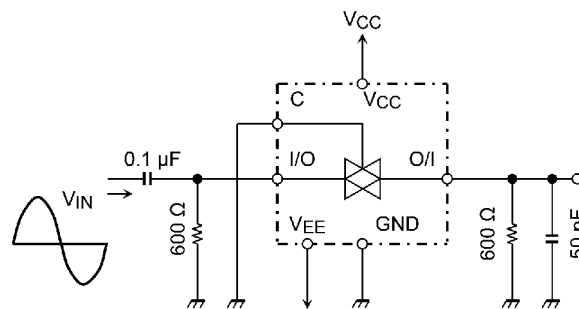
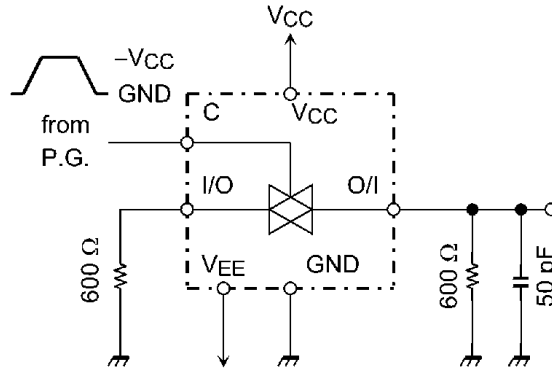


Figure 4 Feedthrough Attenuation



P.G.: Pulse generator

Figure 5 Cross Talk (control input to output signal)

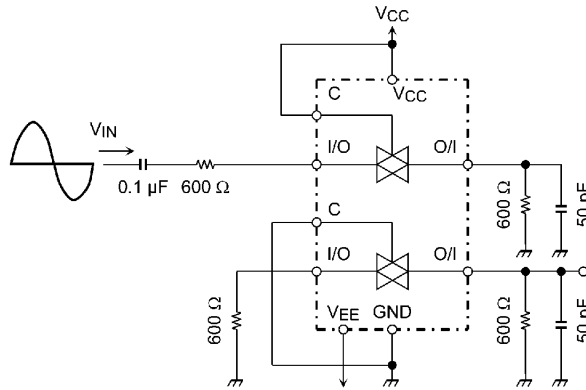
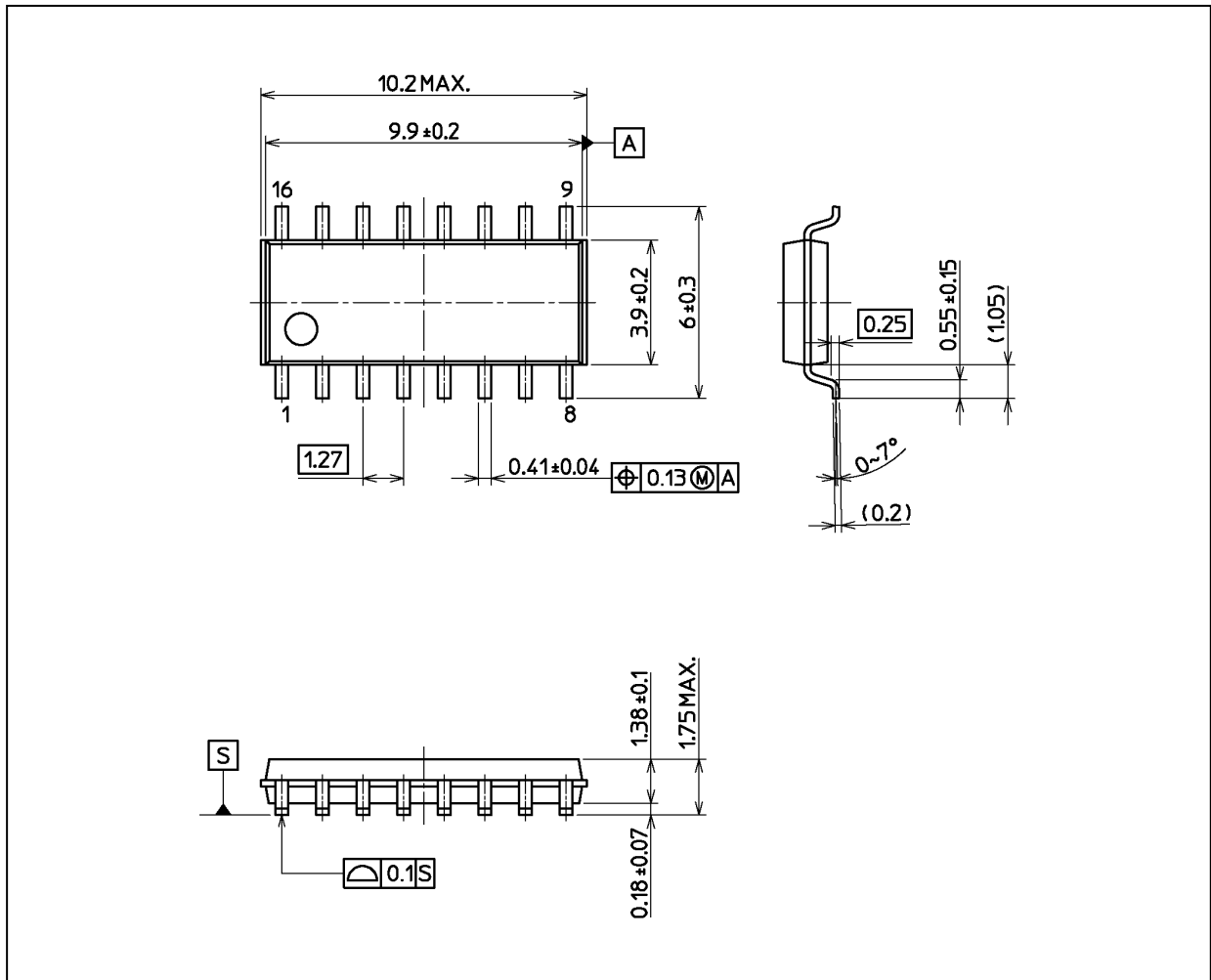


Figure 6 Cross Talk (between any two switches)

Package Dimensions

Unit: mm



Weight: 0.15 g (typ.)

| |
|------------------|
| Package Name(s) |
| Nickname: SOIC16 |

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