CMOS Digital Integrated Circuits Silicon Monolithic

# 74VHC4066AFT

## 1. Functional Description

- Quad Bilateral Switch

## 2. General

The 74VHC4066AFT is high-speed, low-voltage drive QUAD BILATERAL SWITCH fabricated with silicon gate $C^2MOS$ technology.

In 3 V and 5 V systems these can achieve high-speed operation with the low power dissipation that is a feature of CMOS.

It consists of four independent high speed switches capable of controlling either digital or analog signals while maintaining the CMOS low power dissipation.

The switches for each channel are turned ON by the control pin digital signals.

Control pin is equipped with a newly developed input protection circuit that avoids the need for a diode on the plus side (forward side from the input to the $V_{CC}$). As a result, for example, 5.5 V signals can be permitted on the inputs even when the power supply voltage to the circuits is off. As a result of this input power protection, the 74VHC4066AFT can be used in a variety of applications, including in the system which has two power supplies, and in battery backup circuits.

## 3. Features

(1) AEC-Q100 (Rev. H) (Note 1)

(2) Wide operating temperature range: $T_{opr}$ = -40 to 125 °C

(3) Low ON resistance: $R_{ON}$ = 45 Ω (typ.) at $V_{CC}$ = 3.0 V
: $R_{ON}$ = 24 Ω (typ.) at $V_{CC}$ = 4.5 V

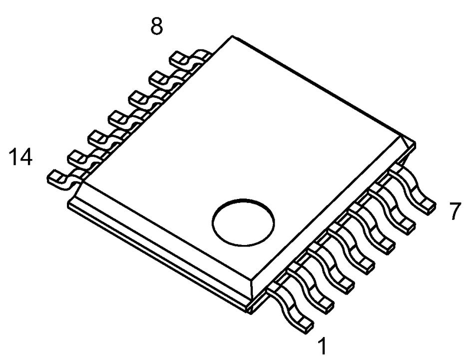
(4) Low power dissipation: $I_{CC}$ = 2.0 μA (max) at $T_a$ = 25 °C

(5) Input level: $V_{IL}$ = 0.8 V (max) at $V_{CC}$ = 3.0 V
: $V_{IH}$ = 2.0 V (min) at $V_{CC}$ = 3.0 V

(6) Power-down protection is provided on all control inputs.

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

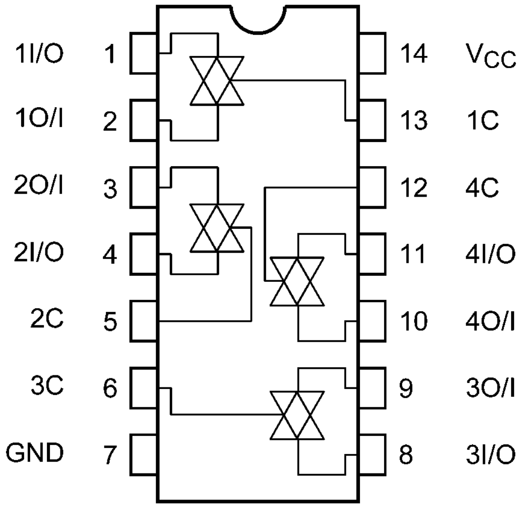
## 4. Packaging




TSSOP14B

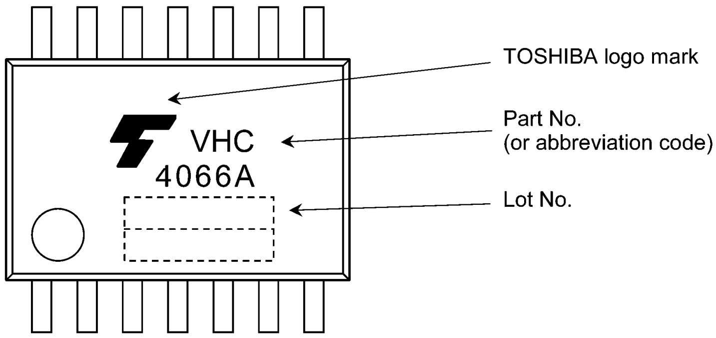
Start of commercial production
2014-10

## 5. Pin Assignment




(top view)

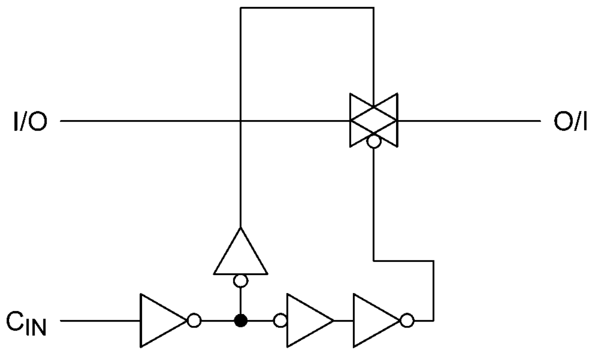
## 6. Marking




## 7. Truth Table

| Control | Switch Function |
|---|---|
| H | On |
| L | Off |

## 8. System Diagram (per circuit)



## 9. Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | | -0.5 to 7.0 | V |
| Input voltage | $V_{IN}$ | | -0.5 to 7.0 | V |
| Switch I/O voltage | $V_{I/O}$ | | -0.5 to $V_{CC}$ + 0.5 | V |
| Input diode current | $I_{IK}$ | | -20 | mA |
| I/O diode current | $I_{I/OK}$ | | ±25 | mA |
| Switch through current | $I_T$ | | ±25 | mA |
| $V_{CC}$/ground current | $I_{CC}$ | | ±50 | mA |
| Power dissipation | $P_D$ | (Note 1) | 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).

Note 1: 180 mW in the range of $T_a$ = -40 to 85 °C. From $T_a$ = 85 to 125 °C a derating factor of -3.25 mW/°C shall be applied until 50 mW.

## 10. Operating Ranges (Note)

| Characteristics | Symbol | Test Condition | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | | 2.0 to 5.5 | V |
| Input voltage | $V_{IN}$ | | 0 to 5.5 | V |
| Switch I/O voltage | $V_{I/O}$ | | 0 to $V_{CC}$ | V |
| Operating temperature | $T_{opr}$ | | -40 to 125 | °C |
| Input rise and fall times | dt/dv | $V_{CC}$ = 2.5 ± 0.2 V | 0 to 200 | ns/V |
| | | $V_{CC}$ = 3.3 ± 0.3 V | 0 to 100 | |
| | | $V_{CC}$ = 5.0 ± 0.5 V | 0 to 20 | |

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.

## 11. Electrical Characteristics

### 11.1. DC Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IH}$ | — | 2.0 | 1.5 | — | — | V |
| | | | 3.0 | 2.0 | — | — | |
| | | | 4.5 | 3.15 | — | — | |
| | | | 5.5 | 3.85 | — | — | |
| Low-level input voltage | $V_{IL}$ | — | 2.0 | — | — | 0.5 | V |
| | | | 3.0 | — | — | 0.8 | |
| | | | 4.5 | — | — | 1.35 | |
| | | | 5.5 | — | — | 1.65 | |
| ON-resistance | $R_{ON}$ | $V_{IN} = V_{IH}$<br>$V_{I/O} = V_{CC}$ to GND<br>$I_{I/O}$ = 2 mA | 2.3 | — | 200 | — | Ω |
| | | | 3.0 | — | 45 | 86 | |
| | | | 4.5 | — | 24 | 37 | |
| | | $V_{IN} = V_{IH}$<br>$V_{I/O} = V_{CC}$ or GND<br>$I_{I/O}$ = 2 mA | 2.3 | — | 28 | 73 | |
| | | | 3.0 | — | 22 | 38 | |
| | | | 4.5 | — | 17 | 27 | |
| Difference of ON-resistance between switches | $\Delta R_{ON}$ | $V_{IN} = V_{IH}$<br>$V_{I/O} = V_{CC}$ to GND<br>$I_{I/O}$ = 2 mA | 2.3 | — | 10 | 25 | Ω |
| | | | 3.0 | — | 5 | 15 | |
| | | | 4.5 | — | 5 | 13 | |
| Input/Output leakage current (Switch OFF) | $I_{OFF}$ | $V_{OS} = V_{CC}$ or GND<br>$V_{IS}$ = GND to $V_{CC}$<br>$V_{IN} = V_{IL}$ | 5.5 | — | — | ±0.1 | μA |
| Input/Output leakage current (Switch ON, output open) | $I_{I/O}$ | $V_{OS} = V_{CC}$ or GND<br>$V_{IN} = V_{IH}$ | 5.5 | — | — | ±0.1 | μA |
| Control input leakage current | $I_{IN}$ | $V_{IN} = V_{CC}$ or GND | 5.5 | — | — | ±0.1 | μA |
| Quiescent supply current | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND | 5.5 | — | — | 2.0 | μA |

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

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IH}$ | — | 2.0 | 1.5 | — | V |
| | | | 3.0 | 2.0 | — | |
| | | | 4.5 | 3.15 | — | |
| | | | 5.5 | 3.85 | — | |
| Low-level input voltage | $V_{IL}$ | — | 2.0 | — | 0.5 | V |
| | | | 3.0 | — | 0.8 | |
| | | | 4.5 | — | 1.35 | |
| | | | 5.5 | — | 1.65 | |
| ON-resistance | $R_{ON}$ | $V_{IN} = V_{IH}$<br>$V_{I/O} = V_{CC}$ to GND<br>$I_{I/O}$ = 2 mA | 2.3 | — | — | Ω |
| | | | 3.0 | — | 108 | |
| | | | 4.5 | — | 46 | |
| | | $V_{IN} = V_{IH}$<br>$V_{I/O} = V_{CC}$ or GND<br>$I_{I/O}$ = 2 mA | 2.3 | — | 84 | |
| | | | 3.0 | — | 44 | |
| | | | 4.5 | — | 31 | |
| Difference of ON-resistance between switches | $\Delta R_{ON}$ | $V_{IN} = V_{IH}$<br>$V_{I/O} = V_{CC}$ to GND<br>$I_{I/O}$ = 2 mA | 2.3 | — | 35 | Ω |
| | | | 3.0 | — | 20 | |
| | | | 4.5 | — | 18 | |
| Input/Output leakage current (Switch OFF) | $I_{OFF}$ | $V_{OS} = V_{CC}$ or GND<br>$V_{IS}$ = GND to $V_{CC}$<br>$V_{IN} = V_{IL}$ | 5.5 | — | ±1.0 | μA |
| Input/Output leakage current (Switch ON, output open) | $I_{I/O}$ | $V_{OS} = V_{CC}$ or GND<br>$V_{IN} = V_{IH}$ | 5.5 | — | ±1.0 | μA |
| Control input leakage current | $I_{IN}$ | $V_{IN} = V_{CC}$ or GND | 5.5 | — | ±1.0 | μA |
| Quiescent supply current | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND | 5.5 | — | 20.0 | μA |

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

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IH}$ | — | 2.0 | 1.5 | — | V |
| | | | 3.0 | 2.0 | — | |
| | | | 4.5 | 3.15 | — | |
| | | | 5.5 | 3.85 | — | |
| Low-level input voltage | $V_{IL}$ | — | 2.0 | — | 0.5 | V |
| | | | 3.0 | — | 0.8 | |
| | | | 4.5 | — | 1.35 | |
| | | | 5.5 | — | 1.65 | |
| ON-resistance | $R_{ON}$ | $V_{IN}$ = $V_{IH}$<br>$V_{I/O}$ = $V_{CC}$ to GND<br>$I_{I/O}$ = 2 mA | 2.3 | — | — | Ω |
| | | | 3.0 | — | 125 | |
| | | | 4.5 | — | 54 | |
| | | $V_{IN}$ = $V_{IH}$<br>$V_{I/O}$ = $V_{CC}$ or GND<br>$I_{I/O}$ = 2 mA | 2.3 | — | 105 | Ω |
| | | | 3.0 | — | 55 | |
| | | | 4.5 | — | 39 | |
| Difference of ON-resistance between switches | $\Delta R_{ON}$ | $V_{IN}$ = $V_{IH}$<br>$V_{I/O}$ = $V_{CC}$ to GND<br>$I_{I/O}$ = 2 mA | 2.3 | — | 45 | Ω |
| | | | 3.0 | — | 25 | |
| | | | 4.5 | — | 23 | |
| Input/Output leakage current (Switch OFF) | $I_{OFF}$ | $V_{OS}$ = $V_{CC}$ or GND<br>$V_{IS}$ = GND to $V_{CC}$<br>$V_{IN}$ = $V_{IL}$ | 5.5 | — | ±4.0 | μA |
| Input/Output leakage current (Switch ON, output open) | $I_{I/O}$ | $V_{OS}$ = $V_{CC}$ or GND<br>$V_{IN}$ = $V_{IH}$ | 5.5 | — | ±4.0 | μA |
| Control input leakage current | $I_{IN}$ | $V_{IN}$ = $V_{CC}$ or GND | 5.5 | — | ±2.0 | μA |
| Quiescent supply current | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | 5.5 | — | 40.0 | μA |

## 11.4. AC Characteristics (Unless otherwise specified, $T_a$ = 25 °C, Input: $t_r = t_f$ = 3 ns)

| Characteristics | Symbol | Note | Test Condition | $V_{CC}$ (V) | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Phase difference between input to output | $\varphi_{I/O}$ | | $C_L$ = 15 pF, $R_L$ = 1 kΩ | 2.5 ± 0.2 | — | 1.2 | 10 | ns |
| | | | | 3.3 ± 0.3 | — | 0.8 | 6 | |
| | | | | 5.0 ± 0.5 | — | 0.3 | 4 | |
| | | | $C_L$ = 50 pF, $R_L$ = 1 kΩ | 2.5 ± 0.2 | — | 2.6 | 12 | |
| | | | | 3.3 ± 0.3 | — | 1.5 | 9 | |
| | | | | 5.0 ± 0.5 | — | 0.6 | 6 | |
| Output enable time | $t_{PZL}$, $t_{PZH}$ | | $C_L$ = 15 pF, $R_L$ = 1 kΩ, See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 3.3 | 15 | ns |
| | | | | 3.3 ± 0.3 | — | 2.3 | 11 | |
| | | | | 5.0 ± 0.5 | — | 1.6 | 7 | |
| | | | $C_L$ = 50 pF, $R_L$ = 1 kΩ, See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 4.2 | 25 | |
| | | | | 3.3 ± 0.3 | — | 3.0 | 18 | |
| | | | | 5.0 ± 0.5 | — | 2.1 | 12 | |
| Output disable time | $t_{PLZ}$, $t_{PHZ}$ | | $C_L$ = 15 pF, $R_L$ = 1 kΩ, See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 6 | 15 | ns |
| | | | | 3.3 ± 0.3 | — | 4.5 | 11 | |
| | | | | 5.0 ± 0.5 | — | 3.2 | 7 | |
| | | | $C_L$ = 50 pF, $R_L$ = 1 kΩ, See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 9.6 | 25 | |
| | | | | 3.3 ± 0.3 | — | 7.2 | 18 | |
| | | | | 5.0 ± 0.5 | — | 5.1 | 12 | |
| Control input capacitance | $C_{IN}$ | | All types | | — | 3 | — | pF |
| Switch terminal capacitance | $C_{OS}$ | | See 12. AC Test Circuit, Figure 2 | | — | 5.5 | — | pF |
| Feedthrough capacitance | $C_{IOS}$ | | See 12. AC Test Circuit, Figure 2 | | — | 0.5 | — | pF |
| Power dissipation capacitance | $C_{PD}$ | (Note 1) | See 12. AC Test Circuit, Figure 2 | | — | 4.5 | — | 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.

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

## 11.5. AC Characteristics (Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r = t_f$ = 3 ns)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Phase difference between input to output | $\varphi_{I/O}$ | $C_L$ = 15 pF<br>$R_L$ = 1 kΩ | 2.5 ± 0.2 | — | 16 | ns |
| | | | 3.3 ± 0.3 | — | 10 | |
| | | | 5.0 ± 0.5 | — | 7 | |
| | | $C_L$ = 50 pF<br>$R_L$ = 1 kΩ | 2.5 ± 0.2 | — | 18 | |
| | | | 3.3 ± 0.3 | — | 12 | |
| | | | 5.0 ± 0.5 | — | 8 | |
| Output enable time | $t_{PZL}$,$t_{PZH}$ | $C_L$ = 15 pF<br>$R_L$ = 1 kΩ<br>See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 20 | ns |
| | | | 3.3 ± 0.3 | — | 15 | |
| | | | 5.0 ± 0.5 | — | 10 | |
| | | $C_L$ = 50 pF<br>$R_L$ = 1 kΩ<br>See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 32 | |
| | | | 3.3 ± 0.3 | — | 22 | |
| | | | 5.0 ± 0.5 | — | 16 | |
| Output disable time | $t_{PLZ}$,$t_{PHZ}$ | $C_L$ = 15 pF<br>$R_L$ = 1 kΩ<br>See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 23 | ns |
| | | | 3.3 ± 0.3 | — | 15 | |
| | | | 5.0 ± 0.5 | — | 10 | |
| | | $C_L$ = 50 pF<br>$R_L$ = 1 kΩ<br>See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 32 | |
| | | | 3.3 ± 0.3 | — | 22 | |
| | | | 5.0 ± 0.5 | — | 16 | |

## 11.6. AC Characteristics (Unless otherwise specified, $T_a$ = -40 to 125 °C, Input: $t_r = t_f$ = 3 ns)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Phase difference between input to output | $\varphi_{I/O}$ | $C_L$ = 15 pF<br>$R_L$ = 1 kΩ | 2.5 ± 0.2 | — | 20 | ns |
| | | | 3.3 ± 0.3 | — | 13 | |
| | | | 5.0 ± 0.5 | — | 9 | |
| | | $C_L$ = 50 pF<br>$R_L$ = 1 kΩ | 2.5 ± 0.2 | — | 22 | |
| | | | 3.3 ± 0.3 | — | 14 | |
| | | | 5.0 ± 0.5 | — | 9.5 | |
| Output enable time | $t_{PZL}$,$t_{PZH}$ | $C_L$ = 15 pF<br>$R_L$ = 1 kΩ<br>See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 23.5 | ns |
| | | | 3.3 ± 0.3 | — | 18 | |
| | | | 5.0 ± 0.5 | — | 12 | |
| | | $C_L$ = 50 pF<br>$R_L$ = 1 kΩ<br>See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 37 | |
| | | | 3.3 ± 0.3 | — | 25 | |
| | | | 5.0 ± 0.5 | — | 19 | |
| Output disable time | $t_{PLZ}$,$t_{PHZ}$ | $C_L$ = 15 pF<br>$R_L$ = 1 kΩ<br>See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 28.5 | ns |
| | | | 3.3 ± 0.3 | — | 18 | |
| | | | 5.0 ± 0.5 | — | 12 | |
| | | $C_L$ = 50 pF<br>$R_L$ = 1 kΩ<br>See 12. AC Test Circuit, Figure 1 | 2.5 ± 0.2 | — | 37 | |
| | | | 3.3 ± 0.3 | — | 25 | |
| | | | 5.0 ± 0.5 | — | 19 | |

## 11.7. Analog Switch Characteristics ($T_a$ = 25 °C) (Note)

| Characteristics | Symbol | Test Condition | | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|---|
| Sine Wave Distortion | THD | $R_L$ = 10 kΩ, $C_L$ = 50 pF, $f_{IN}$ = 1 kHz | $V_{IN}$ = 2.0 $V_{p-p}$ | 3.0 | 0.1 | % |
| | | | $V_{IN}$ = 4.0 $V_{p-p}$ | 4.5 | 0.03 | |
| Maximum frequency response (switch ON) | $f_{MAX(I/O)}$ | $V_{IN}$ is centered at ($V_{CC}$/2).<br>Adjust input for 0dBm.<br>Increase $f_{IN}$ frequency until dB meter reads -3dB.<br>$R_L$ = 50 Ω, $C_L$ = 10 pF, sine wave<br>See 12. AC Test Circuit, Figure 3 | | 3.0 | 250 | MHz |
| | | | | 4.5 | 290 | |
| Feed through attenuation (switch OFF) | FTH | $V_{IN}$ is centered at ($V_{CC}$/2).<br>Adjust input for 0dBm.<br>$R_L$ = 600 Ω, $C_L$ = 50 pF,<br>$f_{IN}$ = 1 MHz, sine wave<br>See 12. AC Test Circuit, Figure 4 | | 3.0 | -45 | dB |
| | | | | 4.5 | -45 | |
| | | $R_L$ = 50 Ω, $C_L$ = 10 pF,<br>$f_{IN}$ = 1 MHz, sine wave | | 3.0 | -65 | |
| | | | | 4.5 | -65 | |
| Crosstalk (control input to signal output) | $X_{talk}$ | $R_L$ = 600 Ω, $C_L$ = 50 pF,<br>$f_{IN}$ = 1 MHz,<br>square wave (tr = tf = 6 ns)<br>See 12. AC Test Circuit, Figure 5 | | 3.0 | 60 | mV |
| | | | | 4.5 | 100 | |
| Crosstalk (between any switches) | $X_{talk}$ | $V_{IN}$ is centered at ($V_{CC}$/2).<br>Adjust input for 0dBm.<br>$R_L$ = 600 Ω, $C_L$ = 50 pF,<br>$f_{IN}$ = 1 MHz, sine wave<br>See 12. AC Test Circuit, Figure 6 | | 3.0 | -45 | dB |
| | | | | 4.5 | -45 | |

Note: These characteristics are determined by design of devices.

## 12. AC Test Circuit

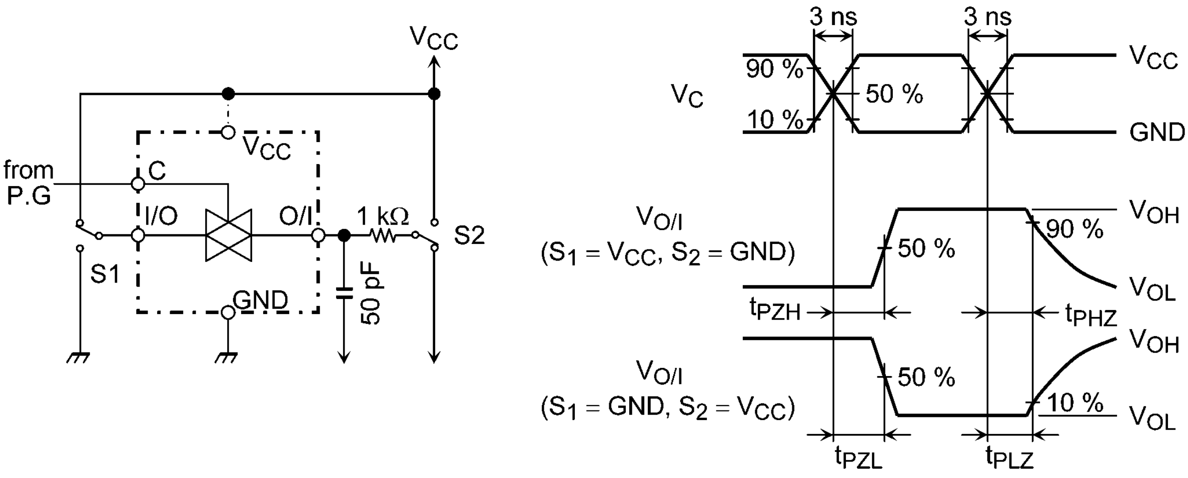



Figure 1 $t_{PLZ}$, $t_{PHZ}$, $t_{PZL}$, $t_{PZH}$

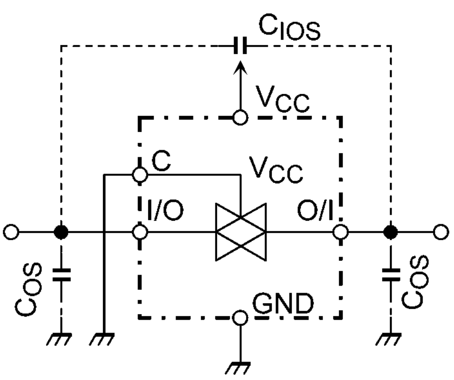



Figure 2 $C_{IOS}$, $C_{OS}$

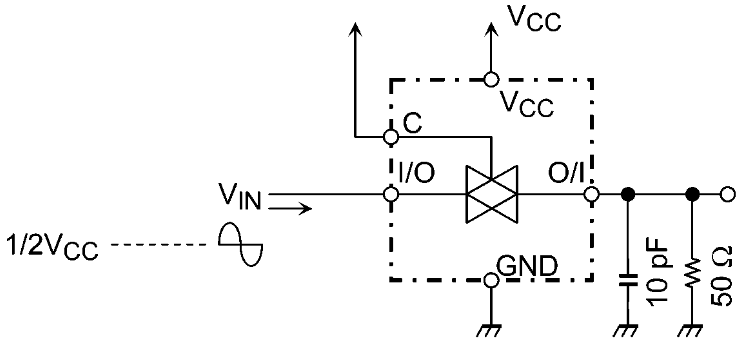



Figure 3 Frequency Response (switch on)

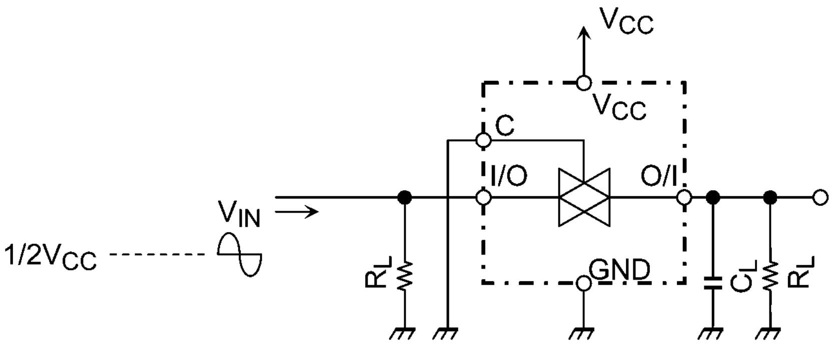



Figure 4 Feedthrough

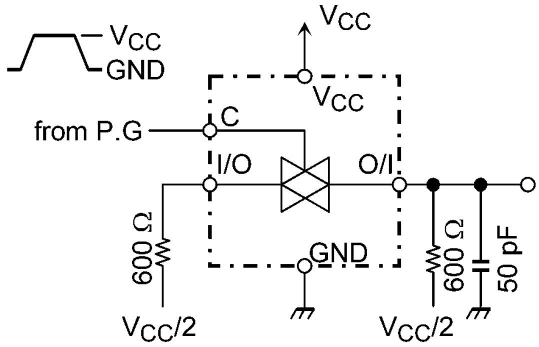



Figure 5 Cross Talk (control input to output signal)

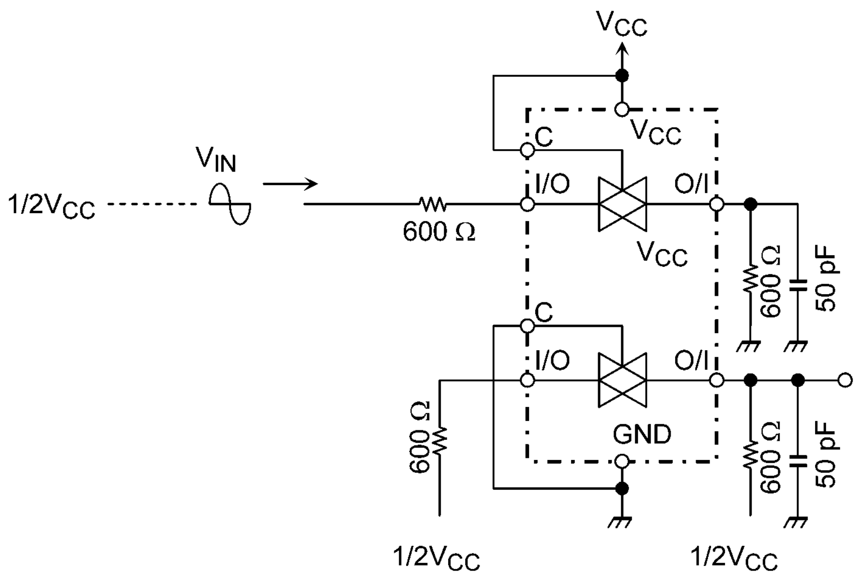
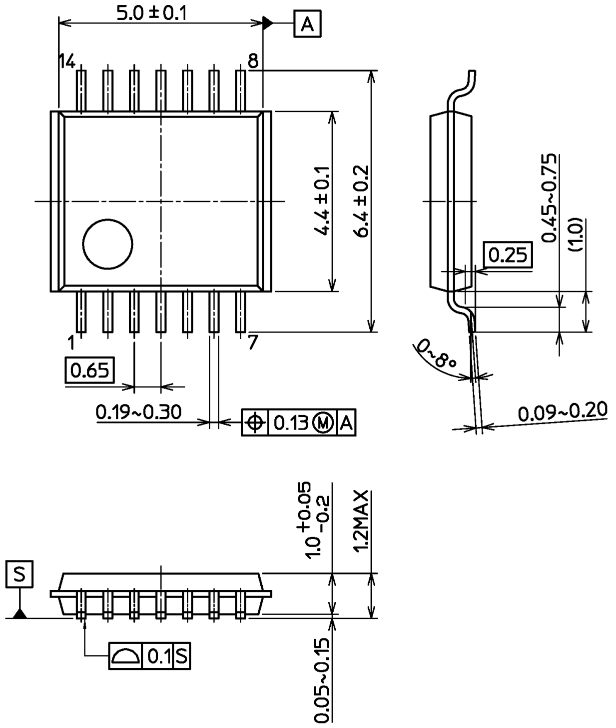



Figure 6 Cross Talk (between any two switches)

## Package Dimensions

Unit: mm




Weight: 0.054 g (typ.)

| Package Name(s) |
|---|
| Nickname: TSSOP14B |

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OCEAN CHIPS

Океан Электроники

Поставка электронных компонентов

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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