TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74HC4066AP, TC74HC4066AF, TC74HC4066AFT

Quad Bilateral Switch

The TC74HC4066A is a high speed CMOS QUAD BILATERAL SWITCH fabricated with silicon gate $C^2MOS$ technology.

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

Control input (C) is provided to control the switch. The switch turns ON while the C input is high, and the switch turns OFF while low.

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

## Features

Low power dissipation: $I_{CC}$ = 1.0 μA (max) at Ta = 25°C

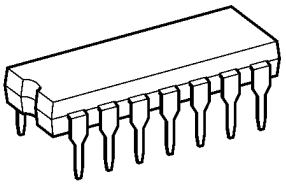
High noise immunity: $V_{NIH}$ = $V_{NIL}$ = 28% $V_{CC}$ (min)

Low ON resistance: $R_{ON}$ = 50 Ω (typ.) at $V_{CC}$ = 9 V

High degree of linearity: THD = 0.05% (typ.) at $V_{CC}$ = 4.5 V

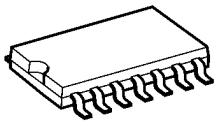
Pin and function compatible with TC4066B series

TC74HC4066AP



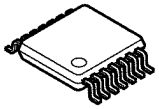
DIP14-P-300-2.54

TC74HC4066AF



SOP14-P-300-1.27A

TC74HC4066AFT



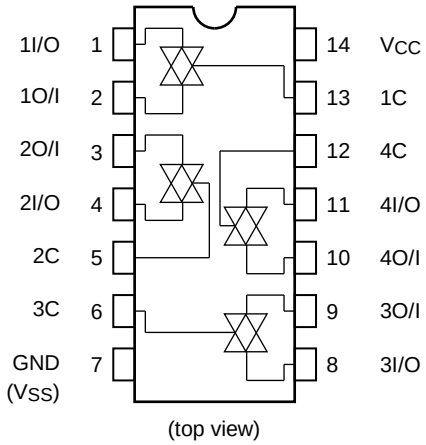
TSSOP14-P-0044-0.65A

Weight

| | |
|---|---|
| DIP14-P-300-2.54 | : 0.96 g (typ.) |
| SOP14-P-300-1.27A | : 0.18 g (typ.) |
| TSSOP14-P-0044-0.65A | : 0.06 g (typ.) |

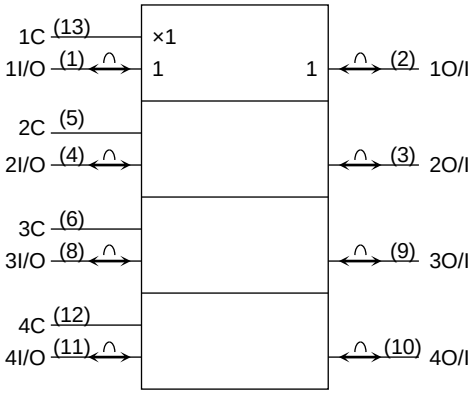
Start of commercial production
1986-11

## Pin Assignment




(top view)

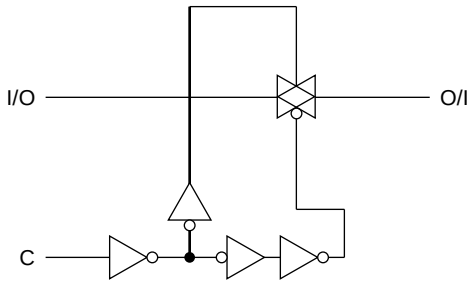
## IEC Logic Symbol




## Truth Table

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

## System diagram (Per Circuit)



## Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage range | $V_{CC}$ | -0.5 to 13 | V |
| Control input voltage | $V_{IN}$ | -0.5 to $V_{CC}$ + 0.5 | V |
| Switch I/O voltage | $V_{I/O}$ | -0.5 to $V_{CC}$ + 0.5 | V |
| Control input diode current | $I_{IK}$ | ±20 | mA |
| I/O diode current | $I_{I/OK}$ | ±20 | mA |
| Switch through Current | $I_T$ | ±25 | mA |
| DC $V_{CC}$/ground current | $I_{CC}$ | ±50 | mA |
| Power dissipation | $P_D$ | 500 (DIP) (Note 1)/180 (SOP/TSSOP) | 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: 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 | $V_{CC}$ | 2 to 12 | V |
| Control input voltage | $V_{IN}$ | 0 to $V_{CC}$ | V |
| Switch I/O voltage | $V_{I/O}$ | 0 to $V_{CC}$ | V |
| Operating temperature | $T_{opr}$ | -40 to 85 | °C |
| Input rise and fall time | $t_r$, $t_f$ | 0 to 1000 ($V_{CC}$ = 2.0 V)<br>0 to 500 ($V_{CC}$ = 4.5 V)<br>0 to 400 ($V_{CC}$ = 6.0 V)<br>0 to 250 ($V_{CC}$ = 10.0 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 $V_{CC}$ or GND.

## Electrical Characteristics

### DC Characteristics

| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | Ta = -40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (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 | — | |
| | | | 9.0 | 6.30 | — | — | 6.30 | — | |
| | | | 12.0 | 8.40 | — | — | 8.40 | — | |
| Low-level control input voltage | $V_{ILC}$ | — | 2.0 | — | — | 0.50 | — | 0.50 | V |
| | | | 4.5 | — | — | 1.35 | — | 1.35 | |
| | | | 9.0 | — | — | 2.70 | — | 2.70 | |
| | | | 12.0 | — | — | 3.60 | — | 3.60 | |
| ON resistance | $R_{ON}$ | $V_{IN} = V_{IHC}$<br>$V_{I/O} = V_{CC}$ to GND<br>$I_{I/O} \leq 1$ mA | 4.5 | — | 96 | 170 | — | 200 | Ω |
| | | | 9.0 | — | 55 | 85 | — | 100 | |
| | | | 12.0 | — | 45 | 80 | — | 90 | |
| | | $V_{IN} = V_{IHC}$<br>$V_{I/O} = V_{CC}$ or GND<br>$I_{I/O} \leq 1$ mA | 2.0 | — | 160 | — | — | — | |
| | | | 4.5 | — | 70 | 100 | — | 130 | |
| | | | 9.0 | — | 50 | 75 | — | 95 | |
| | | | 12.0 | — | 45 | 70 | — | 90 | |
| Difference of ON resistance between switches | $\Delta R_{ON}$ | $V_{IN} = V_{IHC}$<br>$V_{I/O} = V_{CC}$ to GND<br>$I_{I/O} \leq 1$ mA | 4.5 | — | 10 | — | — | — | Ω |
| | | | 9.0 | — | 5 | — | — | — | |
| | | | 12.0 | — | 5 | — | — | — | |
| Input/output leakage current (switch off) | $I_{OFF}$ | $V_{OS} = V_{CC}$ or GND<br>$V_{IS}$ = GND or $V_{CC}$<br>$V_{IN} = V_{ILC}$ | 12.0 | — | — | ±100 | — | ±1000 | nA |
| Switch input leakage current (switch on, output open) | $I_{IZ}$ | $V_{OS}=V_{CC}$ or GND<br>$V_{IN} = V_{IHC}$ | 12.0 | — | — | ±100 | — | ±1000 | nA |
| Control input current | $I_{IN}$ | $V_{IN} = V_{CC}$ or GND | 12.0 | — | — | ±100 | — | ±1000 | nA |
| Quiescent supply current | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND | 6.0 | — | — | 1.0 | — | 10.0 | μA |
| | | | 9.0 | — | — | 4.0 | — | 40.0 | |
| | | | 12.0 | — | — | 8.0 | — | 80.0 | |

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

| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | Ta = -40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | VCC (V) | Min | Typ. | Max | Min | Max | |
| Phase difference between input and output | $\varphi_{I-O}$ | — | 2.0 | — | 10 | 50 | — | 65 | ns |
| | | | 4.5 | — | 4 | 10 | — | 13 | |
| | | | 9.0 | — | 3 | 8 | — | 10 | |
| | | | 12.0 | — | 3 | 7 | — | 9 | |
| Output enable time | $t_{pZL}$ $t_{pZH}$ | $R_L$ = 1 kΩ $C_L$ = 50 pF | 2.0 | — | 18 | 100 | — | 125 | ns |
| | | | 4.5 | — | 8 | 20 | — | 25 | |
| | | | 9.0 | — | 6 | 12 | — | 22 | |
| | | | 12.0 | — | 6 | 12 | — | 18 | |
| Output disable time | $t_{pLZ}$ $t_{pHZ}$ | $R_L$ = 1 kΩ $C_L$ = 50 pF | 2.0 | — | 20 | 115 | — | 145 | ns |
| | | | 4.5 | — | 10 | 23 | — | 29 | |
| | | | 9.0 | — | 8 | 20 | — | 25 | |
| | | | 12.0 | — | 8 | 18 | — | 22 | |
| Maximum control input frequency | | $R_L$ = 1 kΩ $C_L$ = 50 pF $V_{OUT}$ = 1/2 $V_{CC}$ | 2.0 | — | 30 | — | — | — | MHz |
| | | | 4.5 | — | 30 | — | — | — | |
| | | | 9.0 | — | 30 | — | — | — | |
| | | | 12.0 | — | 30 | — | — | — | |
| Control input capacitance | $C_{IN}$ | — | | — | 5 | 10 | — | 10 | pF |
| Switch terminal capacitance | $C_{I/O}$ | — | | — | 6 | — | — | — | pF |
| Feed through capacitance | $C_{IOS}$ | — | | — | 0.5 | — | — | — | pF |
| Power dissipation capacitance | $C_{PD}$ | (Note 1) | | — | 15 | — | — | — | 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:

$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC} / 4$ (per channel)

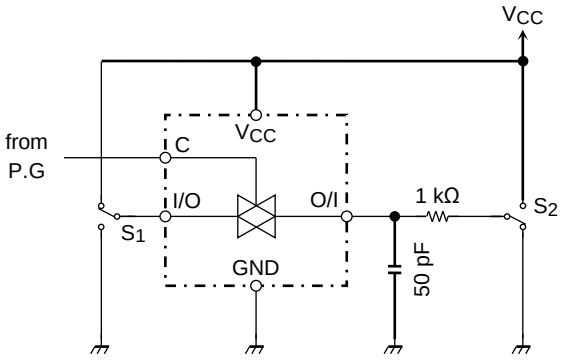
**Analog Switch Characteristics (Note) (GND = 0 V, Ta = 25°C)**

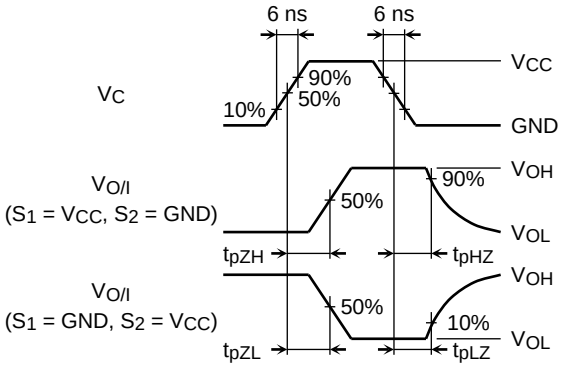
| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|
| Sine wave distortion (T.H.D) | | $f_{IN}$ = 1 kHz, $V_{IN}$ = 4 $V_{p-p}$, @$V_{CC}$ = 4.5 V<br>$R_L$ = 10 kΩ, $V_{IN}$ = 8 $V_{p-p}$, @$V_{CC}$ = 9.0 V<br>$C_L$ = 50 pF | 4.5<br>9.0 | 0.05<br>0.04 | % |
| Frequency response (switch on) | $f_{max}$ | Adjust $f_{IN}$ voltage to obtain 0dBm at $V_{OS}$<br>Increase $f_{IN}$ frequency until dB meter reads -3dB<br>$R_L$ = 50 Ω, $C_L$ = 10 pF<br>$f_{IN}$ = 1 MHz, sine wave | 4.5<br>9.0 | 200<br>200 | MHz |
| Feedthrough attenuation (switch off) | | $V_{IN}$ 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 | 4.5<br>9.0 | -60<br>-60 | dB |
| Crosstalk (control input to signal output) | | $R_L$ = 600 Ω, $C_L$ = 50 pF<br>$f_{IN}$ = 1 MHz, square wave ($t_r$ = $t_f$ = 6 ns) | 4.5<br>9.0 | 60<br>100 | mV |
| Crosstalk (between any switches) | | Adjust $V_{IN}$ to obtain 0dBm at input<br>$R_L$ = 600 Ω, $C_L$ = 50 pF<br>$f_{IN}$ = 1 MHz, sine wave | 4.5<br>9.0 | -60<br>-60 | dB |

Note: These characteristics are determined by design of devices.

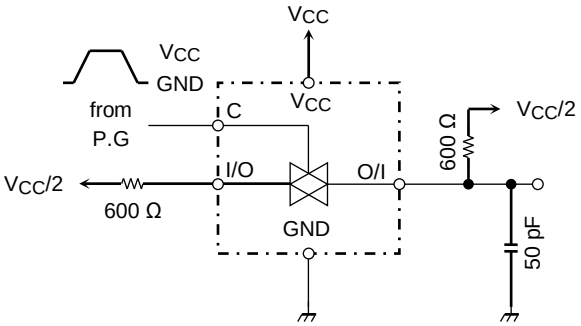
## Switching Characteristics Test Circuits

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

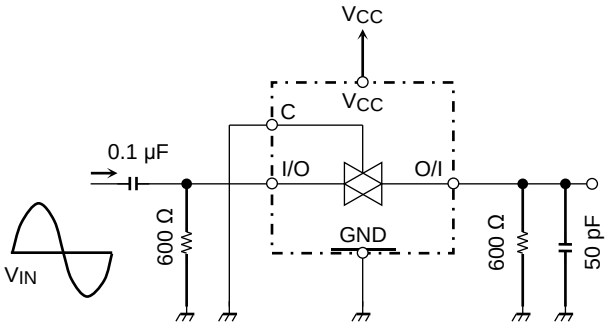


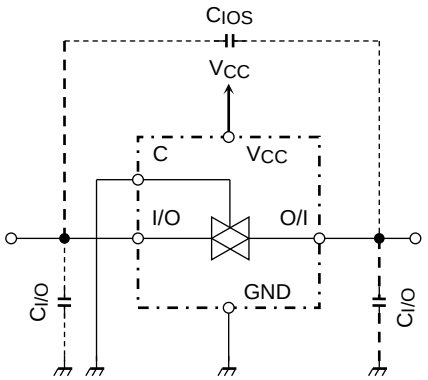

### 2. Cross Talk (control input-switch output)
### $f_{IN}$ = 1 MHz duty = 50% tr = tf = 6 ns



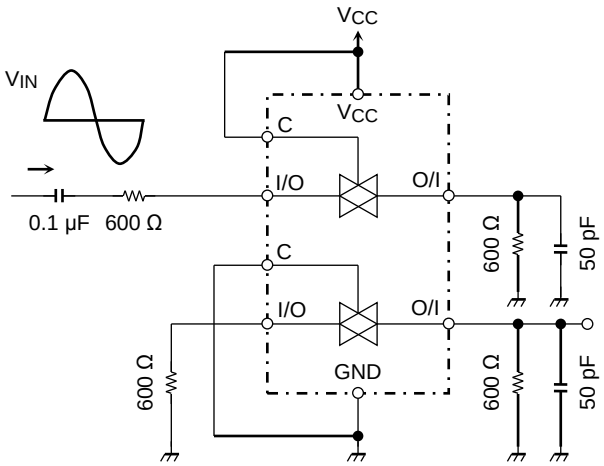

### 3. Feedthrough Attenuation



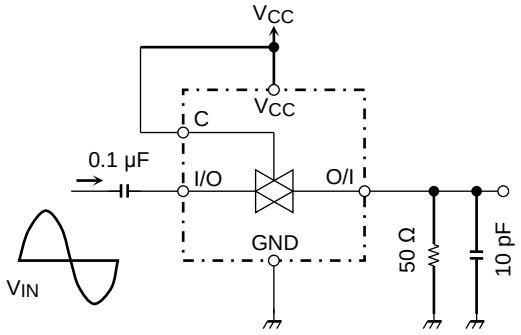
**4. $C_{IOS}$, $C_{I/O}$**




**5. Crosstalk (between any two switches)**

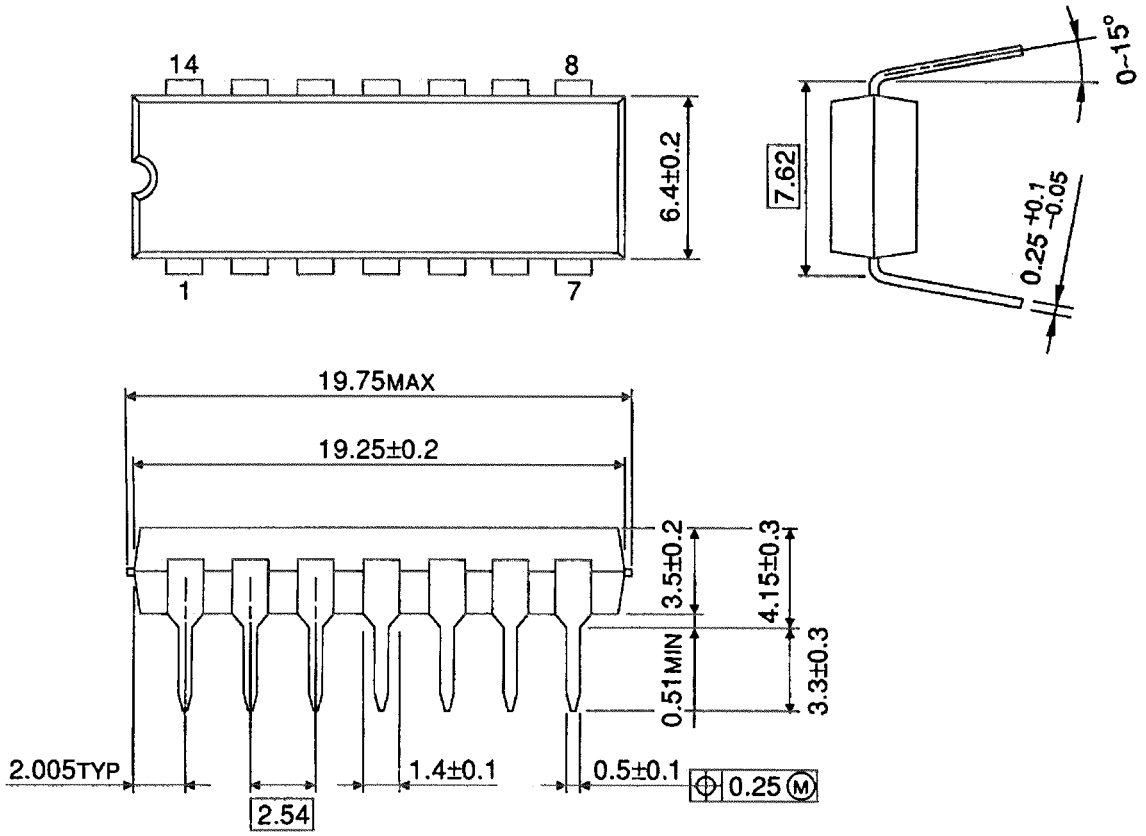



**6. Frequency Response (switch on)**



## Package Dimensions

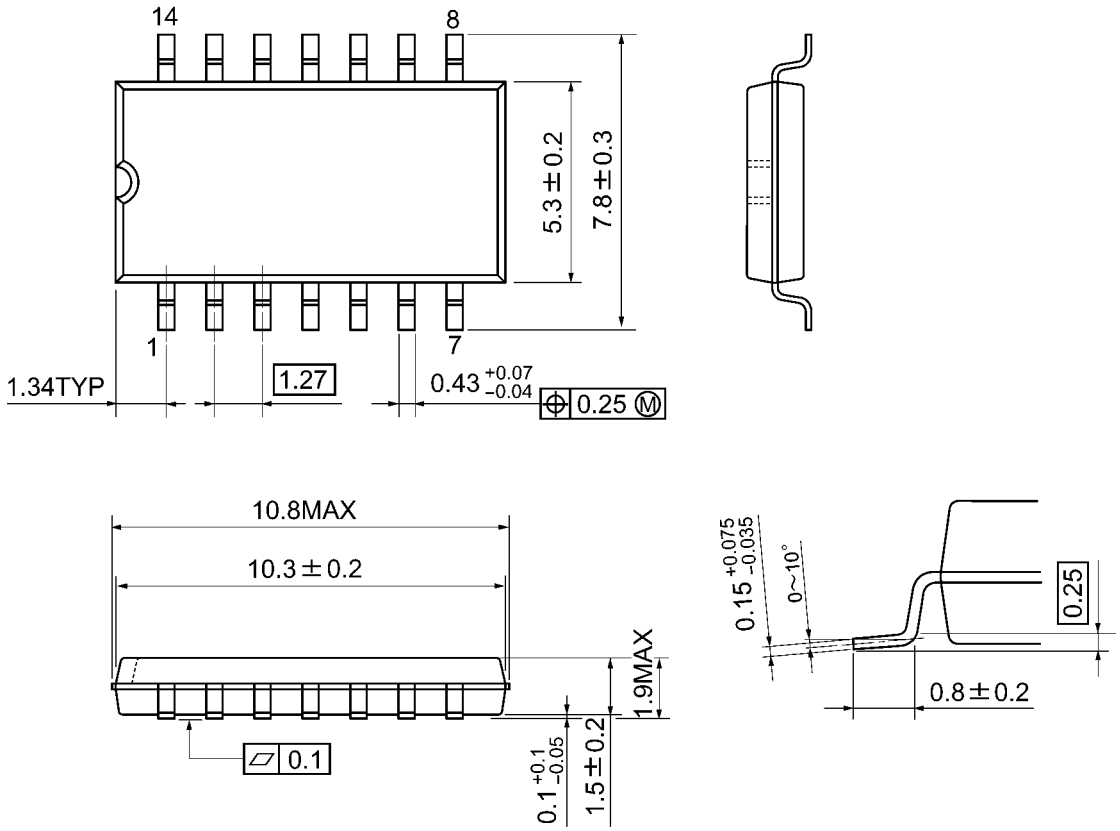
DIP14-P-300-2.54 Unit : mm




Weight: 0.96 g (typ.)

## Package Dimensions

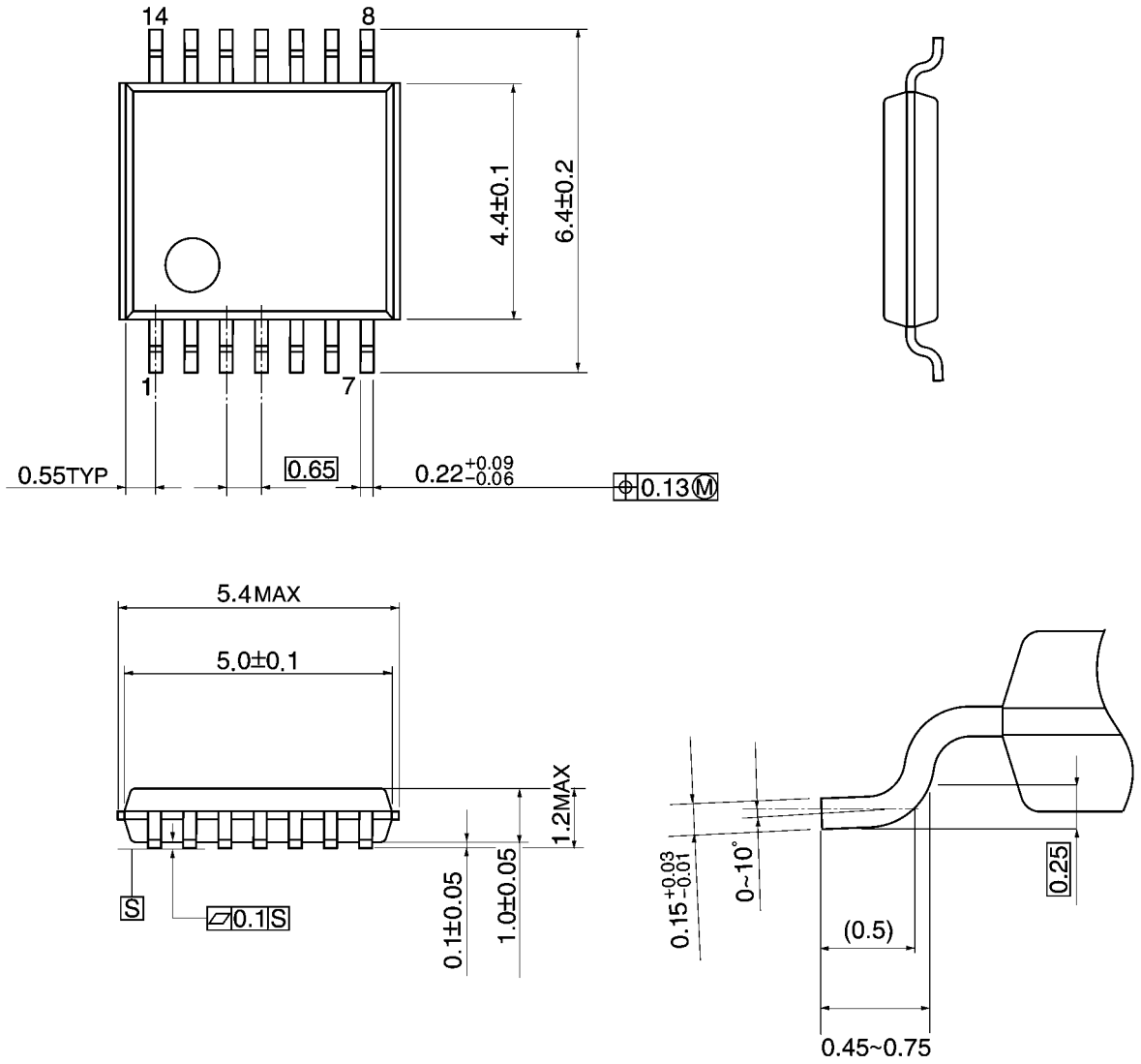
SOP14-P-300-1.27A Unit: mm




Weight: 0.18 g (typ.)

## Package Dimensions

TSSOP14-P-0044-0.65A Unit: mm




Weight: 0.06 g (typ.)

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