TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74LCX373F, TC74LCX373FK

## Low-Voltage Octal D-Type Latch with 5-V Tolerant Inputs and Outputs

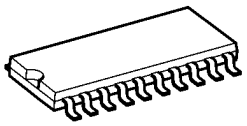
The TC74LCX373 is a high-performance CMOS octal D-type latch. Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (3.3 V) $V_{CC}$ applications, but it could be used to interface to 5-V supply environment for both inputs and outputs.

This 8 bit D-type latch is controlled by a latch enable input (LE) and an output enable input ($\overline{OE}$). When the $\overline{OE}$ input is high, the eight outputs are in a high-impedance state.

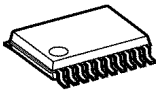
All inputs are equipped with protection circuits against static discharge.

TC74LCX373F



SOP20-P-300-1.27A

TC74LCX373FK



VSSOP20-P-0030-0.50

Weight

SOP20-P-300-1.27A : 0.22 g ( typ.)

VSSOP20-P-0030-0.50 : 0.03 g ( typ.)

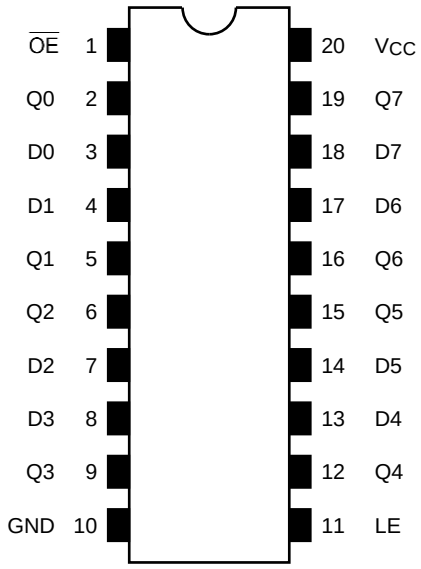
## Features

- Low-voltage operation: $V_{CC}$ = 1.65 V to 3.6 V
- High-speed operation: $t_{pd}$ = 8.0 ns (max) ($V_{CC}$ = 3.0 to 3.6 V)
- Output current: $|I_{OH}|/I_{OL}$ = 24 mA (min) ($V_{CC}$ = 3.0 V)
- Available in JEITA SOP, VSSOP (US)
- Power-down protection provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 373 type

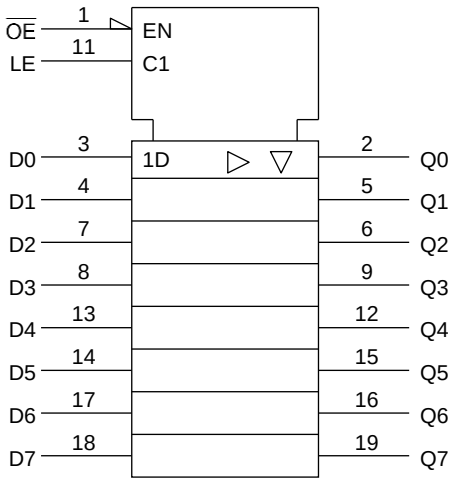
Note: The Electrical Characteristics of $V_{CC}$ = 1.8 ± 0.15 V is only applicable for products which manufactured from January 2009 onward.

Start of commercial production
1994-10

## Pin Assignment (top view)




## IEC Logic Symbol




## Truth Table

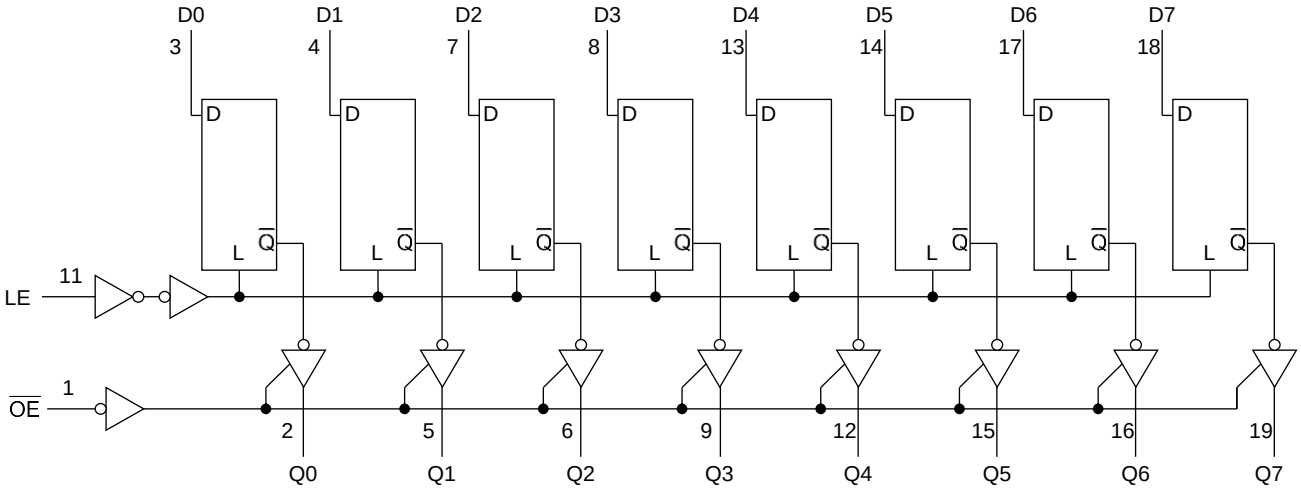
| Inputs | | | Outputs |
|---|---|---|---|
| $\overline{OE}$ | LE | D | |
| H | X | X | Z |
| L | L | X | Qn |
| L | H | L | L |
| L | H | H | H |

X: Don’t care

Z: High impedance

Qn: Q outputs are latched at the time when the LE input is taken to a low logic level.

## System Diagram



## Absolute Maximum Ratings (Note 1)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power supply voltage | $V_{CC}$ | −0.5 to 7.0 | V |
| DC input voltage | $V_{IN}$ | −0.5 to 7.0 | V |
| DC output voltage | $V_{OUT}$ | −0.5 to 7.0 (Note 2) | V |
| | | −0.5 to $V_{CC}$ + 0.5 (Note 3) | |
| Input diode current | $I_{IK}$ | −50 | mA |
| Output diode current | $I_{OK}$ | ±50 (Note 4) | mA |
| DC output current | $I_{OUT}$ | ±50 | mA |
| Power dissipation | $P_D$ | 180 | mW |
| DC $V_{CC}$/ground current | $I_{CC}/I_{GND}$ | ±100 | mA |
| 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: Output in OFF state

Note 3: High or low state. $I_{OUT}$ absolute maximum rating must be observed.

Note 4: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

## Operating Ranges (Note 1)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power supply voltage | $V_{CC}$ | 1.65 to 3.6 | V |
| | | 1.5 to 3.6 (Note 2) | |
| Input voltage | $V_{IN}$ | 0 to 5.5 | V |
| Output voltage | $V_{OUT}$ | 0 to 5.5 (Note 3) | V |
| | | 0 to $V_{CC}$ (Note 4) | |
| Output current | $I_{OH}/I_{OL}$ | ±24 (Note 5) | mA |
| | | ±12 (Note 6) | |
| Operating temperature | $T_{opr}$ | −40 to 85 | °C |
| Input rise and fall time | dt/dv | 0 to 10 (Note 7) | ns/V |

Note 1: 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 2: Data retention only

Note 3: Output in OFF state

Note 4: High or low state

Note 5: $V_{CC}$ = 3.0 to 3.6 V

Note 6: $V_{CC}$ = 2.7 to 3.0 V

Note 7: $V_{IN}$ = 0.8 to 2.0 V, $V_{CC}$ = 3.0 V

## Electrical Characteristics

### DC Characteristics (Ta = –40 to 85°C)

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | H-level | $V_{IH}$ | — | | 1.65 to2.3 | $V_{CC}$ × 0.9 | — | V |
| | | | | | 2.3 to2.7 | 1.7 | — | |
| | | | | | 2.7 to 3.6 | 2.0 | — | |
| | L-level | $V_{IL}$ | — | | 1.65 to2.3 | — | $V_{CC}$ × 0.1 | |
| | | | | | 2.3 to2.7 | — | 0.7 | |
| | | | | | 2.7 to 3.6 | — | 0.8 | |
| Output voltage | H-level | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = –100 μA | 1.65 to 3.6 | $V_{CC}$– 0.2 | — | V |
| | | | | $I_{OH}$ = –4 mA | 1.65 | 1.05 | — | |
| | | | | $I_{OH}$ = –8 mA | 2.3 | 1.7 | — | |
| | | | | $I_{OH}$ = –12 mA | 2.7 | 2.2 | — | |
| | | | | $I_{OH}$ = –18 mA | 3.0 | 2.4 | — | |
| | | | | $I_{OH}$ = –24 mA | 3.0 | 2.2 | — | |
| | L-level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 1.65 to 3.6 | — | 0.2 | |
| | | | | $I_{OL}$ = 4 mA | 1.65 | — | 0.45 | |
| | | | | $I_{OL}$ = 8 mA | 2.3 | — | 0.7 | |
| | | | | $I_{OL}$ = 12 mA | 2.7 | — | 0.4 | |
| | | | | $I_{OL}$ = 16 mA | 3.0 | — | 0.4 | |
| | | | | $I_{OL}$ = 24 mA | 3.0 | — | 0.55 | |
| Input leakage current | | $I_{IN}$ | $V_{IN}$ = 0 to 5.5 V | | 1.65 to 3.6 | — | ±5.0 | μA |
| 3-state output OFF state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 5.5 V | | 1.65 to 3.6 | — | ±5.0 | μA |
| Power-off leakage current | | $I_{OFF}$ | $V_{IN}$/$V_{OUT}$ = 5.5 V | | 0 | — | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 1.65 to 3.6 | — | 10.0 | μA |
| | | | $V_{IN}$/$V_{OUT}$ = 3.6 to 5.5 V | | 1.65 to 3.6 | — | ±10.0 | |
| Increase in $I_{CC}$ per input | | $\Delta I_{CC}$ | $V_{IH}$ = $V_{CC}$ – 0.6 V (per 1 input) | | 2.7 to 3.6 | — | 500 | |

## AC Characteristics (Ta = –40 to 85°C)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (D-Q) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 1.8 ± 0.15 | — | 30.0 | ns |
| | | | 2.5 ± 0.2 | — | 10.0 | |
| | | | 2.7 | — | 9.0 | |
| | | | 3.3 ± 0.3 | 1.5 | 8.0 | |
| Propagation delay time (LE-Q) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 1.8 ± 0.15 | — | 30.0 | ns |
| | | | 2.5 ± 0.2 | — | 10.5 | |
| | | | 2.7 | — | 9.5 | |
| | | | 3.3 ± 0.3 | 1.5 | 8.5 | |
| Output enable time | $t_{pZL}$ $t_{pZH}$ | Figure 1, Figure 3 | 1.8 ± 0.15 | — | 34.0 | ns |
| | | | 2.5 ± 0.2 | — | 17.0 | |
| | | | 2.7 | — | 9.5 | |
| | | | 3.3 ± 0.3 | 1.5 | 8.5 | |
| Output disable time | $t_{pLZ}$ $t_{pHZ}$ | Figure 1, Figure 3 | 1.8 ± 0.15 | — | 32.0 | ns |
| | | | 2.5 ± 0.2 | — | 16.0 | |
| | | | 2.7 | — | 8.5 | |
| | | | 3.3 ± 0.3 | 1.5 | 7.5 | |
| Minimum pulse width (LE) | $t_w$ (H) | Figure 1, Figure 2 | 1.8 ± 0.15 | 12.0 | — | ns |
| | | | 2.5 ± 0.2 | 6.0 | — | |
| | | | 2.7 | 4.0 | — | |
| | | | 3.3 ± 0.3 | 3.3 | — | |
| Minimum setup time | $t_s$ | Figure 1, Figure 2 | 1.8 ± 0.15 | 10.0 | — | ns |
| | | | 2.5 ± 0.2 | 5.0 | — | |
| | | | 2.7 | 2.5 | — | |
| | | | 3.3 ± 0.3 | 2.5 | — | |
| Minimum hold time | $t_h$ | Figure 1, Figure 2 | 1.8 ± 0.15 | 1.5 | — | ns |
| | | | 2.5 ± 0.2 | 1.5 | — | |
| | | | 2.7 | 1.5 | — | |
| | | | 3.3 ± 0.3 | 1.5 | — | |
| Output to output skew | $t_{osLH}$ $t_{osHL}$ | (Note) | 2.7 | — | — | ns |
| | | | 3.3 ± 0.3 | — | 1.0 | |

Note: Parameter guaranteed by design.
($t_{osLH} = |t_{pLHm} - t_{pLHn}|$, $t_{osHL} = |t_{pHLm} - t_{pHLn}|$)

### Dynamic Switching Characteristics (Ta = 25°C, input: $t_r = t_f = 2.5$ ns, $C_L = 50$ pF, $R_L = 500\ \Omega$)

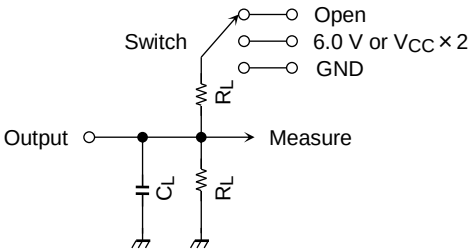
| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|
| Quiet output maximum dynamic $V_{OL}$ | $V_{OLP}$ | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V | 3.3 | 0.8 | V |
| Quiet output minimum dynamic $V_{OL}$ | $\lvert V_{OLV} \rvert$ | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V | 3.3 | 0.8 | V |

### Capacitive Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|
| Input capacitance | $C_{IN}$ | — | 3.3 | 7 | pF |
| Output capacitance | $C_{OUT}$ | — | 3.3 | 8 | pF |
| Power dissipation capacitance | $C_{PD}$ | $f_{IN}$ = 10 MHz (Note) | 3.3 | 25 | pF |

Note: $C_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption.
Average operating current can be obtained by the equation:
$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8$ (per bit)

## AC Test Circuit




| Parameter | Switch | |
|---|---|---|
| $t_{pLH}$, $t_{pHL}$ | Open | |
| $t_{pLZ}$, $t_{pZL}$ | 6.0 V | @ $V_{CC}$ =3.3±0.3V<br>@ $V_{CC}$ =2.7V |
| | $V_{CC}$×2 | @ $V_{CC}$ =2.5±0.2V<br>@ $V_{CC}$ =1.8±0.15V |
| $t_{pHZ}$, $t_{pZH}$ | GND | |

**Figure 1**

## AC Waveform

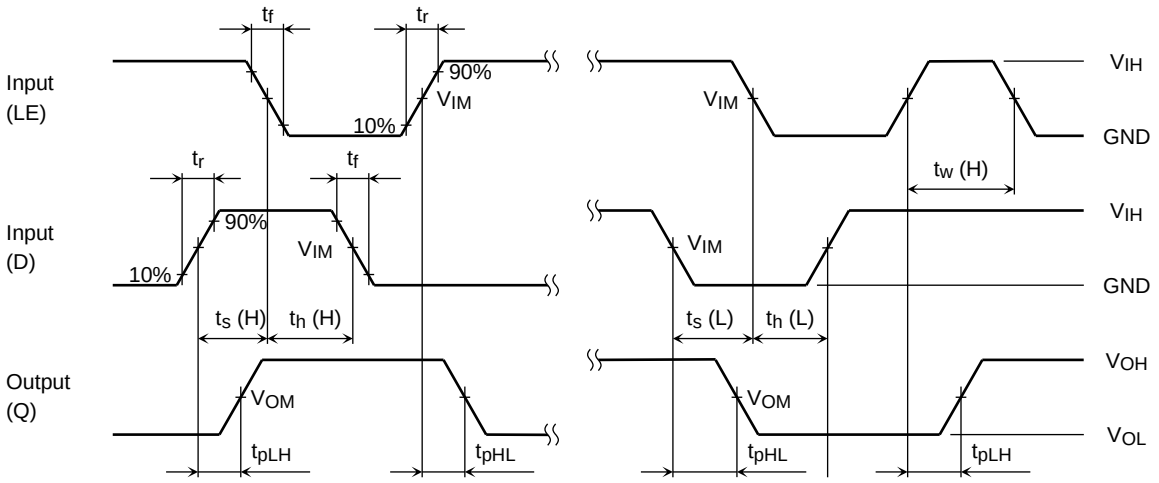



**Figure 2 $t_{pLH}$, $t_{pHL}$, $t_w$, $t_s$, $t_h$**

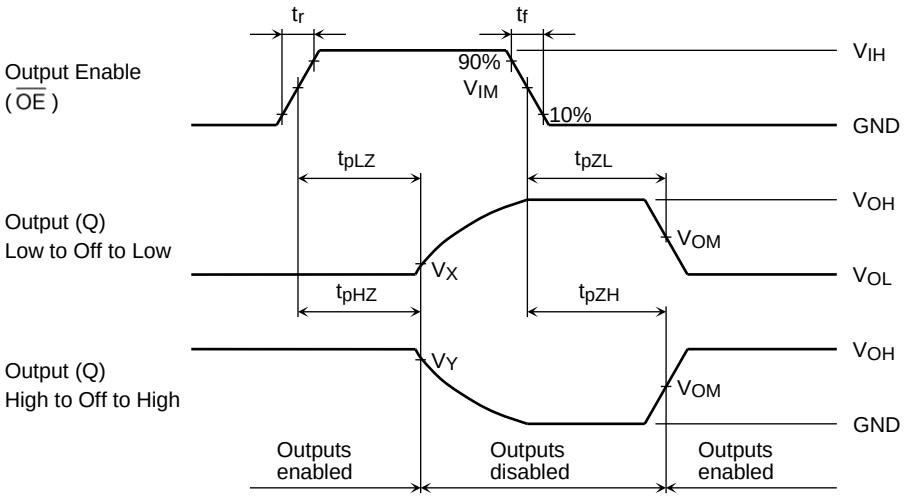
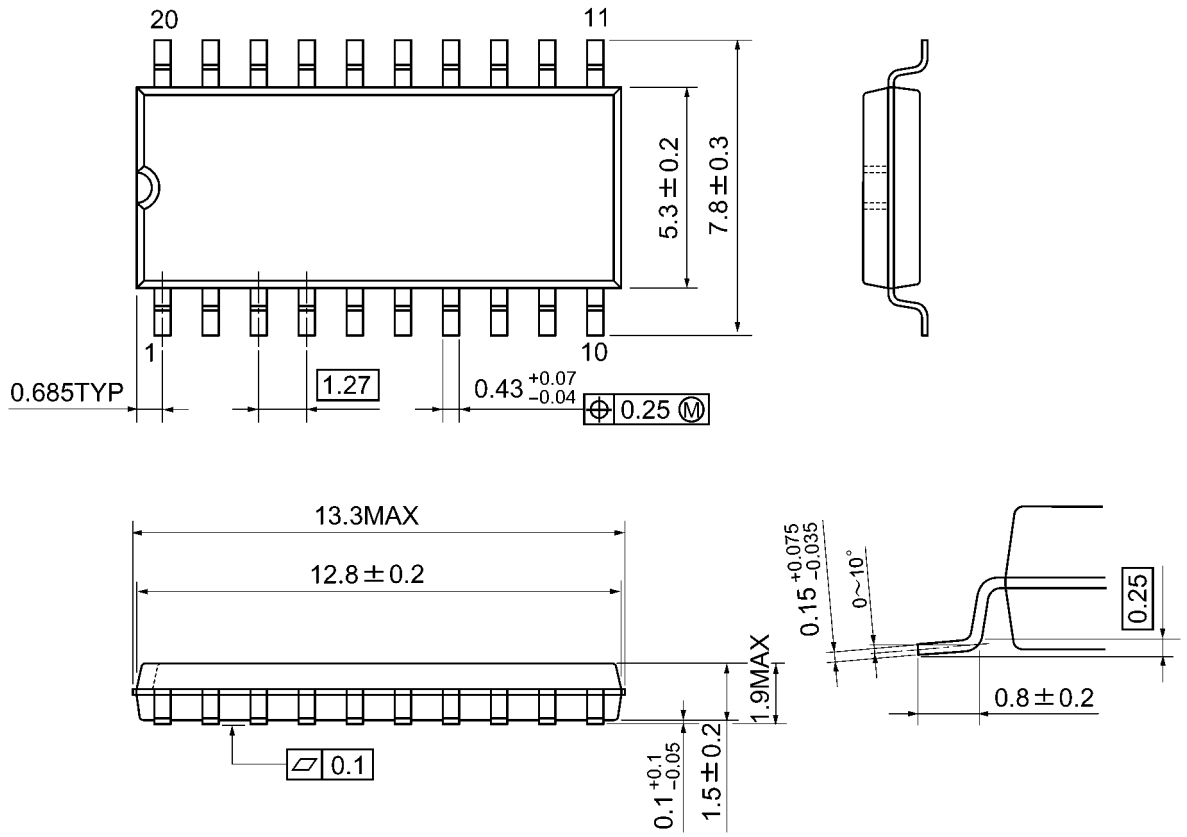



**Figure 3 $t_{pLZ}$, $t_{pHZ}$, $t_{pZL}$, $t_{pZH}$**

| | Symbol | $V_{CC}$ | | |
|---|---|---|---|---|
| | | 3.3 ± 0.3 V<br>2.7 V | 2.5 ± 0.2 V | 1.8 ± 0.15 V |
| Input | $V_{IH}$ | 2.7 V | $V_{CC}$ | $V_{CC}$ |
| | $V_{IM}$ | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |
| | $t_r$, $t_f$ | 2.5 ns | 2.0 ns | 2.0 ns |
| Output | $V_{OM}$ | 1.5 V | $V_{OH}/2$ | $V_{OH}/2$ |
| | $V_X$ | $V_{OL}$ +0.3 V | $V_{OL}$ +0.15 V | $V_{OL}$ +0.15 V |
| | $V_Y$ | $V_{OH}$ -0.3 V | $V_{OH}$ -0.15 V | $V_{OH}$ -0.15 V |
| Load | $C_L$ | 50 pF | 30 pF | 30 pF |
| | $R_L$ | 500 Ω | 500 Ω | 1 kΩ |

## Package Dimensions

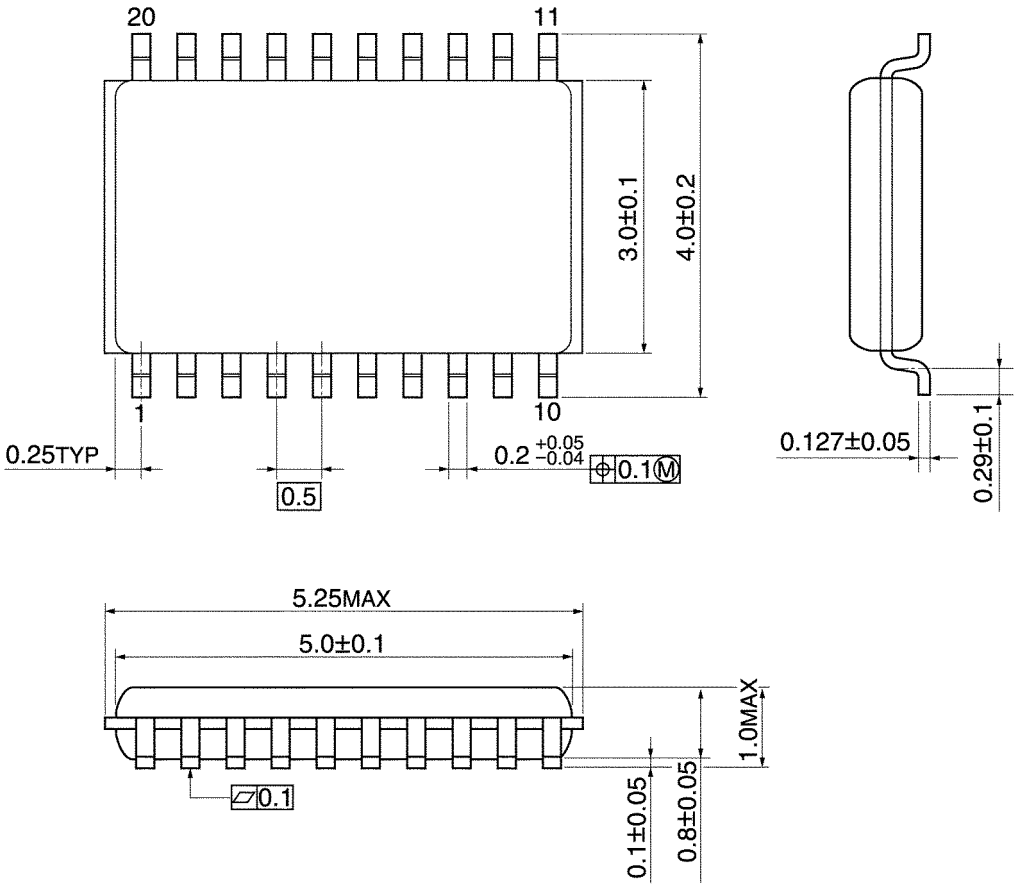
SOP20-P-300-1.27A Unit: mm




Weight: 0.22 g (typ.)

## Package Dimensions

VSSOP20-P-0030-0.50 Unit: mm




Weight: 0.03 g (typ.)

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