CMOS Digital Integrated Circuits Silicon Monolithic

# 74LCX373FT

## 1. Functional Description

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

## 2. General

The 74LCX373FT 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.

## 3. Features

(1) Low-voltage operation: $V_{CC}$ = 1.65 to 3.6 V

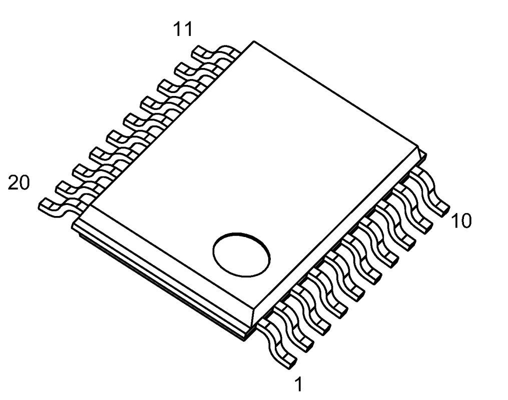
(2) High-speed operation: $t_{pd}$ = 8.0 ns (max) ($V_{CC}$ = 3.0 to 3.6 V)

(3) Output current: $|I_{OH}|/I_{OL}$ = 24 mA (min) ($V_{CC}$ = 3.0 to 3.6 V)

(4) Power-down protection provided on all inputs and outputs

(5) Pin and function compatible with the 74 series (74LVC/ALVC/ etc.) 373 type

## 4. Packaging

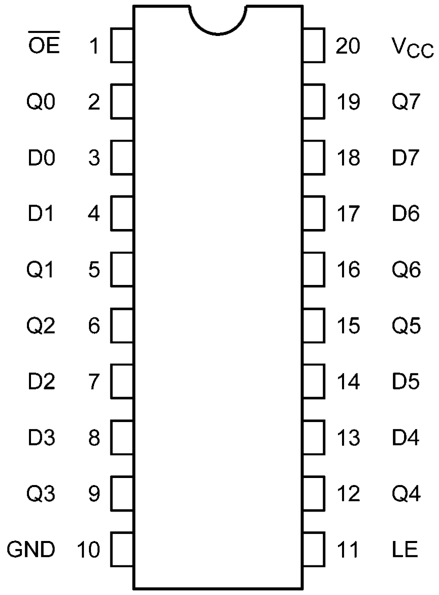



TSSOP20B

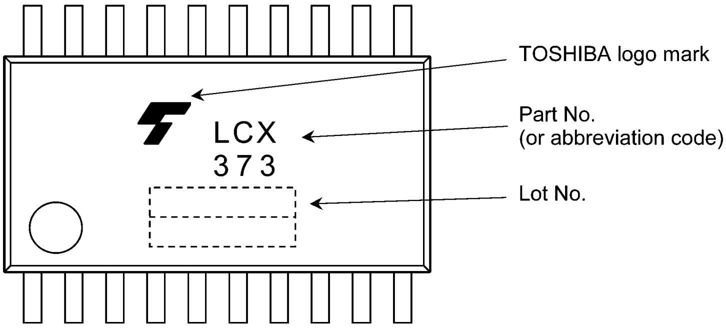
Start of commercial production

2013-11

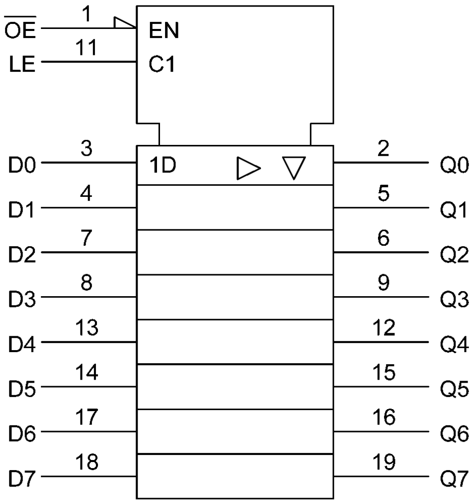
## 5. Pin Assignment




## 6. Marking




## 7. IEC Logic Symbol



## 8. Truth Table

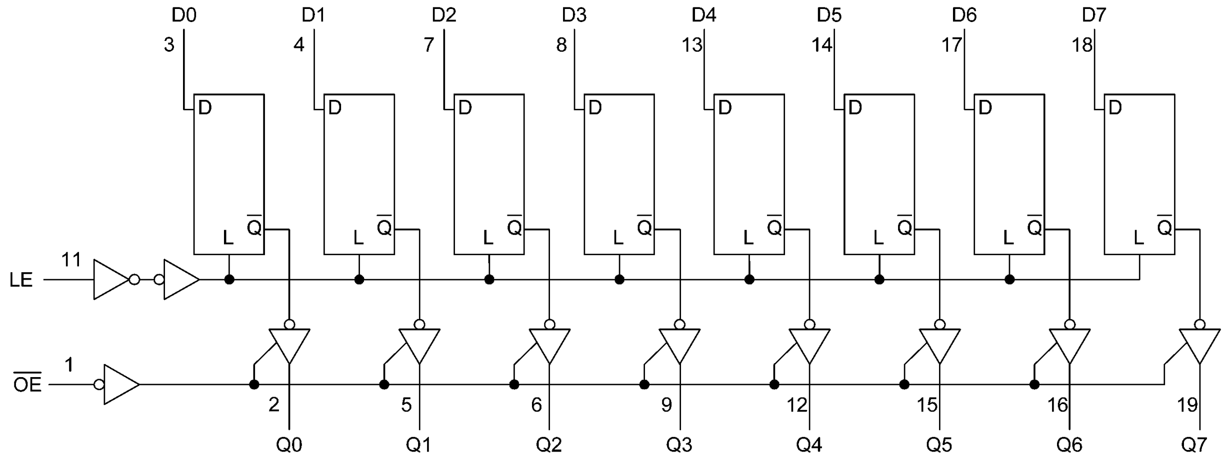
| Input $\overline{OE}$ | Input LE | Input D | Outputs |
|---|---|---|---|
| H | X | X | Z |
| L | L | X | Qn |
| L | H | L | L |
| L | H | H | H |

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.

## 9. System Diagram



## 10. Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | | -0.5 to 6.5 | V |
| Input voltage | $V_{IN}$ | | -0.5 to 6.5 | V |
| Output voltage | $V_{OUT}$ | (Note 1) | -0.5 to 6.5 | V |
| | | (Note 2) | -0.5 to $V_{CC}$ + 0.5 | |
| Input diode current | $I_{IK}$ | | -50 | mA |
| Output diode current | $I_{OK}$ | (Note 3) | ±50 | mA |
| Output current | $I_{OUT}$ | | ±50 | mA |
| Power dissipation | $P_D$ | | 180 | mW |
| $V_{CC}$/ground current | $I_{CC}/I_{GND}$ | | ±100 | mA |
| 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: Output in OFF state.

Note 2: High (H) or Low (L) state. $I_{OUT}$ absolute maximum rating must be observed.

Note 3: $V_{OUT}$ < GND, $V_{OUT}$ > $V_{CC}$

## 11. Operating Ranges (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | | 1.65 to 3.6 | V |
| | | (Note 1) | 1.5 to 3.6 | |
| Input voltage | $V_{IN}$ | | 0 to 5.5 | V |
| Output voltage | $V_{OUT}$ | (Note 2) | 0 to 5.5 | V |
| | | (Note 3) | 0 to $V_{CC}$ | |
| Output current | $I_{OUT}$ | (Note 4) | ±24 | mA |
| | | (Note 5) | ±12 | |
| Operating temperature | $T_{opr}$ | | -40 to 85 | °C |
| Input rise and fall times | dt/dv | (Note 6) | 0 to 10 | ns/V |

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: Data retention only

Note 2: Output in OFF state

Note 3: High or low state

Note 4: $V_{CC}$ = 3.0 to 3.6 V

Note 5: $V_{CC}$ = 2.7 to 3.0 V

Note 6: $V_{IN}$ =0.8 to 2.0 V , $V_{CC}$ = 3.0 V

## 12. Electrical Characteristics

### 12.1. 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 | $V_{IH}$ | — | | 1.65 to 2.3 | $V_{CC} \times 0.9$ | — | V |
| | | | | 2.3 to 2.7 | 1.7 | — | |
| | | | | 2.7 to 3.6 | 2.0 | — | |
| Low-level input voltage | $V_{IL}$ | — | | 1.65 to 2.3 | — | $V_{CC} \times 0.1$ | |
| | | | | 2.3 to 2.7 | — | 0.7 | |
| | | | | 2.7 to 3.6 | — | 0.8 | |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IH}$ 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 | — | |
| Low-level output voltage | $V_{OL}$ | $V_{IN} = V_{IH}$ 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 leakage 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 | |
| Quiescent supply current | $\Delta I_{CC}$ | $V_{IH} = V_{CC}$ - 0.6 V<br>(per input) | | 2.7 to 3.6 | — | 500 | |

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

| Characteristics | Symbol | Note | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|
| Propagation delay time (D-Q) | $t_{PLH}$,$t_{PHL}$ | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 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) | $t_{PLH}$,$t_{PHL}$ | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 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 | $t_{PZL}$,$t_{PZH}$ | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.2, Table 12.6.1 | 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 | $t_{PLZ}$,$t_{PHZ}$ | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.2, Table 12.6.1 | 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) | $t_{w(H)}$ | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 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 | $t_S$ | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 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 | $t_h$ | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 1.8 ± 0.15 | 1.5 | — | ns |
| | | | | 2.5 ± 0.2 | 1.5 | — | |
| | | | | 2.7 | 1.5 | — | |
| | | | | 3.3 ± 0.3 | 1.5 | — | |
| Output skew | $t_{osLH}$,$t_{osHL}$ | (Note 1) | — | 2.7 | — | — | ns |
| | | | | 3.3 ± 0.3 | — | 1.0 | |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = $|t_{PLHm} - t_{PLHn}|$, $t_{osHL}$ = $|t_{PHLm} - t_{PHLn}|$)

## 12.3. Dynamic Switching Characteristics (Unless otherwise specified, $T_a$ = 25°C, Input: $t_r$ = $t_f$ = 2.5 ns, $C_L$ = 50 pF, $R_L$ = 500 Ω)

| 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 $V_{OL}$ | $\|V_{OLV}\|$ | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V | 3.3 | 0.8 | V |

## 12.4. Capacitive Characteristics (Unless otherwise specified, $T_a$ = 25°C)

| Characteristics | Symbol | Note | 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 | $C_{PD}$ | (Note 1) | $f_{IN}$ = 10 MHz | 3.3 | 25 | 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.

$I_{CC}(opr) = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/8$ (per bit)

## 12.5. AC Test Circuit

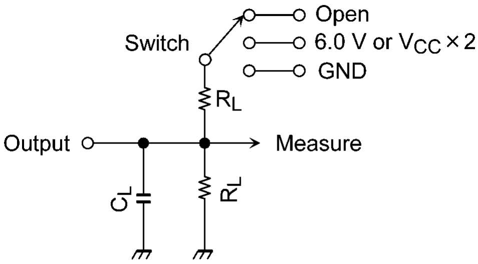



**Table 12.5.1 Parameter for AC Test Circuit**

| Parameter | Switch | Test Condition |
|---|---|---|
| $t_{PLH}$, $t_{PHL}$ | OPEN | — |
| $t_{PLZ}$, $t_{PZL}$ | 6.0 V | $V_{CC}$ = 3.3 ± 0.3 V |
| | | $V_{CC}$ = 2.7 V |
| | $V_{CC}$ × 2 | $V_{CC}$ = 2.5 ± 0.2 V |
| | | $V_{CC}$ = 1.8 ± 0.15 V |
| $t_{PHZ}$, $t_{PZH}$ | GND | — |
| $t_w$, $t_s$, $t_h$ | OPEN | — |

## 12.6. AC Waveform

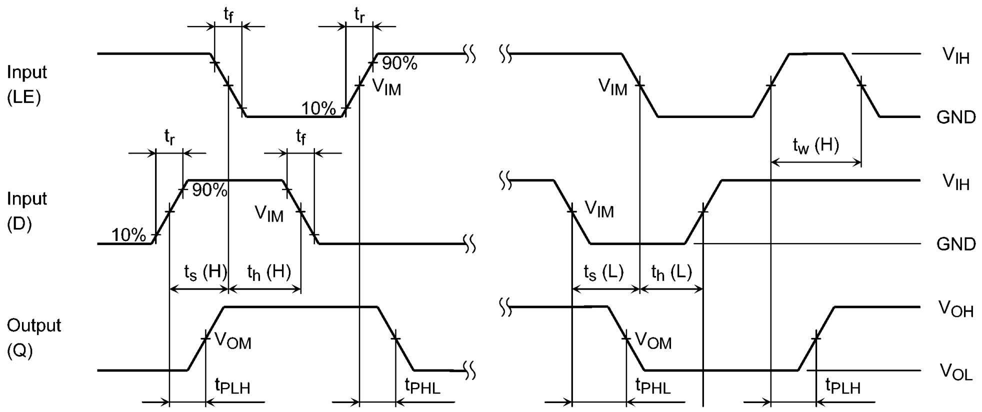



Fig. 12.6.1 $t_{PLH}$, $t_{PHL}$, $t_w$, $t_s$, $t_h$

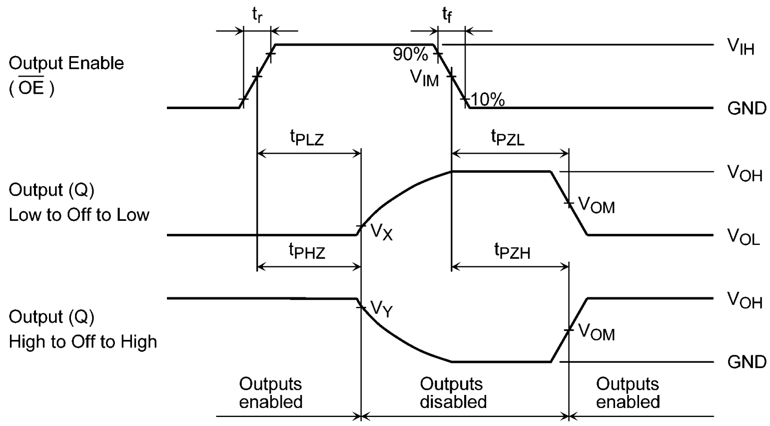


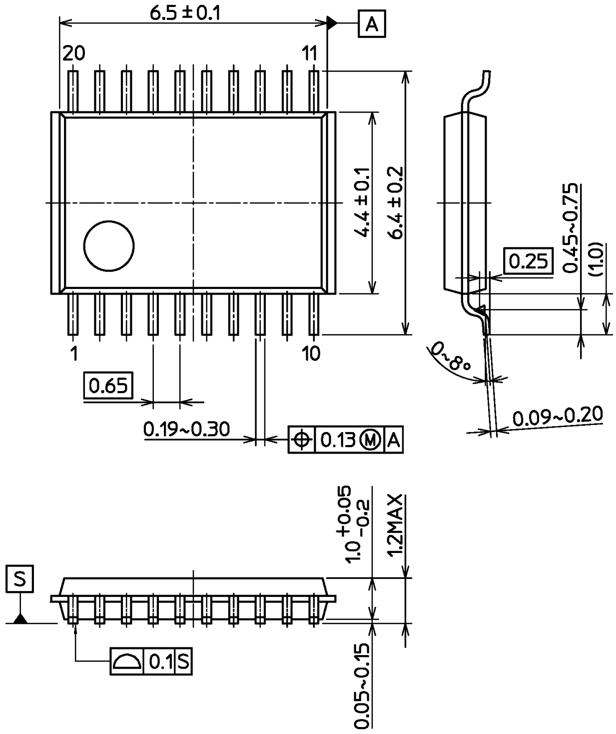

Fig. 12.6.2 $t_{PLZ}$, $t_{PHZ}$, $t_{PZL}$, $t_{PZH}$

Table 12.6.1 AC Waveform Symbols

| | Symbol | $V_{CC}$ = 3.3 ± 0.3 V<br>$V_{CC}$ = 2.7 V | $V_{CC}$ = 2.5 ± 0.2 V | $V_{CC}$ = 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 | $V_{OL}$ - 0.15 V | $V_{OL}$ - 0.15 V |
| Load | $C_L$ | 50 pF | 30 pF | 30 pF |
| | $R_L$ | 500 Ω | 500 Ω | 1 kΩ |

## Package Dimensions

Unit: mm




Weight: 0.071 g (typ.)

| Package Name(s) |
| --- |
| Nickname: TSSOP20B |

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