CMOS Digital Integrated Circuits Silicon Monolithic

# 74LCX138FT

## 1. Functional Description

- Low-Voltage 3-to-8 Line Decoder with 5-V Tolerant Inputs and Outputs

## 2. General

The 74LCX138FT is a high-performance CMOS 3 to 8 decoder. 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 inputs.

When the device is enabled, 3 binary select inputs (A, B and C) determine which one of the outputs ($\overline{Y}0$-$\overline{Y}7$) will go low.

When enable input G1 is held low or either $\overline{G}2A$ or $\overline{G}2B$ is held high, decoding function is inhibited and all outputs go high.

G1,$\overline{G}2A$, and $\overline{G}2B$ inputs are provided to ease cascade connection and for use as an address decoder for memory systems.

All inputs are equipped with protection circuits against static discharge.

## 3. Features

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

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

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

(4) High-speed operation: $t_{pd}$ = 7.0 ns (max) ($V_{CC}$ = 3.3 ± 0.3 V)

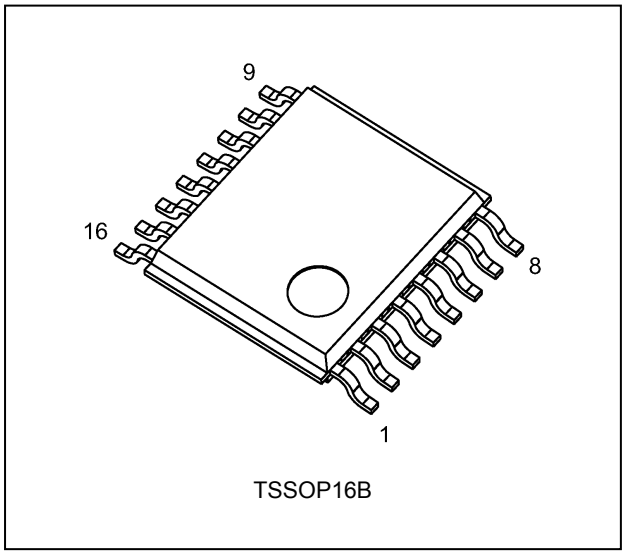
(5) Output current: $|I_{OH}|/I_{OL}$ = 24 mA (min) ($V_{CC}$ = 3.0 V)

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

(7) Pin and function compatible with the 74 series (74LVC/ALVC/ etc.) 138 type

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

## 4. Packaging

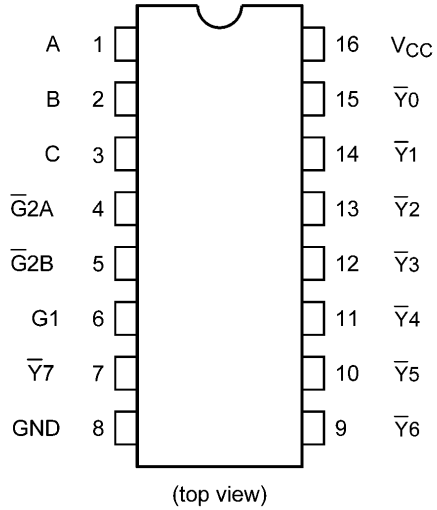



TSSOP16B

Start of commercial production

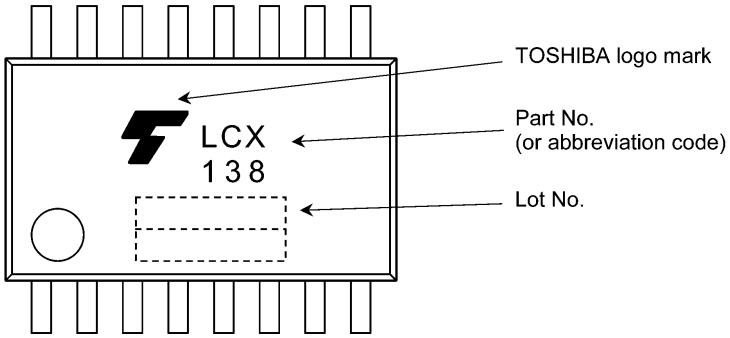
2014-04

## 5. Pin Assignment

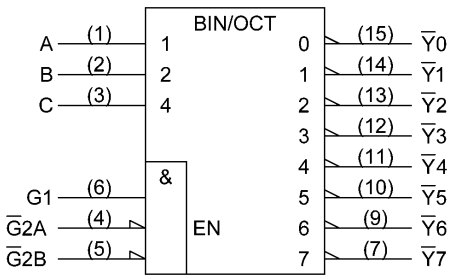


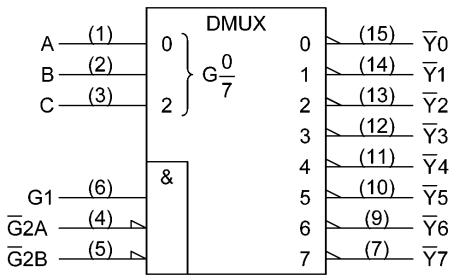

(top view)

## 6. Marking




## 7. IEC Logic Symbol



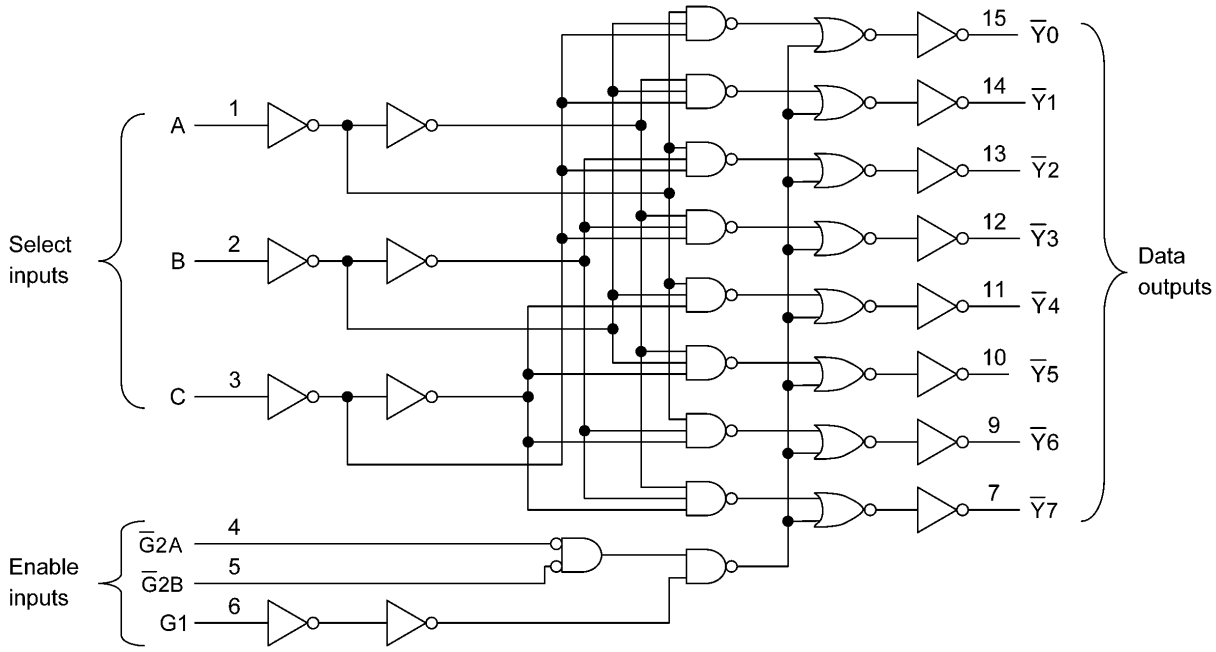



## 8. Truth Table

| Inputs | | | | | | Outputs | | | | | | | | Selected Output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Enable | | | Select | | | | | | | | | | | |
| G1 | $\overline{G2A}$ | $\overline{G2B}$ | C | B | A | $\overline{Y0}$ | $\overline{Y1}$ | $\overline{Y2}$ | $\overline{Y3}$ | $\overline{Y4}$ | $\overline{Y5}$ | $\overline{Y6}$ | $\overline{Y7}$ | |
| L | X | X | X | X | X | H | H | H | H | H | H | H | H | None |
| X | H | X | X | X | X | H | H | H | H | H | H | H | H | None |
| X | X | H | X | X | X | H | H | H | H | H | H | H | H | None |
| H | L | L | L | L | L | L | H | H | H | H | H | H | H | $\overline{Y0}$ |
| H | L | L | L | L | H | H | L | H | H | H | H | H | H | $\overline{Y1}$ |
| H | L | L | L | H | L | H | H | L | H | H | H | H | H | $\overline{Y2}$ |
| H | L | L | L | H | H | H | H | H | L | H | H | H | H | $\overline{Y3}$ |
| H | L | L | H | L | L | H | H | H | H | L | H | H | H | $\overline{Y4}$ |
| H | L | L | H | L | H | H | H | H | H | H | L | H | H | $\overline{Y5}$ |
| H | L | L | H | H | L | H | H | H | H | H | H | L | H | $\overline{Y6}$ |
| H | L | L | H | H | H | H | H | H | H | H | H | H | L | $\overline{Y7}$ |

X: Don't care

## 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 | $P_D$ | (Note 4) | 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: $V_{CC}$ = 0 V
Note 2: High or Low state. $I_{OUT}$ absolute maximum rating must be observed.
Note 3: $V_{OUT}$ < GND, $V_{OUT}$ > $V_{CC}$
Note 4: 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.

## 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 | $I_{OH}$,$I_{OL}$ | (Note 4) | ±24 | mA |
| | | (Note 5) | ±12 | |
| Operating temperature | $T_{opr}$ | | -40 to 125 | °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: $V_{CC}$ = 0 V
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 | — | $V_{CC} \times 0.1$ | V |
| | | | | 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 | V |
| | | | $I_{OL}$ = 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 |
| 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 (per 1 input) | | 2.7 to 3.6 | — | 500 | μA |

## 12.2. 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 | $V_{IH}$ | — | | 1.65 to 2.3 | $V_{CC}$ × 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 | — | $V_{CC}$ × 0.1 | V |
| | | | | 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 | 0.9 | — | |
| | | | $I_{OH}$ = -8 mA | 2.3 | 1.55 | — | |
| | | | $I_{OH}$ = -12 mA | 2.7 | 2.0 | — | |
| | | | $I_{OH}$ = -18 mA | 3.0 | 2.2 | — | |
| | | | $I_{OH}$ = -24 mA | 3.0 | 2.0 | — | |
| Low-level output voltage | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 1.65 to 3.6 | — | 0.2 | V |
| | | | $I_{OL}$ = 4 mA | 1.65 | — | 0.65 | |
| | | | $I_{OL}$ = 8 mA | 2.3 | — | 0.9 | |
| | | | $I_{OL}$ = 12 mA | 2.7 | — | 0.6 | |
| | | | $I_{OL}$ = 16 mA | 3.0 | — | 0.6 | |
| | | | $I_{OL}$ = 24 mA | 3.0 | — | 0.75 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ = 0 to 5.5 V | | 1.65 to 3.6 | — | ±20.0 | μA |
| Power-OFF leakage current | $I_{OFF}$ | $V_{IN}$/$V_{OUT}$ = 5.5 V | | 0 | — | 40.0 | μA |
| Quiescent supply current | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 1.65 to 3.6 | — | 40.0 | μA |
| | | $V_{IN}$/$V_{OUT}$ = 3.6 to 5.5 V | | 1.65 to 3.6 | — | ±40.0 | |
| Quiescent supply current | $\Delta I_{CC}$ | $V_{IH}$ = $V_{CC}$ - 0.6 V (per 1 input) | | 2.7 to 3.6 | — | 5.0 | mA |

## 12.3. 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 (A,B,C - $\overline{Y}$) | $t_{PLH}$,$t_{PHL}$ | | See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1 | 1.8 ± 0.15 | — | 25.0 | ns |
| | | | | 2.5 ± 0.2 | — | 8.0 | |
| | | | | 2.7 | — | 7.0 | |
| | | | | 3.3 ± 0.3 | 1.5 | 6.0 | |
| Propagation delay time ($\overline{G1}$ - $\overline{Y}$) | $t_{PLH}$,$t_{PHL}$ | | See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1 | 1.8 ± 0.15 | — | 25.0 | ns |
| | | | | 2.5 ± 0.2 | — | 9.0 | |
| | | | | 2.7 | — | 8.0 | |
| | | | | 3.3 ± 0.3 | 1.5 | 7.0 | |
| Propagation delay time ($\overline{G2}$ - $\overline{Y}$) | $t_{PLH}$,$t_{PHL}$ | | See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1 | 1.8 ± 0.15 | — | 25.0 | ns |
| | | | | 2.5 ± 0.2 | — | 8.0 | |
| | | | | 2.7 | — | 7.0 | |
| | | | | 3.3 ± 0.3 | 1.5 | 6.0 | |
| Output skew | $t_{osLH}$,$t_{osHL}$ | (Note 1) | — | 2.7 | — | — | ns |
| | | | | 3.3 ± 0.3 | — | 1.0 | |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = $|t_{PLH}m-t_{PLH}n|$, $t_{osHL}$ = $|t_{PHL}m-t_{PHL}n|$)

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

| Characteristics | Symbol | Note | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|
| Propagation delay time (A,B,C - $\overline{Y}$) | $t_{PLH}$,$t_{PHL}$ | | See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1 | 1.8 ± 0.15 | — | 27.5 | ns |
| | | | | 2.5 ± 0.2 | — | 9.0 | |
| | | | | 2.7 | — | 8.0 | |
| | | | | 3.3 ± 0.3 | 1.5 | 7.0 | |
| Propagation delay time ($\overline{G1}$ - $\overline{Y}$) | $t_{PLH}$,$t_{PHL}$ | | See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1 | 1.8 ± 0.15 | — | 27.5 | ns |
| | | | | 2.5 ± 0.2 | — | 10.0 | |
| | | | | 2.7 | — | 9.0 | |
| | | | | 3.3 ± 0.3 | 1.5 | 8.0 | |
| Propagation delay time ($\overline{G2}$ - $\overline{Y}$) | $t_{PLH}$,$t_{PHL}$ | | See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1 | 1.8 ± 0.15 | — | 27.5 | ns |
| | | | | 2.5 ± 0.2 | — | 9.0 | |
| | | | | 2.7 | — | 8.0 | |
| | | | | 3.3 ± 0.3 | 1.5 | 7.0 | |
| Output skew | $t_{osLH}$,$t_{osHL}$ | (Note 1) | — | 2.7 | — | — | ns |
| | | | | 3.3 ± 0.3 | — | 1.0 | |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = $|t_{PLH}m-t_{PLH}n|$, $t_{osHL}$ = $|t_{PHL}m-t_{PHL}n|$)

## 12.5. 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 |

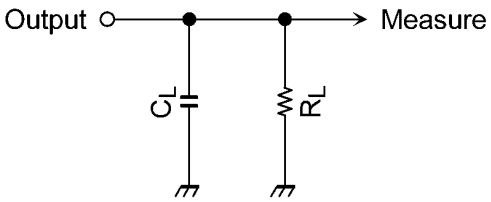
## 12.6. Capacitive Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Note | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{IN}$ | | | 3.3 | 7 | pF |
| Output capacitance | $C_{OUT}$ | | | 0 | 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.

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

## 12.7. AC Test Circuit




## 12.8. AC Waveform

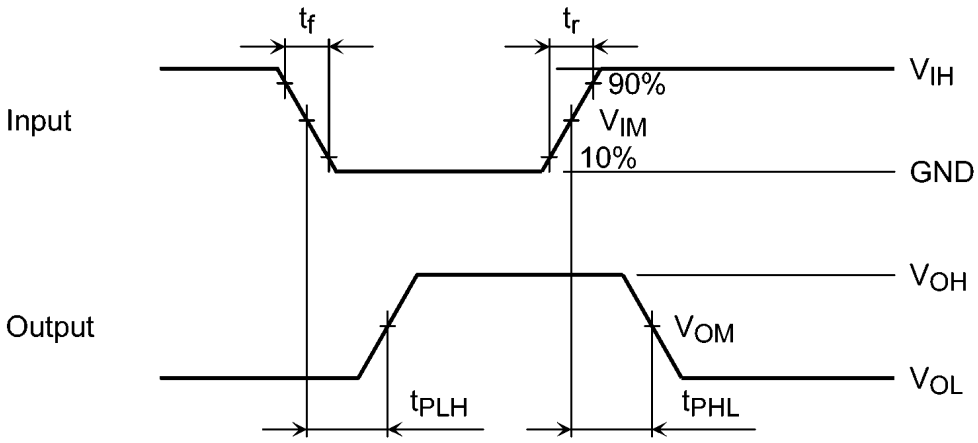


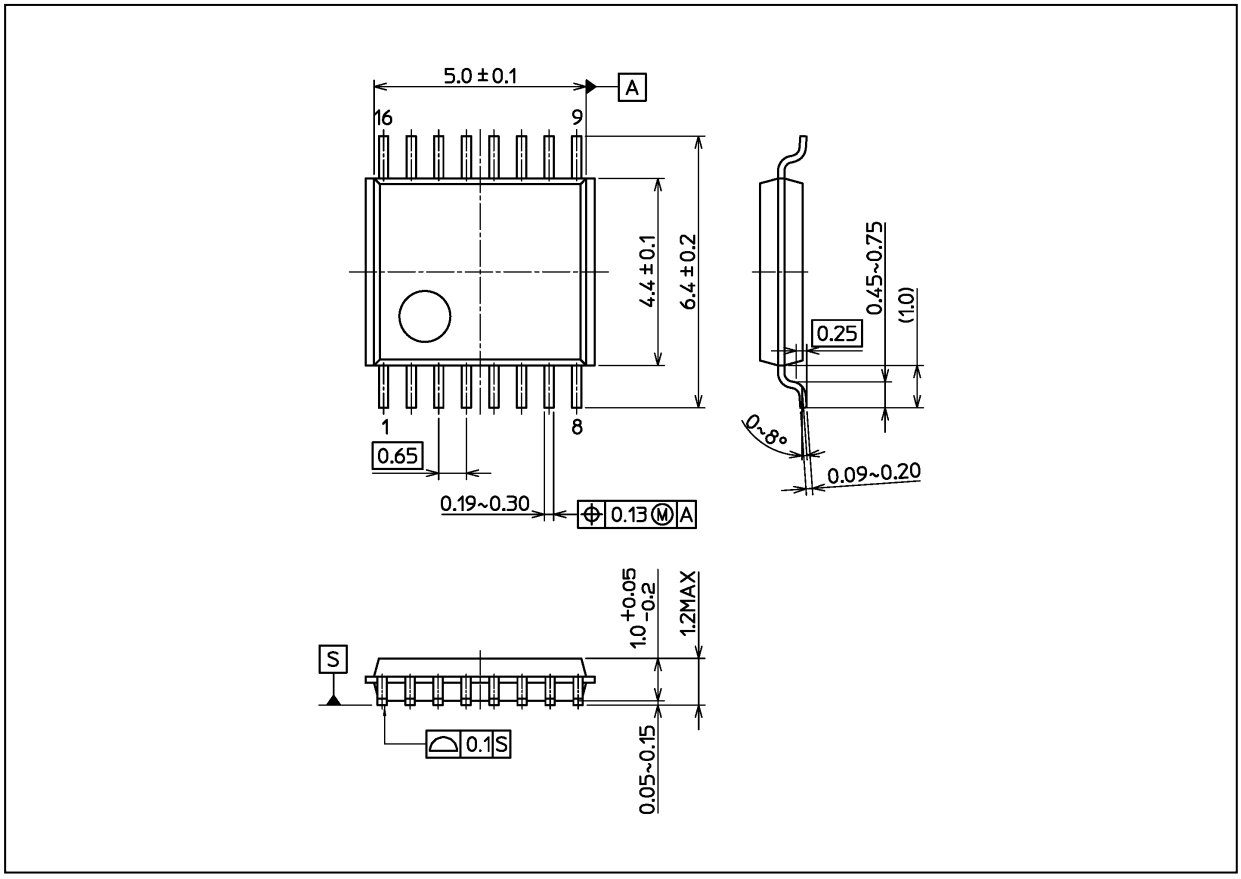

**Fig. 12.8.1 $t_{PLH}$, $t_{PHL}$**

**Table 12.8.1 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 | $V_{OH}/2$ | $V_{OH}/2$ |
| Load | $C_L$ | 50 pF | 30 pF | 30 pF |
| | $R_L$ | 500 Ω | 500 Ω | 1 kΩ |

## Package Dimensions

Unit: mm




Weight: 0.055 g (typ.)

| Package Name(s) |
| --- |
| Nickname: TSSOP16B |

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Живое партнерство

**ООО «ЛайфЭлектроникс»** **“LifeElectronics” LLC**

*ИНН 7805602321 КПП 780501001 Р/С 40702810122510004610 ФАКБ "АБСОЛЮТ БАНК" (ЗАО) в г.Санкт-Петербурге К/С 30101810900000000703 БИК 044030703*

*Компания «Life Electronics» занимается поставками электронных компонентов импортного и отечественного производства от производителей и со складов крупных дистрибьюторов Европы, Америки и Азии.*

*С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибьюторских договоров*

*Мы предлагаем:*

- *Конкурентоспособные цены и скидки постоянным клиентам.*
- *Специальные условия для постоянных клиентов.*
- *Подбор аналогов.*
- *Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.*

- *Приемлемые сроки поставки, возможна ускоренная поставка.*
- *Доставку товара в любую точку России и стран СНГ.*
- *Комплексную поставку.*
- *Работу по проектам и поставку образцов.*
- *Формирование склада под заказчика.*

- *Сертификаты соответствия на поставляемую продукцию (по желанию клиента).*
- *Тестирование поставляемой продукции.*
- *Поставку компонентов, требующих военную и космическую приемку.*
- *Входной контроль качества.*
- *Наличие сертификата ISO.*

*В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.*

*Конструкторский отдел помогает осуществить:*

- *Регистрацию проекта у производителя компонентов.*
- *Техническую поддержку проекта.*
- *Защиту от снятия компонента с производства.*
- *Оценку стоимости проекта по компонентам.*
- *Изготовление тестовой платы монтаж и пусконаладочные работы.*

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***www.lifeelectronics.ru***