

# 74LV4T125FT

## 1. Functional Description

- Quad Bus Buffer, Non-Inverted 3-State Outputs with Level Shifting

## 2. General

74LV4T125 is high speed CMOS quad 3-state bus buffer gate fabricated with silicon gate CMOS technology. This product is able to allow level-up or level-down voltage translation with only one power supply.

The output level is referenced to the power supply voltage and is able to support 1.8-V, 2.5-V, 3.3-V, and 5.0-V CMOS level. The input circuit is designed with a lower threshold. So level-up translation from 1.8 V to 3.3 V or from 3.3 V to 5.0 V is possible.

All input terminals have an input protection circuit with no diode from input terminal to power supply side. All output terminals have an output circuit with no parasitic diode from output terminal to power supply side. These circuits realize an input tolerant function and output power-down protection, and ensure the voltage of input terminals up to 5.5 V without regard to the supply voltage, and the voltage of output terminals up to 5.5 V even if the output terminal is high impedance state or the power supply voltage is not applied. So level-down translation from 3.3 V to 1.8 V or from 5.0 V to 3.3 V is possible.

The wide power supply voltage range of 1.65 V to 5.5 V allows the generation of desired output level to connect to controllers or processors and prevents device destruction due to mismatched supply voltage and input voltage.

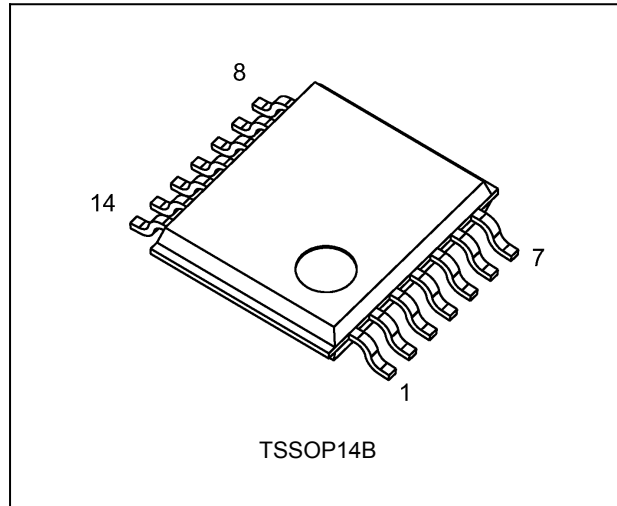
## 3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating voltage range:  $V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$
- (3) Level-up voltage translation
  - 1.2 V to 1.8 V  $\rightarrow$  1.8 V ( $V_{CC} = 1.8 \text{ V}$ )
  - 1.5 V to 2.5 V  $\rightarrow$  2.5 V ( $V_{CC} = 2.5 \text{ V}$ )
  - 1.8 V to 3.3 V  $\rightarrow$  3.3 V ( $V_{CC} = 3.3 \text{ V}$ )
  - 2.5 V to 5.0 V  $\rightarrow$  5.0 V ( $V_{CC} = 5.0 \text{ V}$ )
- (4) Level-down voltage translation
  - 5.0 V to 1.8 V  $\rightarrow$  1.8 V ( $V_{CC} = 1.8 \text{ V}$ )
  - 5.0 V to 2.5 V  $\rightarrow$  2.5 V ( $V_{CC} = 2.5 \text{ V}$ )
  - 5.0 V to 3.3 V  $\rightarrow$  3.3 V ( $V_{CC} = 3.3 \text{ V}$ )
- (5) Low power dissipation:  $I_{CC} = 4.0 \mu\text{A (max)}$  at  $T_a = 25 \text{ }^\circ\text{C}$
- (6) Wide operating temperature range:  $T_{opr} = -40 \text{ to } 125 \text{ }^\circ\text{C}$
- (7) 5.5 V tolerant is provided on all inputs, power down protection is provided on all outputs.
- (8) Low noise:  $V_{OLP} = 0.8 \text{ V (max)}$
- (9) Packages: TSSOP14B

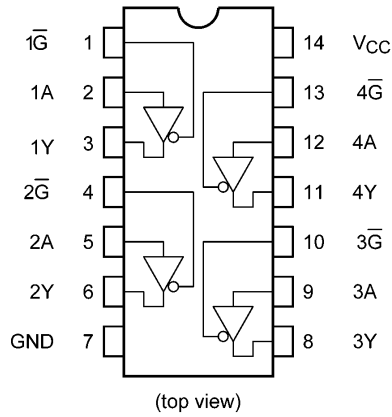
Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

Start of commercial production  
2020-03

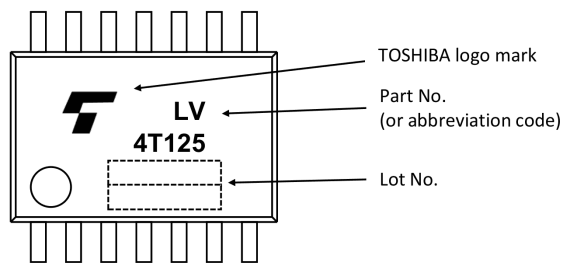
## 4. Packaging



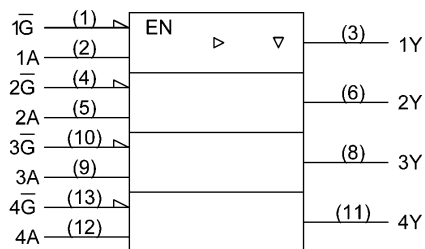
## 5. Pin Assignment



## 6. Marking



## 7. IEC Logic Symbol



### 8. Truth Table

Input $\bar{G}$	Input A	Output Y
H	X	Z
L	L	L
L	H	H

X: Don't care

Z: High impedance

### 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
Output voltage	$V_{OUT}$	(Note 1)	-0.5 to 7.0	V
		(Note 2)	-0.5 to $V_{CC} + 0.5$	
Input diode current	$I_{IK}$		-20	mA
Output diode current	$I_{OK}$	(Note 3)	$\pm 50$	mA
Output current	$I_{OUT}$		$\pm 35$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 50$	mA
Power dissipation	$P_D$	(Note 4)	180	mW
Storage temperature	$T_{stg}$		-65 to 150	$^{\circ}C$

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

Note 4: 180 mW in the range of  $T_a = -40$  to  $85^{\circ}C$ . From  $T_a = 85$  to  $125^{\circ}C$  a derating factor of  $-3.25$  mW/ $^{\circ}C$  shall be applied until 50 mW.

### 10. Operating Ranges (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	$V_{CC}$			1.65 to 5.5	V
Input voltage	$V_{IN}$			0 to 5.5	V
Output voltage	$V_{OUT}$	(Note 1)		0 to 5.5	V
		(Note 2)		0 to $V_{CC}$	
Operating temperature	$T_{opr}$			-40 to 125	$^{\circ}C$
Input rise and fall times	dt/dv		$V_{CC} = 1.8 \pm 0.15$ V, $2.5 \pm 0.2$ V	0 to 20	ns/V
			$V_{CC} = 3.3 \pm 0.3$ V	0 to 10	
			$V_{CC} = 5.0 \pm 0.5$ V	0 to 5	

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: Output in OFF state.

Note 2: High (H) or Low (L) state.

### 11. Electrical Characteristics

#### 11.1. DC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Typ.	Max	Unit		
High-level input voltage	$V_{IH}$	—	1.65 to 1.95	0.95	—	—	V		
			2.3 to 2.7	1.15	—	—			
			3.0 to 3.6	1.3	—	—			
			4.5 to 5.5	2.0	—	—			
Low-level input voltage	$V_{IL}$	—	1.65 to 1.95	—	—	0.4	V		
			2.3 to 2.7	—	—	0.55			
			3.0 to 3.6	—	—	0.65			
			4.5 to 5.5	—	—	0.7			
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	1.65 to 5.5	$V_{CC}-0.1$	—	—	V	
			$I_{OH} = -2\text{ mA}$	1.65	1.35	—	—		
			$I_{OH} = -3\text{ mA}$	2.3	2.05	—	—		
			$I_{OH} = -5\text{ mA}$	3.0	2.7	—	—		
			$I_{OH} = -8\text{ mA}$	4.5	2.6	—	—		
			$I_{OH} = -8\text{ mA}$		3.8	—	—		
			$I_{OH} = -16\text{ mA}$	5.0	3.7	—	—		
			$I_{OH} = -16\text{ mA}$		4.4	—	—		
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	1.65 to 5.5	—	—	0.1	V	
			$I_{OL} = 2\text{ mA}$	1.65	—	—	0.2		
				1.8	—	—	0.2		
			$I_{OL} = 3\text{ mA}$	2.3	—	—	0.2		
				2.5	—	—	0.25		
			$I_{OL} = 5\text{ mA}$	3.0	—	—	0.35		
			$I_{OL} = 8\text{ mA}$	4.5	—	—	0.4		
			$I_{OL} = 8\text{ mA}$		3.3	—	—		0.45
			$I_{OL} = 8\text{ mA}$		4.5	—	—		0.5
			$I_{OL} = 16\text{ mA}$	5.0	—	—	0.55		
$I_{OL} = 16\text{ mA}$	5.0	—	—		0.55				
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to $5.5\text{ V}$	0 to 5.5	—	—	$\pm 0.1$	$\mu\text{A}$		
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $5.5\text{ V}$	1.65 to 5.5	—	—	$\pm 0.5$	$\mu\text{A}$		
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $5.5\text{ V}$	0	—	—	1.0	$\mu\text{A}$		
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	1.65 to 5.5	—	—	4.0	$\mu\text{A}$		
	$I_{CCT}$	One input: $V_{IN} = 3.4\text{ V}$ The other inputs: $V_{CC}$ or GND	5.5	—	—	1.35	$\text{mA}$		
		One input: $V_{IN} = 1.1\text{ V}$ The other inputs: $V_{CC}$ or GND	1.8	—	—	1.35	$\text{mA}$		

### 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	$V_{IH}$	—	1.65 to 1.95	1.0	—	V		
			2.3 to 2.7	1.2	—			
			3.0 to 3.6	1.35	—			
			4.5 to 5.5	2.0	—			
Low-level input voltage	$V_{IL}$	—	1.65 to 1.95	—	0.35	V		
			2.3 to 2.7	—	0.5			
			3.0 to 3.6	—	0.6			
			4.5 to 5.5	—	0.7			
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50 \mu A$	1.65 to 5.5	$V_{CC}-0.1$	—	V	
			$I_{OH} = -2$ mA	1.65	1.3	—		
			$I_{OH} = -3$ mA	2.3	2.0	—		
			$I_{OH} = -5$ mA	3.0	2.6	—		
			$I_{OH} = -8$ mA	4.5	2.5	—		
			$I_{OH} = -8$ mA		3.7	—		
			$I_{OH} = -16$ mA		3.6	—		
			$I_{OH} = -16$ mA	5.0	4.3	—		
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50 \mu A$	1.65 to 5.5	—	0.1	V	
			$I_{OL} = 2$ mA	1.65	—	0.25		
				1.8	—	0.3		
			$I_{OL} = 3$ mA	2.3	—	0.3		
				2.5	—	0.3		
			$I_{OL} = 5$ mA	3.0	—	0.4		
			$I_{OL} = 8$ mA	4.5	—	0.45		
			$I_{OL} = 8$ mA		3.3	—		0.5
			$I_{OL} = 8$ mA		—	0.55		
			$I_{OL} = 16$ mA	5.0	—	0.55		
$I_{OL} = 16$ mA	—	0.55						
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to $5.5$ V	0 to 5.5	—	$\pm 2.0$	$\mu A$		
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $5.5$ V	1.65 to 5.5	—	$\pm 5.0$	$\mu A$		
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $5.5$ V	0	—	10.0	$\mu A$		
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	1.65 to 5.5	—	10.0	$\mu A$		
	$I_{CCT}$	One input: $V_{IN} = 3.4$ V The other inputs: $V_{CC}$ or GND	5.5	—	1.50	mA		
		One input: $V_{IN} = 1.1$ V The other inputs: $V_{CC}$ or GND	1.8	—	1.50	mA		

### 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	$V_{IH}$	—	1.65 to 1.95	1.0	—	V	
			2.3 to 2.7	1.2	—		
			3.0 to 3.6	1.35	—		
			4.5 to 5.5	2.0	—		
Low-level input voltage	$V_{IL}$	—	1.65 to 1.95	—	0.35	V	
			2.3 to 2.7	—	0.5		
			3.0 to 3.6	—	0.6		
			4.5 to 5.5	—	0.7		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50 \mu A$	1.65 to 5.5	$V_{CC}-0.1$	—	V
			$I_{OH} = -2$ mA	1.65	1.3	—	
			$I_{OH} = -3$ mA	2.3	2.0	—	
			$I_{OH} = -5$ mA	3.0	2.6	—	
			$I_{OH} = -8$ mA		2.5	—	
			$I_{OH} = -8$ mA	4.5	3.7	—	
			$I_{OH} = -16$ mA		3.6	—	
			$I_{OH} = -16$ mA	5.0	4.3	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50 \mu A$	1.65 to 5.5	—	0.1	V
			$I_{OL} = 2$ mA	1.65	—	0.25	
				1.8	—	0.3	
			$I_{OL} = 3$ mA	2.3	—	0.3	
				2.5	—	0.3	
			$I_{OL} = 5$ mA	3.0	—	0.4	
			$I_{OL} = 8$ mA		—	0.45	
			$I_{OL} = 8$ mA	3.3	—	0.5	
			$I_{OL} = 8$ mA	4.5	—	0.55	
			$I_{OL} = 16$ mA		—	0.55	
$I_{OL} = 16$ mA	5.0	—	0.55				
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to $5.5$ V	0 to 5.5	—	$\pm 2.0$	$\mu A$	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $5.5$ V	1.65 to 5.5	—	$\pm 10.0$	$\mu A$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $5.5$ V	0	—	20.0	$\mu A$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	1.65 to 5.5	—	40.0	$\mu A$	
	$I_{CCT}$	One input: $V_{IN} = 3.4$ V The other inputs: $V_{CC}$ or GND	5.5	—	1.50	mA	
		One input: $V_{IN} = 1.1$ V The other inputs: $V_{CC}$ or GND	1.8	—	1.50	mA	

### 11.4. AC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Typ.	Max	Unit				
Propagation delay time	$t_{PLH}, t_{PHL}$		—	$1.8 \pm 0.15$	15	—	8.9	27.5	ns				
					30	—	10.1	30.5					
				$2.5 \pm 0.2$	15	—	5.2	10.5	ns				
					30	—	5.9	11.1					
				$3.3 \pm 0.3$	15	—	3.8	6.4	ns				
					30	—	4.4	7.2					
				$5.0 \pm 0.5$	15	—	3.1	4.1	ns				
					30	—	3.4	4.7					
				3-state output enable time	$t_{PZL}, t_{PZH}$		$R_L = 1\text{ k}\Omega$	$1.8 \pm 0.15$	15	—	11.1	34.5	ns
									30	—	12.5	40.5	
$2.5 \pm 0.2$	15	—	6.3					13.1	ns				
	30	—	7.1					15.2					
$3.3 \pm 0.3$	15	—	4.6					8.1	ns				
	30	—	5.2					9.3					
$5.0 \pm 0.5$	15	—	3.1					4.9	ns				
	30	—	3.7					5.8					
3-state output disable time	$t_{PLZ}, t_{PHZ}$		$R_L = 1\text{ k}\Omega$					$1.8 \pm 0.15$	15	—	9.4	26.7	ns
									30	—	13.4	29.6	
				$2.5 \pm 0.2$	15	—	6.0	9.9	ns				
					30	—	8.5	13.0					
				$3.3 \pm 0.3$	15	—	4.7	6.9	ns				
					30	—	6.3	9.0					
				$5.0 \pm 0.5$	15	—	3.6	4.7	ns				
					30	—	4.6	6.7					
				Output skew	$t_{oS LH}, t_{oS HL}$	(Note 1)	—	1.65 to 5.5	15	—	—	1.0	ns
				Input capacitance	$C_{IN}$		—			—	4	10	pF
Output capacitance	$C_{OUT}$		—			—	6	—	pF				
Power dissipation capacitance	$C_{PD}$	(Note 2)	$V_{CC} = 5.5\text{ V}$			—	14	—	pF				

Note 1: Parameter guaranteed by design. ( $t_{oS LH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{oS HL} = |t_{PHLM} - t_{PHLN}|$ )

Note 2:  $C_{PD}$  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.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/4 \text{ (per gate)}$$

### 11.5. AC Characteristics

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

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$		—	$1.8 \pm 0.15$	15	1.0	29.5	ns
					30	1.0	33.2	
				$2.5 \pm 0.2$	15	1.0	11.2	ns
					30	1.0	12.4	
				$3.3 \pm 0.3$	15	1.0	7.2	ns
					30	1.0	8.1	
				$5.0 \pm 0.5$	15	1.0	4.8	ns
					30	1.0	5.6	
3-state output enable time	$t_{PZL}, t_{PHZ}$		$R_L = 1$ k $\Omega$	$1.8 \pm 0.15$	15	1.0	37.1	ns
					30	1.0	44.1	
				$2.5 \pm 0.2$	15	1.0	14.0	ns
					30	1.0	16.2	
				$3.3 \pm 0.3$	15	1.0	9.1	ns
					30	1.0	10.5	
				$5.0 \pm 0.5$	15	1.0	5.9	ns
					30	1.0	6.7	
3-state output disable time	$t_{PLZ}, t_{PHZ}$		$R_L = 1$ k $\Omega$	$1.8 \pm 0.15$	15	1.0	27.8	ns
					30	1.0	29.9	
				$2.5 \pm 0.2$	15	1.0	11.0	ns
					30	1.0	13.7	
				$3.3 \pm 0.3$	15	1.0	7.8	ns
					30	1.0	9.5	
				$5.0 \pm 0.5$	15	1.0	5.5	ns
					30	1.0	7.4	
Output skew	$t_{oS LH}, t_{oS HL}$	(Note 1)	—	1.65 to 5.5	15	—	1.0	ns

Note 1: Parameter guaranteed by design. ( $t_{oS LH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{oS HL} = |t_{PHLM} - t_{PHLN}|$ )

### 11.6. AC Characteristics

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

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$		—	$1.8 \pm 0.15$	15	1.0	29.5	ns
					30	1.0	33.2	
				$2.5 \pm 0.2$	15	1.0	11.7	ns
					30	1.0	13.1	
				$3.3 \pm 0.3$	15	1.0	7.8	ns
					30	1.0	8.8	
$5.0 \pm 0.5$	15	1.0	5.4	ns				
	30	1.0	6.2					
3-state output enable time	$t_{PZL}, t_{PZH}$		$R_L = 1$ k $\Omega$	$1.8 \pm 0.15$	15	1.0	37.1	ns
					30	1.0	44.1	
				$2.5 \pm 0.2$	15	1.0	14.5	ns
					30	1.0	16.9	
				$3.3 \pm 0.3$	15	1.0	9.7	ns
					30	1.0	11.2	
$5.0 \pm 0.5$	15	1.0	6.4	ns				
	30	1.0	7.3					
3-state output disable time	$t_{PLZ}, t_{PHZ}$		$R_L = 1$ k $\Omega$	$1.8 \pm 0.15$	15	1.0	27.8	ns
					30	1.0	29.9	
				$2.5 \pm 0.2$	15	1.0	11.5	ns
					30	1.0	14.1	
				$3.3 \pm 0.3$	15	1.0	8.3	ns
					30	1.0	9.7	
$5.0 \pm 0.5$	15	1.0	5.8	ns				
	30	1.0	7.8					
Output skew	$t_{oS LH}, t_{oS HL}$	(Note 1)	—	1.65 to 5.5	15	—	1.0	ns

Note 1: Parameter guaranteed by design. ( $t_{oS LH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{oS HL} = |t_{PHLM} - t_{PHLN}|$ )

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Limit	Unit
Quiet output maximum dynamic $V_{OL}$	$V_{OLP}$	$C_L = 50$ pF	3.3	0.5	0.8	V
Quiet output minimum dynamic $V_{OL}$	$V_{OLV}$	$C_L = 50$ pF	3.3	-0.5	-0.8	V

## 11.8. AC Test Circuit

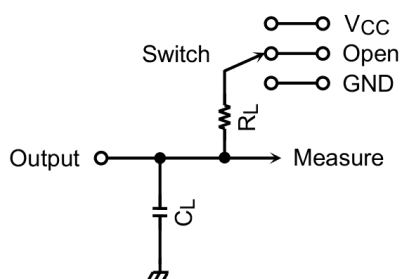


Fig. 11.8.1 AC Test Circuit

Table 11.8.1 Parameter for AC Test Circuit

Characteristics	Switch
$t_{PLH}$ , $t_{PHL}$	Open
$t_{PLZ}$ , $t_{PZL}$	$V_{CC}$
$t_{PHZ}$ , $t_{PZH}$	GND

## 11.9. AC Waveform

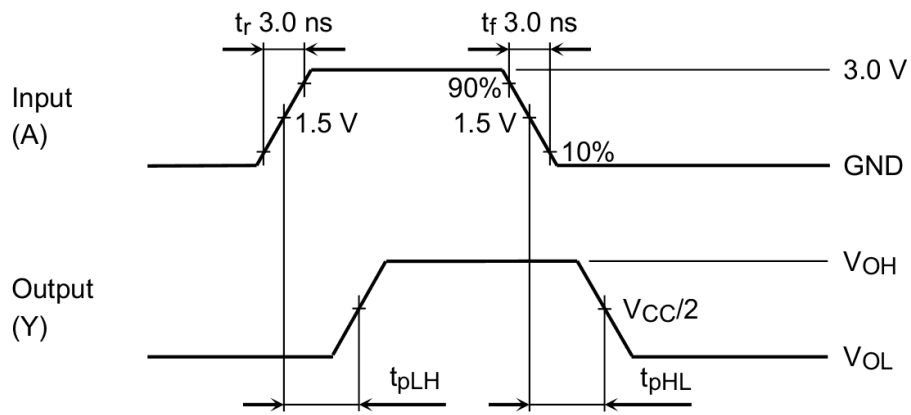


Fig. 11.9.1  $t_{pLH}$ ,  $t_{pHL}$

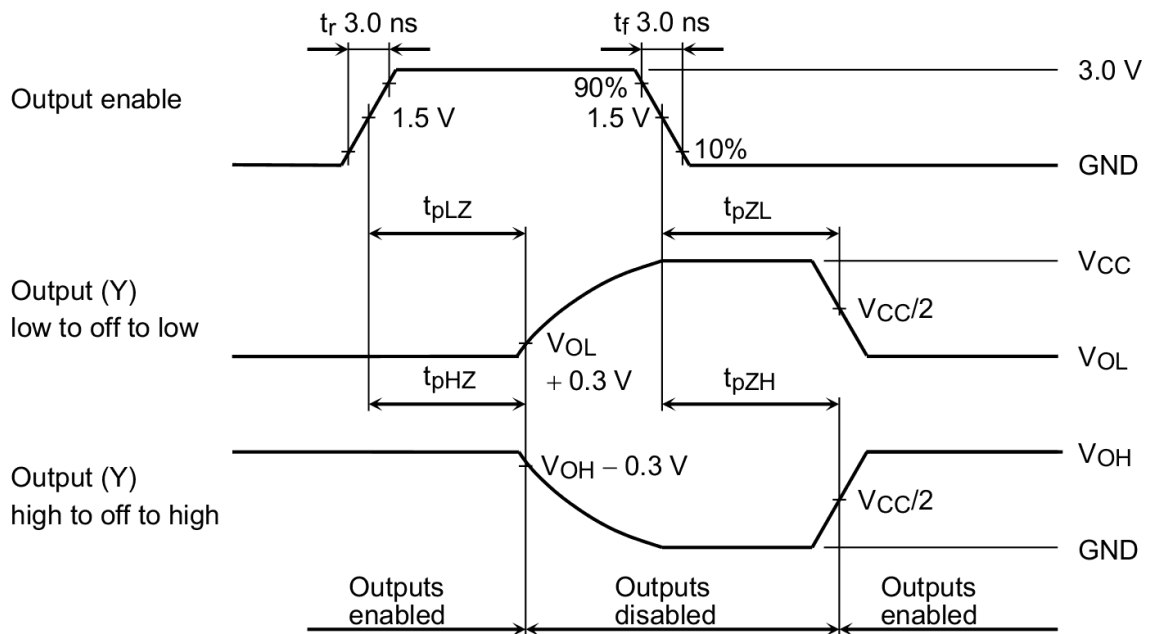
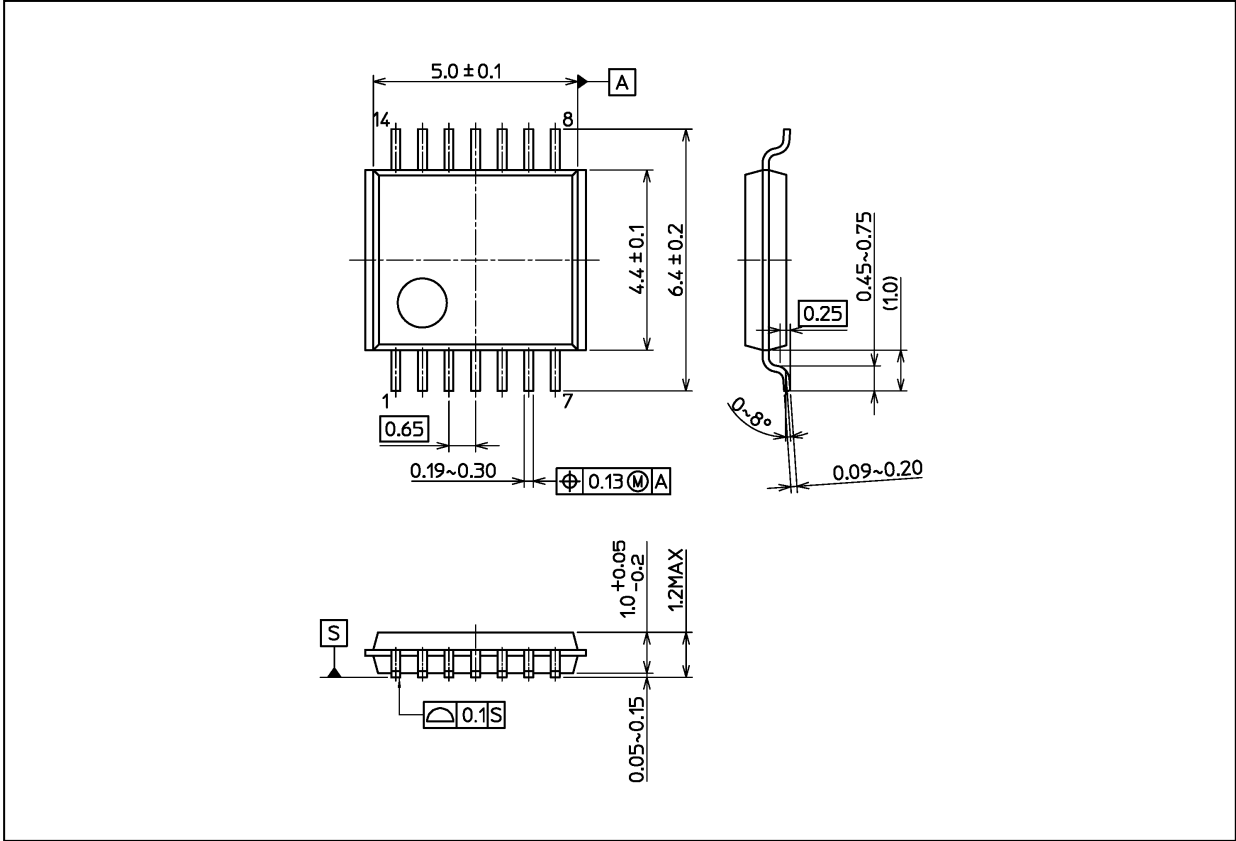


Fig. 11.9.2  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

Package Dimensions

Unit: mm



Weight: 0.054 g (typ.)

Package Name(s)
Nickname: TSSOP14B

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