

# TC7SPN334L6X

## 1. Functional Description

- Low-Voltage, Low-Power 1-Bit Dual-Supply Bus Buffer

## 2. General

The TC7SPN334L6X is a CMOS high-speed single-bit bus buffer designed to interface between two subsystems operating at different voltage levels between 1.1 V and 3.6 V.

Its input and output provide overvoltage tolerance and accept up to 3.6 V in power-down mode (power-down protection).

The TC7SPN334L6X dual-supply bus buffer operates with a  $V_{CCA}$  of 1.2 V, 1.5 V, 1.8 V, or 2.5 V bus and a  $V_{CCB}$  of 1.8 V, 2.5 V or 3.3 V. It is suitable for single-bit interfacing.

The A input interfaces with the 1.2 V, 1.5 V, 1.8 V or 2.5 V bus, and the B output interfaces with the 1.8 V, 2.5 V, 3.3 V bus.

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

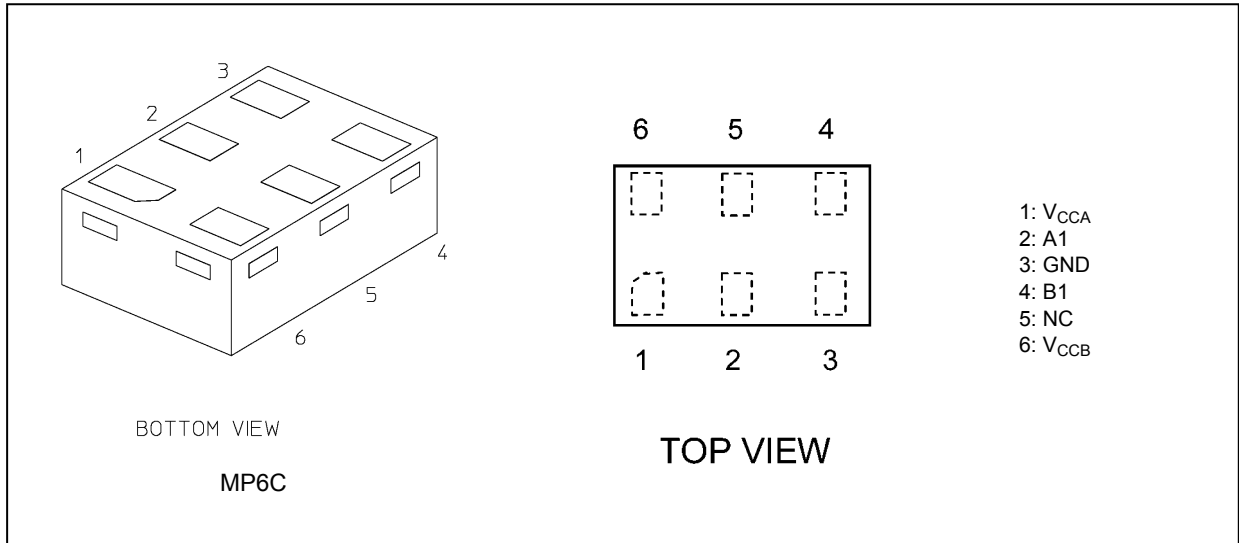
## 3. Features

- (1) Level converter for interfacing 1.2 V to 1.8 V, 1.2 V to 2.5 V, 1.2 V to 3.3 V, 1.5 V to 2.5 V, 1.5 V to 3.3 V, 1.8 V to 2.5 V, 1.8 V to 3.3 V or 2.5 V to 3.3 V system.
- (2) High-speed operation:  $t_{pd} = 3.2$  ns (max) ( $V_{CCA} = 2.5 \pm 0.2$  V,  $V_{CCB} = 3.3 \pm 0.3$  V)  
 $t_{pd} = 3.8$  ns (max) ( $V_{CCA} = 1.8 \pm 0.15$  V,  $V_{CCB} = 3.3 \pm 0.3$  V)  
 $t_{pd} = 4.5$  ns (max) ( $V_{CCA} = 1.5 \pm 0.1$  V,  $V_{CCB} = 3.3 \pm 0.3$  V)  
 $t_{pd} = 6.2$  ns (max) ( $V_{CCA} = 1.2 \pm 0.1$  V,  $V_{CCB} = 3.3 \pm 0.3$  V)  
 $t_{pd} = 4.9$  ns (max) ( $V_{CCA} = 1.8 \pm 0.15$  V,  $V_{CCB} = 2.5 \pm 0.2$  V)  
 $t_{pd} = 5.5$  ns (max) ( $V_{CCA} = 1.5 \pm 0.1$  V,  $V_{CCB} = 2.5 \pm 0.2$  V)  
 $t_{pd} = 6.9$  ns (max) ( $V_{CCA} = 1.2 \pm 0.1$  V,  $V_{CCB} = 2.5 \pm 0.2$  V)  
 $t_{pd} = 9.7$  ns (max) ( $V_{CCA} = 1.2 \pm 0.1$  V,  $V_{CCB} = 1.8 \pm 0.15$  V)
- (3) Output current:  $I_{OHB}/I_{OLB} = \pm 3$  mA (min) ( $V_{CCB} = 3.0$  V)  
 $I_{OHB}/I_{OLB} = \pm 2$  mA (min) ( $V_{CCB} = 2.3$  V)  
 $I_{OHB}/I_{OLB} = \pm 0.5$  mA (min) ( $V_{CCB} = 1.65$  V)
- (4) Latch-up resistance:  $\sim 300$  mA
- (5) ESD resistance: Machine model  $\geq \pm 200$  V, Human body model  $\geq \pm 2000$  V
- (6) Ultra-small package: MP6C
- (7) 3.6 V tolerant function and power-down protection provided on all inputs and output.

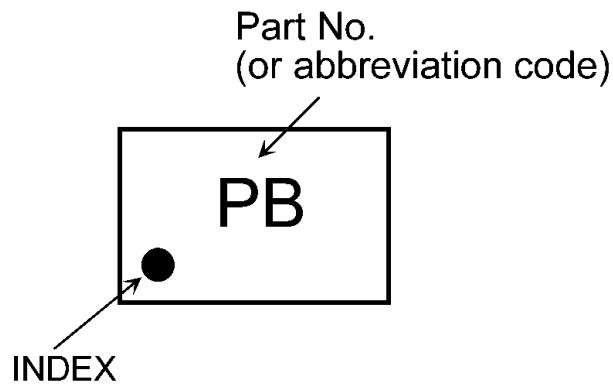
Start of commercial production

2013-10

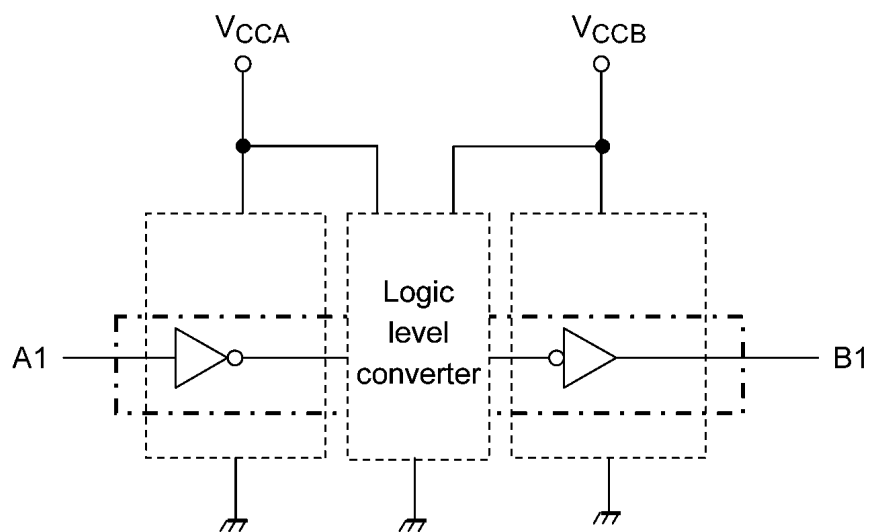
## 4. Packaging and Pin Assignment



## 5. Marking



## 6. Block Diagram



### 7. Principle of Operation

#### 7.1. Truth Table

Input A1	Output B1
L	L
H	H

### 8. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	$V_{CCA}$	(Note 1)	—	-0.5 to 4.6	V
	$V_{CCB}$			-0.5 to 4.6	
Input voltage (A1)	$V_{IN}$		—	-0.5 to 4.6	V
Output voltage (B1)	$V_{OUT}$		$V_{CCB} = 0\text{ V}$	-0.5 to 4.6	V
		(Note 2)	—	-0.5 to $V_{CCB} + 0.5$	
Input diode current	$I_{IK}$		—	-25	mA
Output diode current	$I_{OK}$	(Note 3)	—	$\pm 50$	
Output current	$I_{OUT}$		—	$\pm 6$	mA
$V_{CC}$ /ground current per supply pin	$I_{CCA}$		—	$\pm 25$	mA
	$I_{CCB}$			$\pm 50$	
Power dissipation	$P_D$	(Note 4)	—	250	mW
Storage temperature	$T_{stg}$		—	-65 to 150	$^{\circ}\text{C}$

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: Don't supply a voltage to  $V_{CCB}$  pin when  $V_{CCA}$  is in the OFF state.

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

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

Note 4: Mounted on an FR4 board

### 9. Operating Ranges (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	$V_{CCA}$		—	1.1 to 2.7	V
	$V_{CCB}$			$V_{CCA}$ to 3.6	
Input voltage (A1)	$V_{IN}$		—	0 to 3.6	V
Output voltage (B1)	$V_{OUT}$	(Note 1)	—	0 to 3.6	V
		(Note 2)		0 to $V_{CCB}$	
Output current (B1)	$I_{OUT}$		$V_{CCB} = 3.0$ to $3.6$ V	$\pm 3$	mA
			$V_{CCB} = 2.3$ to $2.7$ V	$\pm 2$	
			$V_{CCB} = 1.65$ to $1.95$ V	$\pm 0.5$	
Input rise time	dt/dv		$V_{IN} = 0.8$ to $2.0$ V, $V_{CCA} = 2.5$ V, $V_{CCB} = 3.0$ V	0 to 10	ns/V
Input fall time				0 to 10	
Operating temperature	$T_{opr}$		—	-40 to 85	°C

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs and bus inputs must be tied to either  $V_{CC}$  or GND. Please connect both bus inputs and the bus outputs with  $V_{CC}$  or GND when the I/O of the bus terminal changes by the function. In this case, please note that the output is not short-circuited.

Note 1: Output in OFF state.

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

### 10. Electrical Characteristics

#### 10.1. DC Characteristics (Unless otherwise specified, $T_a = -40$ to $85$ °C, $1.1$ V $\leq V_{CCA} \leq 2.7$ V, $1.65$ V $\leq V_{CCB} \leq 3.6$ V)

Characteristics	Symbol	Test Condition	$V_{CCA}$ (V)	$V_{CCB}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IHA}$	A1	$1.1 \leq V_{CCA} < 1.4$	1.65 to 3.6	$0.65 \times V_{CCA}$	—	V	
			$1.4 \leq V_{CCA} < 1.65$	1.65 to 3.6	$0.65 \times V_{CCA}$	—		
			$1.65 \leq V_{CCA} < 2.3$	2.3 to 3.6	$0.65 \times V_{CCA}$	—		
			$2.3 \leq V_{CCA} \leq 2.7$	2.7 to 3.6	1.6	—		
Low-level input voltage	$V_{ILA}$	A1	$1.1 \leq V_{CCA} < 1.4$	1.65 to 3.6	—	$0.30 \times V_{CCA}$	V	
			$1.4 \leq V_{CCA} < 1.65$	1.65 to 3.6	—	$0.30 \times V_{CCA}$		
			$1.65 \leq V_{CCA} < 2.3$	2.3 to 3.6	—	$0.35 \times V_{CCA}$		
			$2.3 \leq V_{CCA} \leq 2.7$	2.7 to 3.6	—	0.7		
High-level output voltage	$V_{OHB}$	A1 = $V_{IH}$	$I_{OHB} = -100 \mu\text{A}$	1.1 to 2.7	1.65 to 3.6	$V_{CCB} - 0.2$	V	
			$I_{OHB} = -0.5 \text{ mA}$	1.1 to 1.65	1.65	1.25		—
			$I_{OHB} = -2 \text{ mA}$	1.1 to 2.3	2.3	1.7		—
			$I_{OHB} = -3 \text{ mA}$	1.1 to 2.7	3.0	2.2		—
Low-level output voltage	$V_{OLB}$	A1 = $V_{IL}$	$I_{OLB} = 100 \mu\text{A}$	1.1 to 2.7	1.65 to 3.6	—	V	
			$I_{OLB} = 0.5 \text{ mA}$	1.1 to 1.65	1.65	—		0.2
			$I_{OLB} = 2 \text{ mA}$	1.1 to 2.3	2.3	—		0.3
			$I_{OLB} = 3 \text{ mA}$	1.1 to 2.7	3.0	—		0.6
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to 3.6 V	1.1 to 2.7	1.65 to 3.6	—	$\pm 1.0$	$\mu\text{A}$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN}, B1 = 0$ to 3.6 V	0	0	—	2.0	$\mu\text{A}$	
Quiescent supply current	$I_{CCA}$	$V_{IN} = V_{CCA}$ or GND	1.1 to 2.7	1.65 to 3.6	—	2.0	$\mu\text{A}$	
	$I_{CCB}$	$V_{IN} = V_{CCA}$ or GND	1.1 to 2.7	1.65 to 3.6	—	2.0		
	$I_{CCA}$	$V_{CCA} < V_{IN} \leq 3.6$ V	1.1 to 2.7	1.65 to 3.6	—	$\pm 2.0$		
	$I_{CCB}$	$V_{IN} = V_{CCA}, V_{CCB} \leq B1 \leq 3.6$ V	1.1 to 2.7	1.65 to 3.6	—	$\pm 2.0$		

#### 10.2. AC Characteristics

(Unless otherwise specified,  $T_a = -40$  to  $85$  °C, Input:  $t_r = t_f = 2.0$  ns)

Characteristics	Symbol	Test Condition	$V_{CCA}$ (V)	$V_{CCB}$ (V)	Min	Max	Unit
Propagation delay time (A1 $\rightarrow$ B1)	$t_{PLH}/t_{PHL}$	See Fig. 10.2.1, 10.2.2, Table 10.2.1, 10.2.2.	$2.5 \pm 0.2$	$3.3 \pm 0.3$	0.5	3.2	ns
			$1.8 \pm 0.15$	$3.3 \pm 0.3$	0.8	3.8	
			$1.5 \pm 0.1$	$3.3 \pm 0.3$	1.0	4.5	
			$1.2 \pm 0.1$	$3.3 \pm 0.3$	1.0	6.2	
			$1.8 \pm 0.15$	$2.5 \pm 0.2$	0.8	4.9	
			$1.5 \pm 0.1$	$2.5 \pm 0.2$	1.0	5.5	
			$1.2 \pm 0.1$	$2.5 \pm 0.2$	1.0	6.9	
			$1.2 \pm 0.1$	$1.8 \pm 0.15$	1.0	9.7	

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

Characteristics	Symbol	Note	Test Condition	$V_{CCA}$ (V)	$V_{CCB}$ (V)	Typ.	Unit
Input capacitance	$C_{IN}$		A1	2.5	3.3	7	pF
Output capacitance	$C_{OUT}$		B1	2.5	3.3	8	
Power dissipation capacitance	$C_{PDA}$	(Note 1)		2.5	3.3	3	
	$C_{PDB}$			2.5	3.3	13	

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.

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

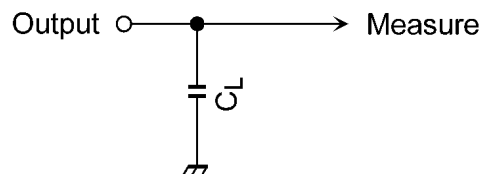


Fig. 10.2.1 AC Test Circuit

Table 10.2.1 Parameter for AC Test Circuit

Parameter	Capacitance	Test Condition
$C_L$	30 pF	$V_{CCB} = 3.3 \pm 0.3\text{ V}$
		$V_{CCB} = 2.5 \pm 0.2\text{ V}$
		$V_{CCB} = 1.8 \pm 0.15\text{ V}$

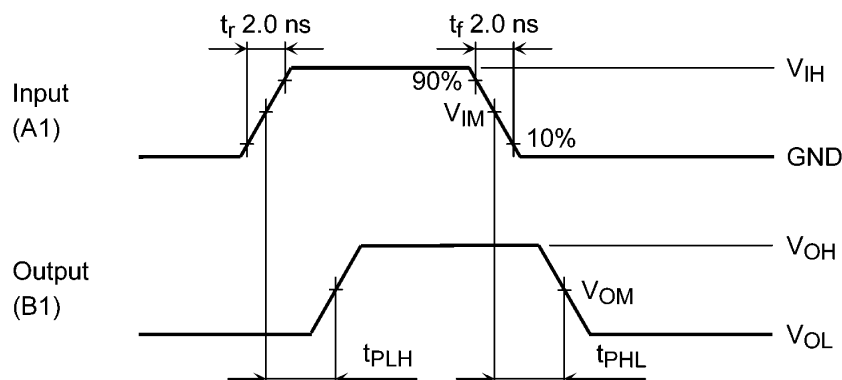


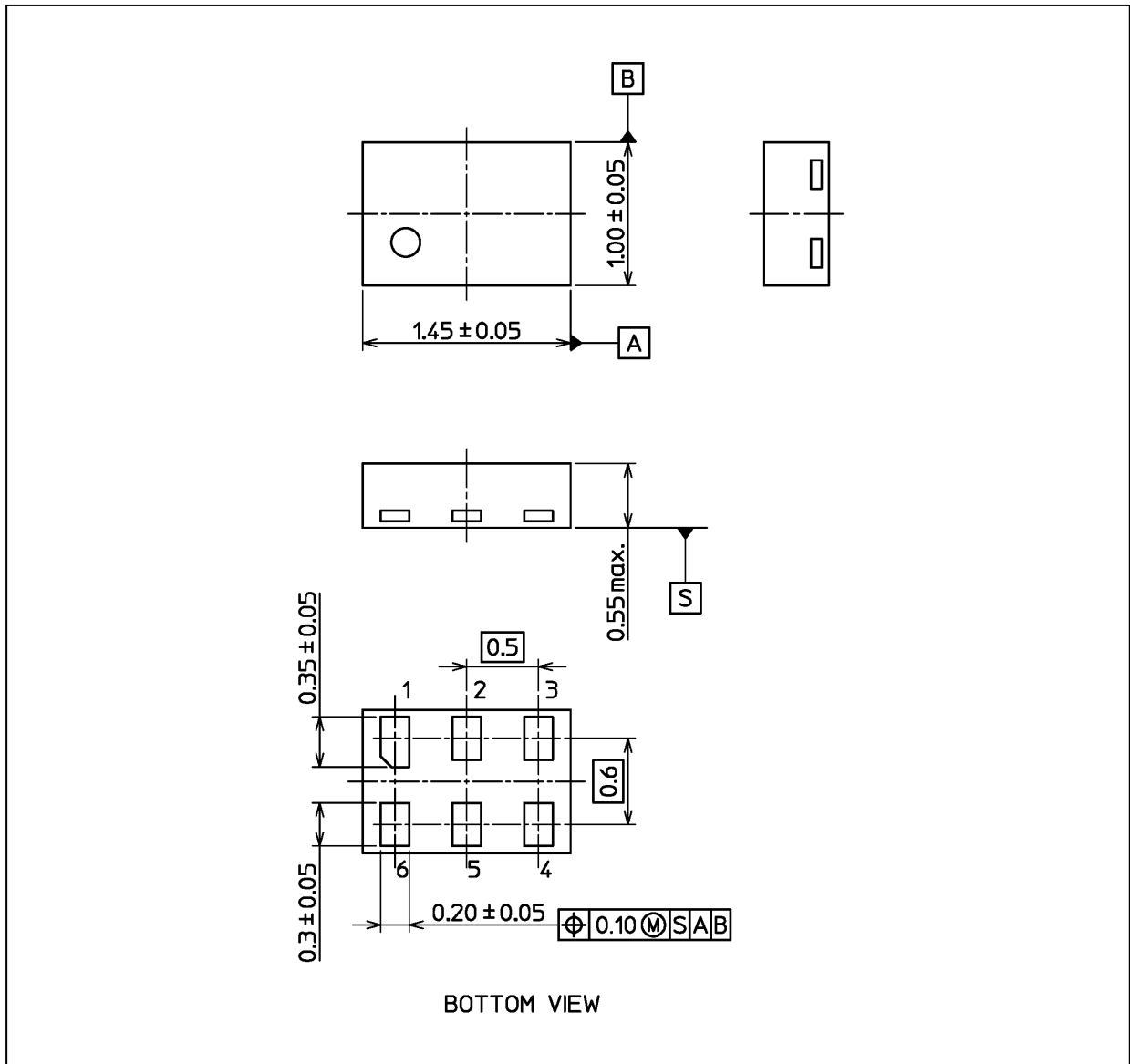
Fig. 10.2.2 AC Waveform

Table 10.2.2 AC Waveform Symbols

$V_{CCA}, V_{CCB}$		Symbol	Value
$3.3 \pm 0.3\text{ V}$	Input	$V_{IH}$	—
		$V_{IM}$	—
	Output	$V_{OM}$	$V_{OH}/2$
$2.5 \pm 0.2\text{ V}$ $1.8 \pm 0.15\text{ V}$	Input	$V_{IH}$	$V_{CCA}$
		$V_{IM}$	$V_{CCA}/2$
	Output	$V_{OM}$	$V_{OH}/2$
$1.5 \pm 0.1\text{ V}$ $1.2 \pm 0.1\text{ V}$	Input	$V_{IH}$	$V_{CCA}$
		$V_{IM}$	$V_{CCA}/2$
	Output	$V_{OM}$	—

## Package Dimensions

Unit: mm



Weight: 0.0024 g (typ.)

Package Name(s)
TOSHIBA: P-UFLGA6-0102-0.50-003
Nickname: MP6C

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