

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.

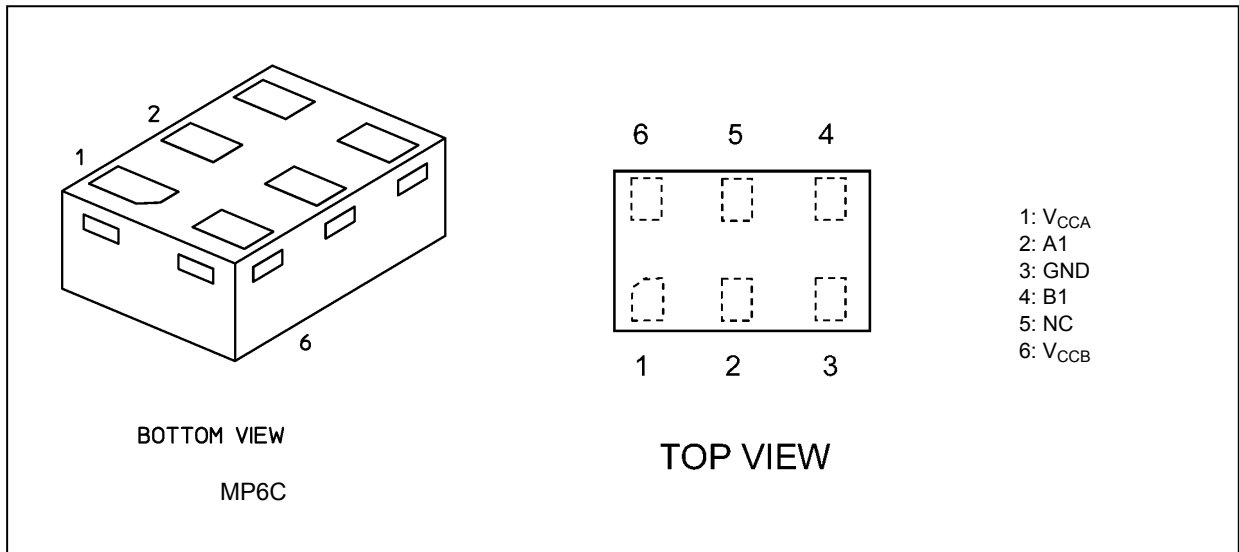
The A input interfaces with the 1.2-V, 1.5-V, 1.8-V or 2.5-V bus, and the B output interfaces with the 1.8-V, 2.5-V, 3.3-V bus.

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

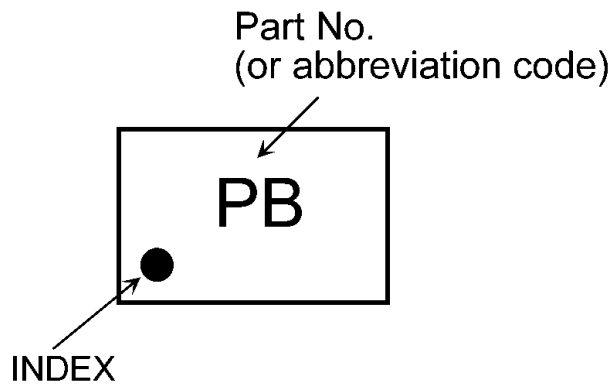
3. Features

- (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 performance: -300 mA
- (5) ESD performance: 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 outputs.

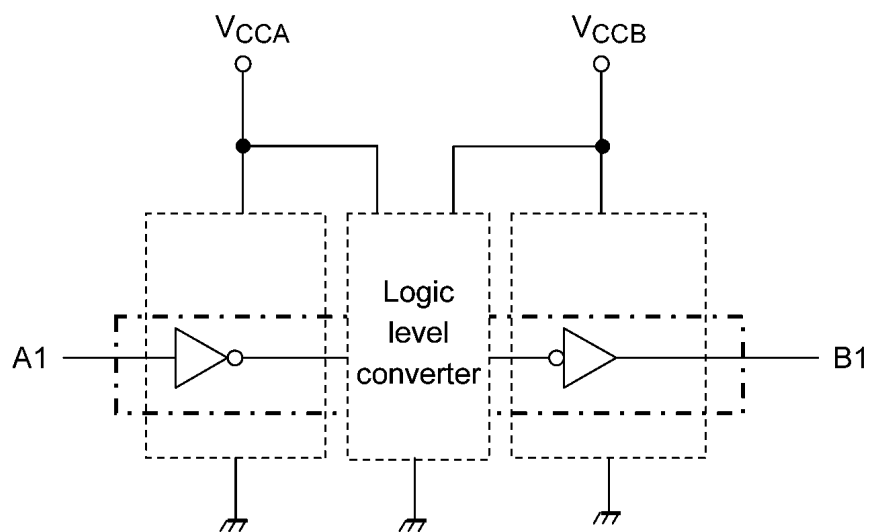
4. Packaging and Pin Assignment



5. Marking



6. Block Diagram



7. Principle of Operation

7.1. Truth Table

Input A1	Input 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_{OUTB}		$V_{CCB} = 0\text{ V}$	-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)	—	± 50	
Output current	I_{OUTB}		—	± 6	mA
V_{CC} /ground current per supply pin	I_{CCA}		—	± 25	mA
	I_{CCB}			± 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_{OUTB}	(Note 1)		0 to 3.6	V
		(Note 2)		0 to V_{CCB}	
Output current (B1)	I_{OUTB}		$V_{CCB} = 3.0\text{ to }3.6\text{ V}$	± 3	mA
			$V_{CCB} = 2.3\text{ to }2.7\text{ V}$	± 2	
			$V_{CCB} = 1.65\text{ to }1.95\text{ V}$	± 0.5	
Input rise time	dt/dv		$V_{IN} = 0.8\text{ to }2.0\text{ V}$, $V_{CCA} = 2.5\text{ V}$, $V_{CCB} = 3.0\text{ V}$	0 to 10	ns/V
Input fall time				0 to 10	
Operating temperature	T_{opr}		—	-40 to 85	$^{\circ}\text{C}$

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, $1.1\text{ V} \leq V_{CCA} \leq 2.7\text{ V}$, $1.65\text{ V} \leq V_{CCB} \leq 3.6\text{ V}$)

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	—	± 1.0	μA	
Power-OFF leakage current	I_{OFF}	$V_{IN}, B1 = 0$ to 3.6 V	0	0	—	2.0	μA	
Quiescent supply current	I_{CCA}	$V_{IN} = V_{CCA}$ or GND	1.1 to 2.7	1.65 to 3.6	—	2.0	μA	
	I_{CCB}	$V_{IN} = V_{CCA}$ or GND	1.1 to 2.7	1.65 to 3.6	—	2.0		
	I_{CCA}	$V_{CCA} < V_{IN} \leq 3.6\text{ V}$	1.1 to 2.7	1.65 to 3.6	—	± 2.0		
	I_{CCB}	$V_{IN} = V_{CCA}, V_{CCB} \leq B1 \leq 3.6\text{ V}$	1.1 to 2.7	1.65 to 3.6	—	± 2.0		

10.2. AC Characteristics

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

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

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

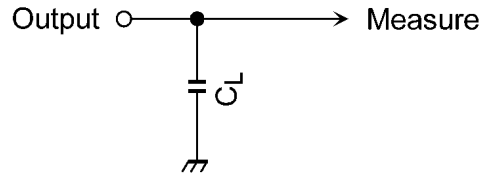


Fig. 10.2.1 AC Test Circuit

Table 10.2.1 Parameter for AC Test Circuit

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

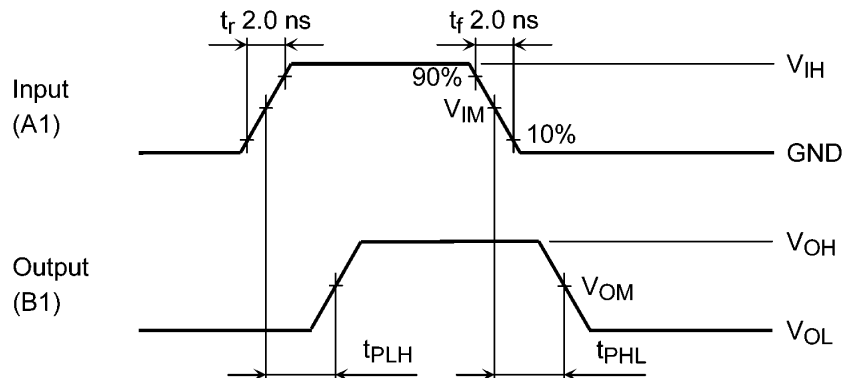


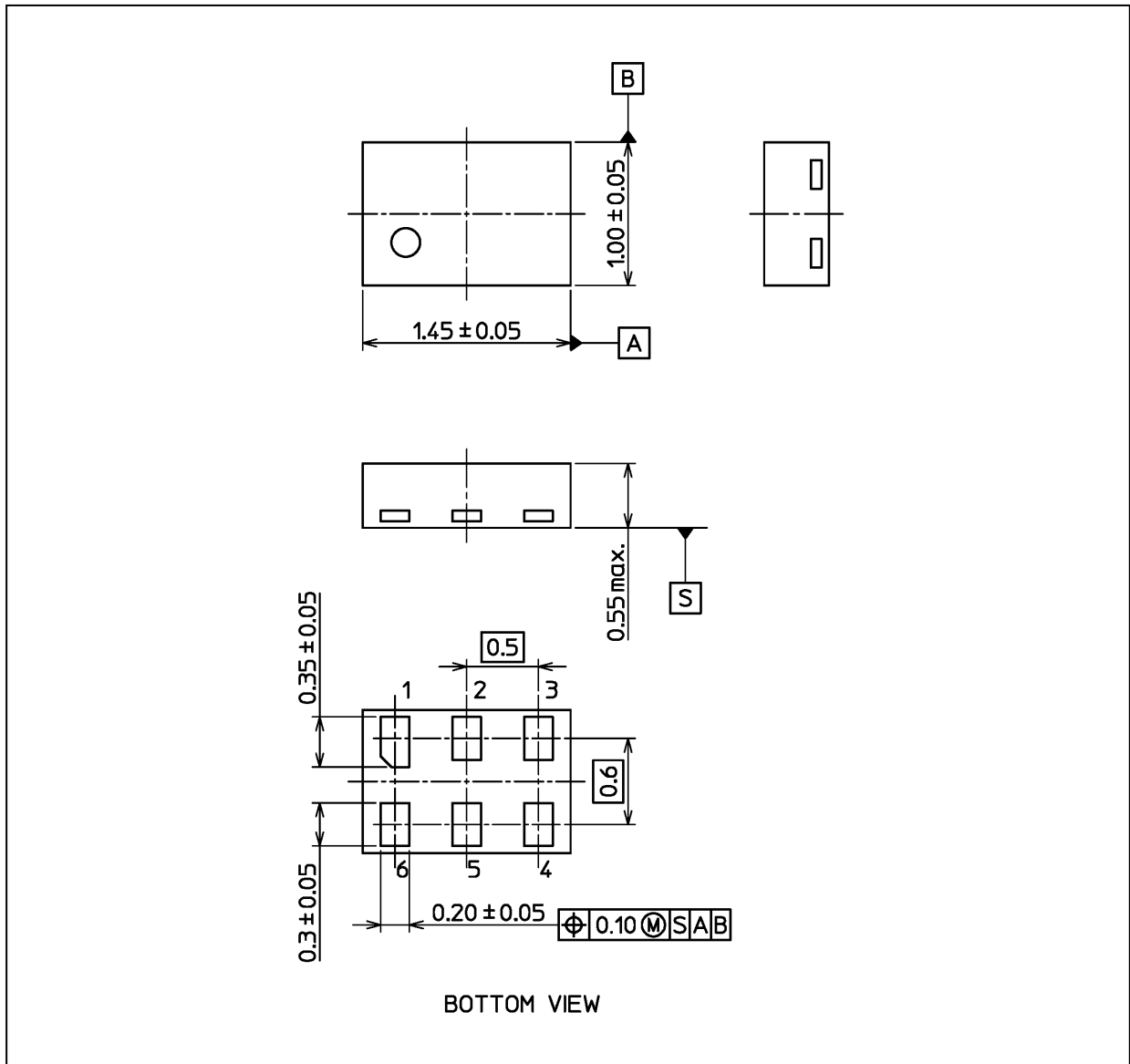
Fig. 10.2.2 AC Waveform

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_{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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