CMOS Digital Integrated Circuits Silicon Monolithic

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 ± 0.2 V, V_{CCB} = 3.3 ± 0.3 V)
t_{pd} = 3.8 ns (max) (V_{CCA} = 1.8 ± 0.15 V, V_{CCB} = 3.3 ± 0.3 V)
t_{pd} = 4.5 ns (max) (V_{CCA} = 1.5 ± 0.1 V, V_{CCB} = 3.3 ± 0.3 V)
t_{pd} = 6.2 ns (max) (V_{CCA} = 1.2 ± 0.1 V, V_{CCB} = 3.3 ± 0.3 V)
t_{pd} = 4.9 ns (max) (V_{CCA} = 1.8 ± 0.15 V, V_{CCB} = 2.5 ± 0.2 V)
t_{pd} = 5.5 ns (max) (V_{CCA} = 1.5 ± 0.1 V, V_{CCB} = 2.5 ± 0.2 V)
t_{pd} = 6.9 ns (max) (V_{CCA} = 1.2 ± 0.1 V, V_{CCB} = 2.5 ± 0.2 V)
t_{pd} = 9.7 ns (max) (V_{CCA} = 1.2 ± 0.1 V, V_{CCB} = 1.8 ± 0.15 V)

(3) Output current: I_{OHB}/I_{OLB} = ±3 mA (min) (V_{CCB} = 3.0 V)
I_{OHB}/I_{OLB} = ±2 mA (min) (V_{CCB} = 2.3 V)
I_{OHB}/I_{OLB} = ±0.5 mA (min) (V_{CCB} = 1.65 V)

(4) Latch-up resistance: -300 mA

(5) ESD resistance: Machine model ≥ ±200 V, Human body model ≥ ±2000 V

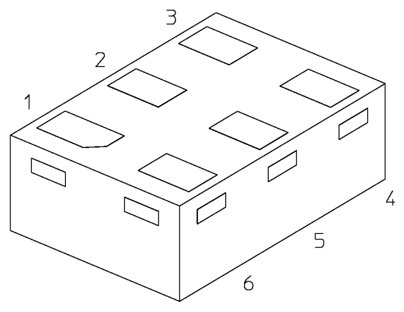
(6) Ultra-small package: MP6C

(7) 3.6 V tolerant function and power-down protection provided on all inputs and output.

Start of commercial production
2013-10

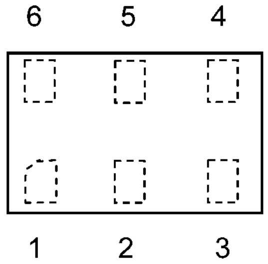
2018-08-07
Rev.2.0

4. Packaging and Pin Assignment



BOTTOM VIEW

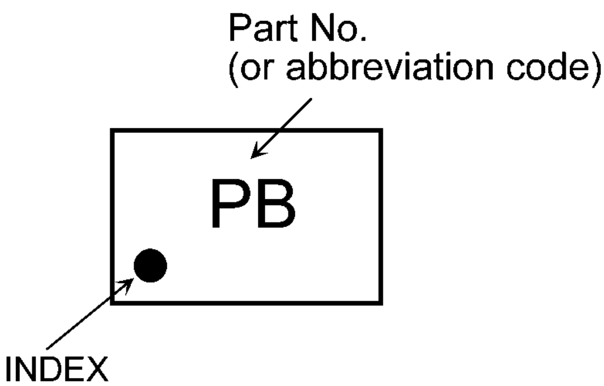
MP6C



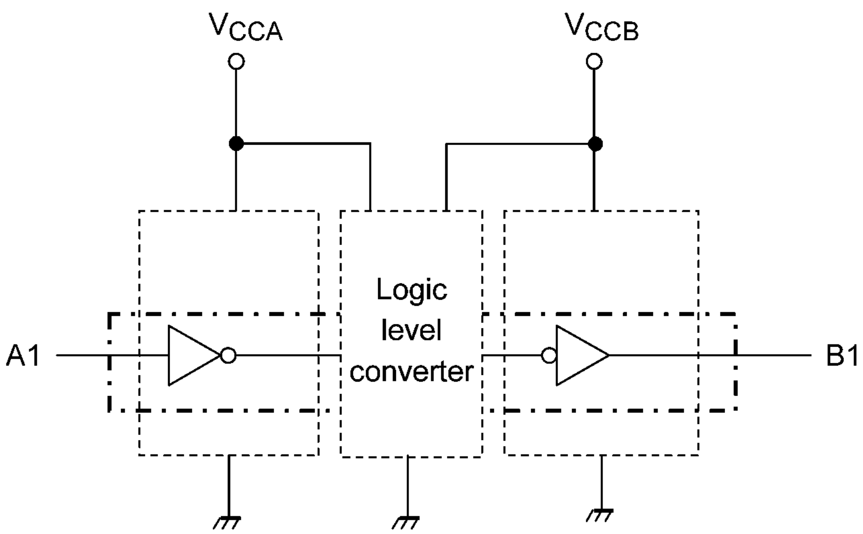
TOP VIEW

1: V_{CCA}
2: A1
3: GND
4: B1
5: NC
6: V_{CCB}

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 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_{OUT}		—	±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	°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} < 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	±3	mA
			V_{CCB} = 2.3 to 2.7 V	±2	
			V_{CCB} = 1.65 to 1.95 V	±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 ≤ V_{CCA} ≤ 2.7 V, 1.65 V ≤ V_{CCB} ≤ 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 ≤ V_{CCA} < 1.4	1.65 to 3.6	0.65×V_{CCA}	—	V
				1.4 ≤ V_{CCA} < 1.65	1.65 to 3.6	0.65×V_{CCA}	—	
				1.65 ≤ V_{CCA} < 2.3	2.3 to 3.6	0.65×V_{CCA}	—	
				2.3 ≤ V_{CCA} ≤ 2.7	2.7 to 3.6	1.6	—	
Low-level input voltage	V_{ILA}	A1		1.1 ≤ V_{CCA} < 1.4	1.65 to 3.6	—	0.30×V_{CCA}	V
				1.4 ≤ V_{CCA} < 1.65	1.65 to 3.6	—	0.30×V_{CCA}	
				1.65 ≤ V_{CCA} < 2.3	2.3 to 3.6	—	0.35×V_{CCA}	
				2.3 ≤ V_{CCA} ≤ 2.7	2.7 to 3.6	—	0.7	
High-level output voltage	V_{OHB}	A1 = V_{IH}	I_{OHB} = -100 μA	1.1 to 2.7	1.65 to 3.6	V_{CCB} - 0.2	—	V
			I_{OHB} = -0.5 mA	1.1 to 1.65	1.65	1.25	—	
			I_{OHB} = -2 mA	1.1 to 2.3	2.3	1.7	—	
			I_{OHB} = -3 mA	1.1 to 2.7	3.0	2.2	—	
Low-level output voltage	V_{OLB}	A1 = V_{IL}	I_{OLB} = 100 μA	1.1 to 2.7	1.65 to 3.6	—	0.2	V
			I_{OLB} = 0.5 mA	1.1 to 1.65	1.65	—	0.3	
			I_{OLB} = 2 mA	1.1 to 2.3	2.3	—	0.6	
			I_{OLB} = 3 mA	1.1 to 2.7	3.0	—	0.55	
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} ≤ 3.6 V		1.1 to 2.7	1.65 to 3.6	—	±2.0	
	I_{CCB}	V_{IN} = V_{CCA}, V_{CCB} ≤ B1 ≤ 3.6 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 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 °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.

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

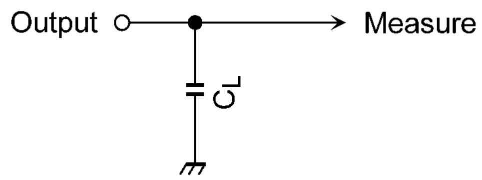


Fig. 10.2.1 AC Test Circuit

Table 10.2.1 Parameter for AC Test Circuit

Parameter	Capacitance	Test Condition
C_L	30 pF	V_{CCB} = 3.3 ± 0.3 V
		V_{CCB} = 2.5 ± 0.2 V
		V_{CCB} = 1.8 ± 0.15 V

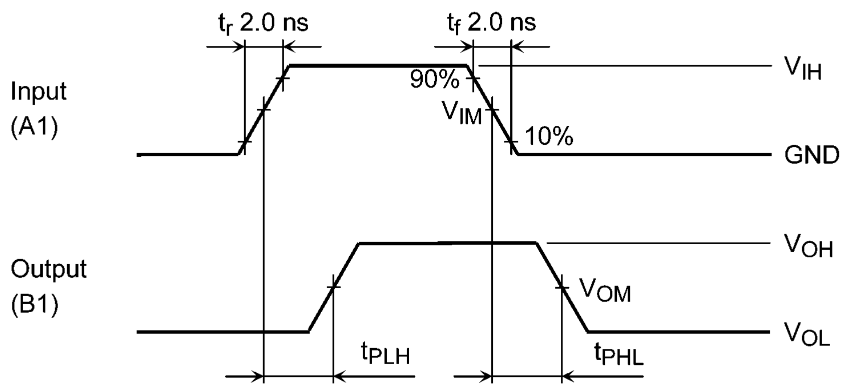


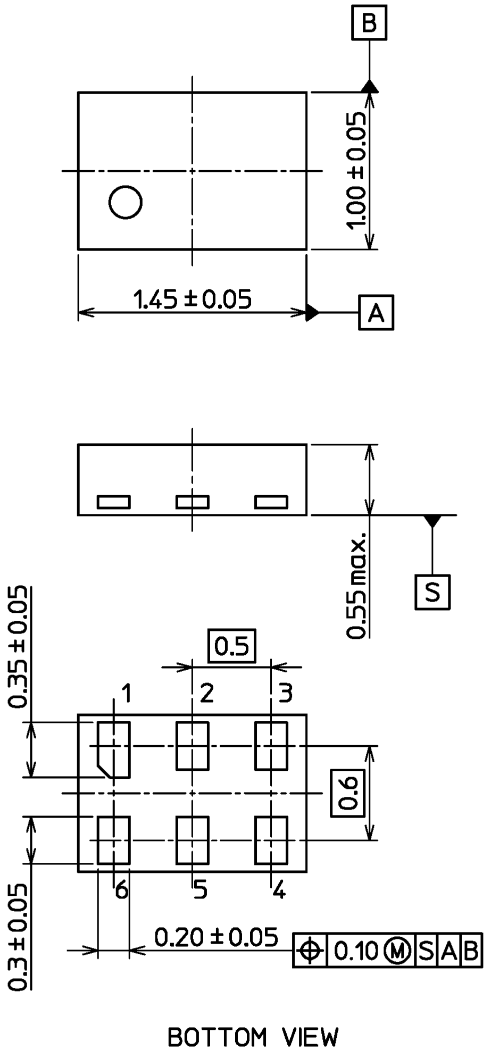
Fig. 10.2.2 AC Waveform

Table 10.2.2 AC Waveform Symbols

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