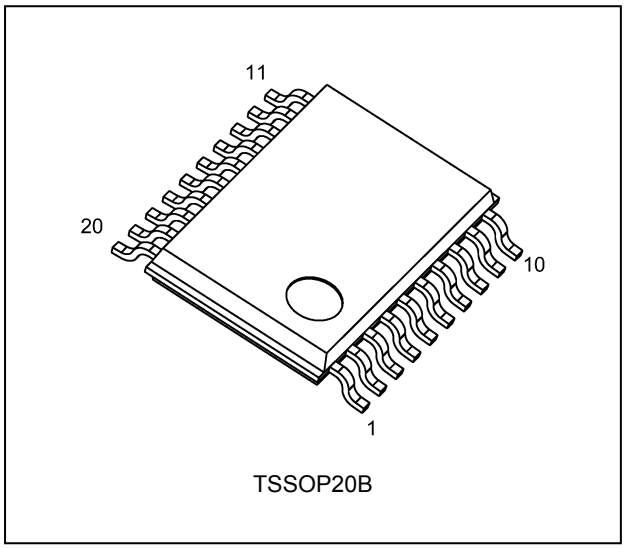
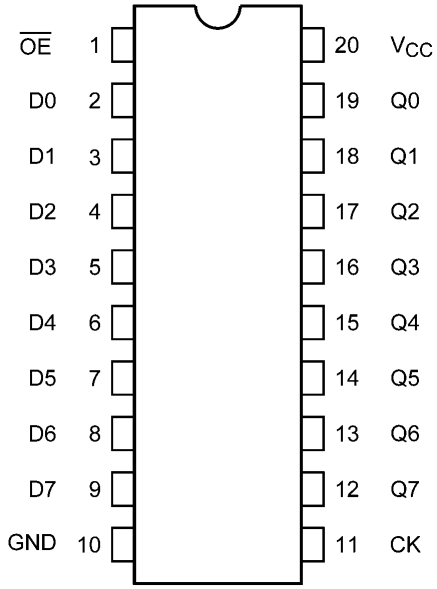
4. Packaging



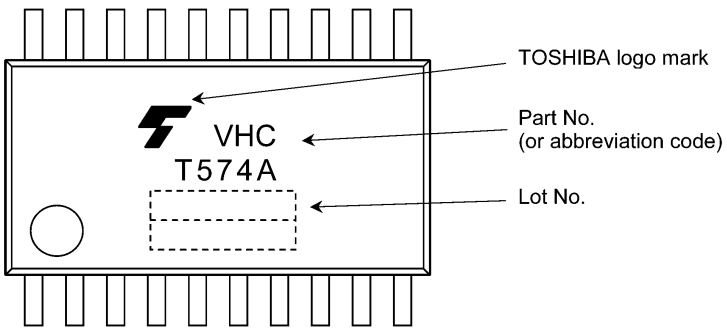
TSSOP20B

5. Pin Assignment

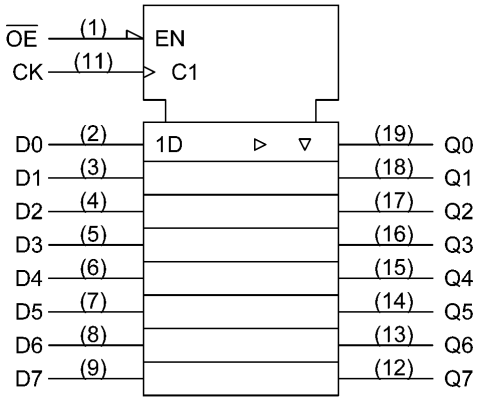


(top view)

6. Marking



7. IEC Logic Symbol

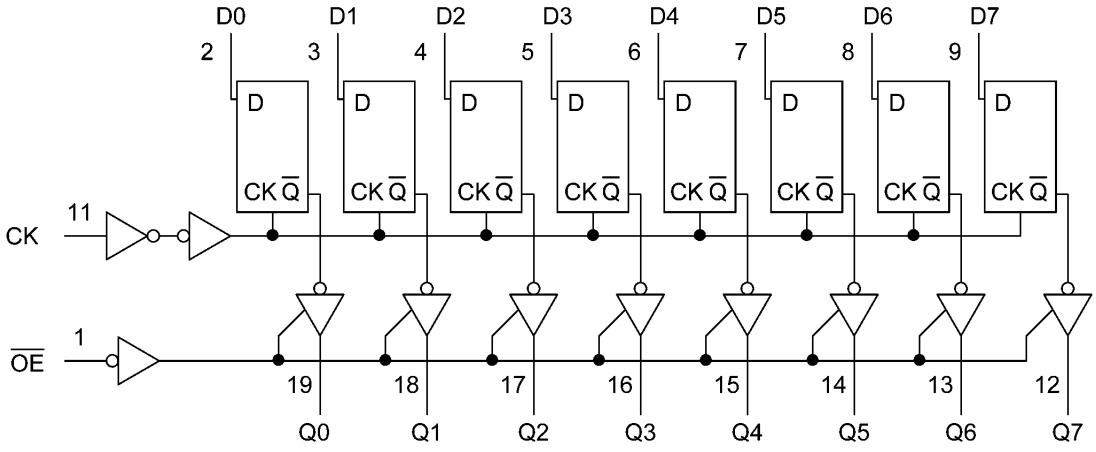


8. Truth Table

Inputs			Output
$\overline{OE}$	CK	D	
H	X	X	Z
L	↓	X	Qn
L	↑	L	L
L	↑	H	H

X: Don't care
Z: High impedance
Qn: No change

9. System Diagram



10. 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)	±20	mA
Output current	I_{OUT}		±25	mA
V_{CC}/ground current	I_{CC}		±75	mA
Power dissipation	P_D	(Note 4)	180	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: 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 °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}		4.5 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	°C
Input rise and fall times	dt/dv		0 to 20	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: Output in Off-state.

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

12. Electrical Characteristics

12.1. DC Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Typ.	Max	Unit
High-level input voltage	V_{IH}	—		4.5 to 5.5	2.0	—	—	V
Low-level input voltage	V_{IL}	—		4.5 to 5.5	—	—	0.8	V
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -50 μA	4.5	4.40	4.50	—	V
			I_{OH} = -8 mA	4.5	3.94	—	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA	4.5	—	0.0	0.10	V
			I_{OL} = 8 mA	4.5	—	—	0.36	
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = V_{CC} or GND		5.5	—	—	±0.25	μA
Input leakage current	I_{IN}	V_{IN} = 5.5 V or GND		0 to 5.5	—	—	±0.1	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	—	4.0	μA
	I_{CCT}	Per input: V_{IN} = 3.4 V Other input: V_{CC} or GND		5.5	—	—	1.35	mA
Output leakage current (Power-OFF)	I_{OPD}	V_{OUT} = 5.5 V		0	—	—	0.5	μA

12.2. 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}	—		4.5 to 5.5	2.0	—	V
Low-level input voltage	V_{IL}	—		4.5 to 5.5	—	0.8	V
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -50 μA	4.5	4.40	—	V
			I_{OH} = -8 mA	4.5	3.80	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA	4.5	—	0.10	V
			I_{OL} = 8 mA	4.5	—	0.44	
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = V_{CC} or GND		5.5	—	±2.50	μA
Input leakage current	I_{IN}	V_{IN} = 5.5 V or GND		0 to 5.5	—	±1.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	40.0	μA
	I_{CCT}	Per input: V_{IN} = 3.4 V Other input: V_{CC} or GND		5.5	—	1.50	mA
Output leakage current (Power-OFF)	I_{OPD}	V_{OUT} = 5.5 V		0	—	5.0	μA

12.3. 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}	—		4.5 to 5.5	2.0	—	V
Low-level input voltage	V_{IL}	—		4.5 to 5.5	—	0.8	V
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -50 μA	4.5	4.40	—	V
			I_{OH} = -8 mA	4.5	3.70	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA	4.5	—	0.10	V
			I_{OL} = 8 mA	4.5	—	0.55	
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = V_{CC} or GND		5.5	—	±10.0	μA
Input leakage current	I_{IN}	V_{IN} = 5.5 V or GND		0 to 5.5	—	±2.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	80.0	μA
	I_{CCT}	Per input: V_{IN} = 3.4 V Other input: V_{CC} or GND		5.5	—	1.50	mA
Output leakage current (Power-OFF)	I_{OPD}	V_{OUT} = 5.5 V		0	—	20.0	μA

12.4. Timing Requirements (Unless otherwise specified, T_a = 25°C, Input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	V_{CC} (V)	Typ.	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}$,$t_{w(H)}$	5.0 ± 0.5	—	6.5	ns
Minimum setup time	t_s	5.0 ± 0.5	—	2.5	ns
Minimum hold time	t_h	5.0 ± 0.5	—	2.5	ns

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

Characteristics	Symbol	V_{CC} (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}$,$t_{w(H)}$	5.0 ± 0.5	8.5	ns
Minimum setup time	t_s	5.0 ± 0.5	2.5	ns
Minimum hold time	t_h	5.0 ± 0.5	2.5	ns

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

Characteristics	Symbol	V_{CC} (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}$,$t_{w(H)}$	5.0 ± 0.5	8.5	ns
Minimum setup time	t_s	5.0 ± 0.5	3.0	ns
Minimum hold time	t_h	5.0 ± 0.5	2.5	ns

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

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Unit
Propagation delay time (CK-Q)	t_{PLH},t_{PHL}		—	5.0 ± 0.5	15	—	4.1	9.4	ns
					50	—	5.6	10.4	
3-state output enable time	t_{PZL},t_{PZH}		R_L = 1 kΩ	5.0 ± 0.5	15	—	6.5	10.2	ns
					50	—	7.3	11.2	
3-state output disable time	t_{PLZ},t_{PHZ}		R_L = 1 kΩ	5.0 ± 0.5	50	—	7.0	11.2	ns
Maximum clock frequency	f_{MAX}		—	5.0 ± 0.5	15	90	140	—	MHz
					50	85	130	—	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	5.0 ± 0.5	50	—	—	1.0	ns
Input capacitance	C_{IN}		—			—	4	10	pF
Output capacitance	C_{OUT}		—			—	9	—	pF
Power dissipation capacitance	C_{PD}	(Note 2)	—			—	25	—	pF

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

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.

$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/8$ (per F/F)

And the total C_{PD} when n pcs of F/F operate can be gained by the following equation.

C_{PD} (total) = 14 + 11 × n

12.8. 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 (CK-Q)	t_{PLH},t_{PHL}		—	5.0 ± 0.5	15	1.0	10.5	ns
					50	1.0	11.5	
3-state output enable time	t_{PZL},t_{PZH}		R_L = 1 kΩ	5.0 ± 0.5	15	1.0	11.5	ns
					50	1.0	12.5	
3-state output disable time	t_{PLZ},t_{PHZ}		R_L = 1 kΩ	5.0 ± 0.5	50	1.0	12.0	ns
Maximum clock frequency	f_{MAX}		—	5.0 ± 0.5	15	80	—	MHz
					50	75	—	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	5.0 ± 0.5	50	—	1.0	ns
Input capacitance	C_{IN}		—			—	10	pF

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

12.9. 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 (CK-Q)	t_{PLH},t_{PHL}		—	5.0 ± 0.5	15	1.0	12.0	ns
					50	1.0	13.0	
3-state output enable time	t_{PZL},t_{PZH}		R_L = 1 kΩ	5.0 ± 0.5	15	1.0	13.0	ns
					50	1.0	14.0	
3-state output disable time	t_{PLZ},t_{PHZ}		R_L = 1 kΩ	5.0 ± 0.5	50	1.0	14.0	ns
Maximum clock frequency	f_{MAX}		—	5.0 ± 0.5	15	70	—	MHz
				5.0 ± 0.5	50	65	—	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	5.0 ± 0.5	50	—	1.0	ns
Input capacitance	C_{IN}		—			—	10	pF

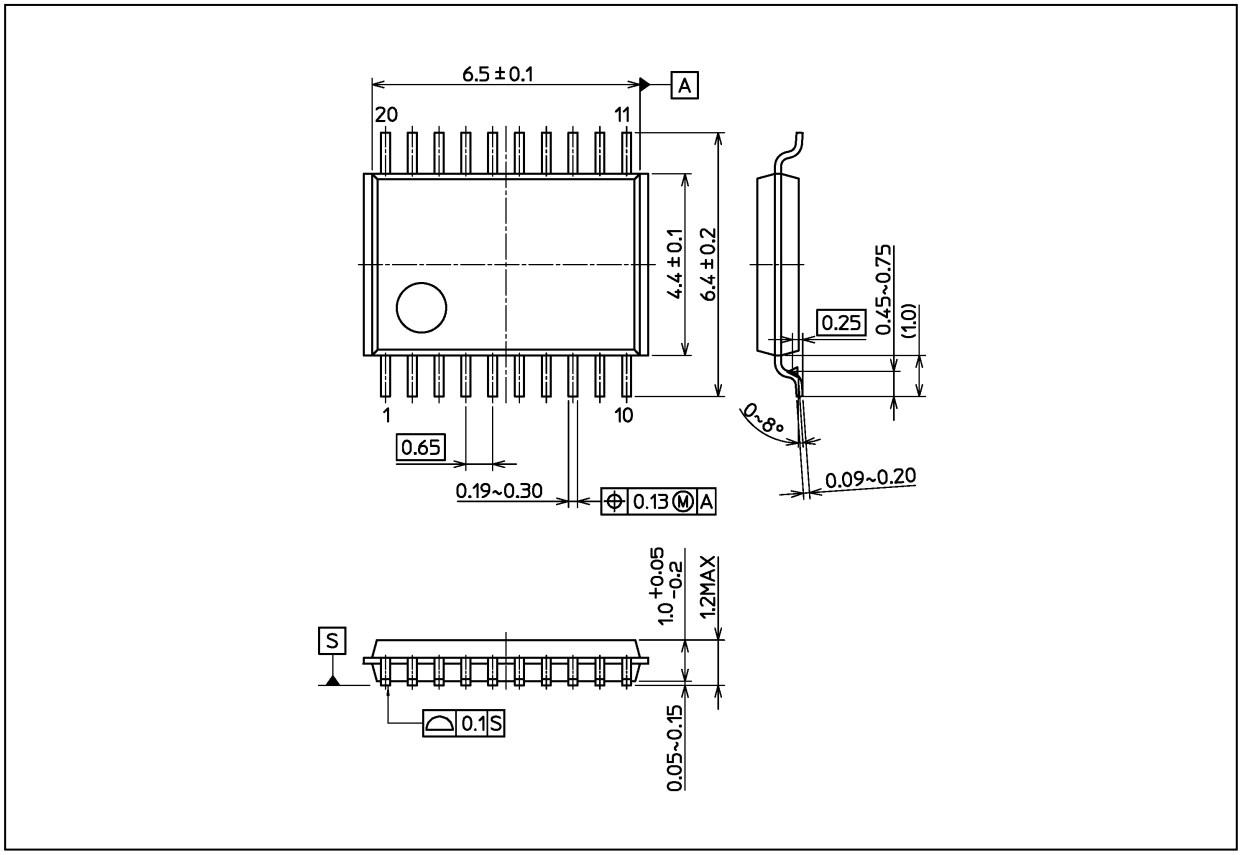
Note 1: Parameter guaranteed by design. (t_{osLH} = $|t_{PLH}m-t_{PLH}n|$, t_{osHL} = $|t_{PHL}m-t_{PHL}n|$)

12.10. 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	5.0	1.1	1.5	V
Quiet output minimum dynamic V_{OL}	V_{OLV}	C_L = 50 pF	5.0	-1.1	-1.5	V
Minimum high-level dynamic input voltage	V_{IHD}	C_L = 50 pF	5.0	—	2.0	V
Maximum low-level dynamic input voltage	V_{ILD}	C_L = 50 pF	5.0	—	0.8	V

Package Dimensions

Unit: mm



Weight: 0.071 g (typ.)

Package Name(s)
Nickname: TSSOP20B

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