CMOS Digital Integrated Circuits Silicon Monolithic

74VHC138FT

1. Functional Description

- 3-to-8 Line Decoder

2. General

The 74VHC138FT is an advanced high speed CMOS 3-to-8 DECODER fabricated with silicon gate C^{2}MOS technology.

It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

When the device is enabled, 3 Binary Select inputs (A, B and C) determine which one of the outputs ($\overline{Y}0$ - $\overline{Y}7$) will go low.

When enable input G1 is held low or either $\overline{G}2A$ or $\overline{G}2B$ is held high, decoding function is inhibited and all outputs go high.

G1, $\overline{G}2A$, and $\overline{G}2B$ inputs are provided to ease cascade connection and for use as an address decoder for memory systems.

An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

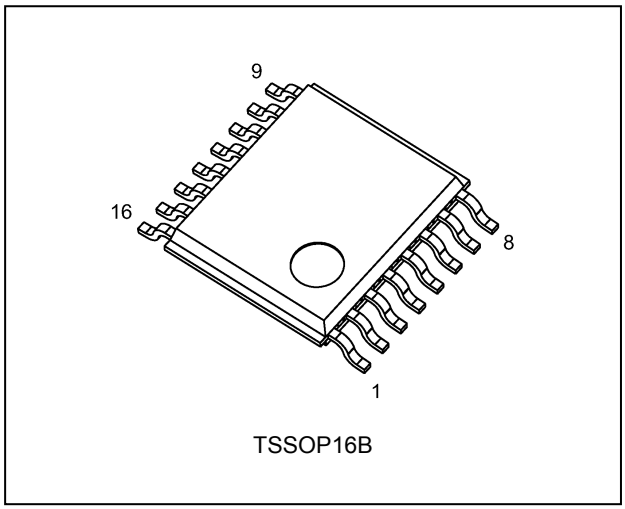
3. Features

(1) AEC-Q100 (Rev. H) (Note 1)
(2) Wide operating temperature: T_{opr} = -40 to 125 °C
(3) High speed: t_{pd} = 5.7 ns (typ.) at V_{CC} = 5 V
(4) Low power dissipation: I_{CC} = 4.0 μA (max) at T_a = 25 °C
(5) High noise immunity: $V_{NIH} = V_{NIL}$ = 28 % V_{CC} (min)
(6) Power down protection is provided on all inputs.
(7) Balanced propagation delays: $t_{PLH} \approx t_{PHL}$
(8) Wide operating voltage range: $V_{CC(opr)}$ = 2.0 V to 5.5 V
(9) Pin and function compatible with 74 series(AC/HC/AHC/LV etc.)138 type.

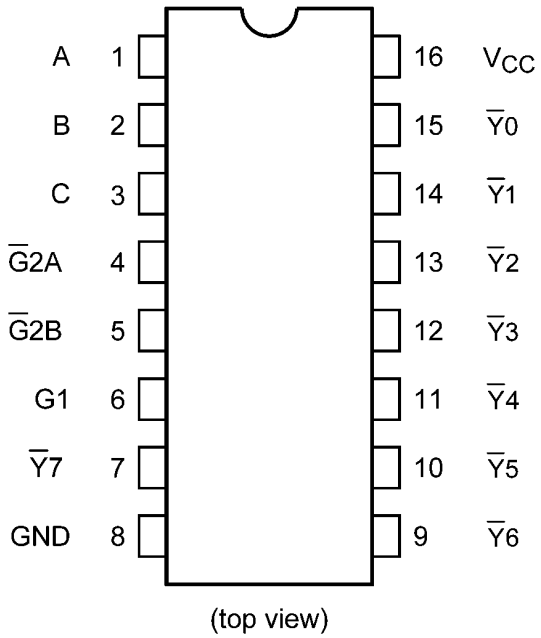
Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

Start of commercial production
2013-05

4. Packaging

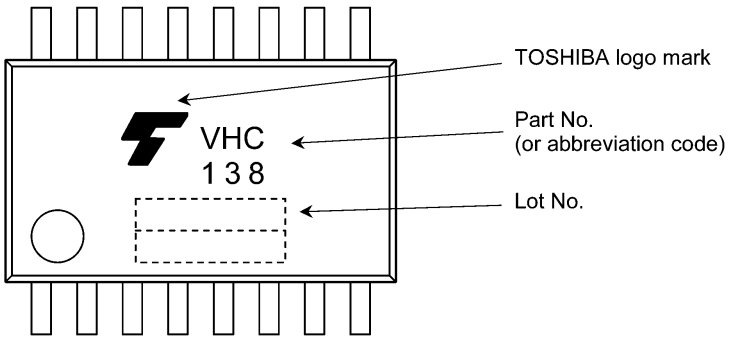


5. Pin Assignment

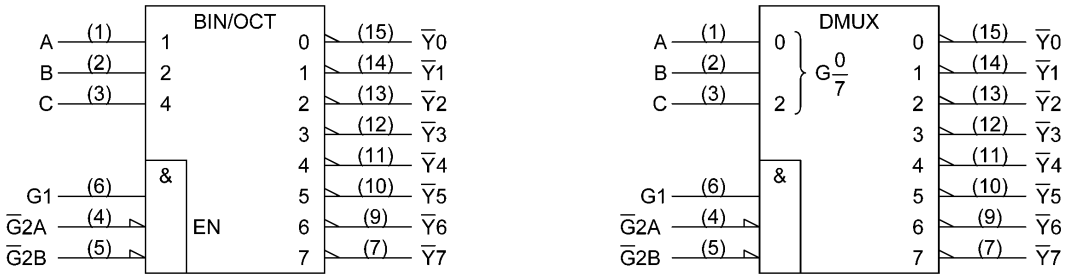


(top view)

6. Marking



7. IEC Logic Symbol

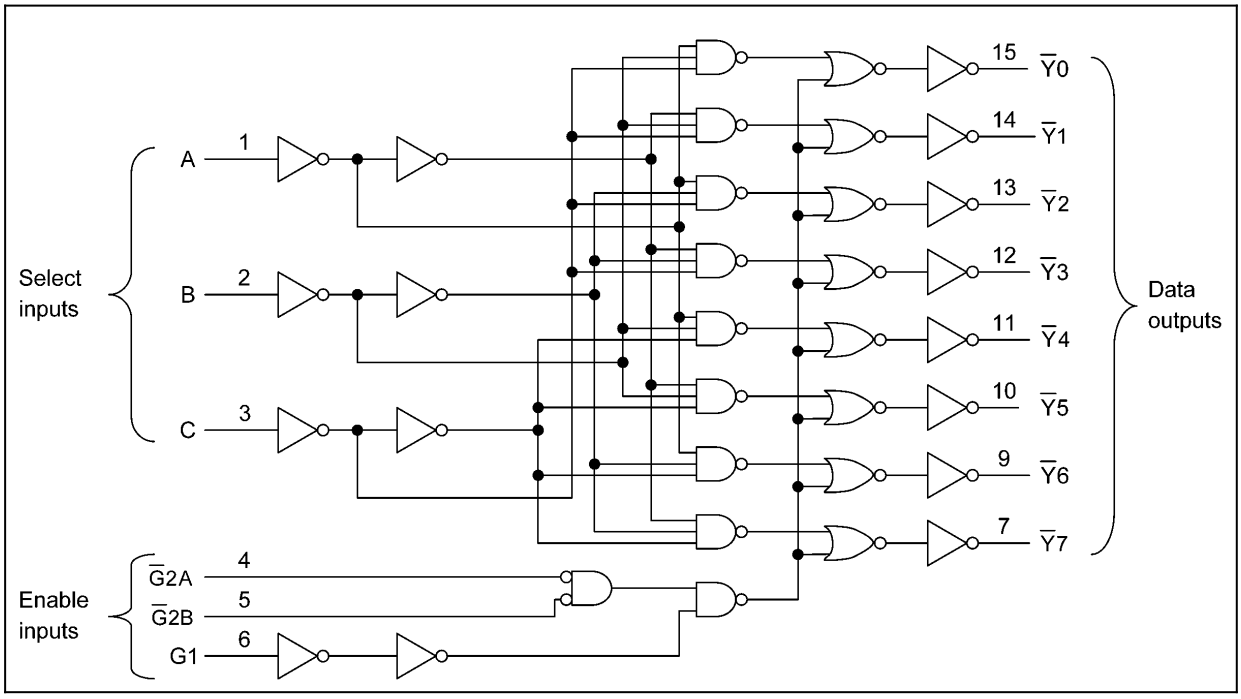


8. Truth Table

Inputs						Outputs								Selected Output
Enable			Select											
G1	G2A	G2B	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	
L	X	X	X	X	X	H	H	H	H	H	H	H	H	None
X	H	X	X	X	X	H	H	H	H	H	H	H	H	None
X	X	H	X	X	X	H	H	H	H	H	H	H	H	None
H	L	L	L	L	L	L	H	H	H	H	H	H	H	Y0
H	L	L	L	L	H	H	L	H	H	H	H	H	H	Y1
H	L	L	L	H	L	H	H	L	H	H	H	H	H	Y2
H	L	L	L	H	H	H	H	H	L	H	H	H	H	Y3
H	L	L	H	L	L	H	H	H	H	L	H	H	H	Y4
H	L	L	H	L	H	H	H	H	H	H	L	H	H	Y5
H	L	L	H	H	L	H	H	H	H	H	H	L	H	Y6
H	L	L	H	H	H	H	H	H	H	H	H	H	L	Y7

X: Don't care

9. Logic 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	
Output voltage	V_{OUT}		-0.5 to V_{CC} + 0.5	
Input diode current	I_{IK}		-20	mA
Output diode current	I_{OK}		±20	
Output current	I_{OUT}		±25	
V_{CC}/ground current	I_{CC}		±75	
Power dissipation	P_D	(Note 1)	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: 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	Test Condition	Rating	Unit
Supply voltage	V_{CC}		2.0 to 5.5	V
Input voltage	V_{IN}		0 to 5.5	
Output voltage	V_{OUT}		0 to V_{CC}	
Operating temperature	T_{opr}		-40 to 125	°C
Input rise and fall times	dt/dv	V_{CC} = 3.3 ± 0.3 V	0 to 100	ns/V
		V_{CC} = 5 ± 0.5 V	0 to 20	

Note: The operating ranges are required to ensure the normal operation of the device. Unused inputs must be tied to either V_{CC} or GND.

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}	—		2.0	1.50	—	—	V
				3.0 to 5.5	V_{CC} × 0.7	—	—	
Low-level input voltage	V_{IL}	—		2.0	—	—	0.50	V
				3.0 to 5.5	—	—	V_{CC} × 0.3	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -50 μA	2.0	1.9	2.0	—	V
				3.0	2.9	3.0	—	
				4.5	4.4	4.5	—	
			I_{OH} = -4 mA	3.0	2.58	—	—	
			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	2.0	—	0.0	0.1	V
				3.0	—	0.0	0.1	
				4.5	—	0.0	0.1	
			I_{OL} = 4 mA	3.0	—	—	0.36	
			I_{OL} = 8 mA	4.5	—	—	0.36	
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

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}	—		2.0	1.50	—	V
				3.0 to 5.5	V_{CC} × 0.7	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.50	V
				3.0 to 5.5	—	V_{CC} × 0.3	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -50 μA	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			I_{OH} = -4 mA	3.0	2.48	—	
			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	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			I_{OL} = 4 mA	3.0	—	0.44	
			I_{OL} = 8 mA	4.5	—	0.44	
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

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}	—		2.0	1.50	—	V
				3.0 to 5.5	V_{CC} × 0.7	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.50	V
				3.0 to 5.5	—	V_{CC} × 0.3	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -50 μA	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			I_{OH} = -4 mA	3.0	2.40	—	
			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	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			I_{OL} = 4 mA	3.0	—	0.55	
			I_{OL} = 8 mA	4.5	—	0.55	
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

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

Characteristics	Symbol	Note	V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Unit
Propagation delay time (A, B, C - $\overline{Y}$)	t_{PLH},t_{PHL}		3.3 ± 0.3	15	—	8.2	11.4	ns
				50	—	10.0	15.8	
			5.0 ± 0.5	15	—	5.7	8.1	
				50	—	7.2	10.1	
Propagation delay time (G1 - $\overline{Y}$)	t_{PLH},t_{PHL}		3.3 ± 0.3	15	—	8.1	12.8	ns
				50	—	10.6	16.3	
			5.0 ± 0.5	15	—	5.6	8.1	
				50	—	7.1	10.1	
Propagation delay time ($\overline{G2}$ - $\overline{Y}$)	t_{PLH},t_{PHL}		3.3 ± 0.3	15	—	8.2	11.4	ns
				50	—	10.7	14.9	
			5.0 ± 0.5	15	—	5.8	8.1	
				50	—	7.3	10.1	
Input capacitance	C_{IN}				—	4	10	pF
Power dissipation capacitance	C_{PD}	(Note 1)			—	34	—	pF

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.

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

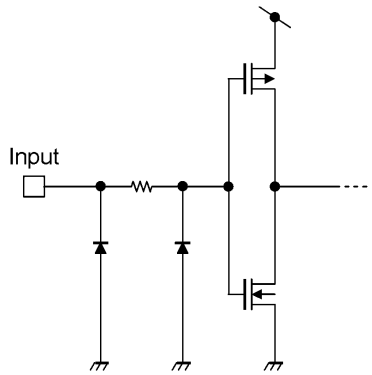
12.5. AC Characteristics
(Unless otherwise specified, T_a = -40 to 85 °C, Input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time (A, B, C -$\overline{Y}$)	t_{PLH},t_{PHL}	3.3 ± 0.3	15	1.0	13.5	ns
			50	1.0	18.0	
		5.0 ± 0.5	15	1.0	9.5	
			50	1.0	11.5	
Propagation delay time (G1 -$\overline{Y}$)	t_{PLH},t_{PHL}	3.3 ± 0.3	15	1.0	15.0	ns
			50	1.0	18.5	
		5.0 ± 0.5	15	1.0	9.5	
			50	1.0	11.5	
Propagation delay time ($\overline{G2}$ -$\overline{Y}$)	t_{PLH},t_{PHL}	3.3 ± 0.3	15	1.0	13.5	ns
			50	1.0	17.0	
		5.0 ± 0.5	15	1.0	9.5	
			50	1.0	11.5	
Input capacitance	C_{IN}			—	10	pF

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

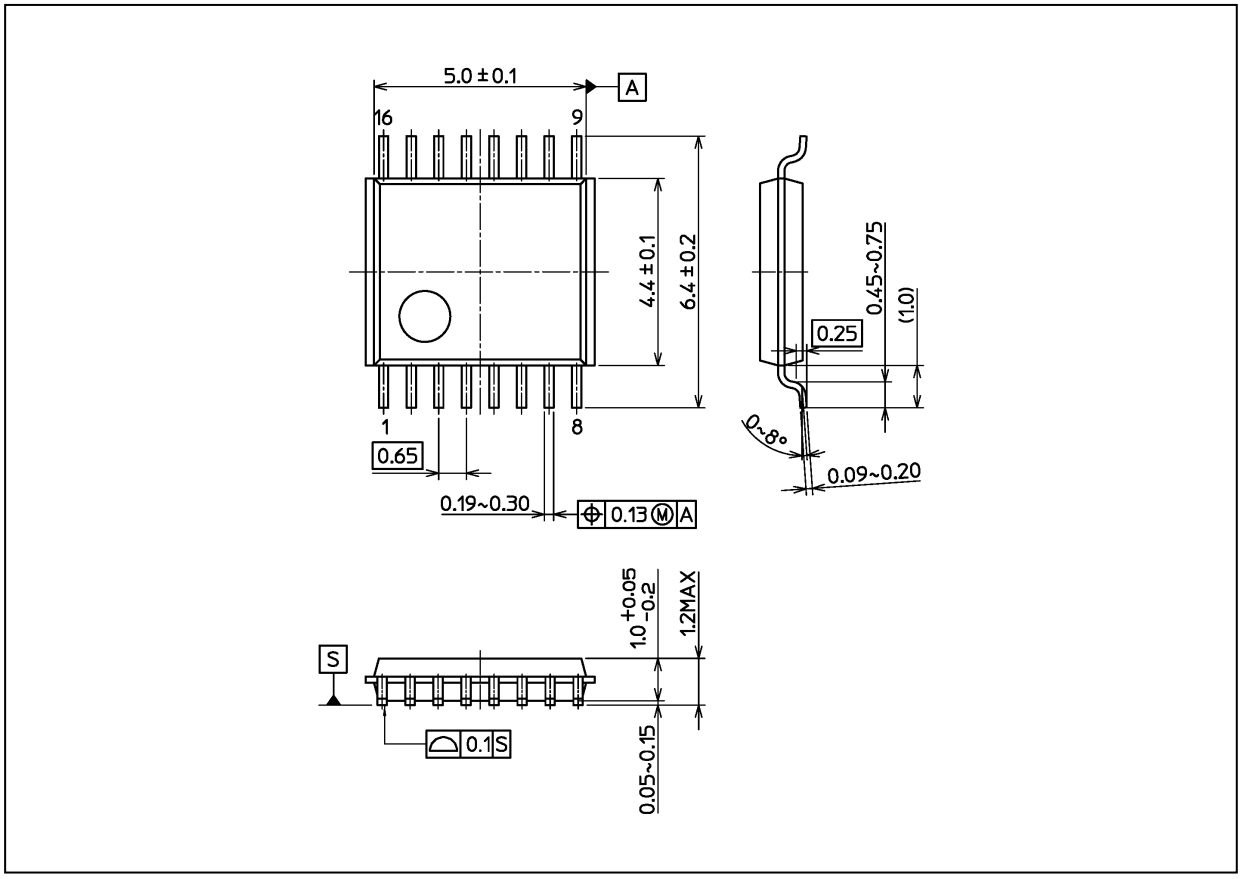
Characteristics	Symbol	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time (A, B, C - $\overline{Y}$)	t_{PLH},t_{PHL}	3.3 ± 0.3	15	1.0	16.5	ns
			50	1.0	20.0	
		5.0 ± 0.5	15	1.0	11.0	
			50	1.0	13.0	
Propagation delay time (G1 - $\overline{Y}$)	t_{PLH},t_{PHL}	3.3 ± 0.3	15	1.0	17.0	ns
			50	1.0	20.5	
		5.0 ± 0.5	15	1.0	11.0	
			50	1.0	13.0	
Propagation delay time ($\overline{G2}$ - $\overline{Y}$)	t_{PLH},t_{PHL}	3.3 ± 0.3	15	1.0	15.5	ns
			50	1.0	19.0	
		5.0 ± 0.5	15	1.0	11.0	
			50	1.0	13.0	ns
Input capacitance	C_{IN}			—	10	pF

13. Input Equivalent Circuit



Package Dimensions

Unit: mm



Weight: 0.055 g (typ.)

Package Name(s)
Nickname: TSSOP16B

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