

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 C²MOS 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 ($\bar{Y}0 - \bar{Y}7$) will go low.

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

G1, $\bar{G}2A$, and $\bar{G}2B$ 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.

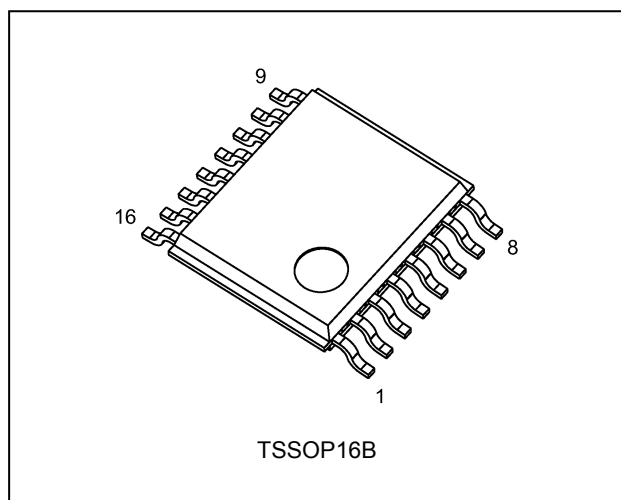
3. Features

- (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 $T_a = 25^{\circ}\text{C}$
- (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.

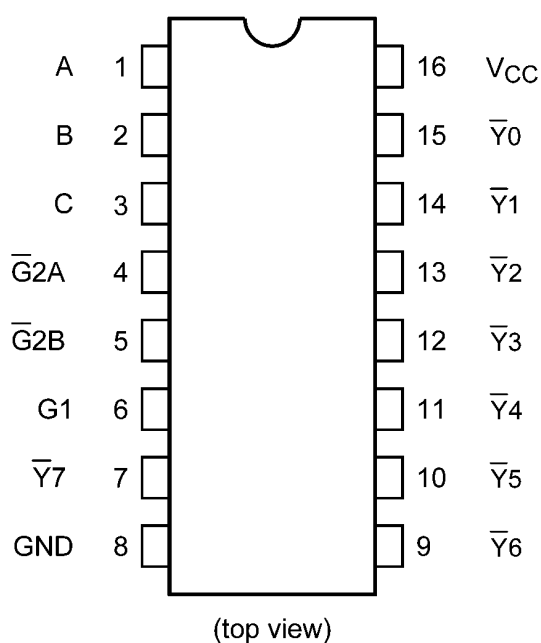
Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

Start of commercial production
2013-05

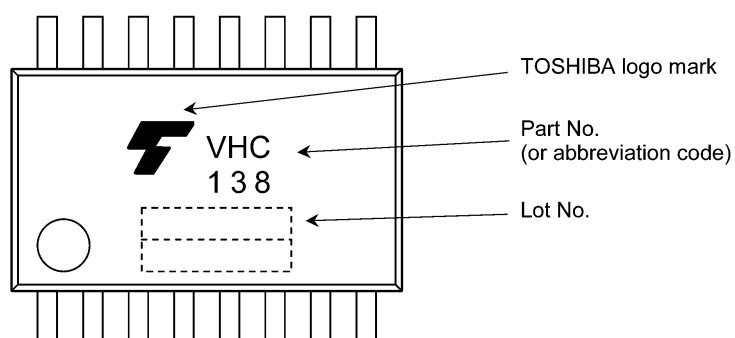
4. Packaging



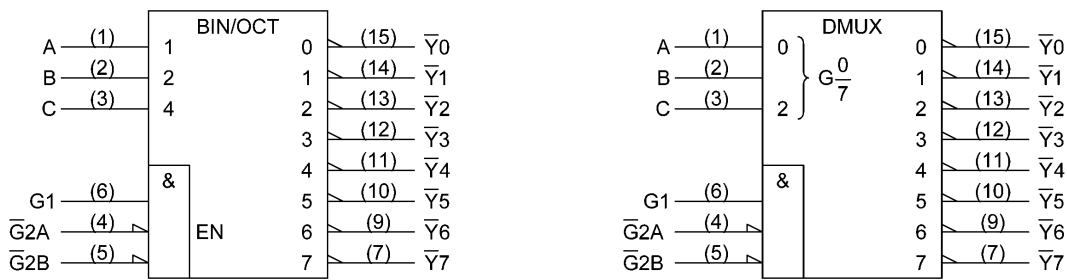
5. Pin Assignment



6. Marking



7. IEC Logic Symbol

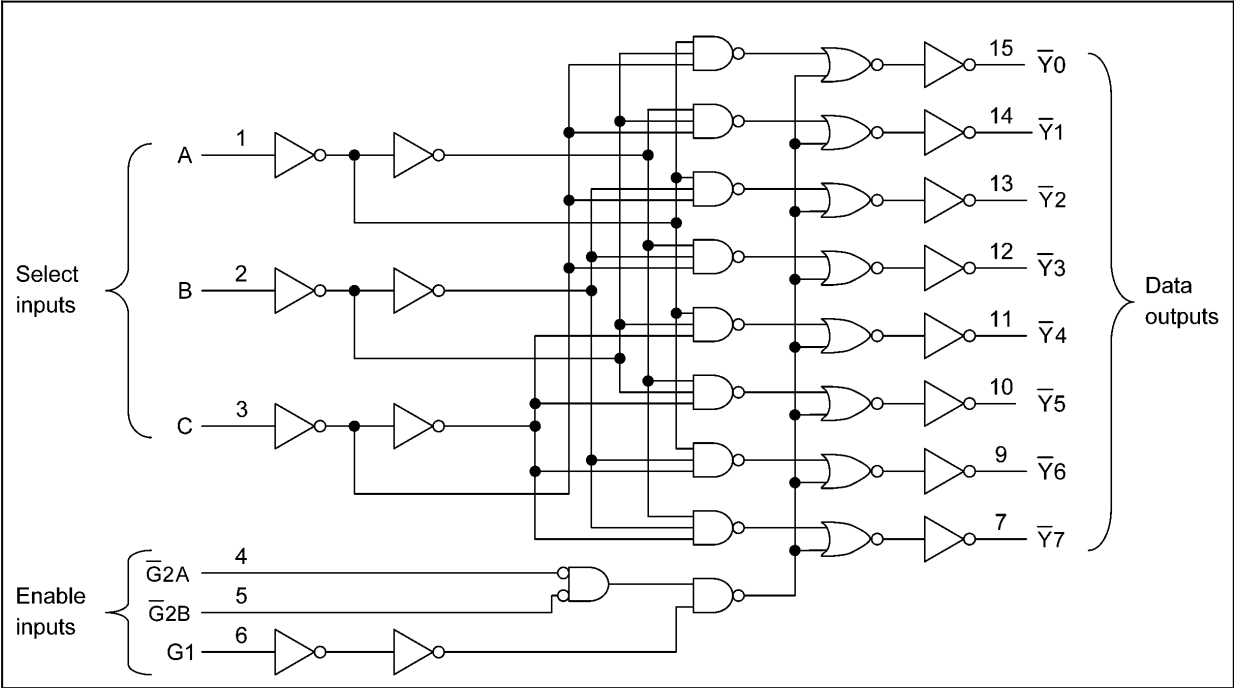


8. Truth Table

Inputs						Outputs								Selected Output
Enable			Select			$\bar{Y}0$	$\bar{Y}1$	$\bar{Y}2$	$\bar{Y}3$	$\bar{Y}4$	$\bar{Y}5$	$\bar{Y}6$	$\bar{Y}7$	
G1	$\overline{G2A}$	$\overline{G2B}$	C	B	A									
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	$\bar{Y}0$
H	L	L	L	L	H	H	L	H	H	H	H	H	H	$\bar{Y}1$
H	L	L	L	H	L	H	H	L	H	H	H	H	H	$\bar{Y}2$
H	L	L	L	H	H	H	H	H	L	H	H	H	H	$\bar{Y}3$
H	L	L	H	L	L	H	H	H	H	L	H	H	H	$\bar{Y}4$
H	L	L	H	L	H	H	H	H	H	H	L	H	H	$\bar{Y}5$
H	L	L	H	H	L	H	H	H	H	H	H	L	H	$\bar{Y}6$
H	L	L	H	H	H	H	H	H	H	H	H	H	L	$\bar{Y}7$

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	$V_{CC} = 3.3 \pm 0.3$ V	0 to 100	ns/V
		$V_{CC} = 5 \pm 0.5$ 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, $T_a = 25\text{ }^{\circ}\text{C}$)

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	$V_{CC} \times 0.7$	—	—	
Low-level input voltage	V_{IL}	—		2.0	—	—	0.50	V
				3.0 to 5.5	—	—	$V_{CC} \times 0.3$	
High-level output voltage	V_{OH}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	2.0	—	V
				3.0	2.9	3.0	—	
				4.5	4.4	4.5	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.58	—	—	
			$I_{OH} = -8\text{ mA}$	4.5	3.94	—	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.0	0.1	V
				3.0	—	0.0	0.1	
				4.5	—	0.0	0.1	
			$I_{OL} = 4\text{ mA}$	3.0	—	—	0.36	
			$I_{OL} = 8\text{ mA}$	4.5	—	—	0.36	
Input leakage current	I_{IN}	$V_{IN} = 5.5\text{ V or GND}$		0 to 5.5	—	—	± 0.1	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC} \text{ or GND}$		5.5	—	—	4.0	μA

12.2. DC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^{\circ}\text{C}$)

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	$V_{CC} \times 0.7$	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.50	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
High-level output voltage	V_{OH}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.48	—	
			$I_{OH} = -8\text{ mA}$	4.5	3.80	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4\text{ mA}$	3.0	—	0.44	
			$I_{OL} = 8\text{ mA}$	4.5	—	0.44	
Input leakage current	I_{IN}	$V_{IN} = 5.5\text{ V or GND}$		0 to 5.5	—	± 1.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC} \text{ or GND}$		5.5	—	40.0	μA

12.3. DC Characteristics (Unless otherwise specified, $T_a = -40$ to $125\text{ }^\circ\text{C}$)

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	$V_{CC} \times 0.7$	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.50	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
High-level output voltage	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
		$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -4\text{ mA}$	3.0	2.40	—	
			$I_{OH} = -8\text{ mA}$	4.5	3.70	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
		$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 4\text{ mA}$	3.0	—	0.55	
			$I_{OL} = 8\text{ mA}$	4.5	—	0.55	
Input leakage current	I_{IN}	$V_{IN} = 5.5\text{ V}$ 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, $T_a = 25\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Symbol	Note	V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Unit
Propagation delay time (A, B, C - $\bar{Y}$)	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 - $\bar{Y}$)	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 ($\bar{G}2$ - $\bar{Y}$)	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.

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

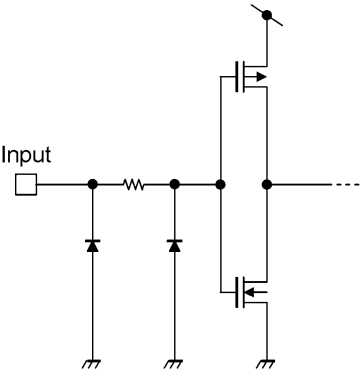
12.5. AC Characteristics
(Unless otherwise specified, $T_a = -40$ to $85\text{ }^{\circ}\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Symbol	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time (A, B, C - $\bar{Y}$)	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 ($G1 - \bar{Y}$)	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 ($\bar{G2} - \bar{Y}$)	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 $125\text{ }^{\circ}\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Symbol	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time (A, B, C - $\bar{Y}$)	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 ($G1 - \bar{Y}$)	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 ($\bar{G2} - \bar{Y}$)	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	ns
			50	1.0	13.0	
Input capacitance	C_{IN}			—	10	pF

13. Input Equivalent Circuit



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