

# 74VHC238FT

## 1. Functional Description

- 3-to-8 Line Decoder

## 2. General

The 74VHC238FT 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 (Y0-Y7) will go High.

When enable input G1 is held low or either  $\overline{G2A}$  or  $\overline{G2B}$  is held high, decoding function is inhibited and all outputs go Low.

G1,  $\overline{G2A}$  and  $\overline{G2B}$  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 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

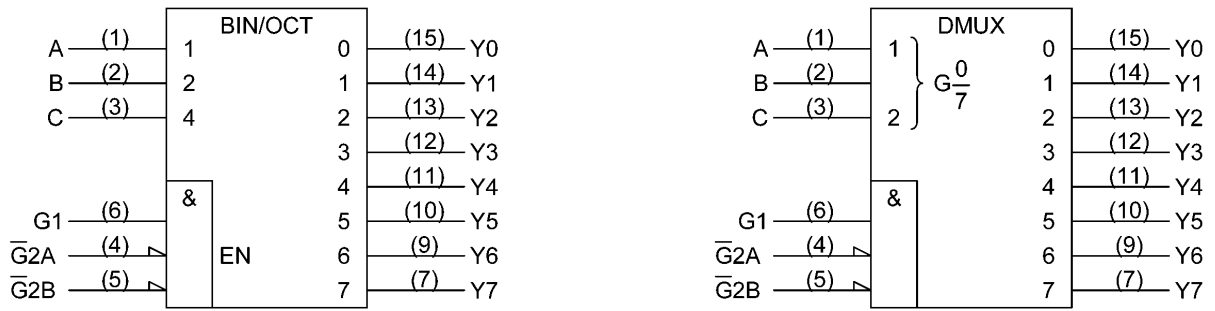
- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature:  $T_{opr} = -40$  to  $125$  °C
- (3) High speed:  $t_{pd} = 5.5$  ns (typ.) at  $V_{CC} = 5$  V
- (4) Low power dissipation:  $I_{CC} = 4.0$   $\mu$ A (max) at  $T_a = 25$  °C
- (5) High noise immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (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.)238 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  
2014-12



**7. IEC Logic Symbol**

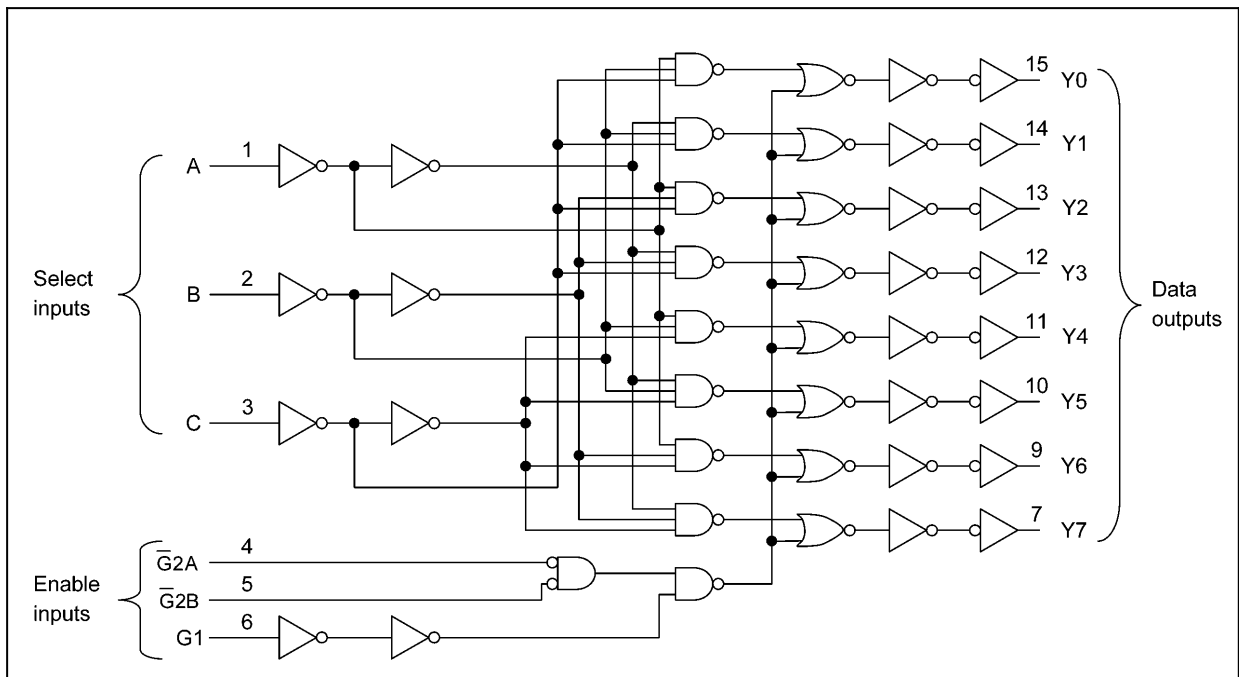


**8. Truth Table**

Inputs						Outputs								Selected Output	
Enable			Select			Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7		
G1	$\bar{G}2A$	$\bar{G}2B$	C	B	A										
L	X	X	X	X	X	L	L	L	L	L	L	L	L	L	None
X	H	X	X	X	X	L	L	L	L	L	L	L	L	L	None
X	X	H	X	X	X	L	L	L	L	L	L	L	L	L	None
H	L	L	L	L	L	H	L	L	L	L	L	L	L	L	Y0
H	L	L	L	L	H	L	H	L	L	L	L	L	L	L	Y1
H	L	L	L	H	L	L	L	H	L	L	L	L	L	L	Y2
H	L	L	L	H	H	L	L	L	H	L	L	L	L	L	Y3
H	L	L	H	L	L	L	L	L	L	H	L	L	L	L	Y4
H	L	L	H	L	H	L	L	L	L	L	H	L	L	L	Y5
H	L	L	H	H	L	L	L	L	L	L	L	H	L	L	Y6
H	L	L	H	H	H	L	L	L	L	L	L	L	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	V
Output voltage	$V_{OUT}$		-0.5 to $V_{CC} + 0.5$	V
Input diode current	$I_{IK}$		-20	mA
Output diode current	$I_{OK}$		$\pm 20$	mA
Output current	$I_{OUT}$		$\pm 25$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 75$	mA
Power dissipation	$P_D$	(Note 1)	180	mW
Storage temperature	$T_{stg}$		-65 to 150	$^{\circ}C$

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  $85^{\circ}C$ . From  $T_a = 85$  to  $125^{\circ}C$  a derating factor of  $-3.25$  mW/ $^{\circ}C$  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	V
Output voltage	$V_{OUT}$		0 to $V_{CC}$	V
Operating temperature	$T_{opr}$		-40 to 125	$^{\circ}C$
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	$V_{OH}$	$V_{IN} = V_{IH}$ 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	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.0	0.1
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	—	—	$\pm 0.1$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	5.5	—	—	4.0	$\mu\text{A}$	

**12.2. DC Characteristics (Unless otherwise specified,  $T_a = -40$  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	$V_{OH}$	$V_{IN} = V_{IH}$ 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	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1
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	—	$\pm 1.0$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	5.5	—	40.0	$\mu\text{A}$	

**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	$V_{CC} \times 0.7$	—	
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 $V_{IL}$	$I_{OH} = -50 \mu A$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
				$I_{OH} = -4$ mA	3.0	2.40	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50 \mu A$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
				$I_{OL} = 4$ mA	3.0	—	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5$ V or GND		0 to 5.5	—	$\pm 2.0$	$\mu A$
				5.5	—	80.0	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	80.0	$\mu A$

**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 - Y)	$t_{PLH}, t_{PHL}$		$3.3 \pm 0.3$	15	—	8.0	12.3	ns
				50	—	10.5	15.8	
			$5.0 \pm 0.5$	15	—	5.5	8.1	
				50	—	7.0	10.1	
Propagation delay time (G1 - Y)	$t_{PLH}, t_{PHL}$		$3.3 \pm 0.3$	15	—	8.1	12.8	ns
				50	—	10.6	16.3	
			$5.0 \pm 0.5$	15	—	5.4	8.1	
				50	—	6.9	10.1	
Propagation delay time ( $\overline{G2}$ - Y)	$t_{PLH}, t_{PHL}$		$3.3 \pm 0.3$	15	—	8.1	12.3	ns
				50	—	10.6	15.8	
			$5.0 \pm 0.5$	15	—	5.7	8.1	
				50	—	7.2	10.1	
Input capacitance	$C_{IN}$				—	4	10	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)			—	37	—	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.

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

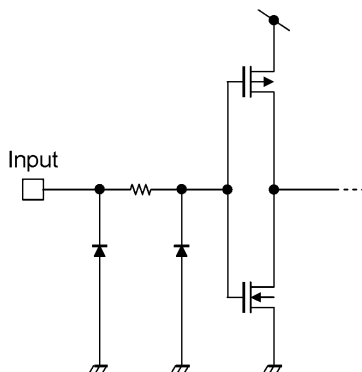
**12.5. AC Characteristics**  
(Unless otherwise specified,  $T_a = -40$  to  $85$  °C, Input:  $t_r = t_f = 3$  ns)

Characteristics	Symbol	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time (A, B, C -Y)	$t_{PLH}, t_{PHL}$	$3.3 \pm 0.3$	15	1.0	14.5	ns
			50	1.0	18.0	
		$5.0 \pm 0.5$	15	1.0	9.5	
			50	1.0	11.5	
Propagation delay time (G1 -Y)	$t_{PLH}, t_{PHL}$	$3.3 \pm 0.3$	15	1.0	15.0	ns
			50	1.0	18.5	
		$5.0 \pm 0.5$	15	1.0	9.5	
			50	1.0	11.5	
Propagation delay time (G2 -Y)	$t_{PLH}, t_{PHL}$	$3.3 \pm 0.3$	15	1.0	14.5	ns
			50	1.0	18.0	
		$5.0 \pm 0.5$	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)

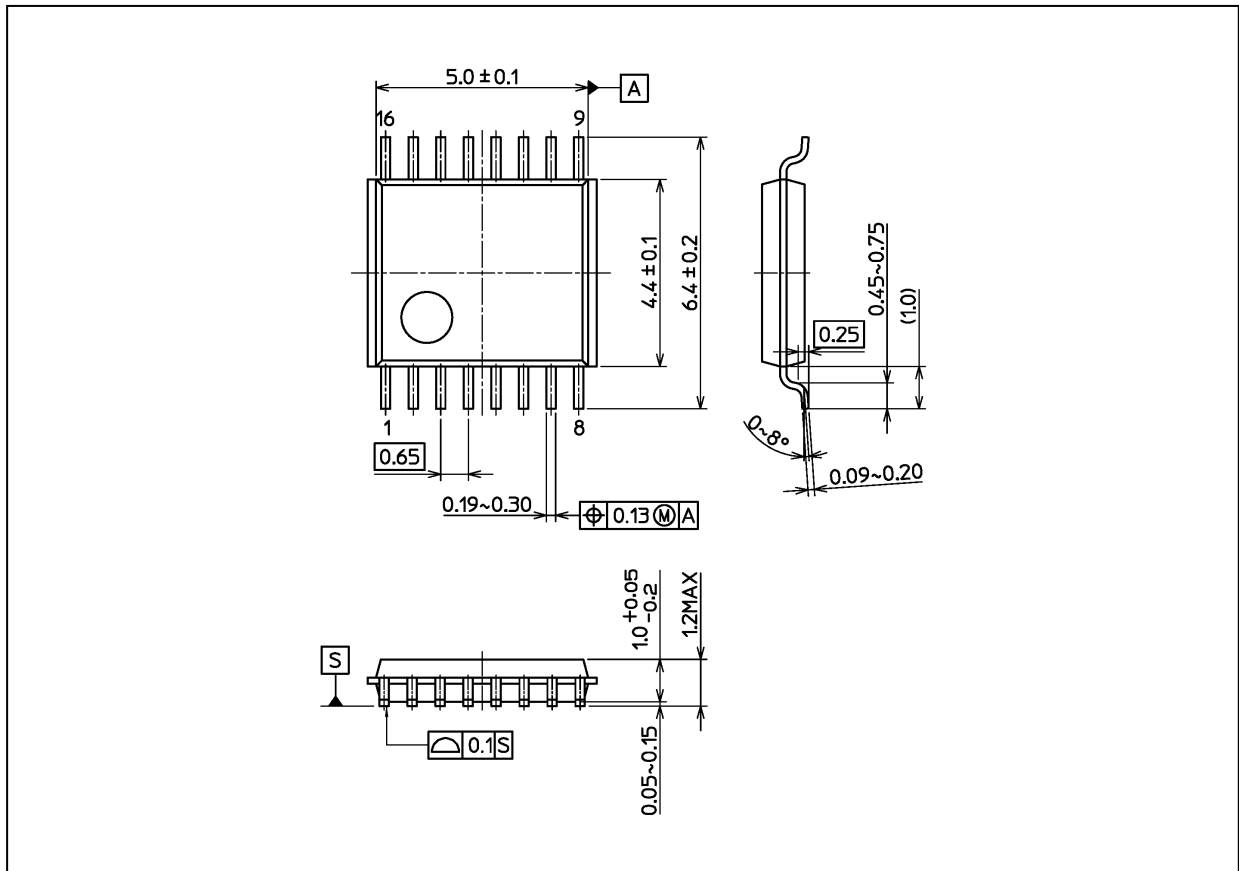
Characteristics	Symbol	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time (A, B, C -Y)	$t_{PLH}, t_{PHL}$	$3.3 \pm 0.3$	15	1.0	16.5	ns
			50	1.0	20.0	
		$5.0 \pm 0.5$	15	1.0	11.0	
			50	1.0	13.0	
Propagation delay time (G1 -Y)	$t_{PLH}, t_{PHL}$	$3.3 \pm 0.3$	15	1.0	17.0	ns
			50	1.0	20.5	
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