

CMOS Digital Integrated Circuits Silicon Monolithic

# TC74AC138P

## 1. Functional Description

- 3-to-8 Line Decoder

## 2. General

The TC74AC138P is an advanced high speed CMOS 3-to-8 LINE DECODER fabricated with silicon gate and double-layer metal wiring C<sup>2</sup>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 ( $\bar{Y}0$  -  $\bar{Y}7$ ) 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.

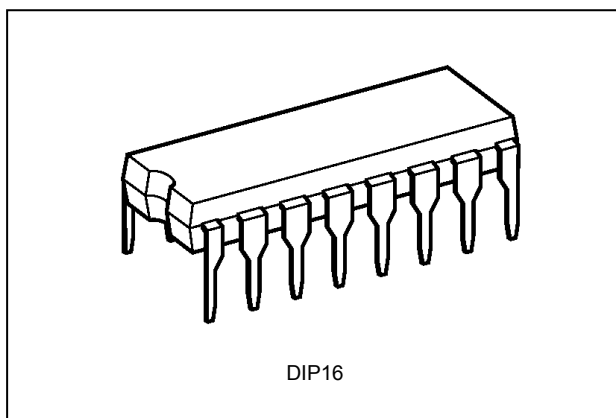
G1,  $\bar{G}2A$ , and  $\bar{G}2B$  inputs are provided to ease cascade connection and for use as an address decoder for memory systems.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.

## 3. Features

- (1) High speed:  $t_{pd} = 5.9$  ns (typ.) at  $V_{CC} = 5.0$  V
- (2) Low power dissipation:  $I_{CC} = 8.0$   $\mu$ A (max) at  $T_a = 25$  °C
- (3) High noise immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (min)
- (4) Output current:  $|I_{OH}|/I_{OL} = 24$  mA (min) ( $V_{CC} = 4.5$  V)
- (5) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (6) Wide operating voltage range:  $V_{CC(opr)} = 2.0$  V to 5.5 V
- (7) Pin and function compatible with 74F138

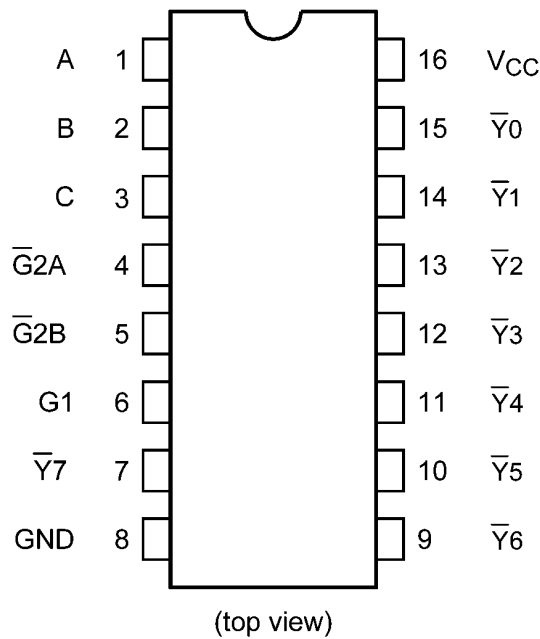
## 4. Packaging



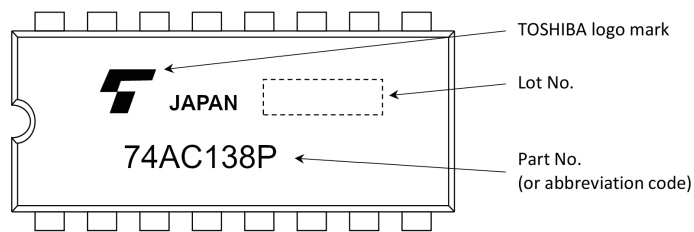
Start of commercial production

1986-05

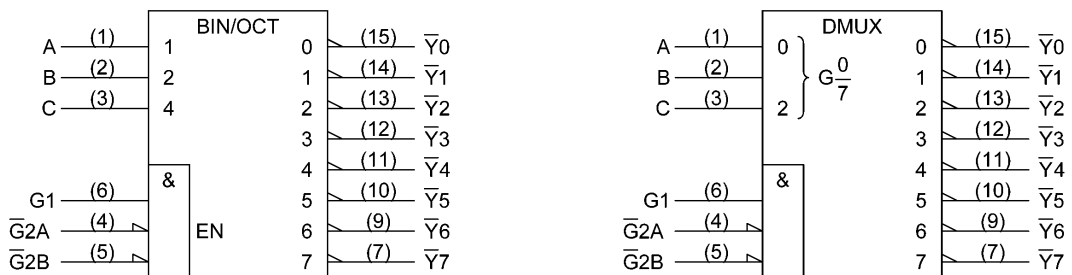
### 5. Pin Assignment



### 6. Marking



### 7. IEC Logic Symbol

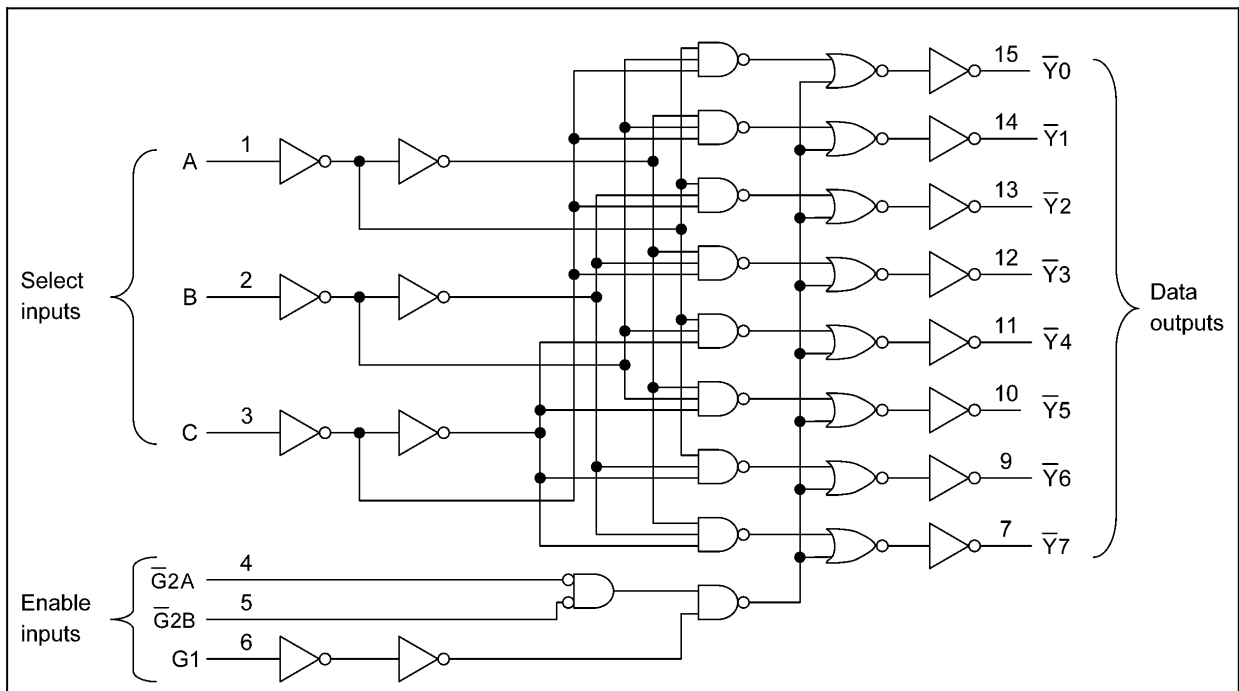


### 8. Truth Table

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	$\bar{G}2A$	$\bar{G}2B$	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 $V_{CC} + 0.5$	
Output voltage	$V_{OUT}$		-0.5 to $V_{CC} + 0.5$	
Input diode current	$I_{IK}$		$\pm 20$	mA
Output diode current	$I_{OK}$		$\pm 50$	
Output current	$I_{OUT}$		$\pm 50$	
$V_{CC}$ /ground current	$I_{CC}$		$\pm 200$	
Power dissipation	$P_D$	(Note 1)	500	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: 500 mW in the range of  $T_a = -40$  to  $65^{\circ}C$ . From  $T_a = 65$  to  $85^{\circ}C$  a derating factor of  $-10$  mW/ $^{\circ}C$  shall be applied until 300 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 $V_{CC}$	
Output voltage	$V_{OUT}$		0 to $V_{CC}$	
Operating temperature	$T_{opr}$		-40 to 85	$^{\circ}C$
Input rise and fall times	$dt/dv$	$V_{CC} = 3.3 \pm 0.3$ V	0 to 100	ns/V
		$V_{CC} = 5.0 \pm 0.5$ V	0 to 20	

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.

### 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	2.10	—	—		
			5.5	3.85	—	—		
Low-level input voltage	$V_{IL}$	—	2.0	—	—	0.50	V	
			3.0	—	—	0.90		
			5.5	—	—	1.65		
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	—	—	
		$I_{OH} = -24\text{ mA}$	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	V
				3.0	—	0.0	0.1	
				4.5	—	0.0	0.1	
			$I_{OL} = 12\text{ mA}$	3.0	—	—	0.36	
			$I_{OL} = 24\text{ mA}$	4.5	—	—	0.36	
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND	5.5	—	—	$\pm 0.1$	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	5.5	—	—	8.0	$\mu\text{A}$	

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

Characteristics	Symbol	Test Condition	Note	$V_{CC}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	V	
				3.0	2.10	—		
				5.5	3.85	—		
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V	
				3.0	—	0.90		
				5.5	—	1.65		
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	—	
			$I_{OH} = -24\text{ mA}$		4.5	3.80	—	
		$I_{OH} = -75\text{ mA}$ (Note 1)	5.5	3.85	—			
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	
			$I_{OL} = 12\text{ mA}$		3.0	—	0.44	
			$I_{OL} = 24\text{ mA}$		4.5	—	0.44	
		$I_{OL} = 74\text{ mA}$ (Note 1)	5.5	—	1.65			
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		5.5	—	$\pm 1.0$	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	80.0	$\mu\text{A}$	

Note 1: This spec indicates the capability of driving  $50\text{ }\Omega$  transmission lines.  
One output should be tested within a 10 ms maximum duration.

### 12.3. AC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Min	Typ.	Max	Unit
Propagation delay time (A, B, C - $\bar{Y}$ )	$t_{PLH}, t_{PHL}$		$C_L = 50\text{ pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	8.5	14.2	ns
				$5.0 \pm 0.5$	—	6.4	9.2	
Propagation delay time (G1 - $\bar{Y}$ )	$t_{PLH}, t_{PHL}$		$C_L = 50\text{ pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	7.5	12.8	ns
				$5.0 \pm 0.5$	—	6.1	8.9	
Propagation delay time ( $\bar{G}2$ - $\bar{Y}$ )	$t_{PLH}, t_{PHL}$		$C_L = 50\text{ pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	8.8	15.0	ns
				$5.0 \pm 0.5$	—	7.2	10.5	
Input capacitance	$C_{IN}$		—	—	5	10	pF	
Power dissipation capacitance	$C_{PD}$	(Note 1)	—	—	143	—	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.

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

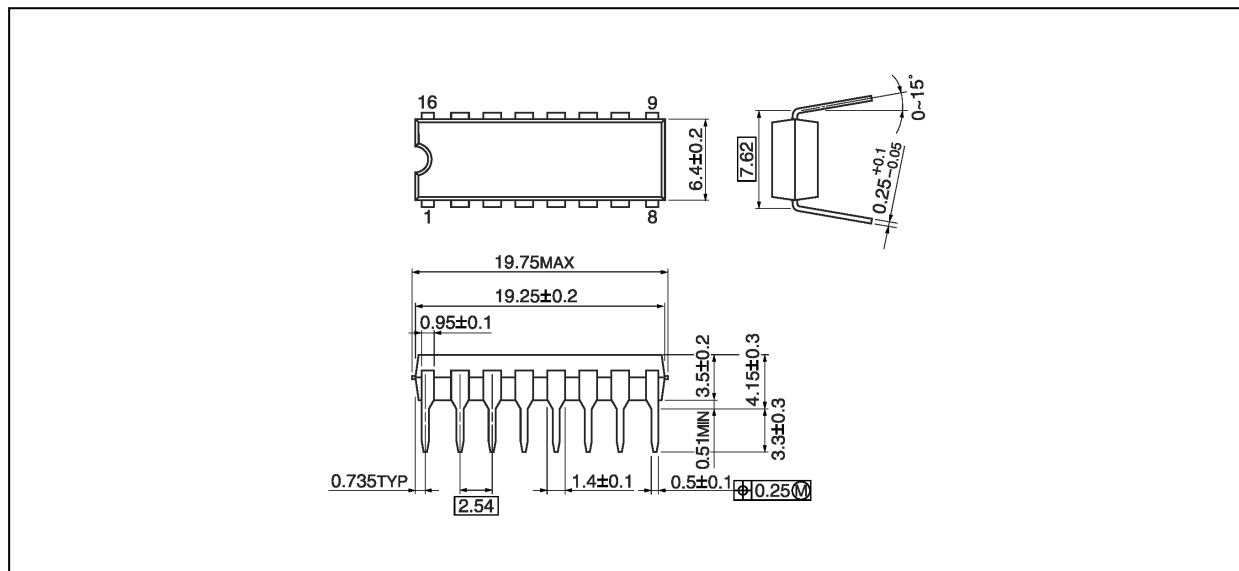
### 12.4. AC Characteristics

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
Propagation delay time (A, B, C - $\bar{Y}$ )	$t_{PLH}, t_{PHL}$	$C_L = 50\text{ pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	1.0	16.3	ns
			$5.0 \pm 0.5$	1.0	10.5	
Propagation delay time (G1 - $\bar{Y}$ )	$t_{PLH}, t_{PHL}$	$C_L = 50\text{ pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	1.0	14.7	ns
			$5.0 \pm 0.5$	1.0	10.2	
Propagation delay time ( $\bar{G}2$ - $\bar{Y}$ )	$t_{PLH}, t_{PHL}$	$C_L = 50\text{ pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	1.0	17.3	ns
			$5.0 \pm 0.5$	1.0	12.0	
Input capacitance	$C_{IN}$	—	—	—	10	pF

### Package Dimensions

Unit: mm



Weight: 1.00 g (typ.)

Package Name(s)
Nickname: DIP16

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