TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74HC238AP, TC74HC238AF

3-to-8 Line Decoder

The TC74HC238A is a high speed CMOS 3-to-8 DECODER fabricated with silicon gate $C^2MOS$ technology.

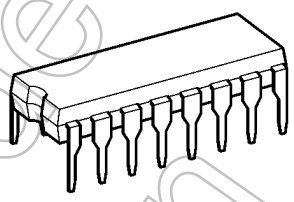
It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

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 $\overline{G}2A$ or $\overline{G}2B$ is held high, decoding function is inhibited and all the outputs go low. G1, $\overline{G}2A$ , and $\overline{G}2B$ inputs are provided ease cascade connection and for use as an adress decoder for memory systems.

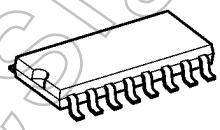
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

TC74HC238AP



DIP16-P-300-2.54A

TC74HC238AF



SOP16-P-300-1.27A

Weight

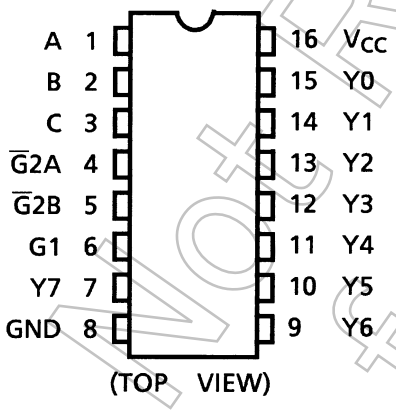
DIP16-P-300-2.54A : 1.00 g (typ.)

SOP16-P-300-1.27A : 0.18 g (typ.)

## Features

- High speed: $t_{pd}$ = 14 ns (typ.) at $V_{CC}$ = 5 V
- Low power dissipation: $I_{CC}$ = 4 μA (max) at Ta = 25°C
- High noise immunity: $V_{NIH} = V_{NIL}$ = 28% $V_{CC}$ (min)
- Output drive capability: 10 LSTTL loads
- Symmetrical output impedance: $|I_{OH}| = I_{OL}$ = 4 mA (min)
- Balanced propagation delays: $t_{pLH} \simeq t_{pHL}$
- Wide operating voltage range: $V_{CC}$ (opr) = 2 to 6 V
- Pin and function compatible with 74LS238

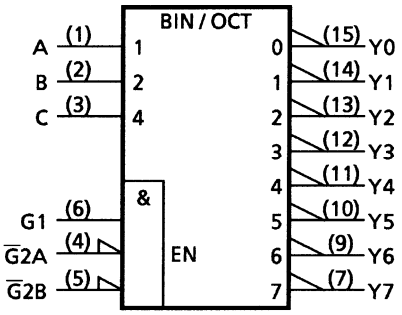
## Pin Assignment

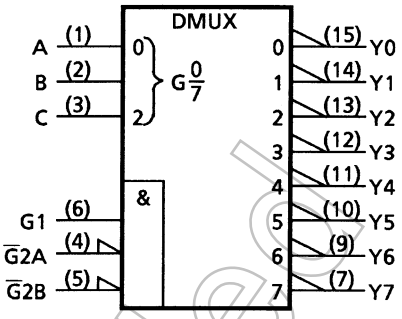





Start of commercial production
1987-11

## IEC Logic Symbol



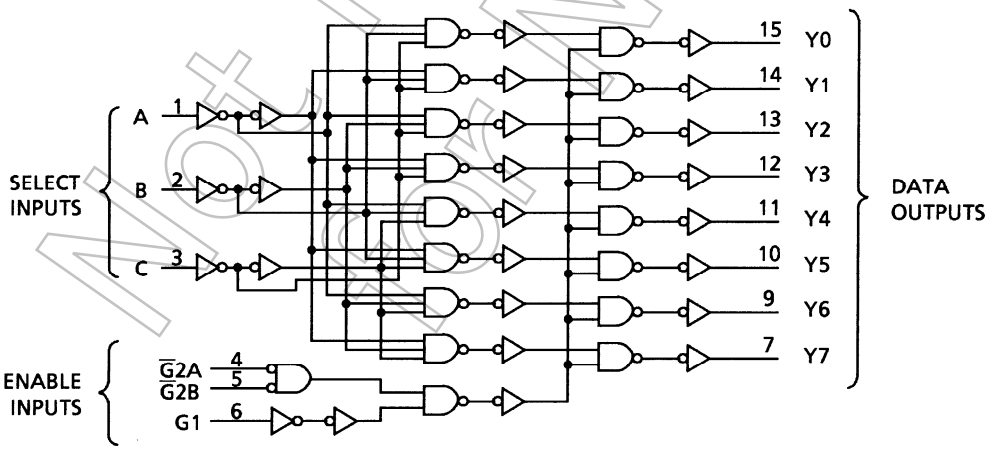




## Truth Table

| Inputs | | | | | | Outputs | | | | | | | | Selected Output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Enable | | | Select | | | Y0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 | |
| G1 | $\overline{G}$2A | $\overline{G}$2B | C | B | A | | | | | | | | | |
| L | X | X | X | X | X | L | L | L | L | L | L | L | L | None |
| X | H | X | X | X | X | L | L | L | L | L | L | L | L | None |
| X | X | H | X | X | X | L | L | L | L | L | L | L | L | None |
| H | L | L | L | L | L | H | L | L | L | L | L | L | L | Y0 |
| H | L | L | L | L | H | L | H | L | L | L | L | L | L | Y1 |
| H | L | L | L | H | L | L | L | H | L | L | L | L | L | Y2 |
| H | L | L | L | H | H | L | L | L | H | L | L | L | L | Y3 |
| H | L | L | H | L | L | L | L | L | L | H | L | L | L | Y4 |
| H | L | L | H | L | H | L | L | L | L | L | H | L | L | Y5 |
| H | L | L | H | H | L | L | L | L | L | L | L | H | L | Y6 |
| H | L | L | H | H | H | L | L | L | L | L | L | L | H | Y7 |

X: Don't care

## System diagram



## Absolute Maximum Ratings (Note 1)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage range | $V_{CC}$ | −0.5 to 7 | V |
| DC input voltage | $V_{IN}$ | −0.5 to $V_{CC}$ + 0.5 | V |
| DC output voltage | $V_{OUT}$ | −0.5 to $V_{CC}$ + 0.5 | V |
| Input diode current | $I_{IK}$ | ±20 | mA |
| Output diode current | $I_{OK}$ | ±20 | mA |
| DC output current | $I_{OUT}$ | ±25 | mA |
| DC $V_{CC}$/ground current | $I_{CC}$ | ±50 | mA |
| Power dissipation | $P_D$ | 500 (DIP) (Note 2)/180 (SOP) | mW |
| Storage temperature | $T_{stg}$ | −65 to 150 | °C |

Note 1: 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 2: 500 mW in the range of Ta = −40°C to 65°C. From Ta = 65°C to 85°C a derating factor of −10 mW/°C shall be applied until 300 mW.

## Operating Ranges (Note)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ | 2 to 6 | V |
| Input voltage | $V_{IN}$ | 0 to $V_{CC}$ | V |
| Output voltage | $V_{OUT}$ | 0 to $V_{CC}$ | V |
| Operating temperature | $T_{opr}$ | −40 to 85 | °C |
| Input rise and fall time | $t_r$, $t_f$ | 0 to 1000 ($V_{CC}$ = 2.0 V)<br>0 to 500 ($V_{CC}$ = 4.5 V)<br>0 to 400 ($V_{CC}$ = 6.0 V) | ns |

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.

## Electrical Characteristics

### DC Characteristics

| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{CC}$ (V) | Min | Typ. | Max | Min | Max | |
| High-level input voltage | $V_{IH}$ | — | | 2.0 | 1.50 | — | — | 1.50 | — | V |
| | | | | 4.5 | 3.15 | — | — | 3.15 | — | |
| | | | | 6.0 | 4.20 | — | — | 4.20 | — | |
| Low-level input voltage | $V_{IL}$ | — | | 2.0 | — | — | 0.50 | — | 0.50 | V |
| | | | | 4.5 | — | — | 1.35 | — | 1.35 | |
| | | | | 6.0 | — | — | 1.80 | — | 1.80 | |
| High-level output voltage | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = −20 μA | 2.0 | 1.9 | 2.0 | — | 1.9 | — | V |
| | | | | 4.5 | 4.4 | 4.5 | — | 4.4 | — | |
| | | | | 6.0 | 5.9 | 6.0 | — | 5.9 | — | |
| | | | $I_{OH}$ = −4 mA | 4.5 | 4.18 | 4.31 | — | 4.13 | — | |
| | | | $I_{OH}$ = −5.2 mA | 6.0 | 5.68 | 5.80 | — | 5.63 | — | |
| Low-level output voltage | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 20 μA | 2.0 | — | 0.0 | 0.1 | | 0.1 | V |
| | | | | 4.5 | — | 0.0 | 0.1 | — | 0.1 | |
| | | | | 6.0 | — | 0.0 | 0.1 | — | 0.1 | |
| | | | $I_{OL}$ = 4 mA | 4.5 | — | 0.17 | 0.26 | — | 0.33 | |
| | | | $I_{OL}$ = 5.2 mA | 6.0 | — | 0.18 | 0.26 | — | 0.33 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ = $V_{CC}$ or GND | | 6.0 | — | — | ±0.1 | — | ±1.0 | μA |
| Quiescent supply current | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 6.0 | — | — | 4.0 | — | 40.0 | μA |

### AC Characteristics ($C_L$ = 15 pF, $V_{CC}$ = 5 V, Ta = 25°C, input: $t_r$ = $t_f$ = 6 ns)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Output transition time | $t_{TLH}$ $t_{THL}$ | — | — | 4 | 8 | ns |
| Propagation delay time (A, B, C-Y) | $t_{pLH}$ $t_{pHL}$ | — | — | 14 | 26 | ns |
| Propagation delay time (G, $\overline{G}$ -Y) | $t_{pLH}$ $t_{pHL}$ | — | — | 14 | 26 | ns |

**AC Characteristics ($C_L$ = 50 pF, input: $t_r = t_f$ = 6 ns)**

| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Min | Typ. | Max | Min | Max | |
| Output transition time | $t_{TLH}$ $t_{THL}$ | — | 2.0 | — | 30 | 75 | — | 95 | ns |
| | | | 4.5 | — | 8 | 15 | — | 19 | |
| | | | 6.0 | — | 7 | 13 | — | 16 | |
| Propagation delay time (A, B, C-Y) | $t_{pLH}$ $t_{pHL}$ | — | 2.0 | — | 50 | 150 | — | 190 | ns |
| | | | 4.5 | — | 17 | 30 | — | 38 | |
| | | | 6.0 | — | 15 | 26 | — | 32 | |
| Propagation delay time (G, $\overline{G}$ -Y) | $t_{pLH}$ $t_{pHL}$ | — | 2.0 | — | 50 | 150 | — | 190 | ns |
| | | | 4.5 | — | 17 | 30 | — | 38 | |
| | | | 6.0 | — | 15 | 26 | — | 32 | |
| Input capacitance | $C_{IN}$ | — | | — | 5 | 10 | — | 10 | pF |
| Power dissipation capacitance | $C_{PD}$ (Note) | — | | — | 53 | — | — | — | pF |

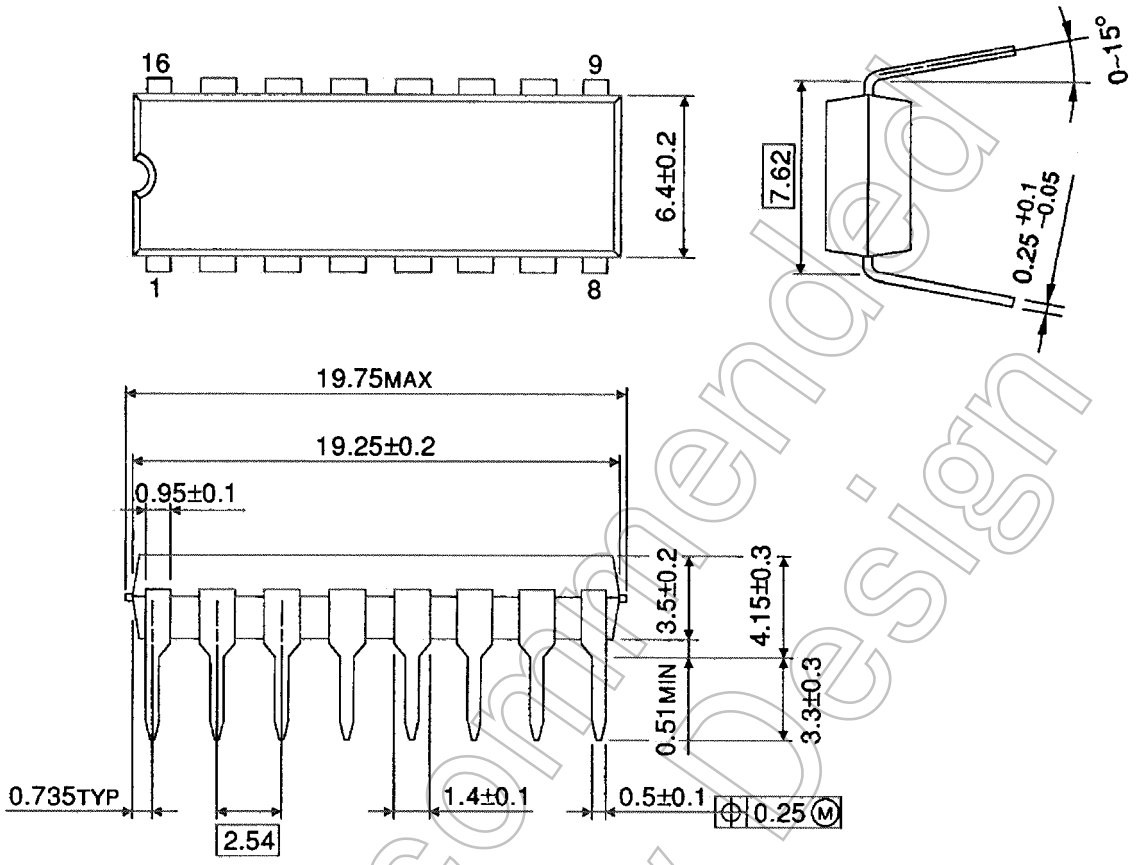
Note: $C_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

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

## Package Dimensions

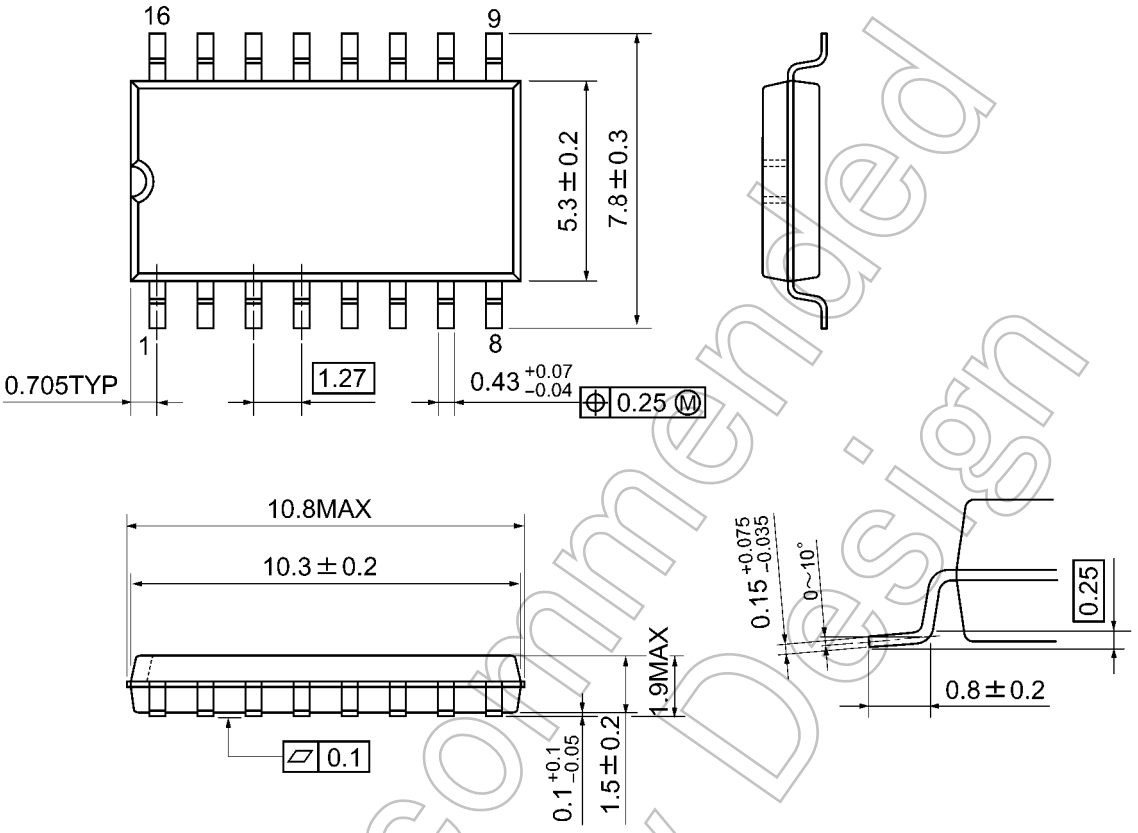
DIP16-P-300-2.54A Unit : mm




Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A Unit: mm




Weight: 0.18 g (typ.)

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