

74HC238-Q100; 74HCT238-Q100

3-to-8 line decoder/demultiplexer

Rev. 1 — 19 February 2013

Product data sheet

1. General description

The 74HC_HCT238_Q100 decodes three binary weighted address inputs (A0, A1 and A2) to eight mutually exclusive outputs (Y0 to Y7). The device features three enable inputs ($\bar{E}1$, $\bar{E}2$ and E3). Every output is LOW unless $\bar{E}1$ and $\bar{E}2$ are LOW and E3 is HIGH. This multiple enable function allows easy parallel expansion to a 1-of-32 (5 to 32 lines) decoder with just four 74HC_HCT238_Q100 ICs and one inverter. The 74HC_HCT238_Q100 can be used as an eight output demultiplexer by using one of the active LOW enable inputs as the data input and the remaining enable inputs as strobes. Inputs include clamp diodes that enable the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} .

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
 - ◆ Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- Input levels:
 - ◆ For 74HC238-Q100: CMOS level
 - ◆ For 74HCT238-Q100: TTL level
- Demultiplexing capability
- Multiple input enable for easy expansion
- Ideal for memory chip select decoding
- Active HIGH mutually exclusive outputs
- Multiple package options
- Complies with JEDEC standard no. 7A
- ESD protection:
 - ◆ MIL-STD-883, method 3015 exceeds 2000 V
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V ($C = 200\text{ pF}$, $R = 0\ \Omega$)

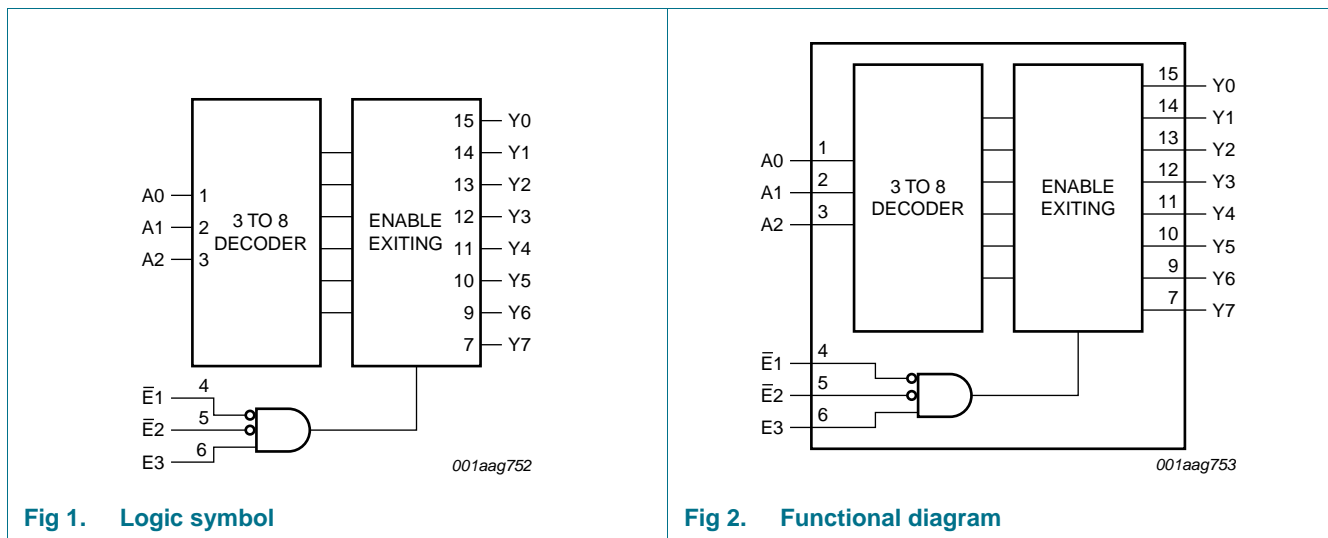


3. Ordering information

Table 1. Ordering information

| Type number | Package | | | Version |
|-----------------|-------------------|----------|--|----------|
| | Temperature range | Name | Description | |
| 74HC238D-Q100 | -40 °C to +125 °C | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |
| 74HC238PW-Q100 | -40 °C to +125 °C | TSSOP16 | plastic thin shrink small outline package; 16 leads; body width 4.4 mm | SOT403-1 |
| 74HC238BQ-Q100 | -40 °C to +125 °C | DHVQFN16 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 × 3.5 × 0.85 mm | SOT763-1 |
| 74HCT238D-Q100 | -40 °C to +125 °C | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |
| 74HCT238PW-Q100 | -40 °C to +125 °C | TSSOP16 | plastic thin shrink small outline package; 16 leads; body width 4.4 mm | SOT403-1 |
| 74HCT238BQ-Q100 | -40 °C to +125 °C | DHVQFN16 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 × 3.5 × 0.85 mm | SOT763-1 |

4. Functional diagram



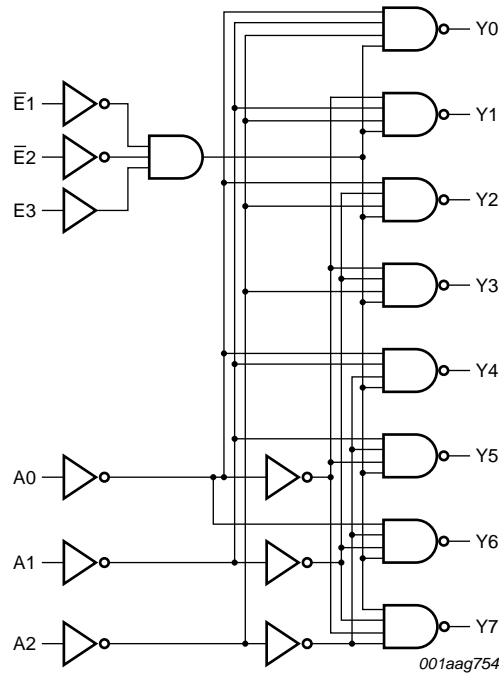


Fig 3. Logic diagram

5. Pinning information

5.1 Pinning

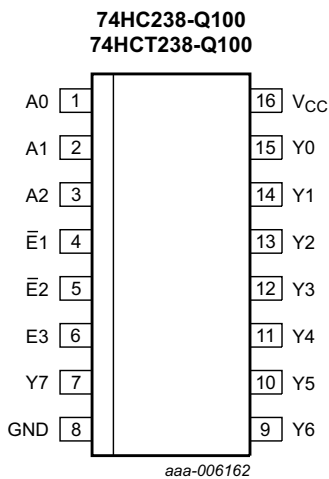
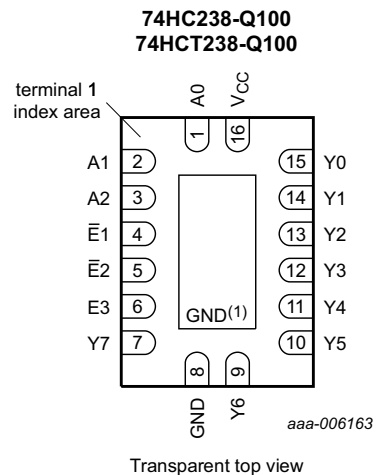


Fig 4. Pin configuration SO16 and TSSOP16



- Transparent top view
- (1) This is not a supply pin. The substrate is attached to this pad using conductive die attach material. There is no electrical or mechanical requirement to solder this pad. However, if it is soldered, the solder land should remain floating or be connected to GND.

Fig 5. Pin configuration DHVQFN16

5.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|-----------------|------------------------------|----------------------------|
| A[0:2] | 1, 2, 3 | address input |
| $\bar{E}1$ | 4 | enable input (active LOW) |
| $\bar{E}2$ | 5 | enable input (active LOW) |
| E3 | 6 | enable input (active HIGH) |
| Y[0:7] | 15, 14, 13, 12, 11, 10, 9, 7 | output (active HIGH) |
| GND | 8 | ground (0 V) |
| V _{CC} | 16 | supply voltage |

6. Functional description

Table 3. Function table^[1]

| Inputs | | | | | | Outputs | | | | | | | |
|------------|------------|----|----|----|----|---------|----|----|----|----|----|----|----|
| $\bar{E}1$ | $\bar{E}2$ | E3 | A0 | A1 | A2 | Y0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 |
| H | X | X | X | X | X | L | L | L | L | L | L | L | L |
| X | H | X | X | X | X | L | L | L | L | L | L | L | L |
| X | X | L | X | X | X | L | L | L | L | L | L | L | L |
| L | L | H | L | L | L | H | L | L | L | L | L | L | L |
| L | L | H | H | L | L | L | H | L | L | L | L | L | L |
| L | L | H | L | H | L | L | L | H | L | L | L | L | L |
| L | L | H | H | H | L | L | L | L | H | L | L | L | L |
| L | L | H | L | L | H | L | L | L | L | H | L | L | L |
| L | L | H | H | L | H | L | L | L | L | L | H | L | L |
| L | L | H | L | H | H | L | L | L | L | L | L | H | L |
| L | L | H | H | H | H | L | L | L | L | L | L | L | H |

[1] H = HIGH voltage level;
 L = LOW voltage level;
 X = don't care.

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------|-------------------------|--|-------|------|------|
| V_{CC} | supply voltage | | -0.5 | +7 | V |
| I_{IK} | input clamping current | $V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ | [1] - | ±20 | mA |
| I_{OK} | output clamping current | $V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ | [1] - | ±20 | mA |
| I_O | output current | $-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$ | - | ±25 | mA |
| I_{CC} | supply current | | - | 50 | mA |
| I_{GND} | ground current | | -50 | - | mA |
| T_{stg} | storage temperature | | -65 | +150 | °C |
| P_{tot} | total power dissipation | | [2] - | 500 | mW |

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] For SO16 packages: above 70 °C the value of P_{tot} derates linearly at 8 mW/K.

For TSSOP16 packages: above 60 °C the value of P_{tot} derates linearly at 5.5 mW/K.

For DHVQFN16 packages: above 60 °C the value of P_{tot} derates linearly at 4.5 mW/K.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | 74HC238-Q100 | | | 74HCT238-Q100 | | | Unit |
|---------------------|-------------------------------------|-------------------------|--------------|------|----------|---------------|------|----------|------|
| | | | Min | Typ | Max | Min | Typ | Max | |
| V_{CC} | supply voltage | | 2.0 | 5.0 | 6.0 | 4.5 | 5.0 | 5.5 | V |
| V_I | input voltage | | 0 | - | V_{CC} | 0 | - | V_{CC} | V |
| V_O | output voltage | | 0 | - | V_{CC} | 0 | - | V_{CC} | V |
| T_{amb} | ambient temperature | | -40 | - | +125 | -40 | - | +125 | °C |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.0\text{ V}$ | - | - | 625 | - | - | - | ns/V |
| | | $V_{CC} = 4.5\text{ V}$ | - | 1.67 | 139 | - | 1.67 | 139 | ns/V |
| | | $V_{CC} = 6.0\text{ V}$ | - | - | 83 | - | - | - | ns/V |

9. Static characteristics

Table 6. Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit | | | | | | |
|---------------------|---------------------------|---|----------------|--|-------------------|----------------------|--------------------------|----------------------------------|------|------|-----|-----|----|-----|---|---|
| | | | Min | Typ | Max | Min | Max | Min | Max | | | | | | | |
| 74HC238-Q100 | | | | | | | | | | | | | | | | |
| V _{IH} | HIGH-level input voltage | V _{CC} = 2.0 V | 1.5 | 1.2 | - | 1.5 | - | 1.5 | - | V | | | | | | |
| | | V _{CC} = 4.5 V | 3.15 | 2.4 | - | 3.15 | - | 3.15 | - | V | | | | | | |
| | | V _{CC} = 6.0 V | 4.2 | 3.2 | - | 4.2 | - | 4.2 | - | V | | | | | | |
| V _{IL} | LOW-level input voltage | V _{CC} = 2.0 V | - | 0.8 | 0.5 | - | 0.5 | - | 0.5 | V | | | | | | |
| | | V _{CC} = 4.5 V | - | 2.1 | 1.35 | - | 1.35 | - | 1.35 | V | | | | | | |
| | | V _{CC} = 6.0 V | - | 2.8 | 1.8 | - | 1.8 | - | 1.8 | V | | | | | | |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} | | | | | | | | | | | | | | |
| | | I _O = -20 μA; V _{CC} = 2.0 V | 1.9 | 2.0 | - | 1.9 | - | 1.9 | - | V | | | | | | |
| | | I _O = -20 μA; V _{CC} = 4.5 V | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V | | | | | | |
| | | I _O = -20 μA; V _{CC} = 6.0 V | 5.9 | 6.0 | - | 5.9 | - | 5.9 | - | V | | | | | | |
| | | I _O = -4.0 mA; V _{CC} = 4.5 V | 3.98 | 4.32 | - | 3.84 | - | 3.7 | - | V | | | | | | |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} | | | | | | | | | | | | | | |
| | | I _O = 20 μA; V _{CC} = 2.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V | | | | | | |
| | | I _O = 20 μA; V _{CC} = 4.5 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V | | | | | | |
| | | I _O = 20 μA; V _{CC} = 6.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V | | | | | | |
| | | I _O = 4.0 mA; V _{CC} = 4.5 V | - | 0.15 | 0.26 | - | 0.33 | - | 0.4 | V | | | | | | |
| I _I | input leakage current | V _I = V _{CC} or GND; V _{CC} = 6.0 V | - | - | ±0.1 | - | ±1.0 | - | ±1.0 | μA | | | | | | |
| | | I _{CC} | supply current | V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V | - | - | 8.0 | - | 80 | - | 160 | μA | | | | |
| | | | | C _I | input capacitance | | - | 3.5 | - | - | - | - | pF | | | |
| | | | | | | 74HCT238-Q100 | | | | | | | | | | |
| | | | | | | V _{IH} | HIGH-level input voltage | V _{CC} = 4.5 V to 5.5 V | 2.0 | 1.6 | - | 2.0 | - | 2.0 | - | V |
| V _{IL} | LOW-level input voltage | V _{CC} = 4.5 V to 5.5 V | - | 1.2 | 0.8 | - | 0.8 | - | 0.8 | V | | | | | | |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V | | | | | | | | | | | | | | |
| | | I _O = -20 μA | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V | | | | | | |
| | | I _O = -4.0 mA | 3.98 | 4.32 | - | 3.84 | - | 3.7 | - | V | | | | | | |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V | | | | | | | | | | | | | | |
| | | I _O = 20 μA | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V | | | | | | |
| | | I _O = 4.0 mA | - | 0.16 | 0.26 | - | 0.33 | - | 0.4 | V | | | | | | |
| I _I | input leakage current | V _I = V _{CC} or GND; V _{CC} = 5.5 V | - | - | ±0.1 | - | ±1.0 | - | ±1.0 | μA | | | | | | |

Table 6. Static characteristics ...continued

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|-----------------|---------------------------|--|-------|-----|-----|------------------|-----|-------------------|-----|---------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| I_{CC} | supply current | $V_I = V_{CC}$ or GND; $V_{CC} = 5.5$ V; $I_O = 0$ A | - | - | 8.0 | - | 80 | - | 160 | μ A |
| ΔI_{CC} | additional supply current | per input pin; $V_I = V_{CC} - 2.1$ V; other inputs at V_{CC} or GND; $V_{CC} = 4.5$ V to 5.5 V; $I_O = 0$ A | | | | | | | | |
| | | An inputs | - | 70 | 252 | - | 315 | - | 343 | μ A |
| | | $\bar{E}1, \bar{E}2$ inputs | - | 40 | 144 | - | 180 | - | 196 | μ A |
| | | E3 input | - | 145 | 522 | - | 653 | - | 711 | μ A |
| C_I | input capacitance | | - | 3.5 | - | - | - | - | pF | |

10. Dynamic characteristics

Table 7. Dynamic characteristics

$GND = 0$ V; test circuit see [Figure 8](#).

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +125 °C | | Unit |
|--------|-----------|------------|-------|-----|-----|-------------------|--------------|------|
| | | | Min | Typ | Max | Max (85 °C) | Max (125 °C) | |

74HC238-Q100

| | | | | | | | | | |
|---------------------------------|-------------------------------|---|-----|----|-----|-----|-----|----|----|
| t_{pd} | propagation delay | An to Y_n ; see Figure 6 | [1] | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 47 | 150 | 190 | 225 | ns | |
| | | $V_{CC} = 4.5$ V | - | 17 | 30 | 38 | 45 | ns | |
| | | $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 14 | - | - | - | ns | |
| | | $V_{CC} = 6.0$ V | - | 14 | 26 | 33 | 38 | ns | |
| | | E3 to Y_n ; see Figure 6 | [1] | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 52 | 160 | 200 | 240 | ns | |
| | | $V_{CC} = 4.5$ V | - | 19 | 32 | 40 | 48 | ns | |
| | | $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 16 | - | - | - | ns | |
| | | $V_{CC} = 6.0$ V | - | 15 | 27 | 34 | 41 | ns | |
| | | \bar{E}_n to Y_n or see Figure 7 | [1] | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 50 | 155 | 195 | 235 | ns | |
| | | $V_{CC} = 4.5$ V | - | 18 | 31 | 39 | 47 | ns | |
| $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 17 | - | - | - | ns | | | |
| $V_{CC} = 6.0$ V | - | 14 | 26 | 33 | 40 | ns | | | |
| t_t | transition time | see Figure 6 and Figure 7 | [2] | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 19 | 75 | 95 | 110 | ns | |
| | | $V_{CC} = 4.5$ V | - | 7 | 15 | 19 | 22 | ns | |
| | | $V_{CC} = 6.0$ V | - | 6 | 13 | 16 | 19 | ns | |
| C_{PD} | power dissipation capacitance | per package; $V_I = GND$ to V_{CC} | [3] | - | 72 | - | - | - | pF |

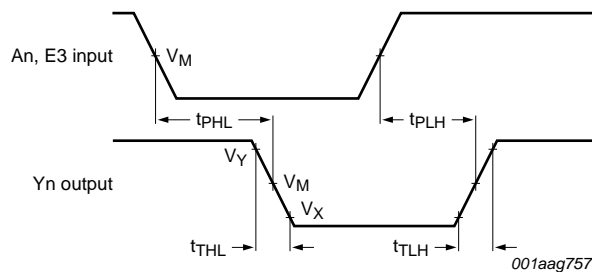
Table 7. Dynamic characteristics

$GND = 0\text{ V}$; test circuit see [Figure 8](#).

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +125 °C | | Unit | |
|----------------------|-------------------------------|--|-------|-----|-----|-------------------|--------------|------|----|
| | | | Min | Typ | Max | Max (85 °C) | Max (125 °C) | | |
| 74HCT238-Q100 | | | | | | | | | |
| t_{pd} | propagation delay | An to Yn; see Figure 6 | [1] | | | | | | |
| | | $V_{CC} = 4.5\text{ V}$ | - | 19 | 35 | 44 | 53 | ns | |
| | | $V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$ | - | 18 | - | - | - | ns | |
| | | E3 to Yn; see Figure 6 | [1] | | | | | | |
| | | $V_{CC} = 4.5\text{ V}$ | - | 20 | 37 | 46 | 56 | ns | |
| | | $V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$ | - | 20 | - | - | - | ns | |
| | | $\bar{E}n$ to Yn or see Figure 7 | [1] | | | | | | |
| | | $V_{CC} = 4.5\text{ V}$ | - | 20 | 35 | 44 | 53 | ns | |
| | | $V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$ | - | 21 | - | - | - | ns | |
| t_t | transition time | $V_{CC} = 4.5\text{ V}$; see Figure 6 and Figure 7 | [2] | - | 7 | 15 | 19 | 22 | ns |
| C_{PD} | power dissipation capacitance | per package; $V_I = GND$ to $V_{CC} - 1.5\text{ V}$ | [3] | - | 76 | - | - | - | pF |

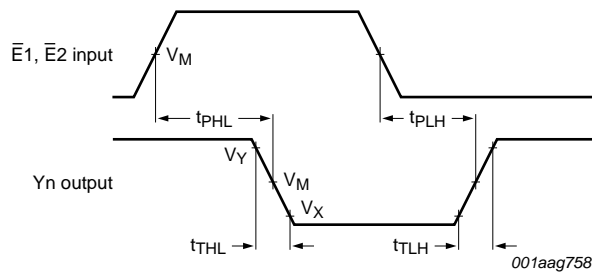
- [1] t_{pd} is the same as t_{PHL} and t_{PLH} .
- [2] t_t is the same as t_{THL} and t_{TLH} .
- [3] C_{PD} is used to determine the dynamic power dissipation (P_D in μW):
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum (C_L \times V_{CC}^2 \times f_o)$ where:
 f_i = input frequency in MHz;
 f_o = output frequency in MHz;
 C_L = output load capacitance in pF;
 V_{CC} = supply voltage in V;
 N = number of inputs switching;
 $\sum (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs.

11. Waveforms



Measurement points are given in [Table 8](#).
 V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Fig 6. Input (An, E3) to output (Yn) propagation delays and output transition times



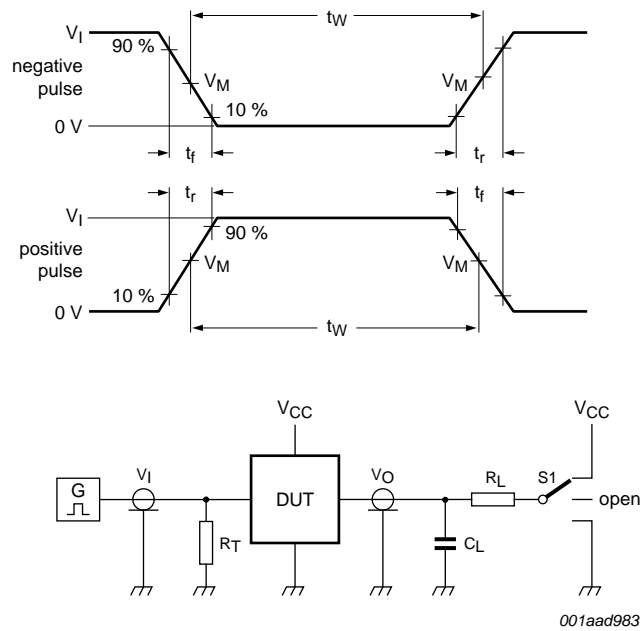
Measurement points are given in [Table 8](#).

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Fig 7. Input ($\bar{E}1, \bar{E}2$) to output (Yn) propagation delays and output transition times

Table 8. Measurement points

| Type | Input | Output | | |
|---------------|-------------|-------------|-------------|-------------|
| | V_M | V_M | V_X | V_Y |
| 74HC238-Q100 | $0.5V_{CC}$ | $0.5V_{CC}$ | $0.1V_{CC}$ | $0.9V_{CC}$ |
| 74HCT238-Q100 | 1.3 V | 1.3 V | $0.1V_{CC}$ | $0.9V_{CC}$ |



Test data is given in [Table 9](#).

Definitions for test circuit:

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

C_L = Load capacitance including jig and probe capacitance.

R_L = Load resistance.

S1 = Test selection switch

Fig 8. Load circuit for measuring switching times

Table 9. Test data

| Type | Input | | Load | | S1 position |
|---------------|----------|------------|--------------|--------------|--------------------|
| | V_I | t_r, t_f | C_L | R_L | t_{PHL}, t_{PLH} |
| 74HC238-Q100 | V_{CC} | 6 ns | 15 pF, 50 pF | 1 k Ω | open |
| 74HCT238-Q100 | 3 V | 6 ns | 15 pF, 50 pF | 1 k Ω | open |

12. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

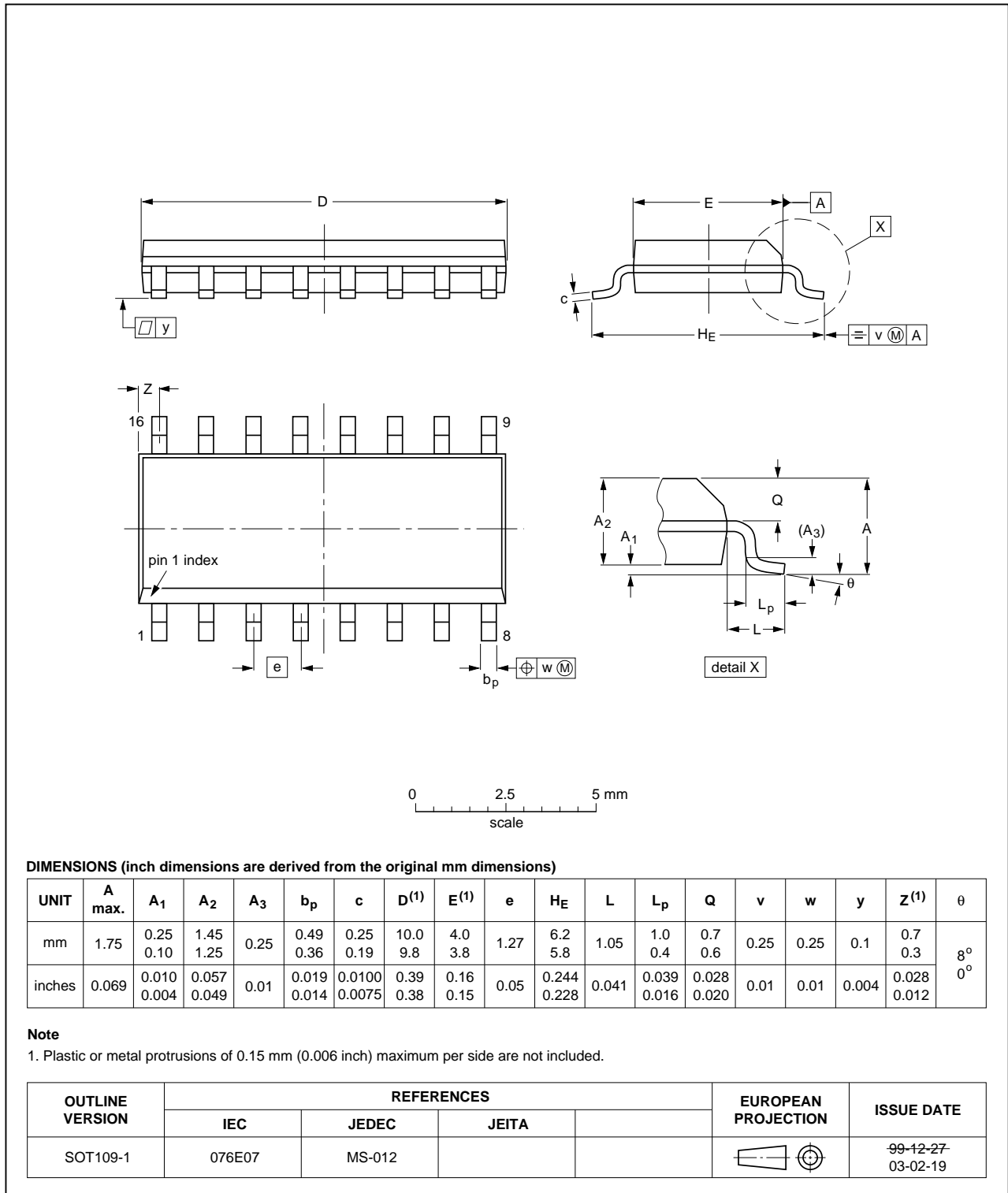


Fig 9. Package outline SOT109-1 (SO16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1

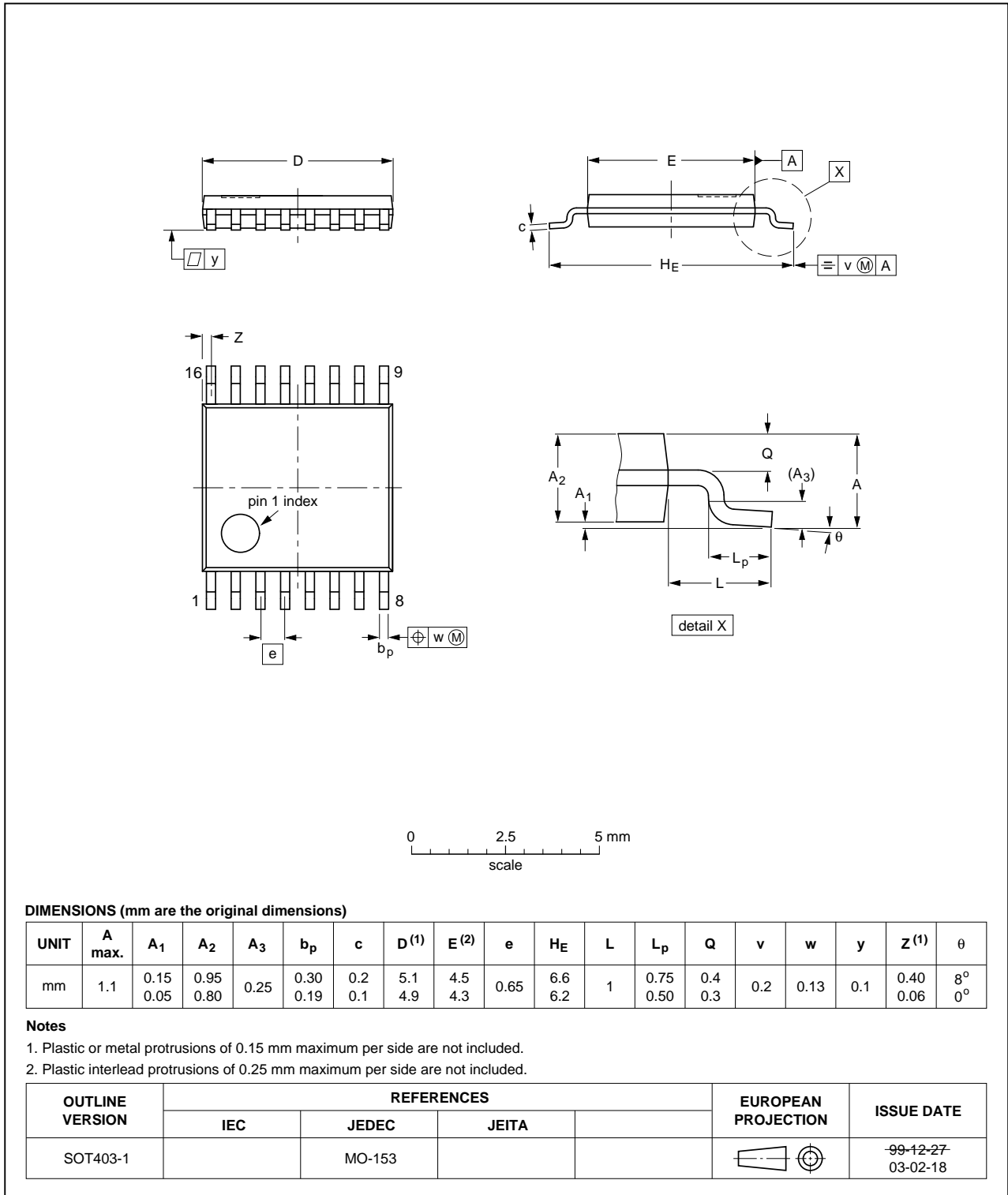


Fig 10. Package outline SOT403-1 (TSSOP16)

DHVQFN16: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 x 3.5 x 0.85 mm

SOT763-1

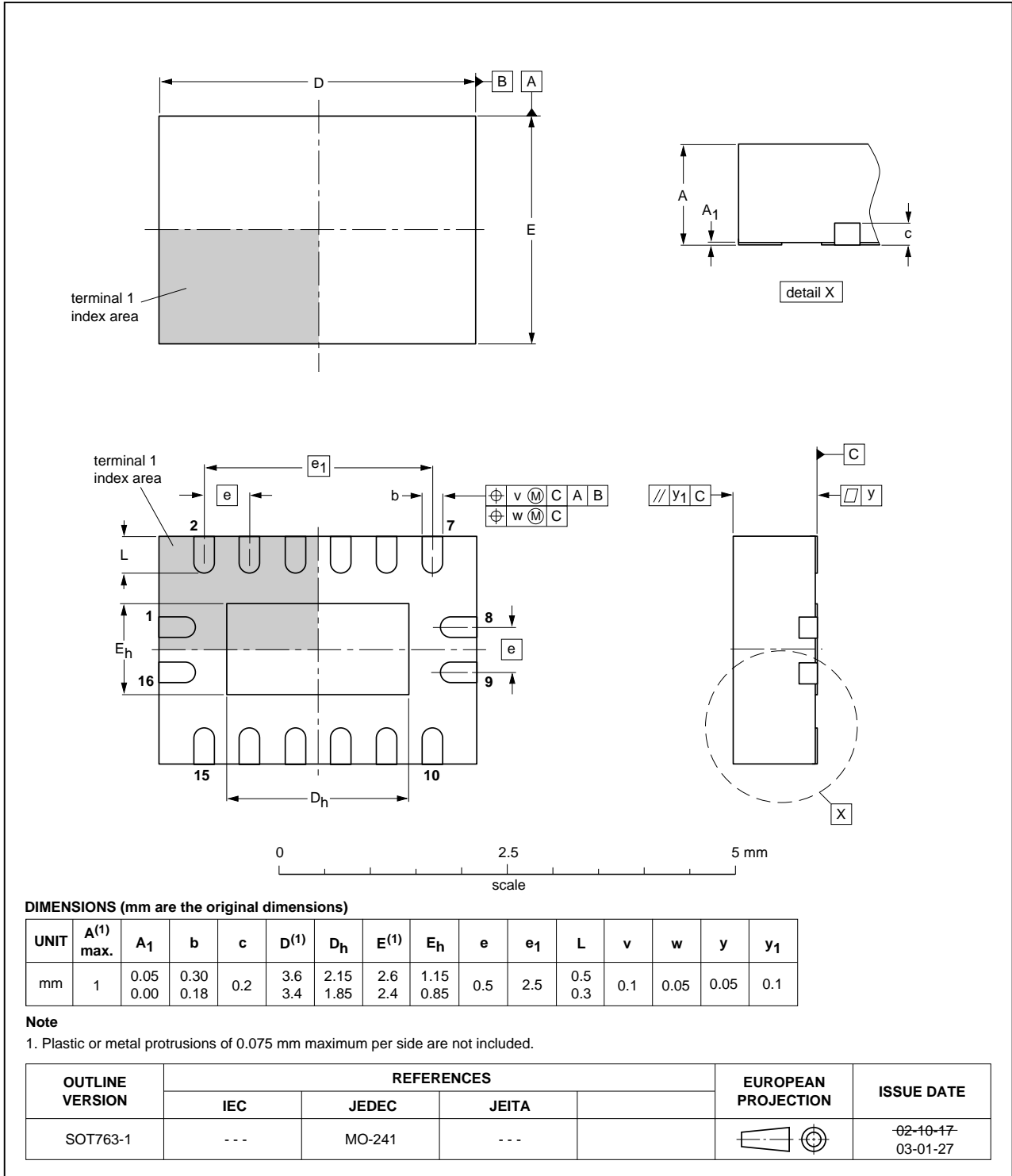


Fig 11. Package outline SOT763-1 (DHVQFN16)

13. Abbreviations

Table 10. Abbreviations

| Acronym | Description |
|---------|---|
| CMOS | Complementary Metal Oxide Semiconductor |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |
| MIL | Military |
| TTL | Transistor-Transistor Logic |

14. Revision history

Table 11. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------------|--------------|--------------------|---------------|------------|
| 74HC_HCT238_Q100 v.1 | 20130219 | Product data sheet | - | - |

15. Legal information

15.1 Data sheet status

| Document status ^{[1][2]} | Product status ^[3] | Definition |
|-----------------------------------|-------------------------------|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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