

74AHC138-Q100; 74AHCT138-Q100

3-to-8 line decoder/demultiplexer; inverting

Rev. 2 — 2 April 2014

Product data sheet

1. General description

The 74AHC138-Q100; 74AHCT138-Q100 are high-speed Si-gate CMOS devices and are pin compatible with Low-power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard No. 7A.

The 74AHC138-Q100; 74AHCT138-Q100 is a 3-to-8 line decoder/demultiplexer. It accepts three binary weighted address inputs (A_0 , A_1 and A_2). When enabled, it provides eight mutually exclusive outputs (\bar{Y}_0 to \bar{Y}_7) that are LOW when selected. There are three enable inputs: two active LOW (\bar{E}_1 and \bar{E}_2) and one active HIGH (E_3). Every output is HIGH unless \bar{E}_1 and \bar{E}_2 are LOW and E_3 is HIGH.

This multiple enable function, allows easy parallel expansion of the device to a 1-of-32 (5 lines to 32 lines) decoder with just four 74AHC138-Q100; 74AHCT138-Q100 devices and one inverter. The 74AHC138-Q100; 74AHCT138-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. Unused enable inputs must be permanently tied to their appropriate active HIGH or LOW state.

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

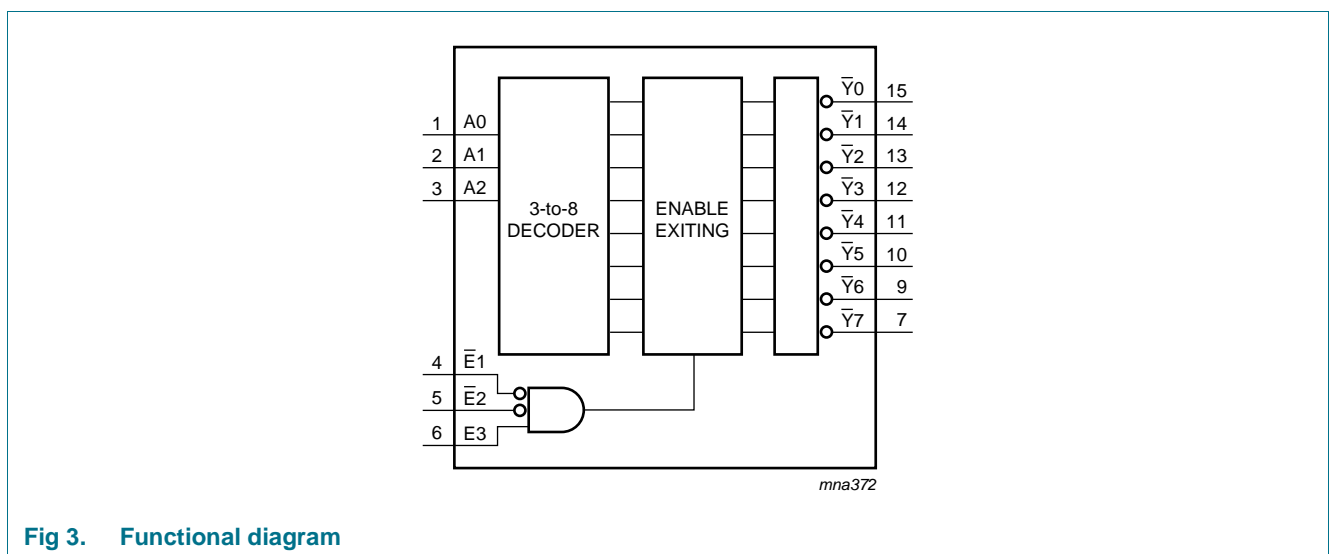
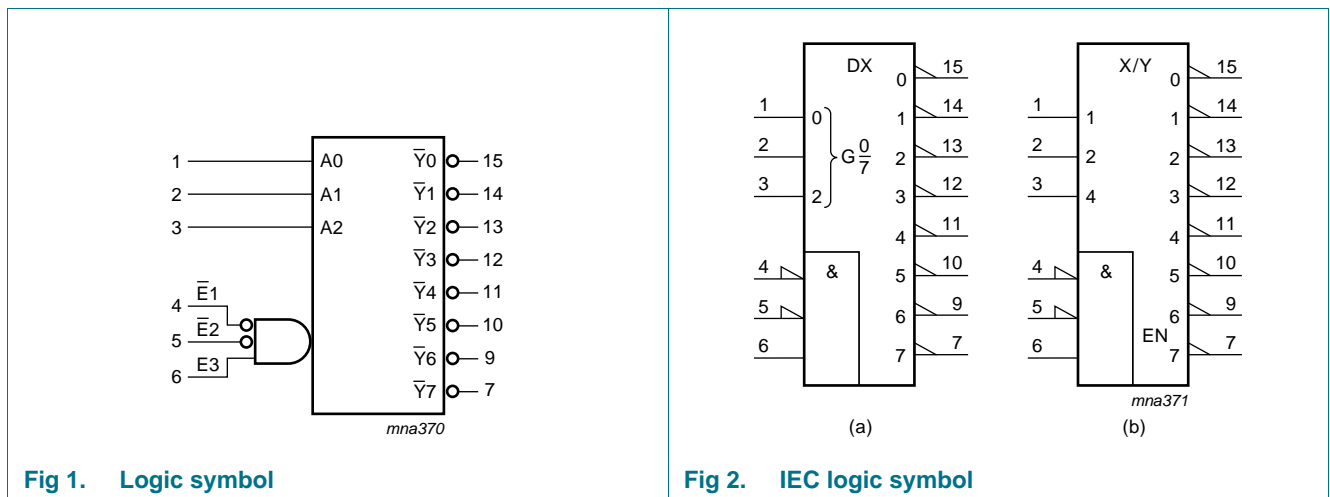
- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
 - ◆ Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- Balanced propagation delays
- All inputs have Schmitt-trigger action
- Demultiplexing capability
- Multiple input enable for easy expansion
- Ideal for memory chip select decoding
- Inputs accept voltages higher than V_{CC}
- For 74AHC138-Q100 only: operates with CMOS input levels
- For 74AHCT138-Q100 only: operates with TTL input levels
- ESD protection:
 - ◆ MIL-STD-883, method 3015 exceeds 2000 V
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V ($C = 200\text{ pF}$, $R = 0\text{ }\Omega$)
- Multiple package options

3. Ordering information

Table 1. Ordering information

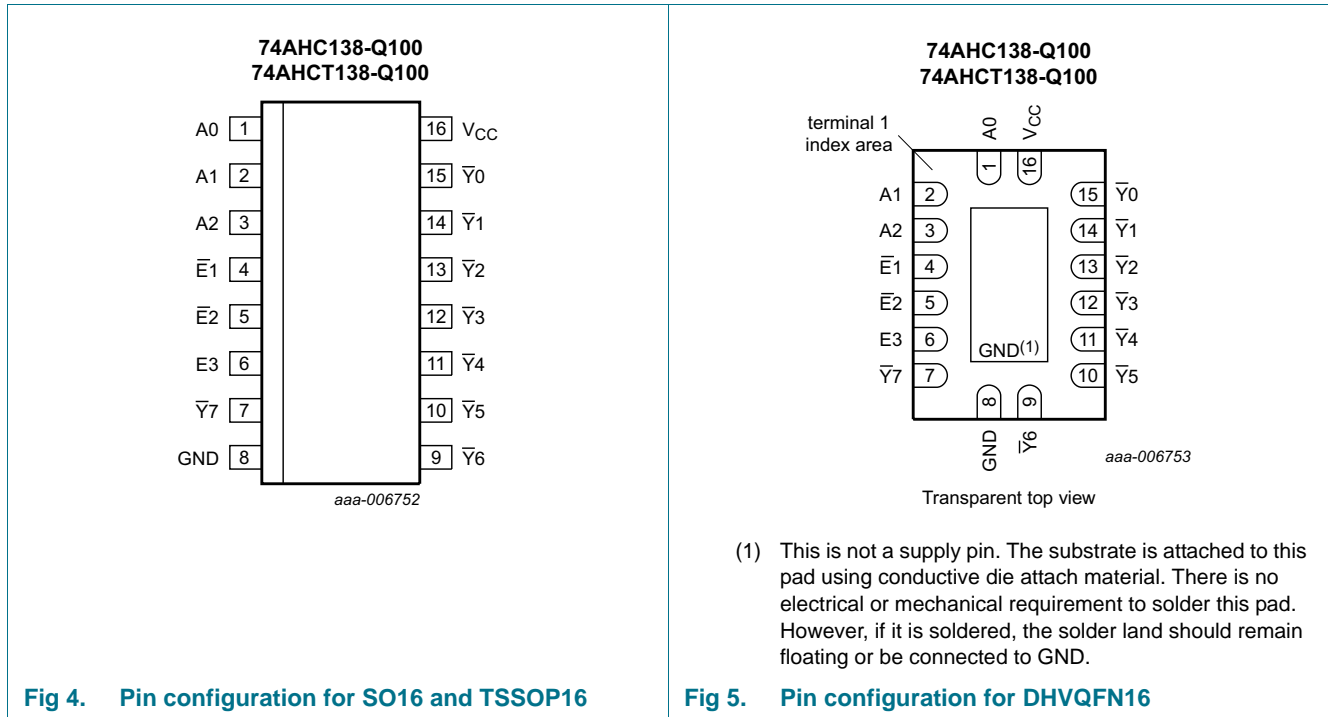
| Type number | Package | | | Version |
|------------------|-------------------|----------|--|----------|
| | Temperature range | Name | Description | |
| 74AHC138D-Q100 | -40 °C to +125 °C | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |
| 74AHCT138D-Q100 | | | | |
| 74AHC138PW-Q100 | -40 °C to +125 °C | TSSOP16 | plastic thin shrink small outline package; 16 leads; body width 4.4 mm | SOT403-1 |
| 74AHCT138PW-Q100 | | | | |
| 74AHC138BQ-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 |
| 74AHCT138BQ-Q100 | | | | |

4. Functional diagram



5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|--------------------------|------------------------------|----------------------------|
| A0 | 1 | address input |
| A1 | 2 | address input |
| A2 | 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) |
| GND | 8 | ground (0 V) |
| $\bar{Y}0$ to $\bar{Y}7$ | 15, 14, 13, 12, 11, 10, 9, 7 | output |
| V _{CC} | 16 | supply voltage |

6. Functional description

Table 3. Function table [1]

| Input | | | | | | Output | | | | | | | |
|------------|------------|----|----|----|----|------------|------------|------------|------------|------------|------------|------------|------------|
| $\bar{E}1$ | $\bar{E}2$ | E3 | A0 | A1 | A2 | $\bar{Y}0$ | $\bar{Y}1$ | $\bar{Y}2$ | $\bar{Y}3$ | $\bar{Y}4$ | $\bar{Y}5$ | $\bar{Y}6$ | $\bar{Y}7$ |
| H | X | X | X | X | X | H | H | H | H | H | H | H | H |
| X | H | X | X | X | X | H | H | H | H | H | H | H | H |
| X | X | L | X | X | X | H | H | H | H | H | H | H | H |
| L | L | H | L | L | L | L | H | H | H | H | H | H | H |
| L | L | H | H | L | L | H | L | H | H | H | H | H | H |
| L | L | H | L | H | L | H | H | L | H | H | H | H | H |
| L | L | H | H | H | L | H | H | H | L | H | H | H | H |
| L | L | H | L | L | H | H | H | H | H | L | H | H | H |
| L | L | H | H | L | H | H | H | H | H | H | L | H | H |
| L | L | H | L | H | H | H | H | H | H | H | H | L | H |
| L | L | H | H | H | H | H | H | H | H | H | H | H | L |

[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 | +7.0 | V |
| V_I | input voltage | | -0.5 | +7.0 | V |
| I_{IK} | input clamping current | $V_I < -0.5$ V | [1] -20 | - | mA |
| I_{OK} | output clamping current | $V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V | [1] - | ±20 | mA |
| I_O | output current | $V_O = -0.5$ V to $(V_{CC} + 0.5$ V) | - | ±25 | mA |
| I_{CC} | supply current | | - | 75 | mA |
| I_{GND} | ground current | | -75 | - | mA |
| T_{stg} | storage temperature | | -65 | +150 | °C |
| P_{tot} | total power dissipation | $T_{amb} = -40$ °C to +125 °C | | | |
| | SO16 package | | [2] - | 500 | mW |
| | TSSOP16 package | | [3] - | 500 | mW |
| | DHVQFN16 package | | [4] - | 500 | mW |

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

[2] P_{tot} derates linearly with 8 mW/K above 70 °C.

[3] P_{tot} derates linearly with 5.5 mW/K above 60 °C.

[4] P_{tot} derates linearly with 4.5 mW/K above 60 °C.

8. Recommended operating conditions

Table 5. Recommended operating conditions

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

| Symbol | Parameter | Conditions | 74AHC138-Q100 | | | 74AHCT138-Q100 | | | Unit |
|------------------|-------------------------------------|---------------------------------|---------------|-----|-----------------|----------------|-----|-----------------|------|
| | | | Min | Typ | Max | Min | Typ | Max | |
| V _{CC} | supply voltage | | 2.0 | 5.0 | 5.5 | 4.5 | 5.0 | 5.5 | V |
| V _I | input voltage | | 0 | - | 5.5 | 0 | - | 5.5 | V |
| V _O | output voltage | | 0 | - | V _{CC} | 0 | - | V _{CC} | V |
| T _{amb} | ambient temperature | | -40 | +25 | +125 | -40 | +25 | +125 | °C |
| Δt/ΔV | input transition rise and fall rate | V _{CC} = 3.3 V ± 0.3 V | - | - | 100 | - | - | - | ns/V |
| | | V _{CC} = 5.0 V ± 0.5 V | - | - | 20 | - | - | 20 | ns/V |

9. Static characteristics

Table 6. Static characteristics

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 | |
| For type 74AHC138-Q100 | | | | | | | | | | |
| V _{IH} | HIGH-level input voltage | V _{CC} = 2.0 V | 1.5 | - | - | 1.5 | - | 1.5 | - | V |
| | | V _{CC} = 3.0 V | 2.1 | - | - | 2.1 | - | 2.1 | - | V |
| | | V _{CC} = 5.5 V | 3.85 | - | - | 3.85 | - | 3.85 | - | V |
| V _{IL} | LOW-level input voltage | V _{CC} = 2.0 V | - | - | 0.5 | - | 0.5 | - | 0.5 | V |
| | | V _{CC} = 3.0 V | - | - | 0.9 | - | 0.9 | - | 0.9 | V |
| | | V _{CC} = 5.5 V | - | - | 1.65 | - | 1.65 | - | 1.65 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} | | | | | | | | |
| | | I _O = -50 μA; V _{CC} = 2.0 V | 1.9 | 2.0 | - | 1.9 | - | 1.9 | - | V |
| | | I _O = -50 μA; V _{CC} = 3.0 V | 2.9 | 3.0 | - | 2.9 | - | 2.9 | - | V |
| | | I _O = -50 μA; V _{CC} = 4.5 V | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V |
| | | I _O = -4.0 mA; V _{CC} = 3.0 V | 2.58 | - | - | 2.48 | - | 2.4 | - | V |
| | I _O = -8.0 mA; V _{CC} = 4.5 V | 3.94 | - | - | 3.8 | - | 3.7 | - | V | |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} | | | | | | | | |
| | | I _O = 50 μA; V _{CC} = 2.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 50 μA; V _{CC} = 3.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 50 μA; V _{CC} = 4.5 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 4.0 mA; V _{CC} = 3.0 V | - | - | 0.36 | - | 0.44 | - | 0.55 | V |
| | I _O = 8.0 mA; V _{CC} = 4.5 V | - | - | 0.36 | - | 0.44 | - | 0.55 | V | |
| I _I | input leakage current | V _I = 5.5 V or GND; V _{CC} = 0 V or 5.5 V | - | - | 0.1 | - | 1.0 | - | 2.0 | μA |
| I _{CC} | supply current | V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V | - | - | 4.0 | - | 40 | - | 80 | μA |
| C _I | input capacitance | | - | 3.0 | 10 | - | 10 | - | 10 | pF |

Table 6. Static characteristics ...continued
 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 | |
| For type 74AHCT138-Q100 | | | | | | | | | | |
| V _{IH} | HIGH-level input voltage | V _{CC} = 4.5 V to 5.5 V | 2.0 | - | - | 2.0 | - | 2.0 | - | V |
| V _{IL} | LOW-level input voltage | V _{CC} = 4.5 V to 5.5 V | - | - | 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 = −50 μA | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V |
| | | I _O = −8.0 mA | 3.94 | - | - | 3.8 | - | 3.7 | - | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V | | | | | | | | |
| | | I _O = 50 μA | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 8.0 mA | - | - | 0.36 | - | 0.44 | - | 0.55 | V |
| I _I | input leakage current | V _I = 5.5 V or GND; V _{CC} = 0 V or 5.5 V | - | - | 0.1 | - | 1.0 | - | 2.0 | μA |
| I _{CC} | supply current | V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V | - | - | 4.0 | - | 40 | - | 80 | μA |
| ΔI _{CC} | additional supply current | per input pin; V _I = V _{CC} − 2.1 V; I _O = 0 A; other pins at V _{CC} or GND; V _{CC} = 4.5 V to 5.5 V | - | - | 1.35 | - | 1.5 | - | 1.5 | mA |
| C _I | input capacitance | | - | 3.0 | 10 | - | 10 | - | 10 | pF |

10. Dynamic characteristics

Table 7. Dynamic characteristics
GND = 0 V; For test circuit see Figure 8.

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|---|-------------------------------|--|-------|--------------------|------|------------------|------|-------------------|------|------|
| | | | Min | Typ ^[1] | Max | Min | Max | Min | Max | |
| For type 74AHC138-Q100 | | | | | | | | | | |
| t_{pd} | propagation delay | An to \bar{Y}_n ; see Figure 6 ^[2] | | | | | | | | |
| | | $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ | | | | | | | | |
| | | $C_L = 15\text{ pF}$ | - | 6.0 | 11.4 | 1.0 | 13.0 | 1.0 | 14.5 | ns |
| | | $C_L = 50\text{ pF}$ | - | 8.6 | 15.8 | 1.0 | 18.0 | 1.0 | 20.0 | ns |
| | | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | | | | | | | |
| | | $C_L = 15\text{ pF}$ | - | 4.4 | 8.1 | 1.0 | 9.5 | 1.0 | 10.5 | ns |
| | | $C_L = 50\text{ pF}$ | - | 6.3 | 10.1 | 1.0 | 11.5 | 1.0 | 13.0 | ns |
| | | $\bar{E}3$ to \bar{Y}_n ; see Figure 6 ^[2] | | | | | | | | |
| | | $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ | | | | | | | | |
| | | $C_L = 15\text{ pF}$ | - | 5.8 | 12.8 | 1.0 | 15.0 | 1.0 | 16.0 | ns |
| | | $C_L = 50\text{ pF}$ | - | 8.2 | 16.3 | 1.0 | 18.5 | 1.0 | 20.5 | ns |
| | | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | | | | | | | |
| | | $C_L = 15\text{ pF}$ | - | 4.2 | 8.1 | 1.0 | 9.5 | 1.0 | 10.5 | ns |
| | | $C_L = 50\text{ pF}$ | - | 6.0 | 10.1 | 1.0 | 11.5 | 1.0 | 13.0 | ns |
| | | $\bar{E}1, \bar{E}2$ to \bar{Y}_n ; see Figure 7 ^[2] | | | | | | | | |
| | | $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ | | | | | | | | |
| | | $C_L = 15\text{ pF}$ | - | 5.7 | 11.4 | 1.0 | 13.5 | 1.0 | 14.5 | ns |
| | | $C_L = 50\text{ pF}$ | - | 8.2 | 14.9 | 1.0 | 17.0 | 1.0 | 19.0 | ns |
| $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | | | | | | | | | |
| $C_L = 15\text{ pF}$ | - | 4.2 | 8.1 | 1.0 | 9.5 | 1.0 | 10.5 | ns | | |
| $C_L = 50\text{ pF}$ | - | 6.0 | 10.1 | 1.0 | 11.5 | 1.0 | 13.0 | ns | | |
| C_{PD} | power dissipation capacitance | $C_L = 50\text{ pF}$; $f_i = 1\text{ MHz}$; $V_I = \text{GND to }V_{CC}$ ^[4] | - | 18.0 | - | - | - | - | - | pF |

Table 7. Dynamic characteristics ...continued

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

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|--------------------------------|-------------------------------|--|-------|--------------------|------|------------------|------|-------------------|------|------|
| | | | Min | Typ ^[1] | Max | Min | Max | Min | Max | |
| For type 74AHCT138-Q100 | | | | | | | | | | |
| t_{pd} | propagation delay | An to \bar{Y}_n ; see Figure 6 ^[2] | | | | | | | | |
| | | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | | | | | | | |
| | | $C_L = 15\text{ pF}$ | - | 4.4 | 10.4 | 1.0 | 12.0 | 1.0 | 13.0 | ns |
| | | $C_L = 50\text{ pF}$ | - | 6.2 | 11.4 | 1.0 | 13.0 | 1.0 | 14.5 | ns |
| | | E3 to \bar{Y}_n ; see Figure 6 ^[2] | | | | | | | | |
| | | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | | | | | | | |
| | | $C_L = 15\text{ pF}$ | - | 4.3 | 9.1 | 1.0 | 10.5 | 1.0 | 11.5 | ns |
| | | $C_L = 50\text{ pF}$ | - | 6.2 | 10.1 | 1.0 | 11.5 | 1.0 | 13.0 | ns |
| | | $\bar{E}1, \bar{E}2$ to \bar{Y}_n ; see Figure 7 ^[2] | | | | | | | | |
| | | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | | | | | | | |
| | | $C_L = 15\text{ pF}$ | - | 4.3 | 9.6 | 1.0 | 11.0 | 1.0 | 12.0 | ns |
| | | $C_L = 50\text{ pF}$ | - | 6.2 | 10.6 | 1.0 | 12.0 | 1.0 | 13.5 | ns |
| C_{PD} | power dissipation capacitance | $C_L = 50\text{ pF}$; $f_i = 1\text{ MHz}$; $V_1 = GND$ to V_{CC} ^[4] | - | 23.0 | - | - | - | - | - | pF |

[1] Typical values are measured at nominal supply voltage ($V_{CC} = 3.3\text{ V}$ and $V_{CC} = 5.0\text{ V}$).

[2] t_{pd} is the same as t_{PLH} and t_{PHL} .

[3] Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.

[4] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz, f_o = output frequency in MHz

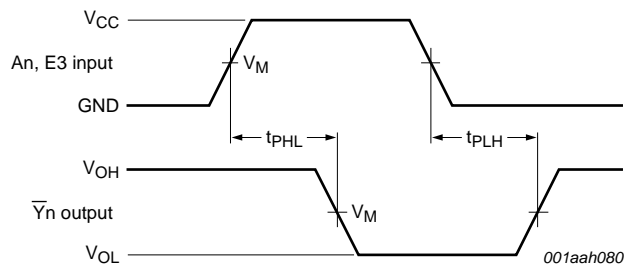
C_L = output load capacitance in pF

V_{CC} = supply voltage in V

N = number of inputs switching

$\sum(C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs.

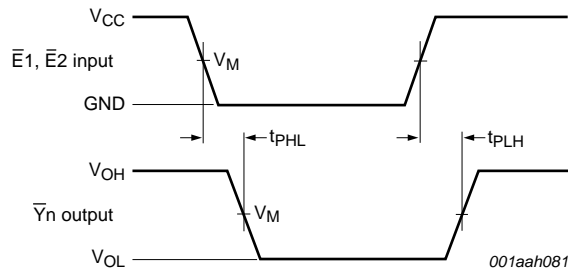
11. Waveforms



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. The inputs An, E3 to outputs \bar{Y}_n propagation delays



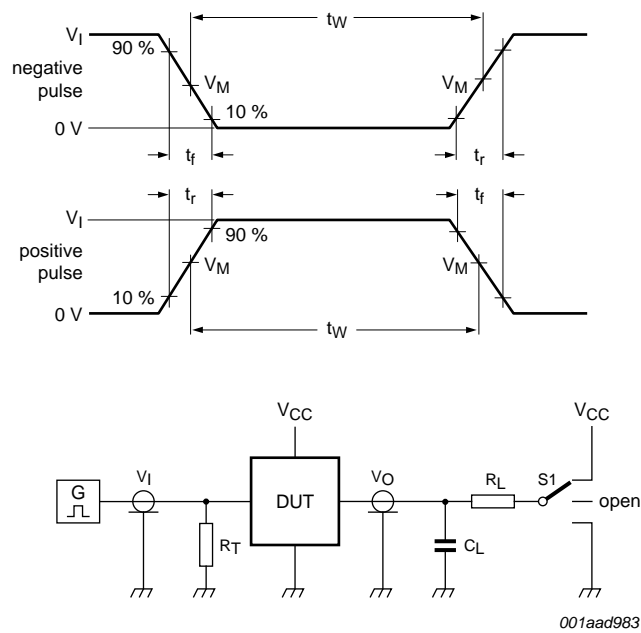
Measurement points are given in [Table 8](#).

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

Fig 7. The inputs \bar{E}_n to outputs \bar{Y}_n propagation delays

Table 8. Measurement points

| Type | Input | Output |
|----------------|--------------------|--------------------|
| | V _M | V _M |
| 74AHC138-Q100 | 0.5V _{CC} | 0.5V _{CC} |
| 74AHCT138-Q100 | 1.5 V | 0.5V _{CC} |



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

Definitions 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 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} | t_{PZH}, t_{PHZ} | t_{PZL}, t_{PLZ} |
| 74AHC138-Q100 | V_{CC} | ≤ 3.0 ns | 15 pF, 50 pF | 1 k Ω | open | GND | V_{CC} |
| 74AHCT138-Q100 | 3.0 V | ≤ 3.0 ns | 15 pF, 50 pF | 1 k Ω | open | GND | V_{CC} |

12. Package outline

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

SOT109-1

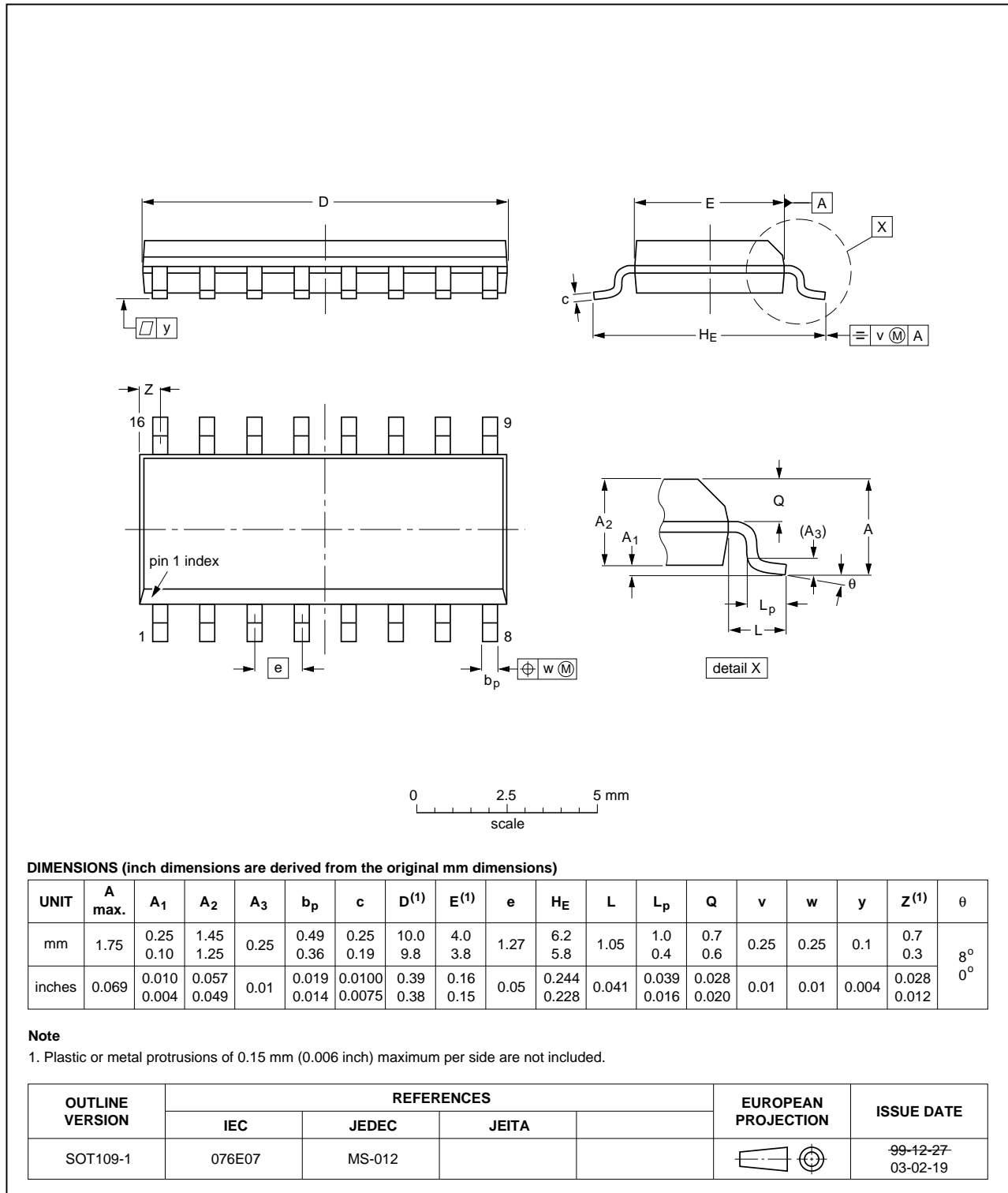


Fig 9. Package outline SOT109-1 (SO16)

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

SOT403-1

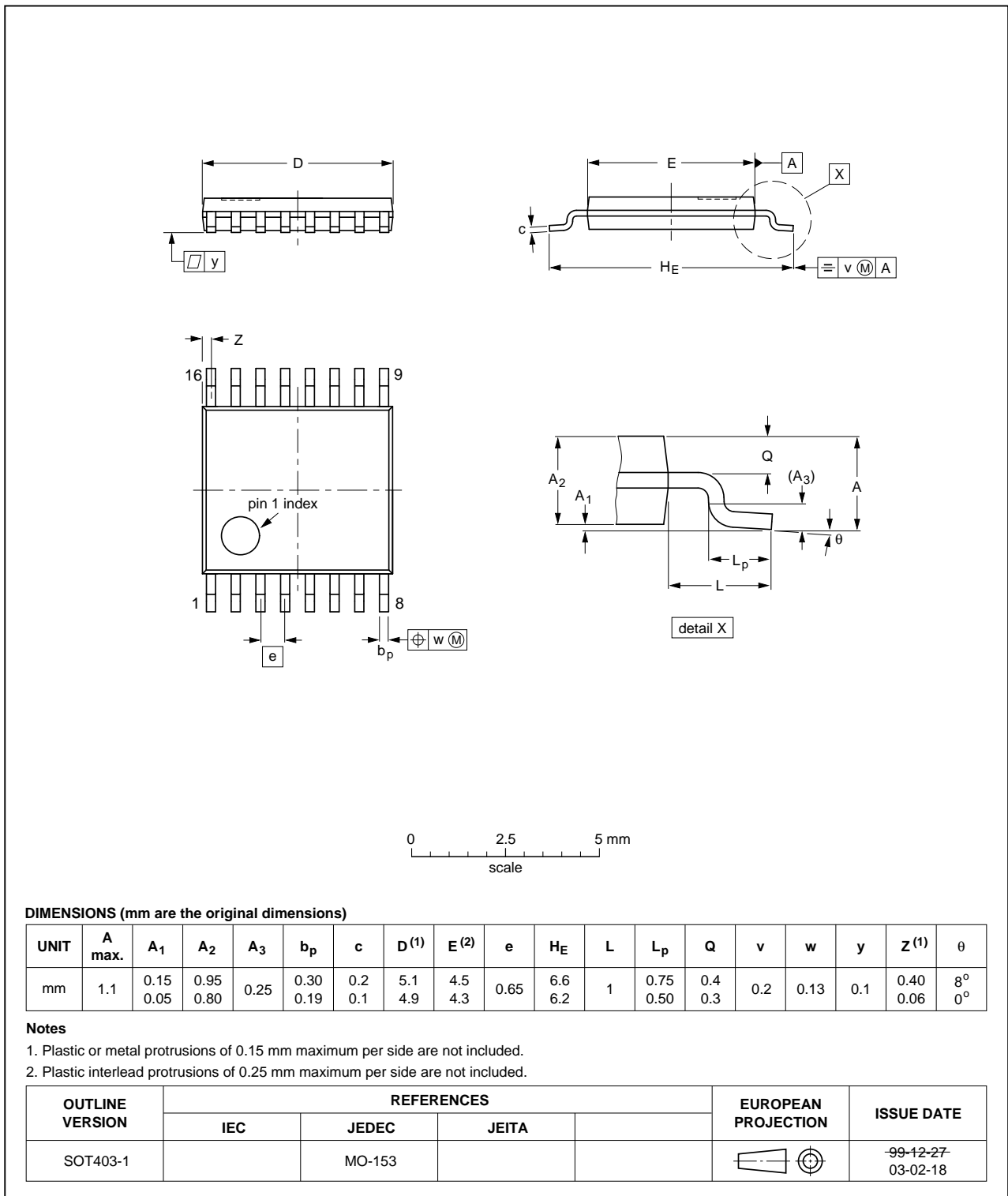


Fig 10. Package outline SOT403-1 (TSSOP16)

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

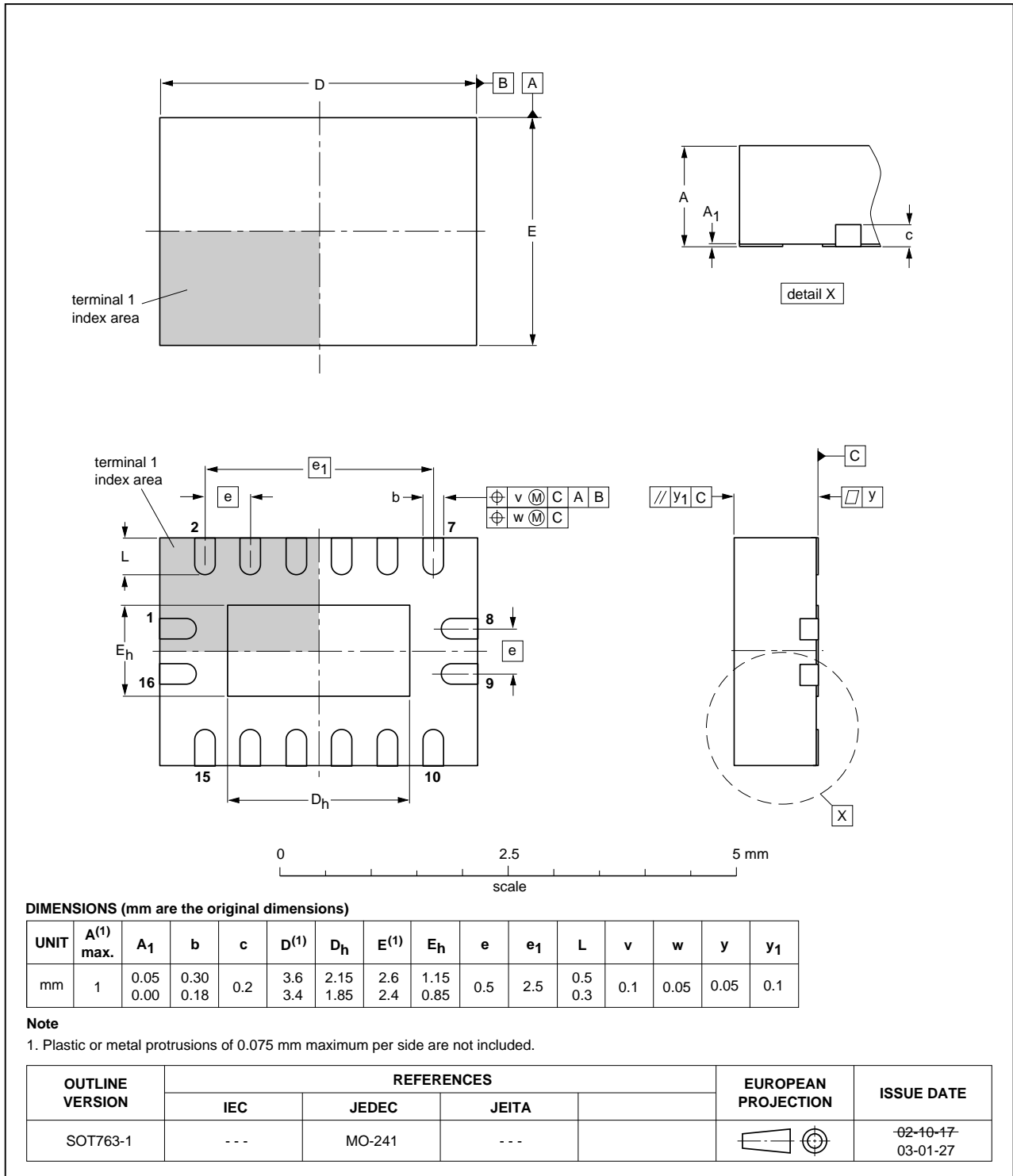


Fig 11. Package outline SOT763-1 (DHVQFN16)

13. Abbreviations

Table 10. Abbreviations

| Acronym | Description |
|---------|--|
| CMOS | Complementary Metal Oxide Semiconductor |
| LSTTL | Low-power Schottky Transistor-Transistor Logic |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |
| MIL | Military |
| CDM | Charged-Device Model |
| TTL | Transistor-Transistor Logic |

14. Revision history

Table 11. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|------------------------|--|--------------------|---------------|------------------------|
| 74AHC_AHCT138_Q100 v.2 | 20140402 | Product data sheet | - | 74AHC_AHCT138_Q100 v.1 |
| Modifications: | <ul style="list-style-type: none"> Description for t_{pd} for the 74AHCT138-Q100 corrected (errata) in Table 7 "Dynamic characteristics" | | | |
| 74AHC_AHCT138_Q100 v.1 | 20130326 | 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".

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