

# 74HC138; 74HCT138

3-to-8 line decoder/demultiplexer; inverting

Rev. 4 — 27 June 2012

Product data sheet

## 1. General description

The 74HC138; 74HCT138 is a high-speed Si-gate CMOS device and is pin compatible with Low-power Schottky TTL (LSTTL).

The 74HC138; 74HCT138 decoder accepts three binary weighted address inputs ( $A_0$ ,  $A_1$  and  $A_2$ ) and when enabled, provides 8 mutually exclusive active LOW outputs ( $\overline{Y}_0$  to  $\overline{Y}_7$ ).

The 74HC138; 74HCT138 features three enable inputs: two active LOW ( $\overline{E}_1$  and  $\overline{E}_2$ ) and one active HIGH ( $E_3$ ). Every output is HIGH unless  $\overline{E}_1$  and  $\overline{E}_2$  are LOW and  $E_3$  is HIGH.

This multiple enable function allows easy parallel expansion of the 74HC138; 74HCT138 to a 1-of-32 (5 lines to 32 lines) decoder with just four 74HC138; 74HCT138 ICs and one inverter.

The 74HC138; 74HCT138 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. Permanently tie unused enable inputs to their appropriate active HIGH- or LOW-state.

The 74HC138; 74HCT138 is identical to the 74HC238; 74HCT238 but has inverting outputs.

## 2. Features and benefits

- Demultiplexing capability
- Multiple input enable for easy expansion
- Complies with JEDEC standard no. 7A
- Ideal for memory chip select decoding
- Active LOW mutually exclusive outputs
- ESD protection:
  - ◆ HBM EIA/JESD22-A114F exceeds 2000 V
  - ◆ MM EIA/JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

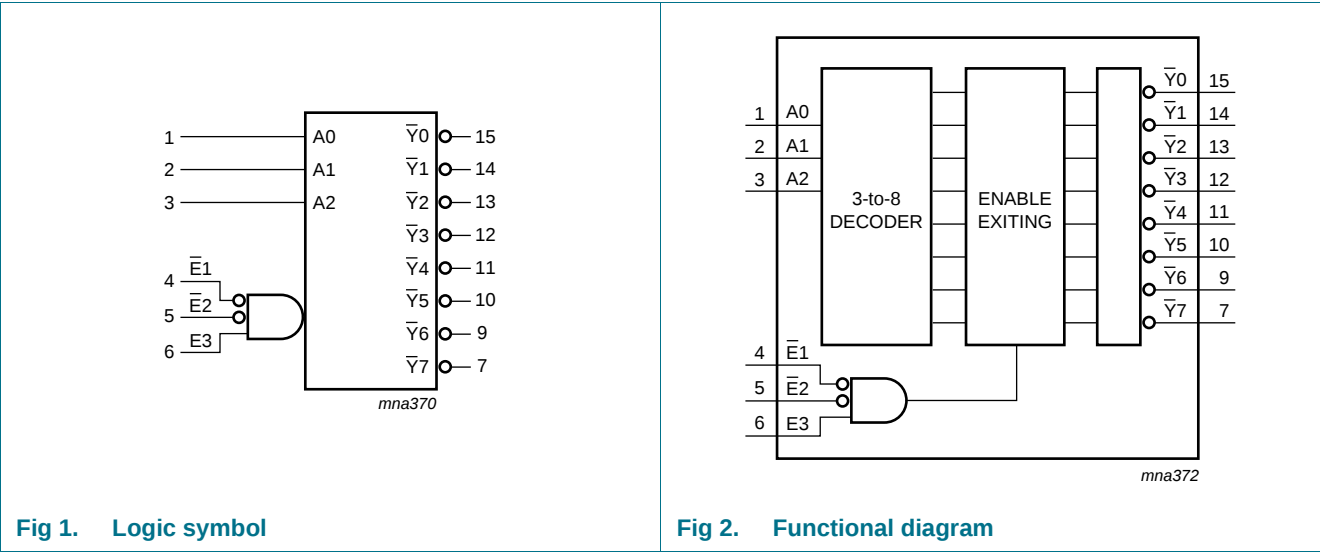


3. Ordering information

Table 1. Ordering information

| Type number | Package           |          |                                                                                                                                |          |
|-------------|-------------------|----------|--------------------------------------------------------------------------------------------------------------------------------|----------|
|             | Temperature range | Name     | Description                                                                                                                    | Version  |
| 74HC138N    | −40 °C to +125 °C | DIP16    | plastic dual in-line package; 16 leads (300 mil)                                                                               | SOT38-4  |
| 74HCT138N   |                   |          |                                                                                                                                |          |
| 74HC138D    | −40 °C to +125 °C | SO16     | plastic small outline package; 16 leads; body width 3.9 mm                                                                     | SOT109-1 |
| 74 HCT138D  |                   |          |                                                                                                                                |          |
| 74HC138DB   | −40 °C to +125 °C | SSOP16   | plastic shrink small outline package; 16 leads; body width 5.3 mm                                                              | SOT338-1 |
| 74HCT138DB  |                   |          |                                                                                                                                |          |
| 74HC138PW   | −40 °C to +125 °C | TSSOP16  | plastic thin shrink small outline package; 16 leads; body width 4.4 mm                                                         | SOT403-1 |
| 74HCT138PW  |                   |          |                                                                                                                                |          |
| 74HC138BQ   | −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 |
| 74HCT138BQ  |                   |          |                                                                                                                                |          |

4. Functional diagram



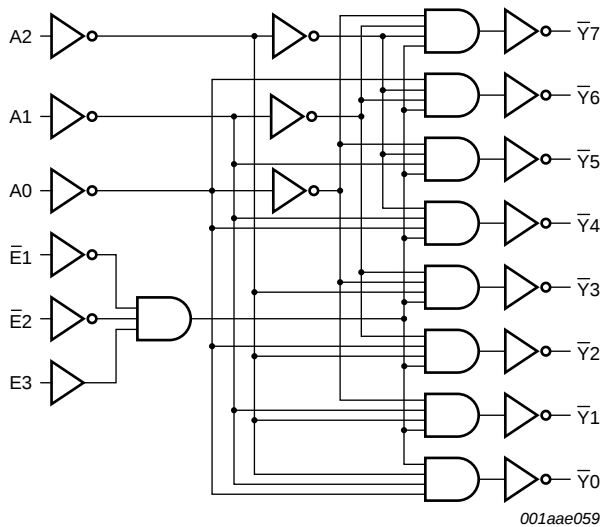


Fig 3. Logic diagram

5. Pinning information

5.1 Pinning

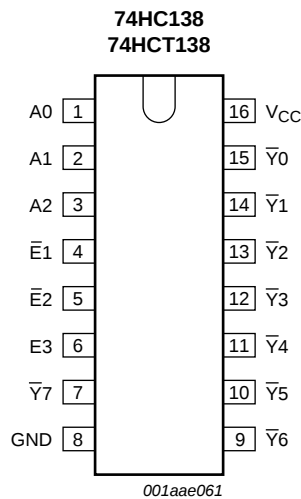
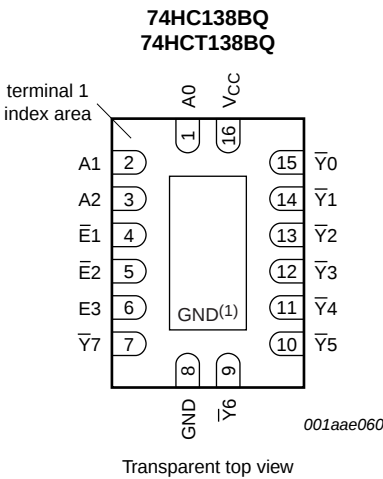


Fig 4. Pin configuration DIP16, SO16, SSOP16 and TSSOP16



- (1) The die substrate is attached to this pad using conductive die attach material. It cannot be used as supply pin or input.

Fig 5. Pin configuration DHVQFN16

## 5.2 Pin description

Table 2. Pin description

| Symbol                                                                                                                   | Pin                          | Description                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| A0, A1, A2                                                                                                               | 1, 2, 3                      | address input A0, A1, A2                                                                                                                     |
| $\overline{E}1, \overline{E}2$                                                                                           | 4, 5                         | enable input $\overline{E}1, \overline{E}2$ (active LOW)                                                                                     |
| E3                                                                                                                       | 6                            | enable input E3 (active HIGH)                                                                                                                |
| $\overline{Y}0, \overline{Y}1, \overline{Y}2, \overline{Y}3, \overline{Y}4, \overline{Y}5, \overline{Y}6, \overline{Y}7$ | 15, 14, 13, 12, 11, 10, 9, 7 | output $\overline{Y}0, \overline{Y}1, \overline{Y}2, \overline{Y}3, \overline{Y}4, \overline{Y}5, \overline{Y}6, \overline{Y}7$ (active LOW) |
| GND                                                                                                                      | 8                            | ground (0 V)                                                                                                                                 |
| V <sub>CC</sub>                                                                                                          | 16                           | positive supply voltage                                                                                                                      |

## 6. Functional description

Table 3. Function table<sup>[1]</sup>

| Control         |                 |    | Input |    |    | Output          |                 |                 |                 |                 |                 |                 |                 |
|-----------------|-----------------|----|-------|----|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| $\overline{E}1$ | $\overline{E}2$ | E3 | A2    | A1 | A0 | $\overline{Y}7$ | $\overline{Y}6$ | $\overline{Y}5$ | $\overline{Y}4$ | $\overline{Y}3$ | $\overline{Y}2$ | $\overline{Y}1$ | $\overline{Y}0$ |
| H               | X               | X  | X     | X  | X  | H               | H               | H               | H               | H               | H               | H               | H               |
| X               | H               | X  |       |    |    |                 |                 |                 |                 |                 |                 |                 |                 |
| X               | X               | L  |       |    |    |                 |                 |                 |                 |                 |                 |                 |                 |
| L               | L               | H  | L     | L  | L  | H               | H               | H               | H               | H               | H               | H               | L               |
|                 |                 |    | L     | L  | H  | H               | H               | H               | H               | H               | H               | L               | H               |
|                 |                 |    | L     | H  | L  | H               | H               | H               | H               | H               | L               | H               | H               |
|                 |                 |    | L     | H  | H  | H               | H               | H               | H               | L               | H               | H               | H               |
|                 |                 |    | H     | L  | L  | H               | H               | H               | L               | H               | H               | H               | H               |
|                 |                 |    | H     | L  | H  | H               | H               | L               | H               | H               | H               | H               | H               |
|                 |                 |    | H     | H  | L  | H               | L               | H               | H               | H               | H               | H               | H               |
|                 |                 |    | H     | H  | H  | L               | H               | H               | H               | H               | H               | H               | 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 <sub>CC</sub>  | supply voltage           |                                                                     | -0.5 | +7   | V    |
| I <sub>IK</sub>  | input clamping current   | V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V | -    | ±20  | mA   |
| I <sub>OK</sub>  | output clamping current  | V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>CC</sub> + 0.5 V | -    | ±20  | mA   |
| I <sub>O</sub>   | output current           | V <sub>O</sub> = -0.5 V to (V <sub>CC</sub> + 0.5 V)                | -    | ±25  | mA   |
| I <sub>CC</sub>  | quiescent supply current |                                                                     | -    | 50   | mA   |
| I <sub>GND</sub> | ground current           |                                                                     | -    | -50  | mA   |
| T <sub>stg</sub> | storage temperature      |                                                                     | -65  | +150 | °C   |

**Table 4.** Limiting values ...continued

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

| Symbol           | Parameter               | Conditions | Min   | Max | Unit |
|------------------|-------------------------|------------|-------|-----|------|
| P <sub>tot</sub> | total power dissipation |            |       |     |      |
|                  | DIP16 package           |            | [1] - | 750 | mW   |
|                  | SO16 package            |            | [2] - | 500 | mW   |
|                  | SSOP16 package          |            | [3] - | 500 | mW   |
|                  | TSSOP16 package         |            | [3] - | 500 | mW   |
|                  | DHVQFN16 package        |            | [4] - | 500 | mW   |

[1] For DIP16 package: P<sub>tot</sub> derates linearly with 12 mW/K above 70 °C.[2] For SO16 package: P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.[3] For SSOP16 and TSSOP16 packages: P<sub>tot</sub> derates linearly with 5.5 mW/K above 60 °C.[4] For DHVQFN16 packages: P<sub>tot</sub> 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              | 74HC138 |      |                 | 74HCT138 |      |                 | Unit |
|------------------|-------------------------------------|-------------------------|---------|------|-----------------|----------|------|-----------------|------|
|                  |                                     |                         | Min     | Typ  | Max             | Min      | Typ  | Max             |      |
| V <sub>CC</sub>  | supply voltage                      |                         | 2.0     | 5.0  | 6.0             | 4.5      | 5.0  | 5.5             | V    |
| V <sub>I</sub>   | input voltage                       |                         | 0       | -    | V <sub>CC</sub> | 0        | -    | V <sub>CC</sub> | V    |
| V <sub>O</sub>   | output voltage                      |                         | 0       | -    | V <sub>CC</sub> | 0        | -    | V <sub>CC</sub> | V    |
| T <sub>amb</sub> | ambient temperature                 |                         | -40     | +25  | +125            | -40      | +25  | +125            | °C   |
| Δt/ΔV            | input transition rise and fall rate | V <sub>CC</sub> = 2.0 V | -       | -    | 625             | -        | -    | -               | ns/V |
|                  |                                     | V <sub>CC</sub> = 4.5 V | -       | 1.67 | 139             | -        | 1.67 | 139             | ns/V |
|                  |                                     | V <sub>CC</sub> = 6.0 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              | T <sub>amb</sub> = 25 °C |     |      | T <sub>amb</sub> = −40 °C to +85 °C |      | T <sub>amb</sub> = −40 °C to +125 °C |      | Unit |
|-----------------|--------------------------|-------------------------|--------------------------|-----|------|-------------------------------------|------|--------------------------------------|------|------|
|                 |                          |                         | Min                      | Typ | Max  | Min                                 | Max  | Min                                  | Max  |      |
| 74HC138         |                          |                         |                          |     |      |                                     |      |                                      |      |      |
| V <sub>IH</sub> | HIGH-level input voltage | V <sub>CC</sub> = 2.0 V | 1.5                      | 1.2 | -    | 1.5                                 | -    | 1.5                                  | -    | V    |
|                 |                          | V <sub>CC</sub> = 4.5 V | 3.15                     | 2.4 | -    | 3.15                                | -    | 3.15                                 | -    | V    |
|                 |                          | V <sub>CC</sub> = 6.0 V | 4.2                      | 3.2 | -    | 4.2                                 | -    | 4.2                                  | -    | V    |
| V <sub>IL</sub> | LOW-level input voltage  | V <sub>CC</sub> = 2.0 V | -                        | 0.8 | 0.5  | -                                   | 0.5  | -                                    | 0.5  | V    |
|                 |                          | V <sub>CC</sub> = 4.5 V | -                        | 2.1 | 1.35 | -                                   | 1.35 | -                                    | 1.35 | V    |
|                 |                          | V <sub>CC</sub> = 6.0 V | -                        | 2.8 | 1.8  | -                                   | 1.8  | -                                    | 1.8  | V    |

**Table 6.** Static characteristics ...continued

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

| Symbol          | Parameter                 | Conditions                                                                                                                                                                                                   | T <sub>amb</sub> = 25 °C |      |      | T <sub>amb</sub> = -40 °C to +85 °C |      | T <sub>amb</sub> = -40 °C to +125 °C |      | Unit |
|-----------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------|------|-------------------------------------|------|--------------------------------------|------|------|
|                 |                           |                                                                                                                                                                                                              | Min                      | Typ  | Max  | Min                                 | Max  | Min                                  | Max  |      |
| V <sub>OH</sub> | HIGH-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                                                                                                                                          |                          |      |      |                                     |      |                                      |      |      |
|                 |                           | I <sub>O</sub> = -20 µA; V <sub>CC</sub> = 2.0 V                                                                                                                                                             | 1.9                      | 2.0  | -    | 1.9                                 | -    | 1.9                                  | -    | V    |
|                 |                           | I <sub>O</sub> = -20 µA; V <sub>CC</sub> = 4.5 V                                                                                                                                                             | 4.4                      | 4.5  | -    | 4.4                                 | -    | 4.4                                  | -    | V    |
|                 |                           | I <sub>O</sub> = -20 µA; V <sub>CC</sub> = 6.0 V                                                                                                                                                             | 5.9                      | 6.0  | -    | 5.9                                 | -    | 5.9                                  | -    | V    |
|                 |                           | I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V                                                                                                                                                            | 3.98                     | 4.32 | -    | 3.84                                | -    | 3.7                                  | -    | V    |
|                 |                           | I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V                                                                                                                                                            | 5.48                     | 5.81 | -    | 5.34                                | -    | 5.2                                  | -    | V    |
| V <sub>OL</sub> | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                                                                                                                                          |                          |      |      |                                     |      |                                      |      |      |
|                 |                           | I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 2.0 V                                                                                                                                                              | -                        | 0    | 0.1  | -                                   | 0.1  | -                                    | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 4.5 V                                                                                                                                                              | -                        | 0    | 0.1  | -                                   | 0.1  | -                                    | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 6.0 V                                                                                                                                                              | -                        | 0    | 0.1  | -                                   | 0.1  | -                                    | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V                                                                                                                                                             | -                        | 0.15 | 0.26 | -                                   | 0.33 | -                                    | 0.4  | V    |
|                 |                           | I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V                                                                                                                                                             | -                        | 0.16 | 0.26 | -                                   | 0.33 | -                                    | 0.4  | V    |
| I <sub>I</sub>  | input leakage current     | V <sub>I</sub> = V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 6.0 V                                                                                                                                          | -                        | -    | ±0.1 | -                                   | ±1.0 | -                                    | ±1.0 | µA   |
| I <sub>OZ</sub> | OFF-state output current  | per input pin; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>V <sub>O</sub> = V <sub>CC</sub> or GND;<br>other inputs at V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 6.0 V; I <sub>O</sub> = 0 A |                          | -    | -    | ±0.5                                | -    | ±5.0                                 | -    | ±10  |
| I <sub>CC</sub> | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A;<br>V <sub>CC</sub> = 6.0 V                                                                                                                    | -                        | -    | 8.0  | -                                   | 80   | -                                    | 160  | µA   |
| C <sub>I</sub>  | input capacitance         |                                                                                                                                                                                                              | -                        | 3.5  | -    |                                     |      |                                      |      | pF   |
| <b>74HCT138</b> |                           |                                                                                                                                                                                                              |                          |      |      |                                     |      |                                      |      |      |
| V <sub>IH</sub> | HIGH-level input voltage  | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                                                                                                                             | 2.0                      | 1.6  | -    | 2.0                                 | -    | 2.0                                  | -    | V    |
| V <sub>IL</sub> | LOW-level input voltage   | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                                                                                                                             | -                        | 1.2  | 0.8  | -                                   | 0.8  | -                                    | 0.8  | V    |
| V <sub>OH</sub> | HIGH-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V                                                                                                                                |                          |      |      |                                     |      |                                      |      |      |
|                 |                           | I <sub>O</sub> = -20 µA                                                                                                                                                                                      | 4.4                      | 4.5  | -    | 4.4                                 | -    | 4.4                                  | -    | V    |
|                 |                           | I <sub>O</sub> = -4 mA                                                                                                                                                                                       | 3.98                     | 4.32 | -    | 3.84                                | -    | 3.7                                  | -    | V    |
| V <sub>OL</sub> | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V                                                                                                                                |                          |      |      |                                     |      |                                      |      |      |
|                 |                           | I <sub>O</sub> = 20 µA                                                                                                                                                                                       | -                        | 0    | 0.1  | -                                   | 0.1  | -                                    | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 4.0 mA                                                                                                                                                                                      | -                        | 0.15 | 0.26 | -                                   | 0.33 | -                                    | 0.4  | V    |
| I <sub>I</sub>  | input leakage current     | V <sub>I</sub> = V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 5.5 V                                                                                                                                          | -                        | -    | ±0.1 | -                                   | ±1.0 | -                                    | ±1.0 | µA   |
| I <sub>OZ</sub> | OFF-state output current  | per input pin; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>V <sub>O</sub> = V <sub>CC</sub> or GND;<br>other inputs at V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 5.5 V; I <sub>O</sub> = 0 A |                          | -    | -    | ±0.5                                | -    | ±5.0                                 | -    | ±10  |
| I <sub>CC</sub> | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A;<br>V <sub>CC</sub> = 5.5 V                                                                                                                    | -                        | -    | 8.0  | -                                   | 80   | -                                    | 160  | µA   |

**Table 6.** Static characteristics ...continued

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

| Symbol           | Parameter                 | Conditions                                                                                                                                        | T <sub>amb</sub> = 25 °C |     |     | T <sub>amb</sub> = –40 °C to +85 °C |       | T <sub>amb</sub> = –40 °C to +125 °C |       | Unit |
|------------------|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-----|-----|-------------------------------------|-------|--------------------------------------|-------|------|
|                  |                           |                                                                                                                                                   | Min                      | Typ | Max | Min                                 | Max   | Min                                  | Max   |      |
| ΔI <sub>CC</sub> | additional supply current | V <sub>I</sub> = V <sub>CC</sub> – 2.1 V;<br>other inputs at V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 4.5 V to 5.5 V;<br>I <sub>O</sub> = 0 A |                          |     |     |                                     |       |                                      |       |      |
|                  |                           | per input pin; A <sub>n</sub> inputs                                                                                                              | -                        | 150 | 540 | -                                   | 675   | -                                    | 735   | μA   |
|                  |                           | per input pin; $\overline{E}_n$ inputs                                                                                                            | -                        | 125 | 450 | -                                   | 562.5 | -                                    | 612.5 | μA   |
|                  |                           | per input pin; E3 input                                                                                                                           | -                        | 100 | 360 | -                                   | 450   | -                                    | 490   | μA   |
| C <sub>I</sub>   | input capacitance         |                                                                                                                                                   | -                        | 3.5 | -   |                                     |       |                                      |       | pF   |

## 10. Dynamic characteristics

**Table 7.** Dynamic characteristicsVoltages are referenced to GND (ground = 0 V); C<sub>L</sub> = 50 pF unless otherwise specified; for test circuit see [Figure 8](#).

| Symbol | Parameter | Conditions | T <sub>amb</sub> = 25 °C |     |     | T <sub>amb</sub> = –40 °C to +85 °C |     | T <sub>amb</sub> = –40 °C to +125 °C |     | Unit |
|--------|-----------|------------|--------------------------|-----|-----|-------------------------------------|-----|--------------------------------------|-----|------|
|        |           |            | Min                      | Typ | Max | Min                                 | Max | Min                                  | Max |      |

### For type 74HC138

|                 |                               |                                                                                              |   |    |     |   |     |   |     |    |
|-----------------|-------------------------------|----------------------------------------------------------------------------------------------|---|----|-----|---|-----|---|-----|----|
| t <sub>pd</sub> | propagation delay             | A <sub>n</sub> to $\overline{Y}_n$ ; see <a href="#">Figure 6</a> <sup>[1]</sup>             |   |    |     |   |     |   |     |    |
|                 |                               | V <sub>CC</sub> = 2.0 V                                                                      | - | 41 | 150 | - | 190 | - | 225 | ns |
|                 |                               | V <sub>CC</sub> = 4.5 V                                                                      | - | 15 | 30  | - | 38  | - | 45  | ns |
|                 |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF                                                | - | 12 | -   | - | -   | - | -   | ns |
|                 |                               | V <sub>CC</sub> = 6.0 V                                                                      | - | 12 | 26  | - | 33  | - | 38  | ns |
|                 |                               | E3 to $\overline{Y}_n$ ; see <a href="#">Figure 6</a> <sup>[1]</sup>                         |   |    |     |   |     |   |     |    |
|                 |                               | V <sub>CC</sub> = 2.0 V                                                                      | - | 47 | 150 | - | 190 | - | 225 | ns |
|                 |                               | V <sub>CC</sub> = 4.5 V                                                                      | - | 17 | 20  | - | 38  | - | 45  | ns |
|                 |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF                                                | - | 14 | -   | - | -   | - | -   | ns |
|                 |                               | V <sub>CC</sub> = 6.0 V                                                                      | - | 14 | 26  | - | 33  | - | 38  | ns |
|                 |                               | $\overline{E}_n$ to $\overline{Y}_n$ ; see <a href="#">Figure 7</a> <sup>[1]</sup>           |   |    |     |   |     |   |     |    |
|                 |                               | V <sub>CC</sub> = 2.0 V                                                                      | - | 47 | 150 | - | 190 | - | 225 | ns |
|                 |                               | V <sub>CC</sub> = 4.5 V                                                                      | - | 17 | 20  | - | 38  | - | 45  | ns |
|                 |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF                                                | - | 14 | -   | - | -   | - | -   | ns |
|                 |                               | V <sub>CC</sub> = 6.0 V                                                                      | - | 14 | 26  | - | 33  | - | 38  | ns |
| t <sub>t</sub>  | transition time               | $\overline{Y}_n$ ; see <a href="#">Figure 6</a> and <a href="#">Figure 7</a> <sup>[2]</sup>  |   |    |     |   |     |   |     |    |
|                 |                               | V <sub>CC</sub> = 2.0 V                                                                      | - | 19 | 75  | - | 95  | - | 110 | ns |
|                 |                               | V <sub>CC</sub> = 4.5 V                                                                      | - | 7  | 15  | - | 19  | - | 22  | ns |
|                 |                               | V <sub>CC</sub> = 6.0 V                                                                      | - | 6  | 13  | - | 16  | - | 19  | ns |
| C <sub>PD</sub> | power dissipation capacitance | C <sub>L</sub> = 50 pF; f = 1 MHz;<br>V <sub>I</sub> = GND to V <sub>CC</sub> <sup>[3]</sup> | - | 67 | -   | - | -   | - | -   | pF |

**Table 7. Dynamic characteristics ...continued**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50$  pF unless otherwise specified; for test circuit see [Figure 8](#).

| Symbol            | Parameter                     | Conditions                                                                                       | T <sub>amb</sub> = 25 °C |     |     | T <sub>amb</sub> = −40 °C to +85 °C |     | T <sub>amb</sub> = −40 °C to +125 °C |     | Unit |
|-------------------|-------------------------------|--------------------------------------------------------------------------------------------------|--------------------------|-----|-----|-------------------------------------|-----|--------------------------------------|-----|------|
|                   |                               |                                                                                                  | Min                      | Typ | Max | Min                                 | Max | Min                                  | Max |      |
| For type 74HCT138 |                               |                                                                                                  |                          |     |     |                                     |     |                                      |     |      |
| t <sub>pd</sub>   | propagation delay             | An to $\overline{Y}_n$ ; see <a href="#">Figure 6</a> <a href="#">[1]</a>                        |                          |     |     |                                     |     |                                      |     |      |
|                   |                               | V <sub>CC</sub> = 4.5 V                                                                          | -                        | 20  | 35  | -                                   | 44  | -                                    | 53  | ns   |
|                   |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF                                                    | -                        | 17  | -   | -                                   | -   | -                                    | -   | ns   |
|                   |                               | E3 to $\overline{Y}_n$ ; see <a href="#">Figure 6</a> <a href="#">[1]</a>                        |                          |     |     |                                     |     |                                      |     |      |
|                   |                               | V <sub>CC</sub> = 4.5 V                                                                          | -                        | 18  | 40  | -                                   | 50  | -                                    | 60  | ns   |
|                   |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF                                                    | -                        | 19  | -   | -                                   | -   | -                                    | -   | ns   |
|                   |                               | $\overline{E}_n$ to $\overline{Y}_n$ ; see <a href="#">Figure 7</a> <a href="#">[1]</a>          |                          |     |     |                                     |     |                                      |     |      |
|                   |                               | V <sub>CC</sub> = 4.5 V                                                                          | -                        | 19  | 40  | -                                   | 50  | -                                    | 60  | ns   |
|                   |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF                                                    | -                        | 19  | -   | -                                   | -   | -                                    | ns  |      |
| t <sub>t</sub>    | transition time               | $\overline{Y}_n$ ; see <a href="#">Figure 6</a> and <a href="#">Figure 7</a> <a href="#">[2]</a> |                          |     |     |                                     |     |                                      |     |      |
|                   |                               | V <sub>CC</sub> = 4.5 V                                                                          | -                        | 7   | 15  | -                                   | 19  | -                                    | 22  | ns   |
| C <sub>PD</sub>   | power dissipation capacitance | C <sub>L</sub> = 50 pF; f = 1 MHz; V <sub>I</sub> = GND to V <sub>CC</sub> <a href="#">[3]</a>   | -                        | 67  | -   | -                                   | -   | -                                    | -   | pF   |

[1] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.

[2] t<sub>t</sub> is the same as t<sub>THL</sub> and t<sub>TLH</sub>.

[3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).

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

f<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

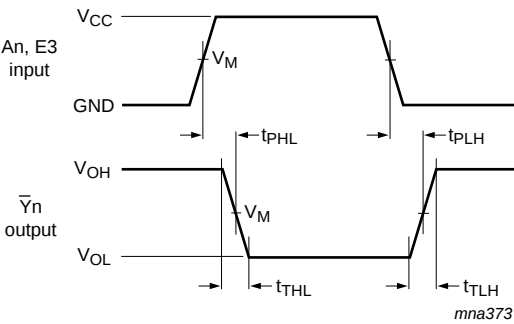
C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

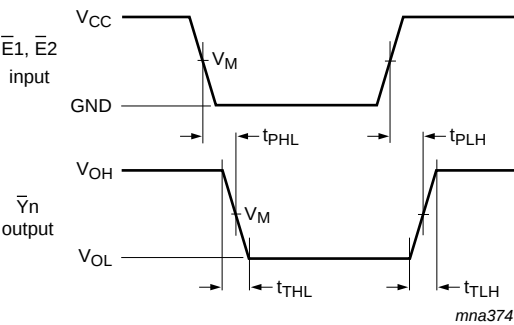
$\Sigma(C_L \times V_{CC}^2 \times f_o)$  = sum of outputs.

11. Waveforms



Measurement points are given in [Table 8](#).  
V<sub>OL</sub> and V<sub>OH</sub> are typical voltage output levels that occur with the output load.

**Fig 6. Propagation delay input (An) and enable input (E3) to output (Y<sub>n</sub>) and transition time output (Y<sub>n</sub>)**

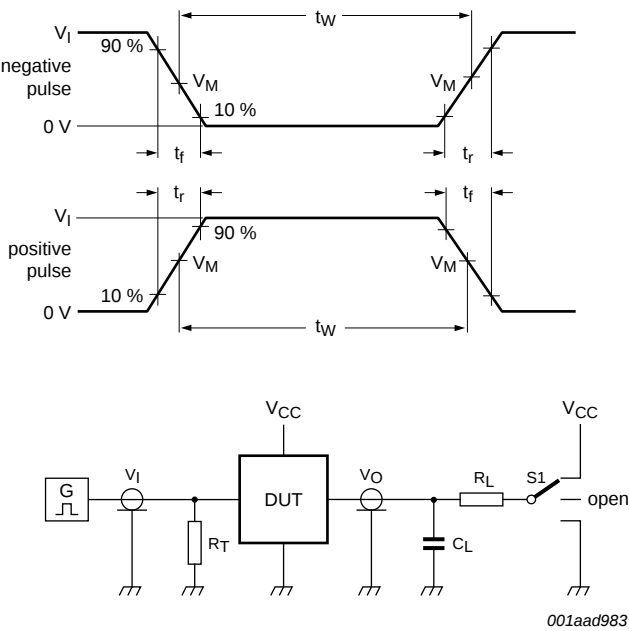


Measurement points are given in [Table 8](#).  
V<sub>OL</sub> and V<sub>OH</sub> are typical voltage output levels that occur with the output load.

**Fig 7. Propagation delay enable input (E<sub>n</sub>) to output (Y<sub>n</sub>) and transition time output (Y<sub>n</sub>)**

**Table 8. Measurement points**

| Type     | Input              | Output             |
|----------|--------------------|--------------------|
|          | V <sub>M</sub>     | V <sub>M</sub>     |
| 74HC138  | 0.5V <sub>CC</sub> | 0.5V <sub>CC</sub> |
| 74HCT138 | 1.3 V              | 1.3 V              |



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 circuitry for measuring switching times

Table 9. Test data

| Type     | Input    |            | Load         |              | S1 position        |                    |                    |
|----------|----------|------------|--------------|--------------|--------------------|--------------------|--------------------|
|          | $V_I$    | $t_r, t_f$ | $C_L$        | $R_L$        | $t_{PHL}, t_{PLH}$ | $t_{PZH}, t_{PHZ}$ | $t_{PZL}, t_{PLZ}$ |
| 74HC138  | $V_{CC}$ | 6 ns       | 15 pF, 50 pF | 1 k $\Omega$ | open               | GND                | $V_{CC}$           |
| 74HCT138 | 3 V      | 6 ns       | 15 pF, 50 pF | 1 k $\Omega$ | open               | GND                | $V_{CC}$           |

12. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4

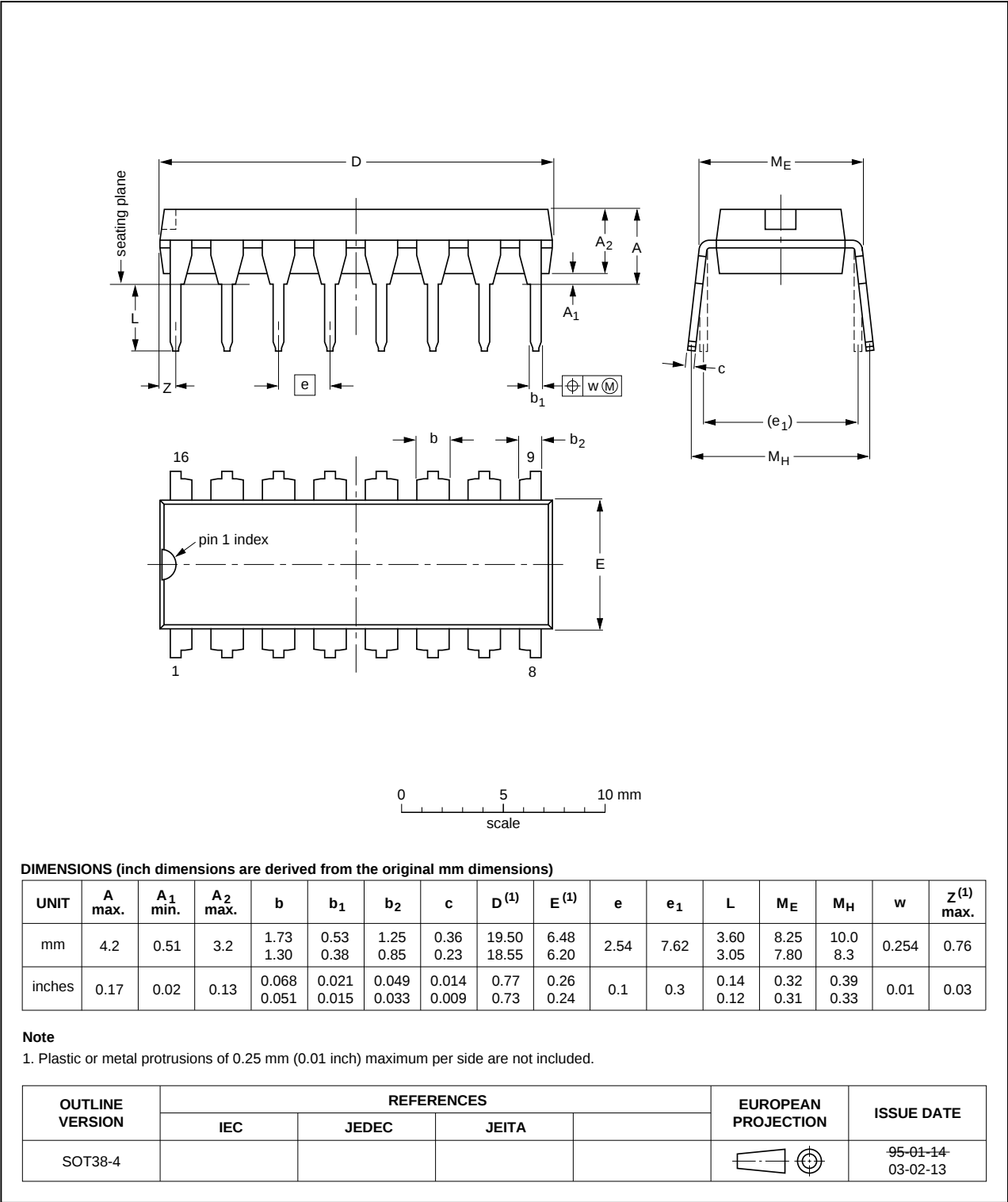
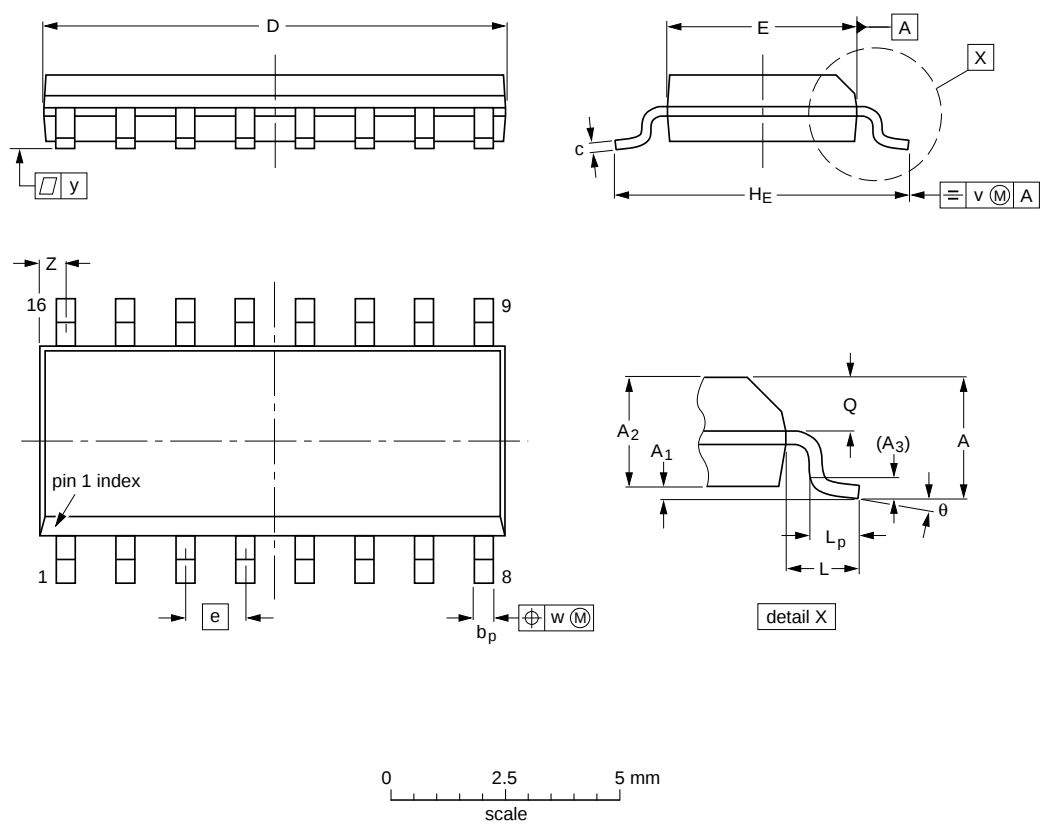


Fig 9. Package outline SOT38-4 (DIP16)

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

SOT109-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

| UNIT   | A<br>max. | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | b <sub>p</sub> | c                | D <sup>(1)</sup> | E <sup>(1)</sup> | e    | H <sub>E</sub> | L     | L <sub>p</sub> | Q              | v    | w    | y     | z <sup>(1)</sup> | θ        |
|--------|-----------|----------------|----------------|----------------|----------------|------------------|------------------|------------------|------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm     | 1.75      | 0.25<br>0.10   | 1.45<br>1.25   | 0.25           | 0.49<br>0.36   | 0.25<br>0.19     | 10.0<br>9.8      | 4.0<br>3.8       | 1.27 | 6.2<br>5.8     | 1.05  | 1.0<br>0.4     | 0.7<br>0.6     | 0.25 | 0.25 | 0.1   | 0.7<br>0.3       | 8°<br>0° |
| inches | 0.069     | 0.010<br>0.004 | 0.057<br>0.049 | 0.01           | 0.019<br>0.014 | 0.0100<br>0.0075 | 0.39<br>0.38     | 0.16<br>0.15     | 0.05 | 0.244<br>0.228 | 0.041 | 0.039<br>0.016 | 0.028<br>0.020 | 0.01 | 0.01 | 0.004 | 0.028<br>0.012   |          |

Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

| OUTLINE<br>VERSION | REFERENCES |        |       |  | EUROPEAN<br>PROJECTION | ISSUE DATE           |
|--------------------|------------|--------|-------|--|------------------------|----------------------|
|                    | IEC        | JEDEC  | JEITA |  |                        |                      |
| SOT109-1           | 076E07     | MS-012 |       |  |                        | 99-12-27<br>03-02-19 |

Fig 10. Package outline SOT109-1 (SO16)

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

SOT403-1

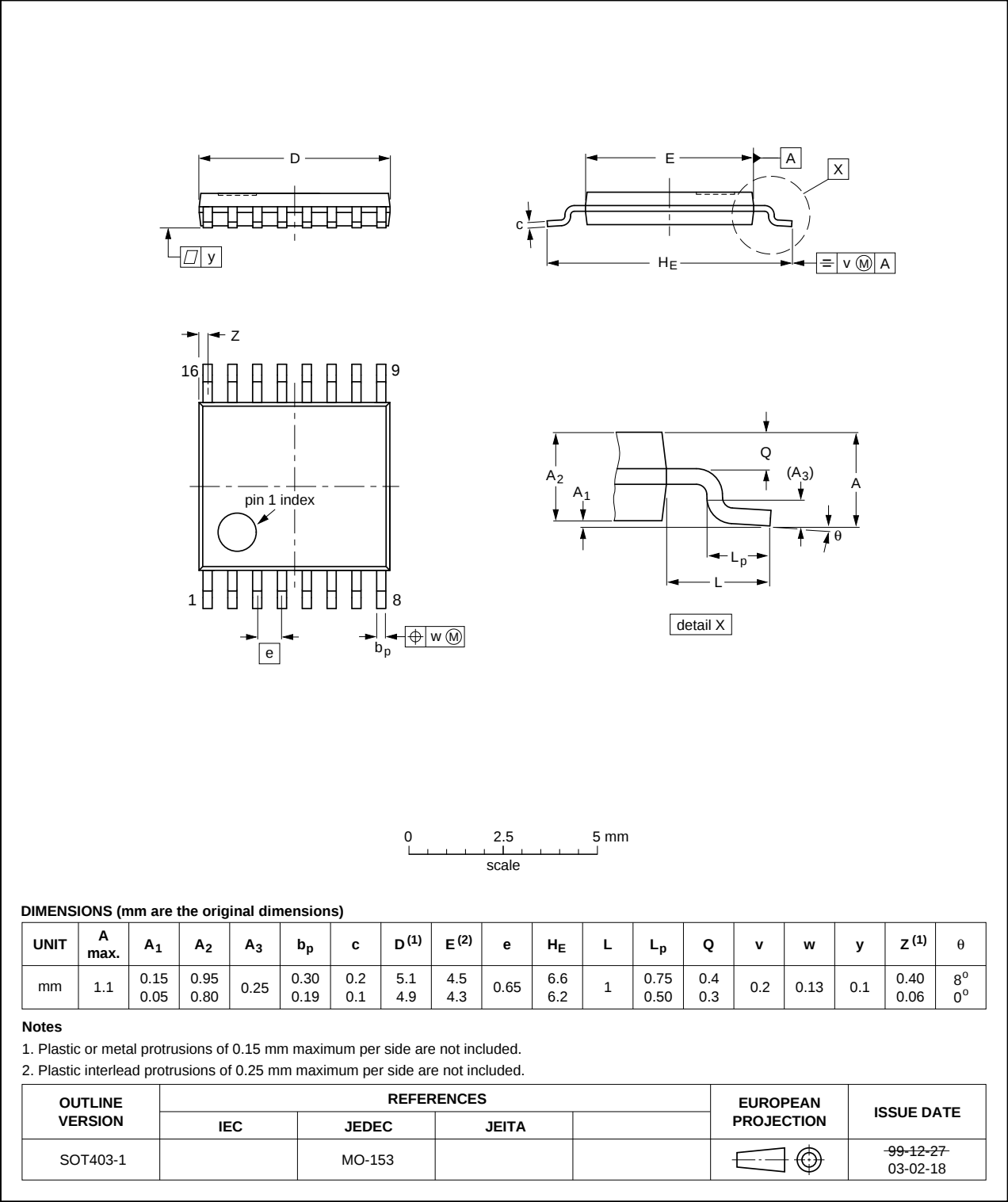


Fig 11. Package outline SOT403-1 (TSSOP16)

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1

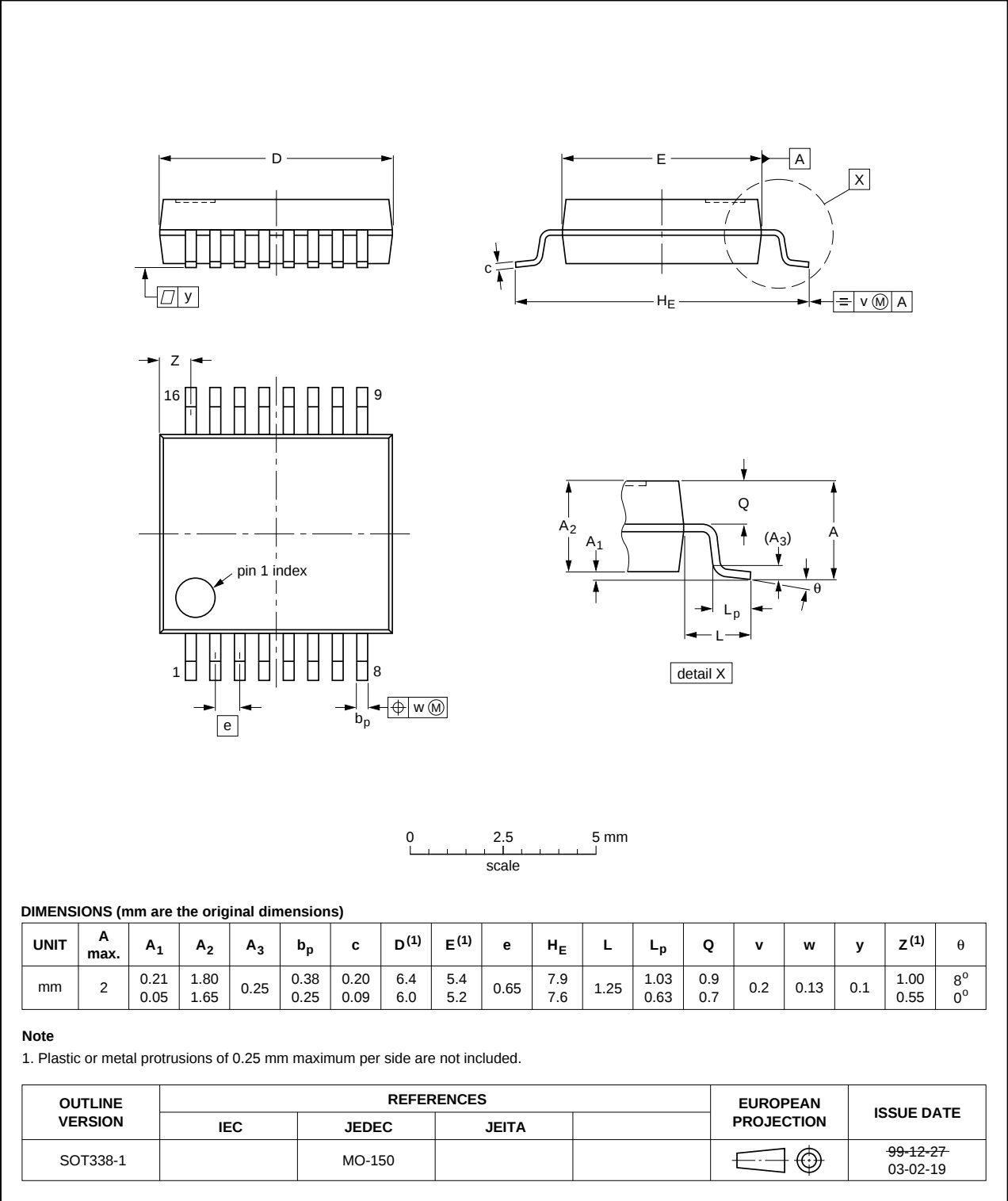


Fig 12. Package outline SOT338-1 (SSOP16)

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

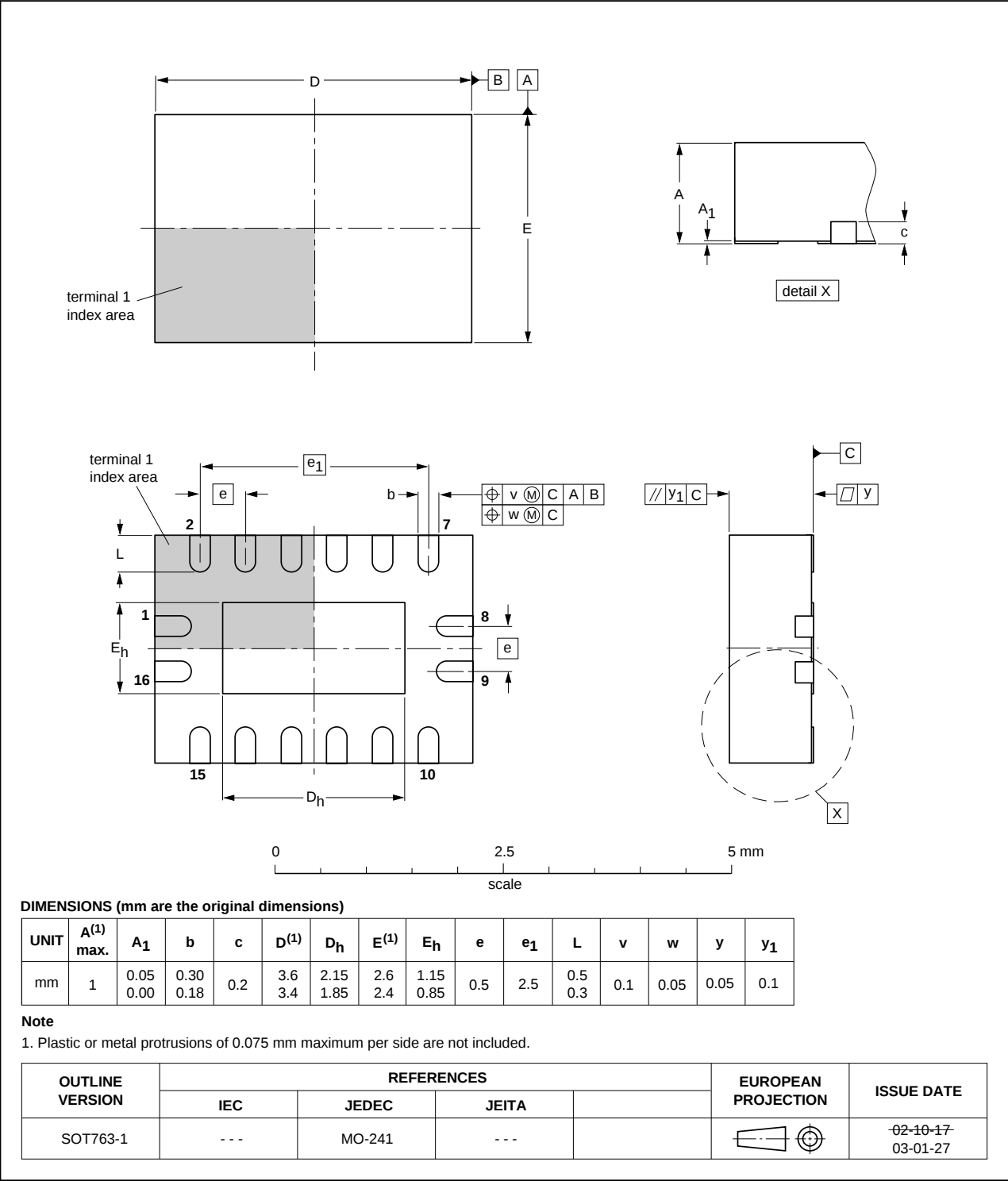


Fig 13. Package outline SOT763-1 (DHVQFN16)

## 13. Abbreviations

Table 10. Abbreviations

| Acronym | Description                                    |
|---------|------------------------------------------------|
| CMOS    | Complementary Metal Oxide Semiconductor        |
| DUT     | Device Under Test                              |
| ESD     | ElectroStatic Discharge                        |
| HBM     | Human Body Model                               |
| LSTTL   | Low-power Schottky Transistor-Transistor Logic |
| MM      | Machine Model                                  |

## 14. Revision history

Table 11. Revision history

| Document ID         | Release date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Data sheet status     | Change notice | Doc. number | Supersedes          |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|-------------|---------------------|
| 74HC_HCT138 v.4     | 20120627                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Product data sheet    | -             | -           | 74HC_HCT138 v.3     |
| Modifications:      | <ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>• Legal texts have been adapted to the new company name where appropriate.</li><li>• SOT38-1 changed to SOT38-4.</li></ul>                                                                                                                                                                                               |                       |               |             |                     |
| 74HC_HCT138 v.3     | 20051223                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Product data sheet    | -             | -           | 74HC_HCT138_CNV v.2 |
| Modifications:      | <ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors.</li><li>• <a href="#">Section 3 "Ordering information"</a>, <a href="#">Section 5 "Pinning information"</a> and <a href="#">Section 12 "Package outline"</a>: Added DHVQFN package information</li><li>• <a href="#">Section 9 "Static characteristics"</a>: Added from the family specification</li></ul> |                       |               |             |                     |
| 74HC_HCT138_CNV v.2 | 19970827                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Product specification | -             | -           | -                   |

## 15. Legal information

### 15.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | 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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Date of release: 27 June 2012

Document identifier: 74HC\_HCT138



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