

# 74HC4060; 74HCT4060

14-stage binary ripple counter with oscillator

Rev. 03 — 14 July 2008

Product data sheet

## 1. General description

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The 74HC4060; 74HCT4060 are high-speed Si-gate CMOS device and is pin compatible with the HEF4060.

The 74HC4060; 74HCT4060 are 14-stage ripple-carry counter/dividers and oscillators with three oscillator terminals (RS, RTC and CTC), ten buffered outputs (Q3 to Q9 and Q11 to Q13) and an overriding asynchronous master reset (MR). The oscillator configuration allows design of either RC or crystal oscillator circuits. The oscillator may be replaced by an external clock signal at input RS. In this case keep the other oscillator pins (RTC and CTC) floating. The counter advances on the negative-going transition of RS. A HIGH level on MR resets the counter (Q3 to Q9 and Q11 to Q13 = LOW), independent of other input conditions. In the HCT version, the MR input is TTL compatible, but the RS input has CMOS input switching levels and can be driven by a TTL output by using a pull-up resistor to  $V_{CC}$ .

## 2. Features

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- All active components on chip
- RC or crystal oscillator configuration
- Complies with JEDEC standard no. 7 A
- ESD protection:
  - ◆ HBM JESD22-A114E exceeds 2000 V
  - ◆ MM 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. Applications

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- Control counters
- Timers
- Frequency dividers
- Time-delay circuits

## 4. Ordering information

Table 1. Ordering information

| Type number               | Package           |          |  |          |
|---------------------------|-------------------|----------|--|----------|
|                           | Temperature range | Name     | Description  | Version  |
| 74HC4060N<br>74HCT4060N   | -40 °C to +125 °C | DIP16    | plastic dual in-line package; 16 leads (300 mil)   | SOT38-4  |
| 74HC4060D<br>74HCT4060D   | -40 °C to +125 °C | SO16     | plastic small outline package; 16 leads;<br>body width 3.9 mm  | SOT109-1 |
| 74HC4060DB<br>74HCT4060DB | -40 °C to +125 °C | SSOP16   | plastic shrink small outline package; 16 leads;<br>body width 5.3 mm   | SOT338-1 |
| 74HC4060PW                | -40 °C to +125 °C | TSSOP16  | plastic thin shrink small outline package; 16 leads;<br>body width 4.4 mm  | SOT403-1 |
| 74HC4060BQ<br>74HCT4060BQ | -40 °C to +125 °C | DHVQFN16 | plastic dual in-line compatible thermal-enhanced<br>very thin quad flat package; no leads; 16 terminals;<br>body 2.5 × 3.5 × 0.85 mm | SOT763-1 |

## 5. Functional diagram

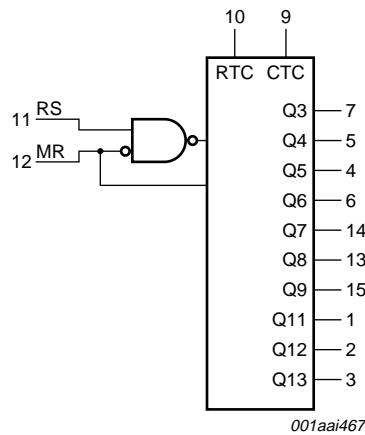


Fig 1. Logic symbol

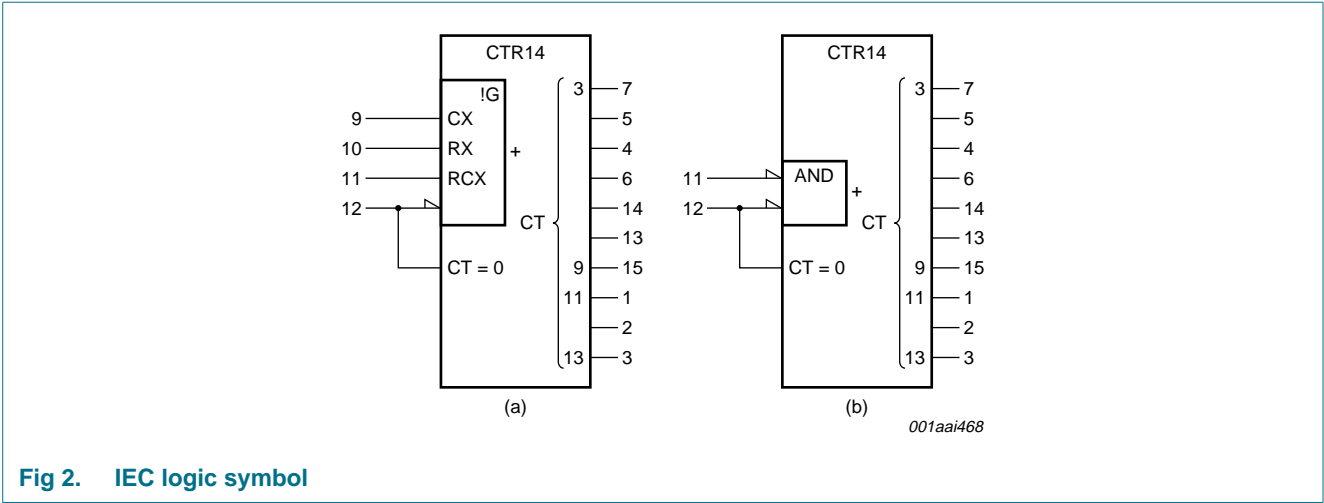


Fig 2. IEC logic symbol

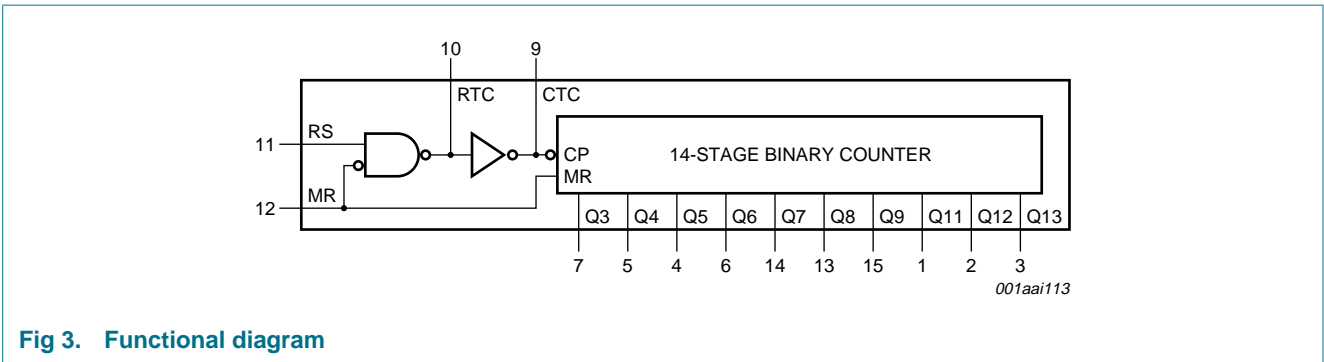


Fig 3. Functional diagram

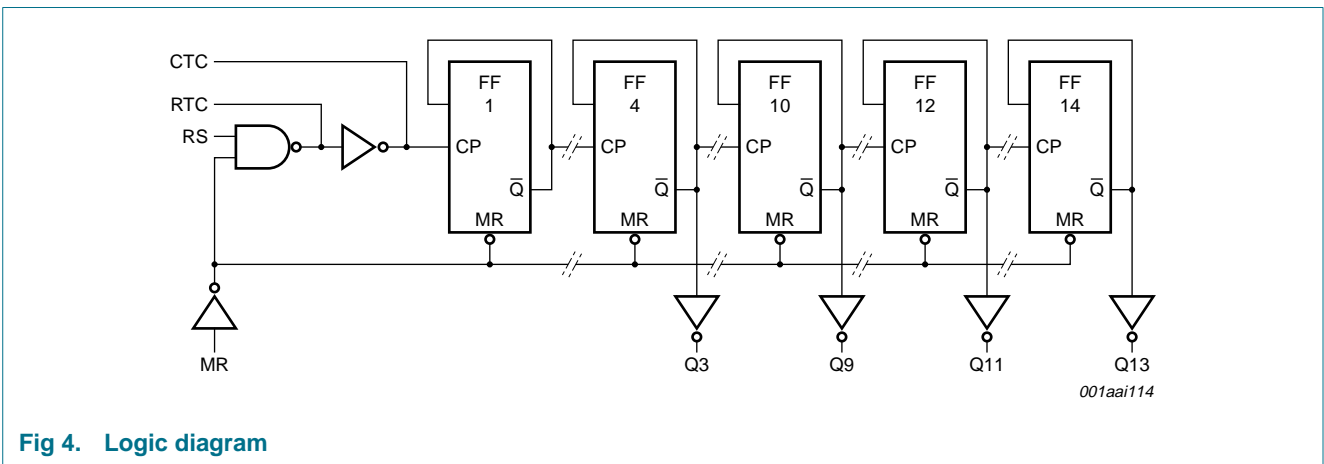
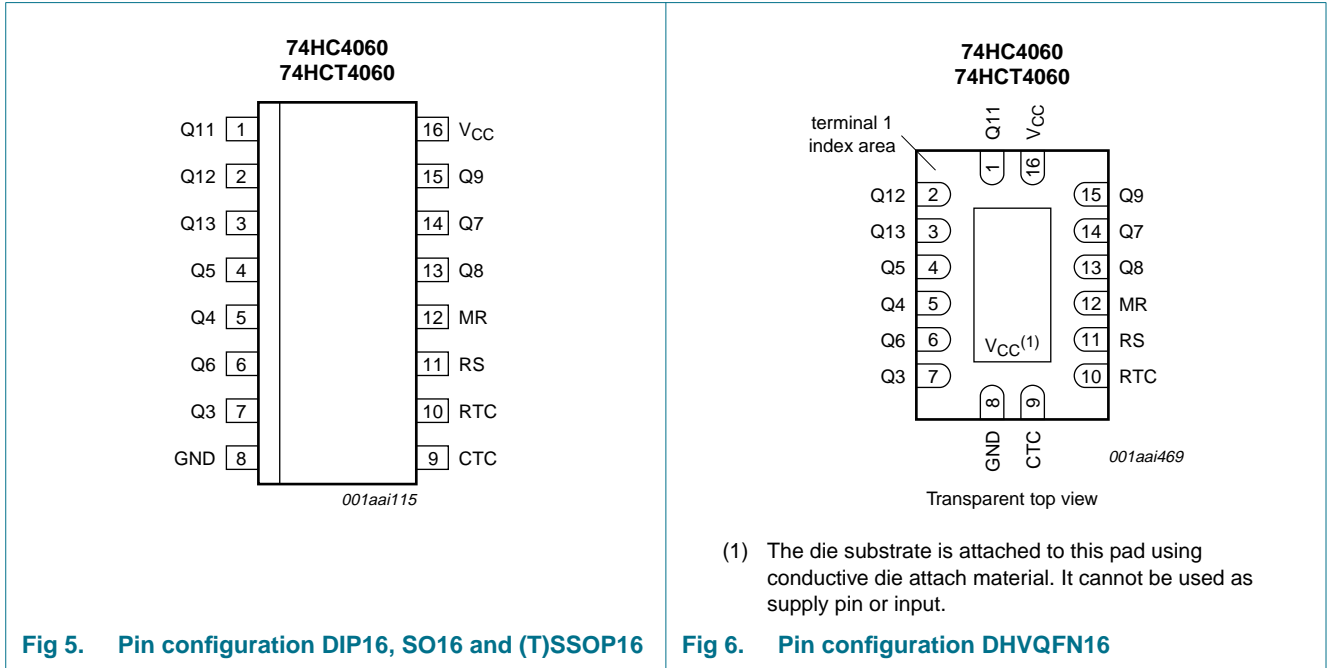


Fig 4. Logic diagram

6. Pinning information

6.1 Pinning



6.2 Pin description

Table 2. Pin description

| Symbol     | Pin                    | Description                      |
|------------|------------------------|----------------------------------|
| Q11 to Q13 | 1, 2, 3                | counter output                   |
| Q3 to Q9   | 7, 5, 4, 6, 14, 13, 15 | counter output                   |
| GND        | 8                      | ground (0 V)                     |
| CTC        | 9                      | external capacitor connection    |
| RTC        | 10                     | external resistor connection     |
| RS         | 11                     | clock input /oscillator pin      |
| MR         | 12                     | master reset input (active HIGH) |
| VCC        | 16                     | supply voltage                   |

7. Functional description

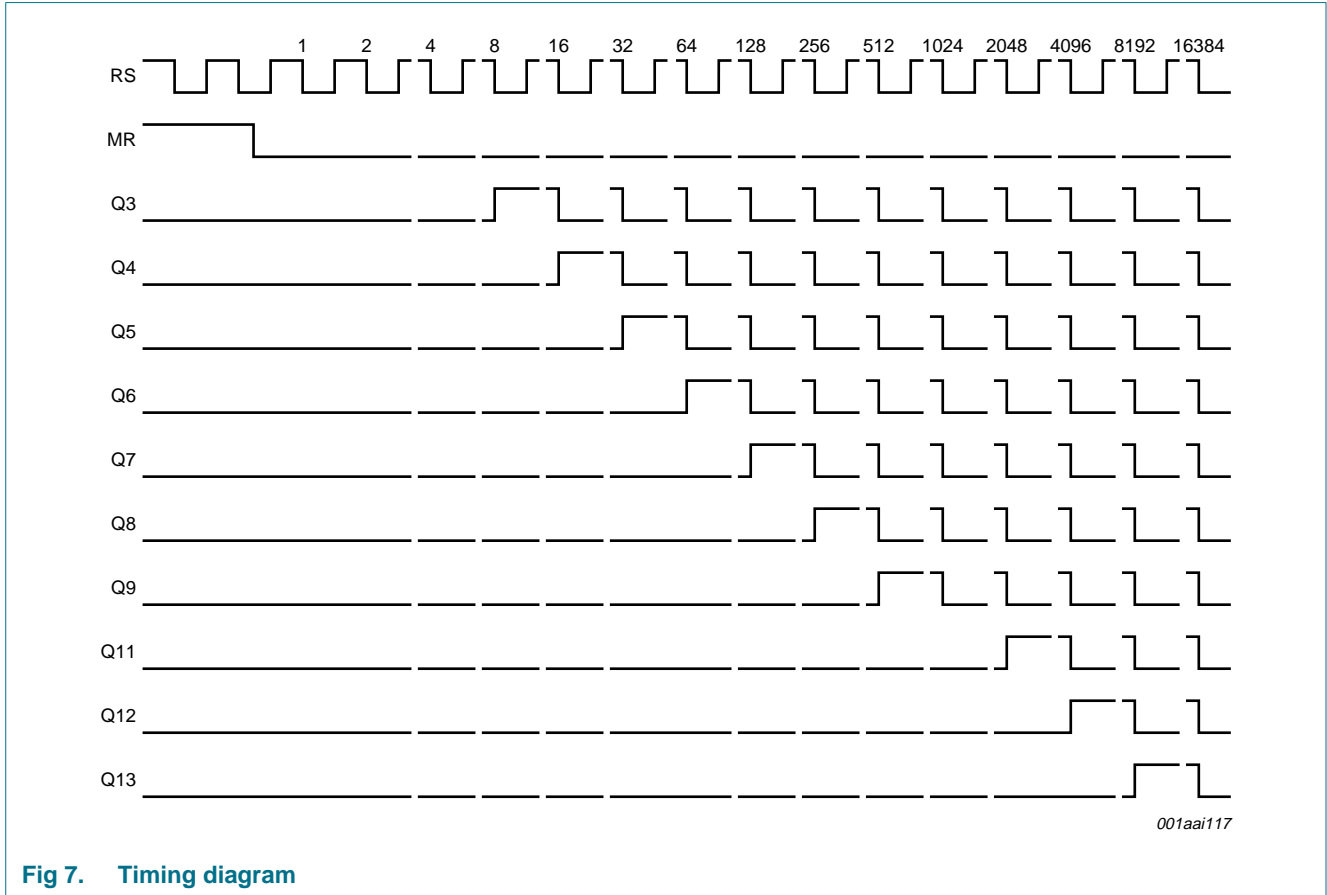


Fig 7. Timing diagram

8. Limiting values

Table 3. 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 | [1] - | ±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 | [1] - | ±20  | mA   |
| I <sub>O</sub>   | output current          | -0.5 V < V <sub>O</sub> < V <sub>CC</sub> + 0.5 V                   | -     | ±25  | mA   |
| I <sub>CC</sub>  | supply current          |   | -     | 50   | mA   |
| I <sub>GND</sub> | ground current          |   | -50   | -    | mA   |
| T <sub>stg</sub> | storage temperature     |   | -65   | +150 | °C   |

**Table 3. 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 | T <sub>amb</sub> = -40 °C to +125 °C |     |     |      |    |
|                  |                         | DIP16 package                        | [2] | -   | 750  | mW |
|                  |                         | SO16 package                         | [3] | -   | 500  | mW |
|                  |                         | (T)SSOP16 package                    | [4] | -   | 500  | mW |
|                  |                         | DHVQFN16 package                     | [5] | -   | 500  | mW |

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

[2] P<sub>tot</sub> derates linearly with 12 mW/K above 70 °C.

[3] P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.

[4] P<sub>tot</sub> derates linearly with 5.5 mW/K above 60 °C.

[5] P<sub>tot</sub> derates linearly with 4.5 mW/K above 60 °C.

## 9. Recommended operating conditions

**Table 4. Recommended operating conditions**

Voltages are referenced to GND (ground = 0 V)

| Symbol           | Parameter                           | Conditions              | 74HC4060 |      |                 | 74HCT4060 |      |                 | 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      | -    | +125            | -40       | -    | +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 |

## 10. Static characteristics

**Table 5. 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 |      |
| <b>74HC4060</b>         |                          |                         |       |     |     |                  |     |                   |     |      |
| V <sub>IH</sub>         | HIGH-level input voltage | MR input                |       |     |     |                  |     |                   |     |      |
|                         |                          | V <sub>CC</sub> = 2.0 V | 1.5   | 1.3 | -   | 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   | 3.1 | -   | 4.2              | -   | 4.2               | -   | V    |
|                         |                          | RS input                |       |     |     |                  |     |                   |     |      |
|                         |                          | V <sub>CC</sub> = 2.0 V | 1.7   | -   | -   | 1.7              | -   | 1.7               | -   | V    |
| V <sub>CC</sub> = 4.5 V | 3.6                      | -                       | -     | 3.6 | -   | 3.6              | -   | V                 |     |      |
| V <sub>CC</sub> = 6.0 V | 4.8                      | -                       | -     | 4.8 | -   | 4.8              | -   | V                 |     |      |

**Table 5. 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  |      |
| V <sub>IL</sub>   | LOW-level input voltage | MR input                |                           |                           |      |                  |      |                   |      |      |
|   |                         | 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    |
|   |                         | RS input                |                           |                           |      |                  |      |                   |      |      |
|   |                         | V <sub>CC</sub> = 2.0 V | -                         | -                         | 0.3  | -                | 0.3  | -                 | 0.3  | V    |
|   |                         | V <sub>CC</sub> = 4.5 V | -                         | -                         | 0.9  | -                | 0.9  | -                 | 0.9  | V    |
|   |                         | V <sub>CC</sub> = 6.0 V | -                         | -                         | 1.2  | -                | 1.2  | -                 | 1.2  | V    |
|   |                         | V <sub>OH</sub>         | HIGH-level output voltage | RTC output; RS = MR = GND |      |                  |      |                   |      |      |
| 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> = -2.6 mA; V <sub>CC</sub> = 4.5 V                                   | 3.98                    |                         |                           | -                         | -    | 3.84             | -    | 3.7               | -    | V    |
| I <sub>O</sub> = -3.3 mA; V <sub>CC</sub> = 6.0 V                                   | 5.48                    |                         |                           | -                         | -    | 5.34             | -    | 5.2               | -    | V    |
| RTC output; RS = MR = V <sub>CC</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> = -0.65 mA; V <sub>CC</sub> = 4.5 V                                  | 3.98                    |                         |                           | -                         | -    | 3.84             | -    | 3.7               | -    | V    |
| I <sub>O</sub> = -0.85 mA; V <sub>CC</sub> = 6.0 V                                  | 5.48                    |                         |                           | -                         | -    | 5.34             | -    | 5.2               | -    | V    |
| CTC output;<br>RS = V <sub>IH</sub> ; MR = V <sub>IL</sub>                          |                         |                         |                           |                           |      |                  |      |                   |      |      |
| I <sub>O</sub> = -3.2 mA; V <sub>CC</sub> = 4.5 V                                   | 3.98                    |                         |                           | -                         | -    | 3.84             | -    | 3.7               | -    | V    |
| I <sub>O</sub> = -4.2 mA; V <sub>CC</sub> = 6.0 V                                   | 5.48                    |                         |                           | -                         | -    | 5.34             | -    | 5.2               | -    | V    |
| V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>except RTC output          |                         |                         |                           |                           |      |                  |      |                   |      |      |
| 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    |
| V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>except RTC and CTC outputs |                         |                         |                           |                           |      |                  |      |                   |      |      |
| I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V                                   | 3.98                    |                         |                           | -                         | -    | 3.84             | -    | 3.7               | -    | V    |
| I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V                                   | 5.48                    | -                       | -                         | 5.34                      | -    | 5.2              | -    | V                 |      |      |

**Table 5. 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  |      |   |
| V <sub>OL</sub>   | LOW-level output voltage | RTC output; RS = V <sub>CC</sub> ;<br>MR = GND  |       |     |      |                  |      |                   |      |      |   |
|   |                          | 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> = 2.6 mA; V <sub>CC</sub> = 4.5 V  | -     | -   | 0.26 | -                | 0.33 | -                 | 0.4  | V    |   |
|   |                          | I <sub>O</sub> = 3.3 mA; V <sub>CC</sub> = 6.0 V  | -     | -   | 0.26 | -                | 0.33 | -                 | 0.4  | V    |   |
|   |                          | CTC output; RS = V <sub>IL</sub> ;<br>MR = V <sub>IH</sub>                                |       |     |      |                  |      |                   |      |      |   |
|   |                          | I <sub>O</sub> = 3.2 mA; V <sub>CC</sub> = 4.5 V  | -     | -   | 0.26 | -                | 0.33 | -                 | 0.4  | V    |   |
|   |                          | I <sub>O</sub> = 4.2 mA; V <sub>CC</sub> = 6.0 V  | -     | -   | 0.26 | -                | 0.33 | -                 | 0.4  | V    |   |
|   |                          | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>except RTC output                |       |     |      |                  |      |                   |      |      |   |
|   |                          | 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    |   |
| V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>except RTC and CTC outputs |                          |   |       |     |      |                  |      |                   |      |      |   |
| I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V                                    | -                        | -   | 0.26  | -   | 0.33 | -                | 0.4  | V                 |      |      |   |
| I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V                                    | -                        | -   | 0.26  | -   | 0.33 | -                | 0.4  | V                 |      |      |   |
| I <sub>I</sub>  | input leakage current    | V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V                          | -     | -   | ±0.1 | -                | ±1.0 | -                 | ±1.0 | μA   |   |
| 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>74HCT4060</b>  |                          |   |       |     |      |                  |      |                   |      |      |   |
| V <sub>IH</sub>   | HIGH-level input voltage | MR input;<br>V <sub>CC</sub> = 4.5 V to 5.5 V   | [1]   | 2.0 | -    | -                | 2.0  | -                 | 2.0  | -    | V |
| V <sub>IL</sub>   | LOW-level input voltage  | MR input;<br>V <sub>CC</sub> = 4.5 V to 5.5 V   | [1]   | -   | -    | 0.8              | -    | 0.8               | -    | 0.8  | V |



**Table 5. 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  |      |
| V <sub>OH</sub>                                  | HIGH-level output voltage | RTC output; RS = MR = V <sub>CC</sub>   |       |     |      |                  |      |                   |      |      |
|  |                           | 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> = -0.65 mA; V <sub>CC</sub> = 4.5 V  | 3.98  | -   | -    | 3.84             | -    | 3.7               | -    | V    |
|  |                           | RTC output; RS = MR = GND   |       |     |      |                  |      |                   |      |      |
|  |                           | 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> = -2.6 mA; V <sub>CC</sub> = 4.5 V   | 3.98  | -   | -    | 3.84             | -    | 3.7               | -    | V    |
|  |                           | CTC output; RS = V <sub>IH</sub> ;<br>MR = V <sub>IL</sub>  |       |     |      |                  |      |                   |      |      |
|  |                           | I <sub>O</sub> = -3.2 mA; V <sub>CC</sub> = 4.5 V   | 3.98  | -   | -    | 3.84             | -    | 3.7               | -    | V    |
|  |                           | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>except RTC output  |       |     |      |                  |      |                   |      |      |
|  |                           | I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V  | 4.4   | 4.5 | -    | 4.4              | -    | 4.4               | -    | V    |
| V <sub>OL</sub>                                  | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>except RTC and CTC outputs   |       |     |      |                  |      |                   |      |      |
|  |                           | I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V   | 3.98  | -   | -    | 3.84             | -    | 3.7               | -    | V    |
|  |                           | RTC output; RS = V <sub>CC</sub> ;<br>MR = GND  |       |     |      |                  |      |                   |      |      |
|  |                           | 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> = 2.6 mA; V <sub>CC</sub> = 4.5 V  | -     | -   | 0.26 | -                | 0.33 | -                 | 0.4  | V    |
|  |                           | CTC output; RS = V <sub>IL</sub> ;<br>MR = V <sub>IH</sub>  |       |     |      |                  |      |                   |      |      |
|  |                           | I <sub>O</sub> = 3.2 mA; V <sub>CC</sub> = 4.5 V  | -     | -   | 0.26 | -                | 0.33 | -                 | 0.4  | V    |
|  |                           | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>except RTC output  |       |     |      |                  |      |                   |      |      |
|  |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V   | -     | 0   | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|  |                           | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>except RTC and CTC outputs   |       |     |      |                  |      |                   |      |      |
| I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V | -                         | -   | 0.26  | -   | 0.33 | -                | 0.4  | V                 |      |      |
| I <sub>I</sub>                                   | input leakage current     | V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V  | -     | -   | ±0.1 | -                | ±1.0 | -                 | ±1.0 | μA   |
| I <sub>CC</sub>                                  | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 5.5 V; I <sub>O</sub> = 0 A   | -     | -   | 8.0  | -                | 80   | -                 | 160  | μA   |
| ΔI <sub>CC</sub>                                 | additional supply current | per input pin;<br>V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; other inputs at V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 4.5 V to 5.5 V; I <sub>O</sub> = 0 A | -     | 40  | 144  | -                | 180  | -                 | 196  | μA   |
| C <sub>I</sub>                                   | input capacitance         |   | -     | 3.5 | -    | -                | -    | -                 | -    | pF   |

[1] For HCT4060, only input MR (pin 12) has TTL input switching levels.

## 11. Dynamic characteristics

**Table 6. Dynamic characteristics**

$GND = 0\text{ V}$ ;  $C_L = 50\text{ pF}$  unless otherwise specified; for test circuit see [Figure 11](#).

| Symbol          | Parameter                                      | Conditions  | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|-----------------|--|---|-------|-----|-----|------------------|-----|-------------------|-----|------|
|                 |  |   | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| <b>74HC4060</b> |  |   |       |     |     |                  |     |                   |     |      |
| $t_{pd}$        | propagation delay                              | RS to Q3; see <a href="#">Figure 8</a> <sup>[1]</sup>   |       |     |     |                  |     |                   |     |      |
|                 |  | $V_{CC} = 2.0\text{ V}$                                 | -     | 99  | 300 | -                | 375 | -                 | 450 | ns   |
|                 |  | $V_{CC} = 4.5\text{ V}$                                 | -     | 36  | 60  | -                | 75  | -                 | 90  | ns   |
|                 |  | $V_{CC} = 5.0\text{ V}$ ; $C_L = 15\text{ pF}$          | -     | 31  | -   | -                | -   | -                 | -   | ns   |
|                 |  | $V_{CC} = 6.0\text{ V}$                                 | -     | 29  | 51  | -                | 64  | -                 | 77  | ns   |
|                 |  | Qn to Qn+1; see <a href="#">Figure 9</a> <sup>[2]</sup> |       |     |     |                  |     |                   |     |      |
|                 |  | $V_{CC} = 2.0\text{ V}$                                 | -     | 22  | 80  | -                | 100 | -                 | 120 | ns   |
|                 |  | $V_{CC} = 4.5\text{ V}$                                 | -     | 8   | 16  | -                | 20  | -                 | 24  | ns   |
|                 | $V_{CC} = 5.0\text{ V}$ ; $C_L = 15\text{ pF}$ | -   | 6     | -   | -   | -                | -   | -                 | ns  |      |
|                 | $V_{CC} = 6.0\text{ V}$                        | -   | 6     | 14  | -   | 17               | -   | 20                | ns  |      |
| $t_{PHL}$       | HIGH to LOW propagation delay                  | MR to Qn; see <a href="#">Figure 10</a>                 |       |     |     |                  |     |                   |     |      |
|                 |  | $V_{CC} = 2.0\text{ V}$                                 | -     | 55  | 175 | -                | 220 | -                 | 265 | ns   |
|                 |  | $V_{CC} = 4.5\text{ V}$                                 | -     | 20  | 35  | -                | 44  | -                 | 53  | ns   |
|                 |  | $V_{CC} = 5.0\text{ V}$ ; $C_L = 15\text{ pF}$          | -     | 17  | -   | -                | -   | -                 | -   | ns   |
|                 | $V_{CC} = 6.0\text{ V}$                        | -   | 16    | 30  | -   | 37               | -   | 45                | ns  |      |
| $t_t$           | transition time                                | Qn; see <a href="#">Figure 8</a> <sup>[3]</sup>         |       |     |     |                  |     |                   |     |      |
|                 |  | $V_{CC} = 2.0\text{ V}$                                 | -     | 19  | 75  | -                | 95  | -                 | 110 | ns   |
|                 |  | $V_{CC} = 4.5\text{ V}$                                 | -     | 7   | 15  | -                | 19  | -                 | 22  | ns   |
|                 |  | $V_{CC} = 6.0\text{ V}$                                 | -     | 6   | 13  | -                | 16  | -                 | 19  | ns   |
| $t_W$           | pulse width                                    | RS (HIGH or LOW); see <a href="#">Figure 8</a>          |       |     |     |                  |     |                   |     |      |
|                 |  | $V_{CC} = 2.0\text{ V}$                                 | 80    | 17  | -   | 100              | -   | 120               | -   | ns   |
|                 |  | $V_{CC} = 4.5\text{ V}$                                 | 16    | 6   | -   | 20               | -   | 24                | -   | ns   |
|                 |  | $V_{CC} = 6.0\text{ V}$                                 | 14    | 5   | -   | 17               | -   | 20                | -   | ns   |
|                 |  | MR (HIGH); see <a href="#">Figure 10</a>                |       |     |     |                  |     |                   |     |      |
|                 |  | $V_{CC} = 2.0\text{ V}$                                 | 80    | 25  | -   | 100              | -   | 120               | -   | ns   |
|                 |  | $V_{CC} = 4.5\text{ V}$                                 | 16    | 9   | -   | 20               | -   | 24                | -   | ns   |
|                 |  | $V_{CC} = 6.0\text{ V}$                                 | 14    | 7   | -   | 17               | -   | 20                | -   | ns   |
| $t_{rec}$       | recovery time                                  | MR to RS; see <a href="#">Figure 10</a>                 |       |     |     |                  |     |                   |     |      |
|                 |  | $V_{CC} = 2.0\text{ V}$                                 | 100   | 28  | -   | 125              | -   | 150               | -   | ns   |
|                 |  | $V_{CC} = 4.5\text{ V}$                                 | 20    | 10  | -   | 25               | -   | 30                | -   | ns   |
|                 |  | $V_{CC} = 6.0\text{ V}$                                 | 17    | 8   | -   | 21               | -   | 26                | -   | ns   |

**Table 6. Dynamic characteristics ...continued**  
*GND = 0 V; C<sub>L</sub> = 50 pF unless otherwise specified; for test circuit see Figure 11.*

| Symbol           | Parameter                     | Conditions   | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|------------------|-------------------------------|--|-------|-----|-----|------------------|-----|-------------------|-----|------|
|                  |                               |  | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| f <sub>max</sub> | maximum frequency             | RS; see <a href="#">Figure 8</a>   |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 2.0 V  | 6     | 26  | -   | 4.8              | -   | 4                 | -   | MHz  |
|                  |                               | V <sub>CC</sub> = 4.5 V  | 30    | 80  | -   | 24               | -   | 20                | -   | MHz  |
|                  |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF  | -     | 87  | -   | -                | -   | -                 | -   | MHz  |
|                  |                               | V <sub>CC</sub> = 6.0 V  | 35    | 95  | -   | 28               | -   | 24                | -   | MHz  |
| C <sub>PD</sub>  | power dissipation capacitance | V <sub>I</sub> = GND to V <sub>CC</sub> ;<br>V <sub>CC</sub> = 5 V; f <sub>i</sub> = 1 MHz | [4]   | -   | 40  | -                | -   | -                 | -   | pF   |
| <b>74HCT4060</b> |                               |  |       |     |     |                  |     |                   |     |      |
| t <sub>pd</sub>  | propagation delay             | RS to Q3; see <a href="#">Figure 8</a>   | [1]   |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | -     | 33  | 66  | -                | 83  | -                 | 99  | ns   |
|                  |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF  | -     | 31  | -   | -                | -   | -                 | -   | ns   |
|                  |                               | Qn to Qn+1; see <a href="#">Figure 9</a>   | [2]   |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | -     | 8   | 16  | -                | 20  | -                 | 24  | ns   |
|                  |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF  | -     | 6   | -   | -                | -   | -                 | ns  |      |
| t <sub>PHL</sub> | HIGH to LOW propagation delay | MR to Qn; see <a href="#">Figure 10</a>  |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | -     | 21  | 44  | -                | 55  | -                 | 66  | ns   |
|                  |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF  | -     | 18  | -   | -                | -   | -                 | ns  |      |
| t <sub>t</sub>   | transition time               | Qn; see <a href="#">Figure 8</a>   | [3]   |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | -     | 7   | 15  | -                | 19  | -                 | 22  | ns   |
| t <sub>W</sub>   | pulse width                   | RS (HIGH or LOW); see <a href="#">Figure 8</a>   |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | 16    | 6   | -   | 20               | -   | 24                | -   | ns   |
|                  |                               | MR (HIGH); see <a href="#">Figure 10</a>   |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | 16    | 6   | -   | 20               | -   | 24                | -   | ns   |
| t <sub>rec</sub> | recovery time                 | MR to RS; see <a href="#">Figure 10</a>  |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | 26    | 13  | -   | 33               | -   | 39                | -   | ns   |
| f <sub>max</sub> | maximum frequency             | RS; see <a href="#">Figure 8</a>   |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | 30    | 80  | -   | 24               | -   | 20                | -   | MHz  |
|                  |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF  | -     | 88  | -   | -                | -   | -                 | -   | MHz  |

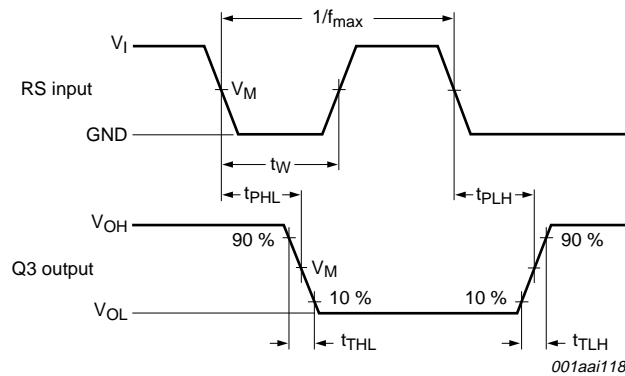
**Table 6. Dynamic characteristics ...continued**

$GND = 0\text{ V}$ ;  $C_L = 50\text{ pF}$  unless otherwise specified; for test circuit see [Figure 11](#).

| Symbol   | Parameter                     | Conditions   | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|----------|-------------------------------|--|-------|-----|-----|------------------|-----|-------------------|-----|------|
|          |                               |  | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| $C_{PD}$ | power dissipation capacitance | $V_I = GND$ to $V_{CC} - 1.5\text{ V}$ ;<br>$V_{CC} = 5\text{ V}$ ; $f_i = 1\text{ MHz}$ | [4]   | -   | 40  | -                | -   | -                 | -   | pF   |

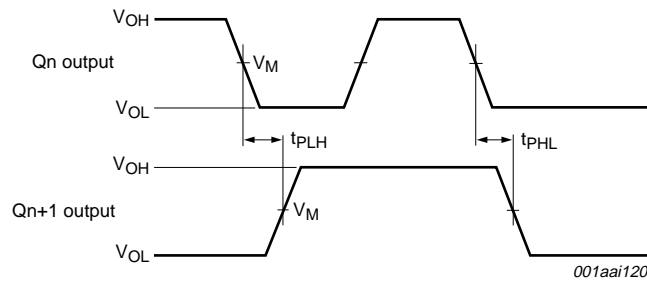
- [1]  $t_{pd}$  is the same as  $t_{PHL}$  and  $t_{PLH}$ .
- [2]  $Q_{n+1}$  is the next  $Q_n$  output.
- [3]  $t_i$  is the same as  $t_{THL}$  and  $t_{TLH}$ .
- [4]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ):  
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o)$  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.

## 12. Waveforms



Measurement points are given in [Table 7](#).  
 $V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.

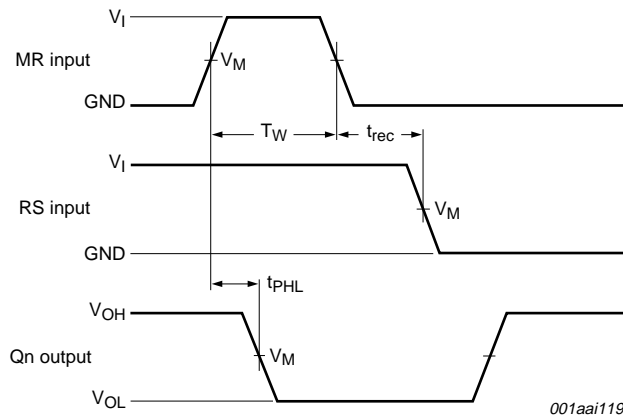
**Fig 8. Waveforms showing the clock (RS) to output (Q3) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency**



Measurement points are given in [Table 7](#).

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

**Fig 9. Waveforms showing the output Qn to output Qn+1 propagation delays**



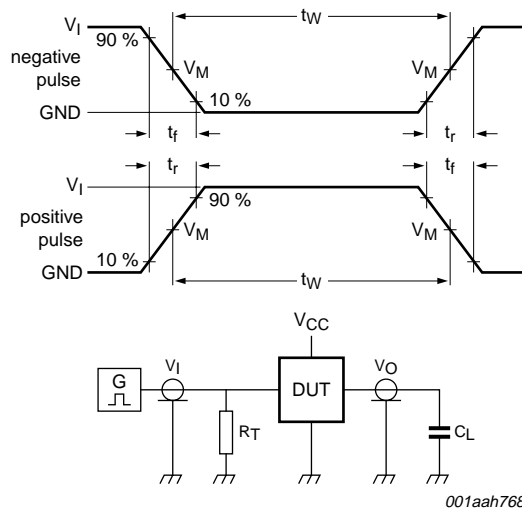
Measurement points are given in [Table 7](#).

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

**Fig 10. Waveforms showing the master reset (MR) pulse width, the master reset to output (Qn) propagation delays and the master reset to clock (RS) recovery time**

**Table 7. Measurement points**

| Type      | Input               | Output              |
|-----------|---------------------|---------------------|
|           | $V_M$               | $V_M$               |
| 74HC4060  | $0.5 \times V_{CC}$ | $0.5 \times V_{CC}$ |
| 74HCT4060 | 1.3 V               | 1.3 V               |



Test data is given in [Table 8](#).

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.

Fig 11. Test circuit for measuring switching times

Table 8. Test data

| Type      | Input    |            | Load         |
|-----------|----------|------------|--------------|
|           | $V_I$    | $t_r, t_f$ | $C_L$        |
| 74HC4060  | $V_{CC}$ | 6 ns       | 15 pF, 50 pF |
| 74HCT4060 | 3 V      | 6 ns       | 15 pF, 50 pF |

### 13. RC oscillator

#### 13.1 Timing component limitations

The oscillator frequency is mainly determined by  $R_t C_t$ , provided  $R_2 \approx 2R_t$  and  $R_2 C_2 \ll R_t C_t$ . The function of  $R_2$  is to minimize the influence of the forward voltage across the input protection diodes on the frequency. The stray capacitance  $C_2$  should be kept as small as possible. In consideration of accuracy,  $C_t$  must be larger than the inherent stray capacitance.  $R_t$  must be larger than the ON resistance in series with it, which typically is 280  $\Omega$  at  $V_{CC} = 2.0$  V, 130  $\Omega$  at  $V_{CC} = 4.5$  V and 100  $\Omega$  at  $V_{CC} = 6.0$  V.

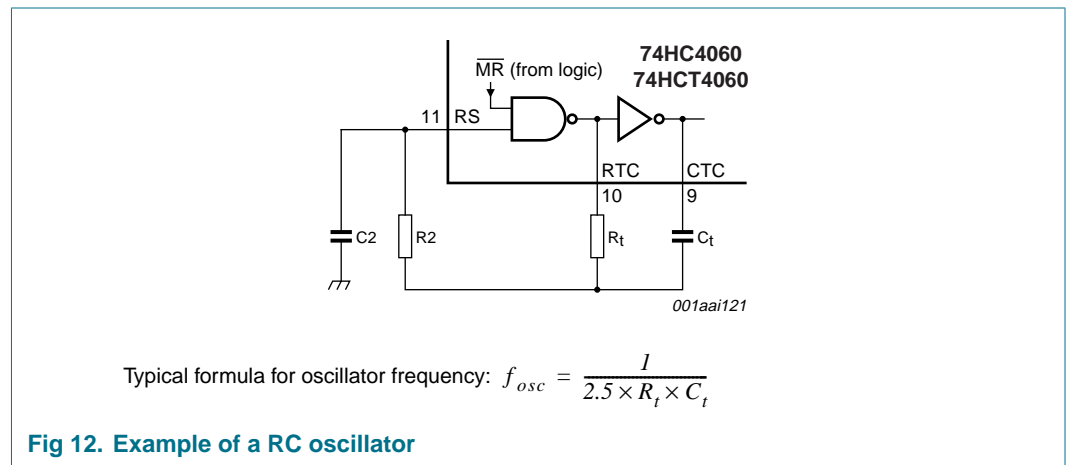


Fig 12. Example of a RC oscillator

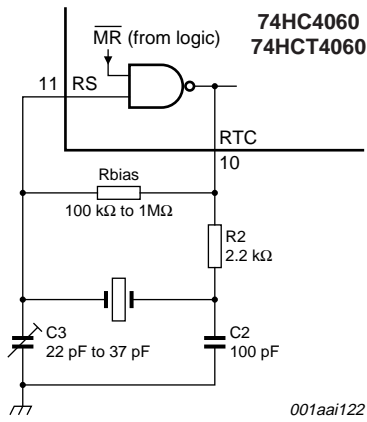
The recommended values for these components to maintain agreement with the typical oscillation formula are:

$C_t > 50$  pF, up to any practical value and  $10$  k $\Omega < R_t < 1$  M $\Omega$ .

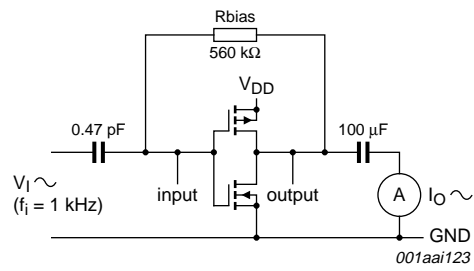
In order to avoid start-up problems,  $R_t \geq 1$  k $\Omega$ .

#### 13.2 Typical crystal oscillator circuit

In [Figure 13](#),  $R_2$  is the power limiting resistor. For starting and maintaining oscillation a minimum transconductance is necessary, so  $R_2$  should not be too large. A practical value for  $R_2$  is 2.2 k $\Omega$ .



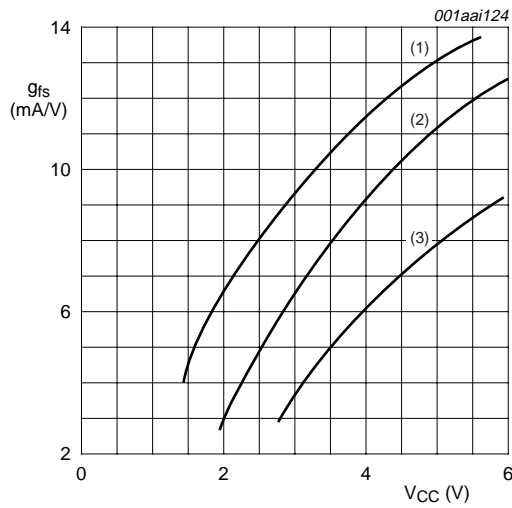
**Fig 13. External component connection for a crystal oscillator**



$g_{fs} = \Delta I_O / \Delta V_i$  at  $V_O$  is constant; MR = LOW.

See also [Figure 15](#).

**Fig 14. Test set-up for measuring forward transconductance**

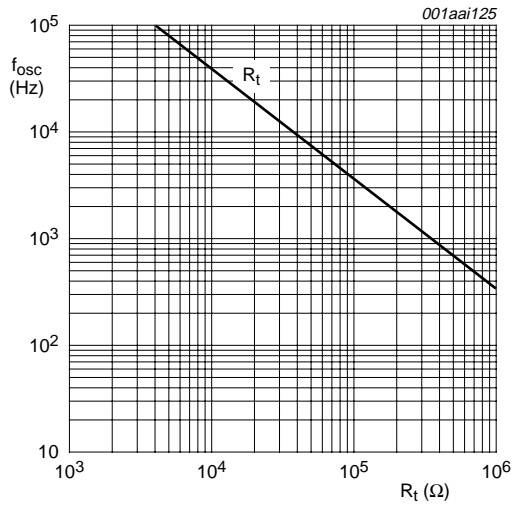


T<sub>amb</sub> = 25 °C.

- (1) Maximum.
- (2) Typical.
- (3) Minimum.

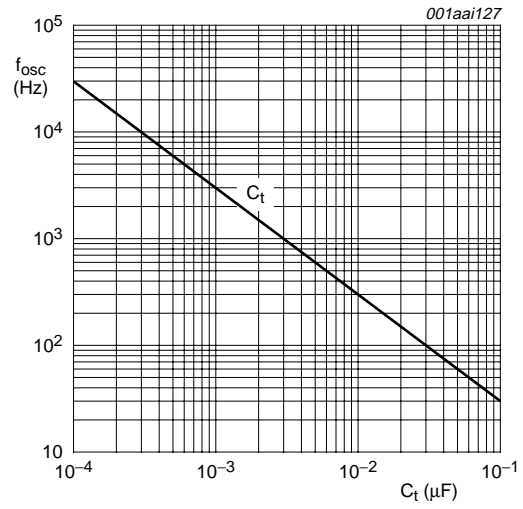
**Fig 15. Typical forward transconductance as function of the supply voltage**





$V_{CC} = 2.0\text{ V to }6.0\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}.$   
 For  $R_f$  curve:  $C_t = 1\text{ nF}; R_2 = 2 \times R_f.$

**Fig 16. RC oscillator frequency as a function of  $R_f$**



$V_{CC} = 2.0\text{ V to }6.0\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}.$   
 For  $C_t$  curve:  $R_f = 100\text{ k}\Omega; R_2 = 200\text{ k}\Omega.$

**Fig 17. RC oscillator frequency as a function of  $C_t$**

14. Package outline

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

SOT38-4

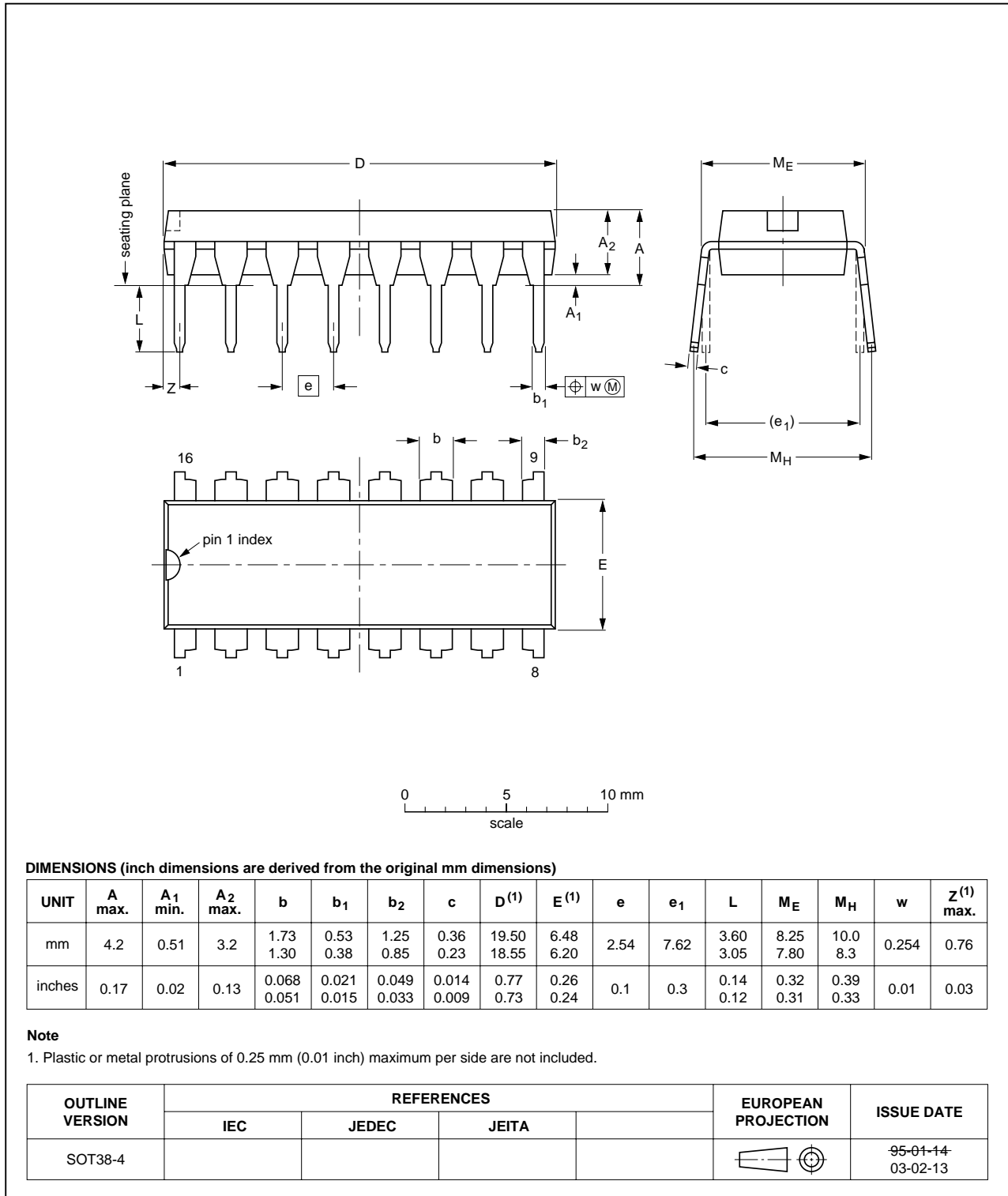


Fig 18. Package outline SOT38-4 (DIP16)

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

SOT109-1

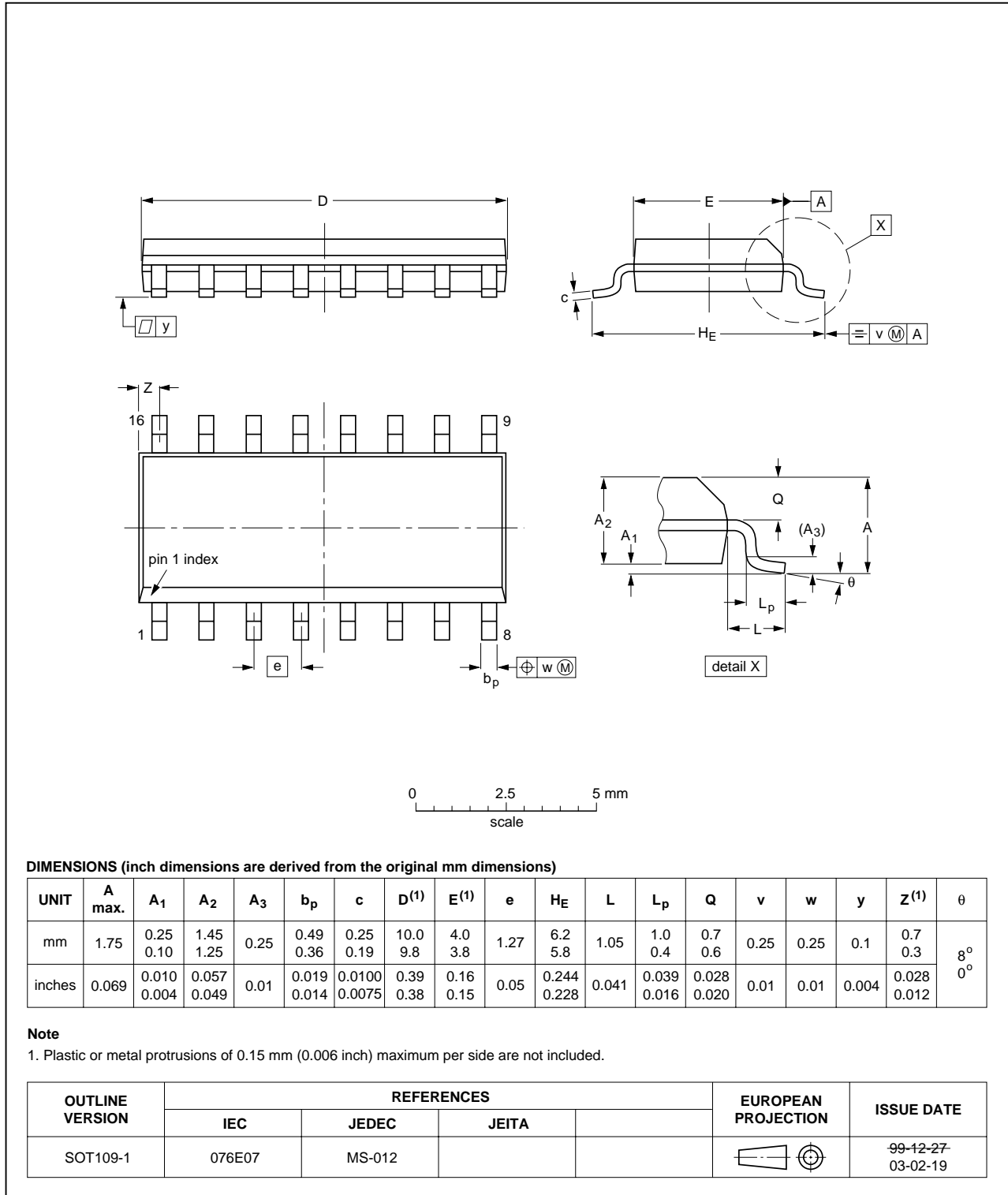


Fig 19. Package outline SOT109-1 (SO16)

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

SOT338-1

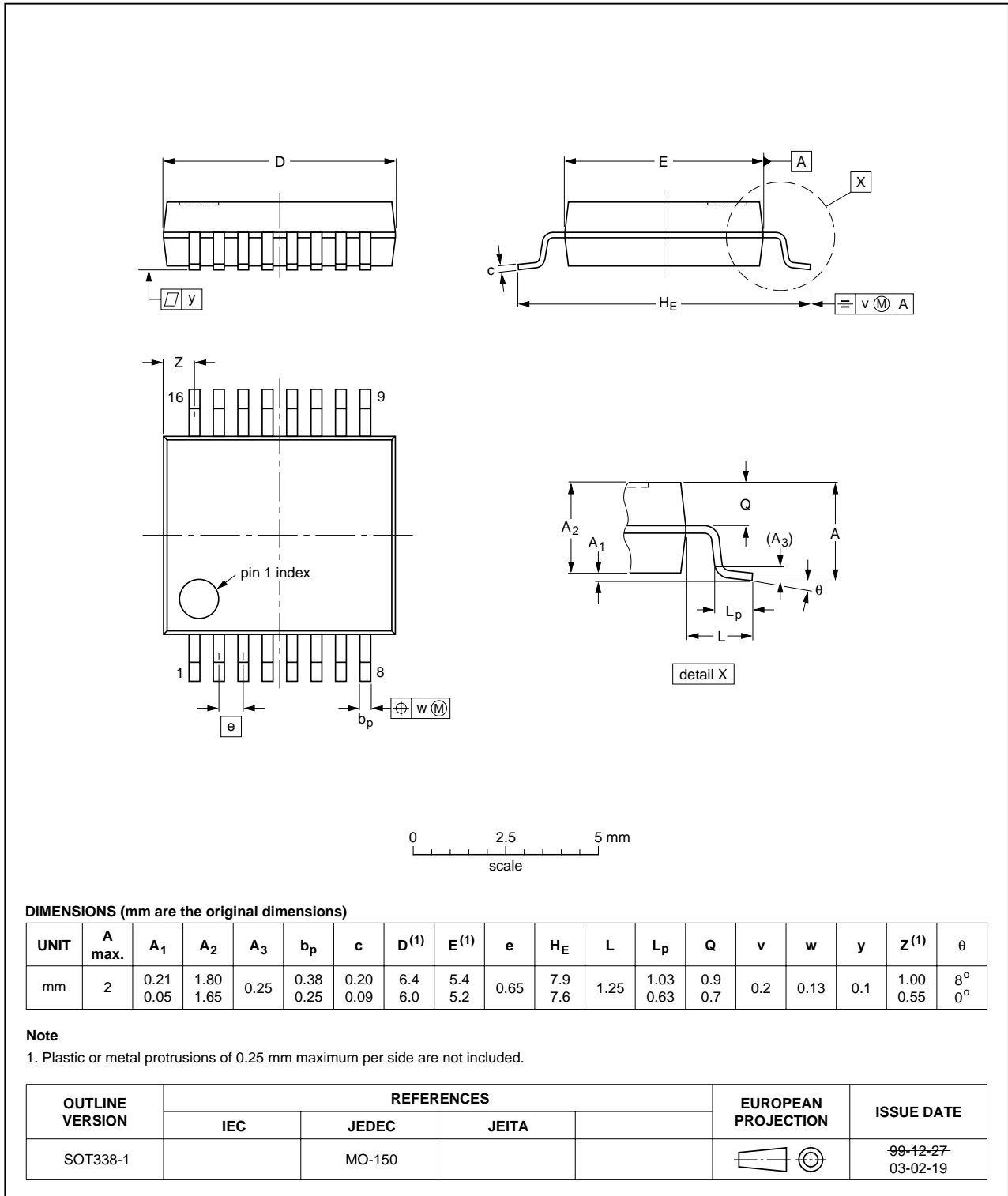


Fig 20. Package outline SOT338-1 (SSOP16)

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

SOT403-1

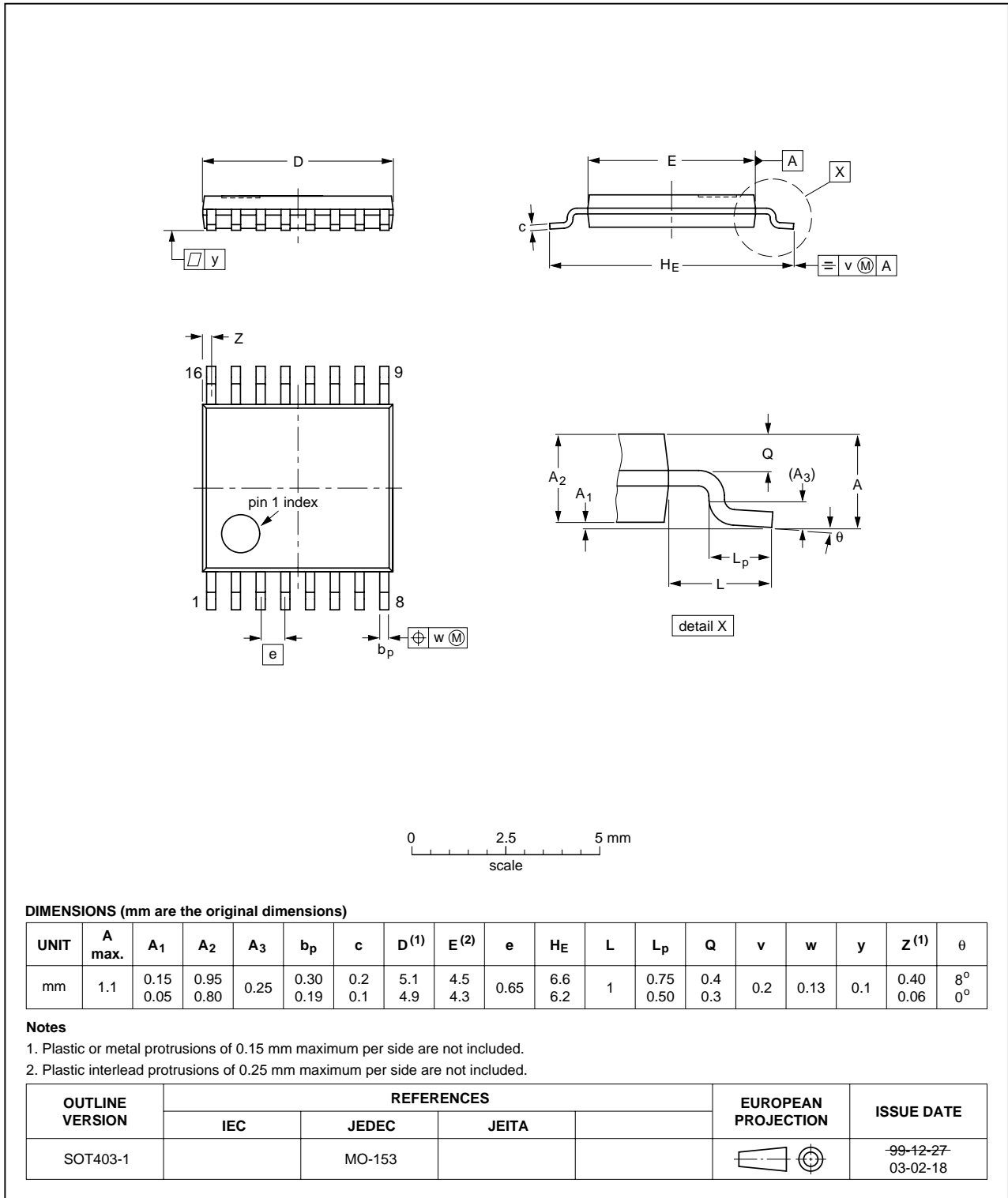


Fig 21. Package outline SOT403-1 (TSSOP16)

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

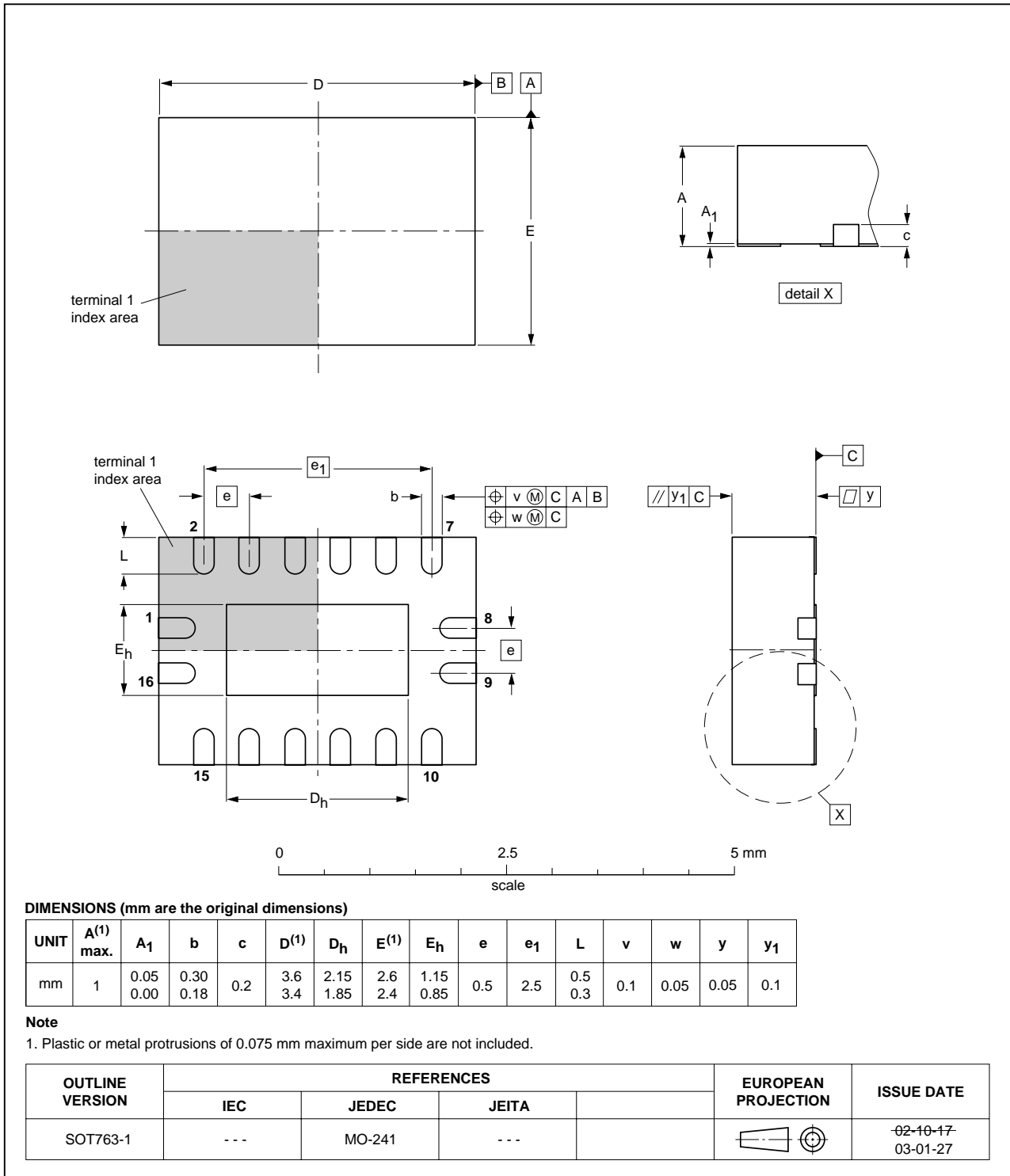


Fig 22. Package outline SOT763-1 (DHVQFN16)

## 15. Abbreviations

**Table 9. Abbreviations**

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

## 16. Revision history

**Table 10. Revision history**

| Document ID        | Release date   | Data sheet status     | Change notice | Supersedes         |
|--------------------|--|-----------------------|---------------|--------------------|
| 74HC_HCT4060_3     | 20080714   | Product data sheet    | -             | 74HC_HCT4060_CNV_2 |
| 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>• <a href="#">Section 4</a>: DHVQFN16 package added.</li> <li>• <a href="#">Section 8</a>: derating values added for DHVQFN16 package.</li> <li>• <a href="#">Section 14</a>: outline drawing added for DHVQFN16 package.</li> </ul> |                       |               |                    |
| 74HC_HCT4060_CNV_2 | 19970901   | Product specification | -             | -                  |

## 17. Legal information

## 18. 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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