

# 74HC4520-Q100; 74HCT4520-Q100

## Dual 4-bit synchronous binary counter

Rev. 1 — 4 December 2014

Product data sheet

### 1. General description

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The 74HC4520-Q100; 74HCT4520-Q100 are dual 4-bit internally synchronous binary counters with two clock inputs ( $\overline{nCP0}$  and  $\overline{nCP1}$ ). They have buffered outputs from all 4 bit positions ( $nQ0$  to  $nQ3$ ), and an asynchronous master reset input ( $\overline{nMR}$ ). The counter advances on either the LOW-to-HIGH transition of  $\overline{nCP0}$  when  $\overline{nCP1}$  is HIGH. It also advances on the HIGH-to-LOW transition of  $\overline{nCP1}$  if  $\overline{nCP0}$  is LOW. Either  $\overline{nCP0}$  or  $\overline{nCP1}$  may be used as the clock input to the counter. The other clock input may be used as a clock enable input. A HIGH on  $\overline{nMR}$  resets the counter ( $nQ0$  to  $nQ3 = \text{LOW}$ ) independent of  $\overline{nCP0}$  and  $\overline{nCP1}$ . Inputs include clamp diodes. It enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

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

### 2. Features and benefits

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- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - ◆ Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard no. 7A
- Input levels:
  - ◆ For 74HC4520-Q100: CMOS level
  - ◆ For 74HCT4520-Q100: TTL level
- ESD protection:
  - ◆ MIL-STD-883, method 3015 exceeds 2000 V
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V ( $C = 200\text{ pF}$ ,  $R = 0\text{ }\Omega$ )
- Multiple package options

### 3. Applications

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- Multistage synchronous counting
- Multistage asynchronous counting
- Frequency dividers



## 4. Ordering information

Table 1. Ordering information

| Type number     | Package           |         |  | Version  |
|-----------------|-------------------|---------|--|----------|
|                 | Temperature range | Name    | Description  |          |
| 74HC4520D-Q100  | -40 °C to +125 °C | SO16    | plastic small outline package; 16 leads; body width 3.9 mm             | SOT109-1 |
| 74HCT4520D-Q100 |                   |         |  |          |
| 74HC4520PW-Q100 | -40 °C to +125 °C | TSSOP16 | plastic thin shrink small outline package; 16 leads; body width 4.4 mm | SOT403-1 |

## 5. Functional diagram

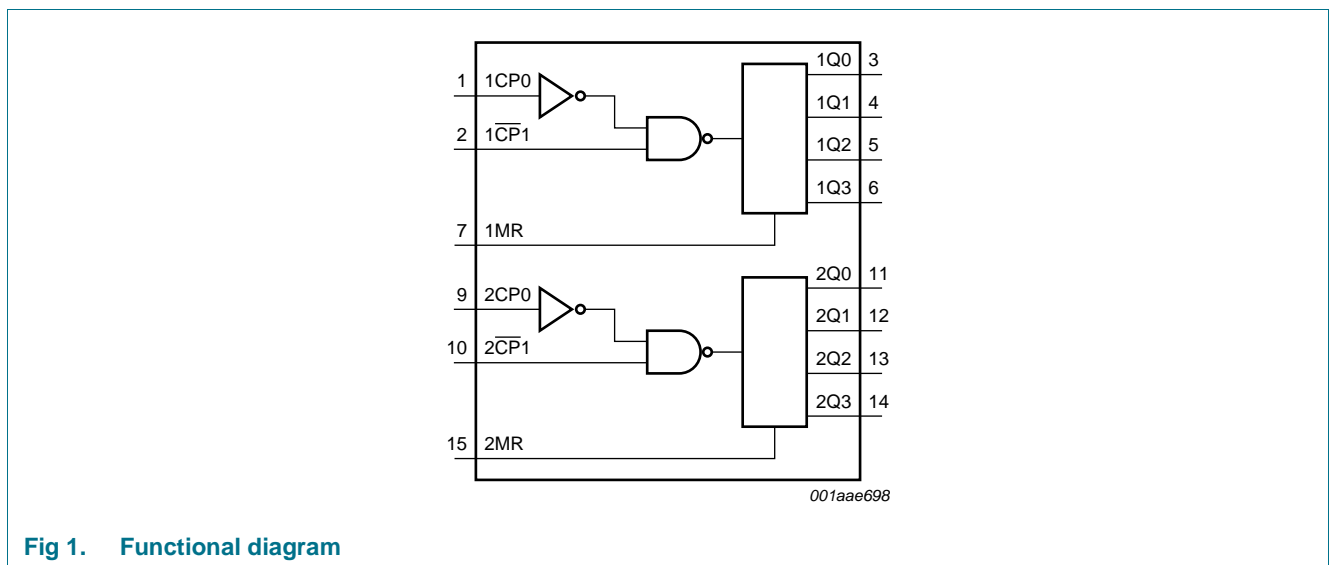


Fig 1. Functional diagram

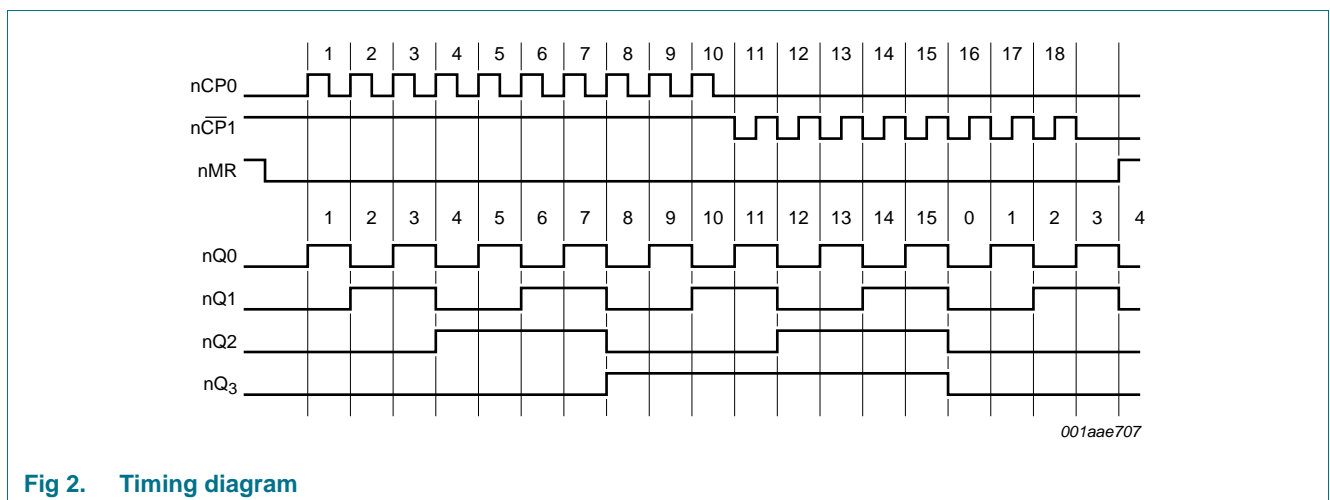


Fig 2. Timing diagram

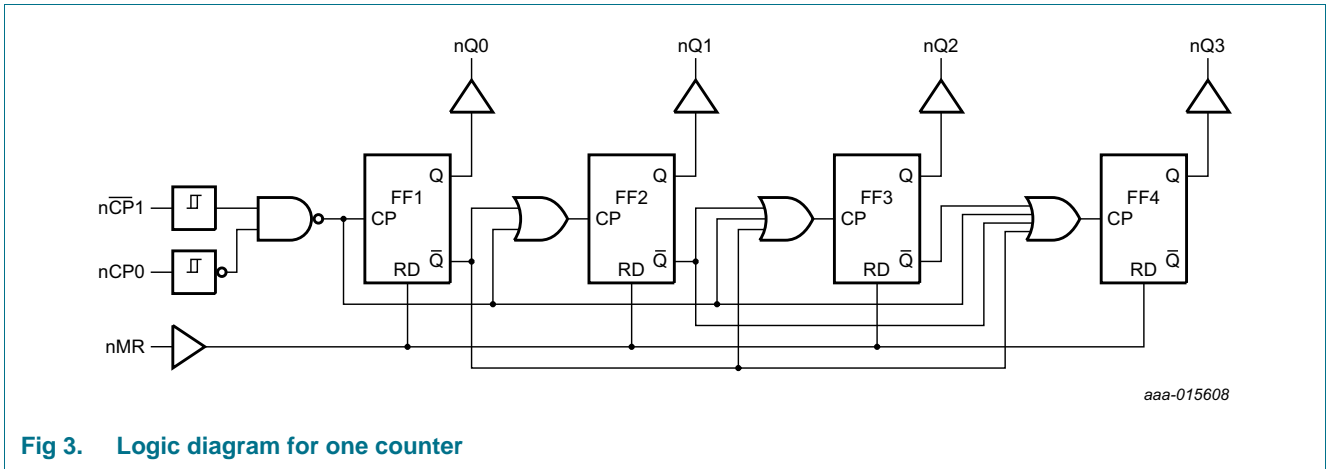


Fig 3. Logic diagram for one counter

## 6. Pinning information

### 6.1 Pinning

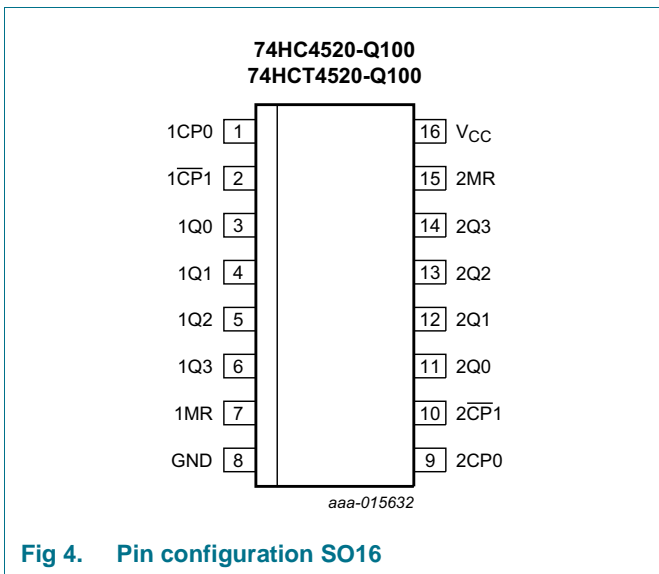


Fig 4. Pin configuration SO16

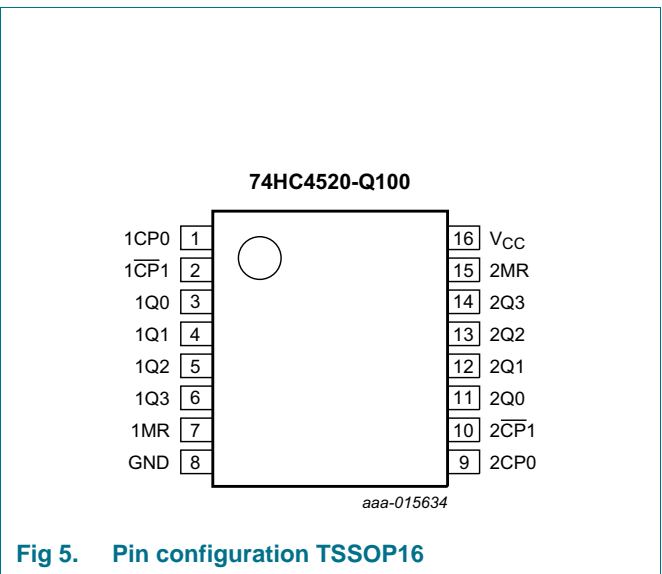


Fig 5. Pin configuration TSSOP16

### 6.2 Pin description

Table 2. Pin description

| Symbol          | Pin            | Description                                   |
|-----------------|----------------|---|
| 1CP0, 2CP0      | 1, 9           | clock input (LOW-to-HIGH edge-triggered)      |
| 1CP1, 2CP1      | 2, 10          | clock input (HIGH-to-LOW edge-triggered)      |
| 1Q0 to 1Q3      | 3, 4, 5, 6     | output  |
| 1MR, 2MR        | 7, 15          | asynchronous master reset input (active HIGH) |
| GND             | 8              | ground (0 V)                                  |
| 2Q0 to 2Q3      | 11, 12, 13, 14 | output  |
| V <sub>CC</sub> | 16             | supply voltage                                |

## 7. Functional description

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

| nCP0 | nCP1 | nMR | Mode             |
|------|------|-----|------------------|
| ↑    | H    | L   | counter advances |
| L    | ↓    | L   | counter advances |
| ↓    | X    | L   | no change        |
| X    | ↑    | L   | no change        |
| ↑    | L    | L   | no change        |
| H    | ↓    | L   | no change        |
| X    | X    | H   | nQ0 to nQ3 = LOW |

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = positive-going transition; ↓ = negative-going transition.

## 8. Limiting values

Table 4. Limiting values

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

| Symbol    | Parameter               | Conditions   | Min  | Max  | Unit |
|-----------|-------------------------|--|------|------|------|
| $V_{CC}$  | supply voltage          |  | -0.5 | +7.0 | V    |
| $I_{IK}$  | input clamping current  | $V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ | -    | ±20  | mA   |
| $I_{OK}$  | output clamping current | $V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ | -    | ±20  | mA   |
| $I_O$     | output current          | $V_O = -0.5\text{ V}$ to $V_{CC} + 0.5\text{ V}$       | -    | ±25  | mA   |
| $I_{CC}$  | supply current          |  | -    | 50   | mA   |
| $I_{GND}$ | ground current          |  | -50  | -    | mA   |
| $T_{stg}$ | storage temperature     |  | -65  | +150 | °C   |
| $P_{tot}$ | total power dissipation | SO16 and TSSOP16 packages <sup>[1]</sup>               | -    | 500  | mW   |

[1] For SO16 package: above 70 °C the value of  $P_{tot}$  derates linearly at 8 mW/K.  
For TSSOP16 package: above 60 °C the value of  $P_{tot}$  derates linearly at 5.5 mW/K.

## 9. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

| Symbol              | Parameter                           | Conditions              | 74HC4520-Q100 |      |          | 74HCT4520-Q100 |      |          | Unit |
|---------------------|-------------------------------------|-------------------------|---------------|------|----------|----------------|------|----------|------|
|                     |                                     |                         | Min           | Typ  | Max      | Min            | Typ  | Max      |      |
| $V_{CC}$            | supply voltage                      |                         | 2.0           | 5.0  | 6.0      | 4.5            | 5.0  | 5.5      | V    |
| $V_I$               | input voltage                       |                         | 0             | -    | $V_{CC}$ | 0              | -    | $V_{CC}$ | V    |
| $V_O$               | output voltage                      |                         | 0             | -    | $V_{CC}$ | 0              | -    | $V_{CC}$ | V    |
| $T_{amb}$           | ambient temperature                 |                         | -40           | +25  | +125     | -40            | +25  | +125     | °C   |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.0\text{ V}$ | -             | -    | 625      | -              | -    | -        | ns/V |
|                     |                                     | $V_{CC} = 4.5\text{ V}$ | -             | 1.67 | 139      | -              | 1.67 | 139      | ns/V |
|                     |                                     | $V_{CC} = 6.0\text{ V}$ | -             | -    | 83       | -              | -    | -        | ns/V |

## 10. Static characteristics

**Table 6. Static characteristics**

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

| Symbol               | Parameter                 | Conditions   | 25 °C |      |      | -40 °C to +85 °C |      | -40 °C to +125 °C |       | Unit |
|----------------------|---------------------------|--|-------|------|------|------------------|------|-------------------|-------|------|
|                      |                           |  | Min   | Typ  | Max  | Min              | Max  | Min               | Max   |      |
| <b>74HC4520-Q100</b> |                           |  |       |      |      |                  |      |                   |       |      |
| 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    |
| 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; V <sub>CC</sub> = 4.5 V   | 3.98  | 4.32 | -    | 3.84             | -    | 3.7               | -     | V    |
|                      |                           | I <sub>O</sub> = -5.2; 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; 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; V <sub>CC</sub> = 6.0 V | -     | -    | 8.0  | -                | 80.0 | -                 | 160.0 | μA   |
| C <sub>I</sub>       | input capacitance         |  | -     | 3.5  | -    | -                | -    | -                 | -     | pF   |

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

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

| Symbol                | Parameter                 | Conditions  | 25 °C |      |      | -40 °C to +85 °C |      | -40 °C to +125 °C |       | Unit |
|-----------------------|---------------------------|---|-------|------|------|------------------|------|-------------------|-------|------|
|                       |                           |   | Min   | Typ  | Max  | Min              | Max  | Min               | Max   |      |
| <b>74HCT4520-Q100</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> = -4.0 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; 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; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 5.5 V  | -     | -    | 8.0  | -                | 80.0 | -                 | 160.0 | μA   |
| ΔI <sub>CC</sub>      | additional supply current | per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 4.5 V to 5.5 V; I <sub>O</sub> = 0 A |       |      |      |                  |      |                   |       |      |
|                       |                           | pin nCP0, nCP1  | -     | 80   | 288  | -                | 360  | -                 | 392   | μA   |
|                       |                           | pin nMR   | -     | 150  | 540  | -                | 675  | -                 | 735   | μA   |
| C <sub>I</sub>        | input capacitance         |   | -     | 3.5  | -    | -                | -    | -                 | -     | pF   |

## 11. Dynamic characteristics

**Table 7. Dynamic characteristics**

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

| Symbol                  | Parameter         | Conditions   | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|-------------------------|-------------------|--|-------|-----|-----|------------------|-----|-------------------|-----|------|
|                         |                   |  | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| <b>74HC4520-Q100</b>    |                   |  |       |     |     |                  |     |                   |     |      |
| t <sub>pd</sub>         | propagation delay | nCP0 to nQn; see <a href="#">Figure 6</a> <sup>[1]</sup> |       |     |     |                  |     |                   |     |      |
|                         |                   | V <sub>CC</sub> = 2.0 V                                  | -     | 77  | 240 | -                | 300 | -                 | 360 | ns   |
|                         |                   | V <sub>CC</sub> = 4.5 V                                  | -     | 28  | 48  | -                | 60  | -                 | 72  | ns   |
|                         |                   | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF          | -     | 24  | -   | -                | -   | -                 | -   | ns   |
|                         |                   | V <sub>CC</sub> = 6.0 V                                  | -     | 22  | 41  | -                | 51  | -                 | 61  | ns   |
|                         |                   | nCP1 to nQn; see <a href="#">Figure 6</a> <sup>[1]</sup> |       |     |     |                  |     |                   |     |      |
|                         |                   | V <sub>CC</sub> = 2.0 V                                  | -     | 77  | 240 | -                | 300 | -                 | 360 | ns   |
|                         |                   | V <sub>CC</sub> = 4.5 V                                  | -     | 28  | 48  | -                | 60  | -                 | 72  | ns   |
|                         |                   | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF          | -     | 24  | -   | -                | -   | -                 | -   | ns   |
| V <sub>CC</sub> = 6.0 V | -                 | 22   | 41    | -   | 51  | -                | 61  | ns                |     |      |

**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 7](#).

| Symbol                | Parameter                     | Conditions  | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|-----------------------|-------------------------------|---|-------|-----|-----|------------------|-----|-------------------|-----|------|
|                       |                               |   | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| t <sub>PHL</sub>      | HIGH to LOW propagation delay | nMR to nQn; see <a href="#">Figure 6</a>  |       |     |     |                  |     |                   |     |      |
|                       |                               | V <sub>CC</sub> = 2.0 V   | -     | 44  | 150 | -                | 190 | -                 | 225 | ns   |
|                       |                               | V <sub>CC</sub> = 4.5 V   | -     | 16  | 30  | -                | 38  | -                 | 45  | ns   |
|                       |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF   | -     | 13  | -   | -                | -   | -                 | -   | ns   |
|                       |                               | V <sub>CC</sub> = 6.0 V   | -     | 13  | 26  | -                | 33  | -                 | 38  | ns   |
| t <sub>t</sub>        | transition time               | nQn; see <a href="#">Figure 6</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   |
| t <sub>w</sub>        | pulse width                   | nCP0, nCP1 HIGH or LOW; see <a href="#">Figure 6</a>  |       |     |     |                  |     |                   |     |      |
|                       |                               | V <sub>CC</sub> = 2.0 V   | 80    | 22  | -   | 100              | -   | 120               | -   | ns   |
|                       |                               | V <sub>CC</sub> = 4.5 V   | 16    | 8   | -   | 20               | -   | 24                | -   | ns   |
|                       |                               | V <sub>CC</sub> = 6.0 V   | 14    | 6   | -   | 17               | -   | 20                | -   | ns   |
|                       |                               | nMR HIGH; see <a href="#">Figure 6</a>  |       |     |     |                  |     |                   |     |      |
|                       |                               | V <sub>CC</sub> = 2.0 V   | 120   | 39  | -   | 150              | -   | 180               | -   | ns   |
|                       |                               | V <sub>CC</sub> = 4.5 V   | 24    | 14  | -   | 30               | -   | 36                | -   | ns   |
|                       |                               | V <sub>CC</sub> = 6.0 V   | 20    | 11  | -   | 26               | -   | 31                | -   | ns   |
| t <sub>rec</sub>      | recovery time                 | nMR to nCP0, nCP1; see <a href="#">Figure 6</a>   |       |     |     |                  |     |                   |     |      |
|                       |                               | V <sub>CC</sub> = 2.0 V   | 0     | -28 | -   | 0                | -   | 0                 | -   | ns   |
|                       |                               | V <sub>CC</sub> = 4.5 V   | 0     | -10 | -   | 0                | -   | 0                 | -   | ns   |
|                       |                               | V <sub>CC</sub> = 6.0 V   | 0     | -8  | -   | 0                | -   | 0                 | -   | ns   |
| t <sub>su</sub>       | set-up time                   | nCP0 to nCP1; nCP1 to nCP0; see <a href="#">Figure 6</a>  |       |     |     |                  |     |                   |     |      |
|                       |                               | V <sub>CC</sub> = 2.0 V   | 80    | 14  | -   | 100              | -   | 120               | -   | ns   |
|                       |                               | V <sub>CC</sub> = 4.5 V   | 16    | 5   | -   | 20               | -   | 24                | -   | ns   |
|                       |                               | V <sub>CC</sub> = 6.0 V   | 14    | 4   | -   | 17               | -   | 20                | -   | ns   |
| f <sub>max</sub>      | maximum frequency             | nCP0, nCP1; see <a href="#">Figure 6</a>  |       |     |     |                  |     |                   |     |      |
|                       |                               | V <sub>CC</sub> = 2.0 V   | 6     | 19  | -   | 4.8              | -   | 4                 | -   | MHz  |
|                       |                               | V <sub>CC</sub> = 4.5 V   | 30    | 58  | -   | 24               | -   | 20                | -   | MHz  |
|                       |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF   | -     | 68  | -   | -                | -   | -                 | -   | MHz  |
|                       |                               | V <sub>CC</sub> = 6.0 V   | 35    | 69  | -   | 28               | -   | 24                | -   | MHz  |
| C <sub>PD</sub>       | power dissipation capacitance | V <sub>I</sub> = GND to V <sub>CC</sub> ; V <sub>CC</sub> = 5 V; <sup>[3]</sup><br>f <sub>i</sub> = 1 MHz | -     | 29  | -   | -                | -   | -                 | -   | pF   |
| <b>74HCT4520-Q100</b> |                               |   |       |     |     |                  |     |                   |     |      |
| t <sub>pd</sub>       | propagation delay             | nCP0 to nQn; see <a href="#">Figure 6</a> <sup>[1]</sup>  |       |     |     |                  |     |                   |     |      |
|                       |                               | V <sub>CC</sub> = 4.5 V   | -     | 28  | 53  | -                | 66  | -                 | 80  | ns   |
|                       |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF   | -     | 24  | -   | -                | -   | -                 | -   | ns   |
|                       |                               | nCP1 to nQn; see <a href="#">Figure 6</a> <sup>[1]</sup>  |       |     |     |                  |     |                   |     |      |
|                       |                               | V <sub>CC</sub> = 4.5 V   | -     | 25  | 53  | -                | 66  | -                 | 80  | ns   |
|                       |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF   | -     | 24  | -   | -                | -   | -                 | ns  |      |

**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 7](#).

| Symbol           | Parameter                     | Conditions   | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|------------------|-------------------------------|--|-------|-----|-----|------------------|-----|-------------------|-----|------|
|                  |                               |  | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| t <sub>PHL</sub> | HIGH to LOW propagation delay | nMR to nQn; see <a href="#">Figure 6</a>   |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | -     | 16  | 35  | -                | 44  | -                 | 53  | ns   |
|                  |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF  | -     | 13  | -   | -                | -   | -                 | -   | ns   |
| t <sub>t</sub>   | transition time               | nQn; see <a href="#">Figure 6</a> [2]  |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | -     | 7   | 15  | -                | 19  | -                 | 22  | ns   |
| t <sub>W</sub>   | pulse width                   | nCP0, nCP1 HIGH or LOW; see <a href="#">Figure 6</a>   |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | 20    | 10  | -   | 25               | -   | 30                | -   | ns   |
|                  |                               | nMR HIGH; see <a href="#">Figure 6</a>   |       |     |     |                  |     |                   |     |      |
| t <sub>rec</sub> | recovery time                 | nMR to nCP0, nCP1; see <a href="#">Figure 6</a>  |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | 0     | -8  | -   | 0                | -   | 0                 | -   | ns   |
| t <sub>su</sub>  | set-up time                   | nCP0 to nCP1; nCP1 to nCP0; see <a href="#">Figure 6</a>   |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | 16    | 6   | -   | 20               | -   | 24                | -   | ns   |
| f <sub>max</sub> | maximum frequency             | nCP0, nCP1; see <a href="#">Figure 6</a>   |       |     |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 4.5 V  | 30    | 58  | -   | 24               | -   | 20                | -   | MHz  |
|                  |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF  | -     | 64  | -   | -                | -   | -                 | -   | MHz  |
| C <sub>PD</sub>  | power dissipation capacitance | V <sub>I</sub> = GND to V <sub>CC</sub> - 1.5 V; V <sub>CC</sub> = 5 V; f <sub>i</sub> = 1 MHz [3] | -     | 24  | -   | -                | -   | -                 | -   | pF   |

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

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

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;

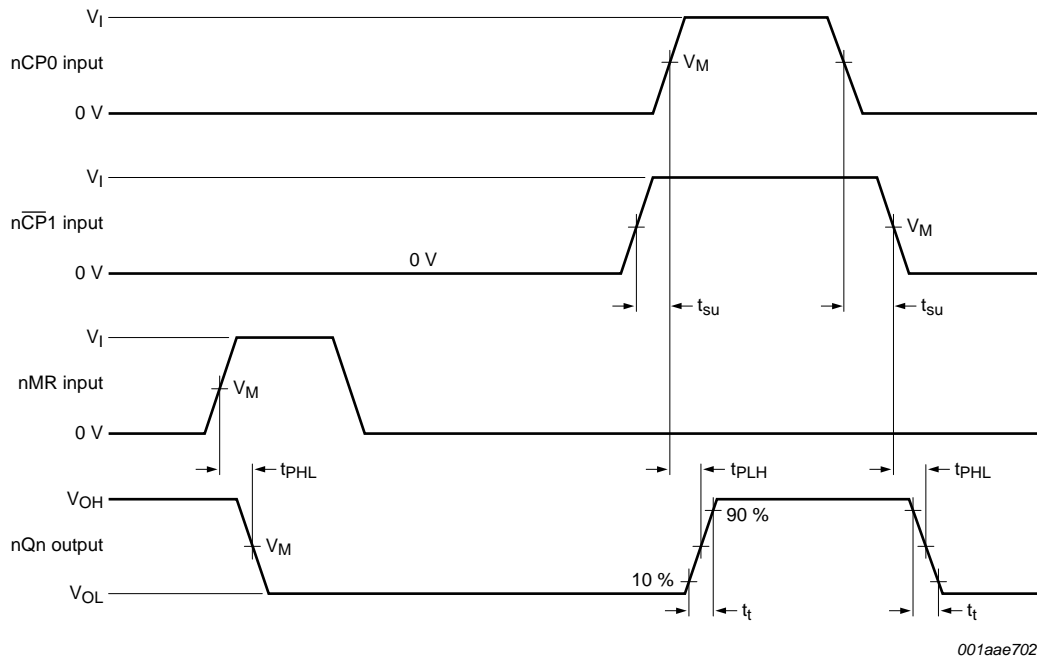
V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

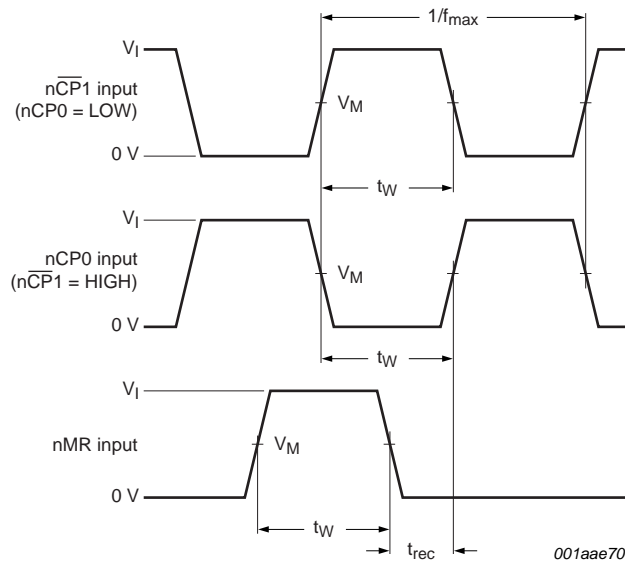
∑(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of outputs.



12. Waveforms



a. nCP0 and nCP1 set-up times, propagation delays and output transition times



b. nMR recovery time, minimum nCP0, nCP1, nMR pulse widths and maximum frequency

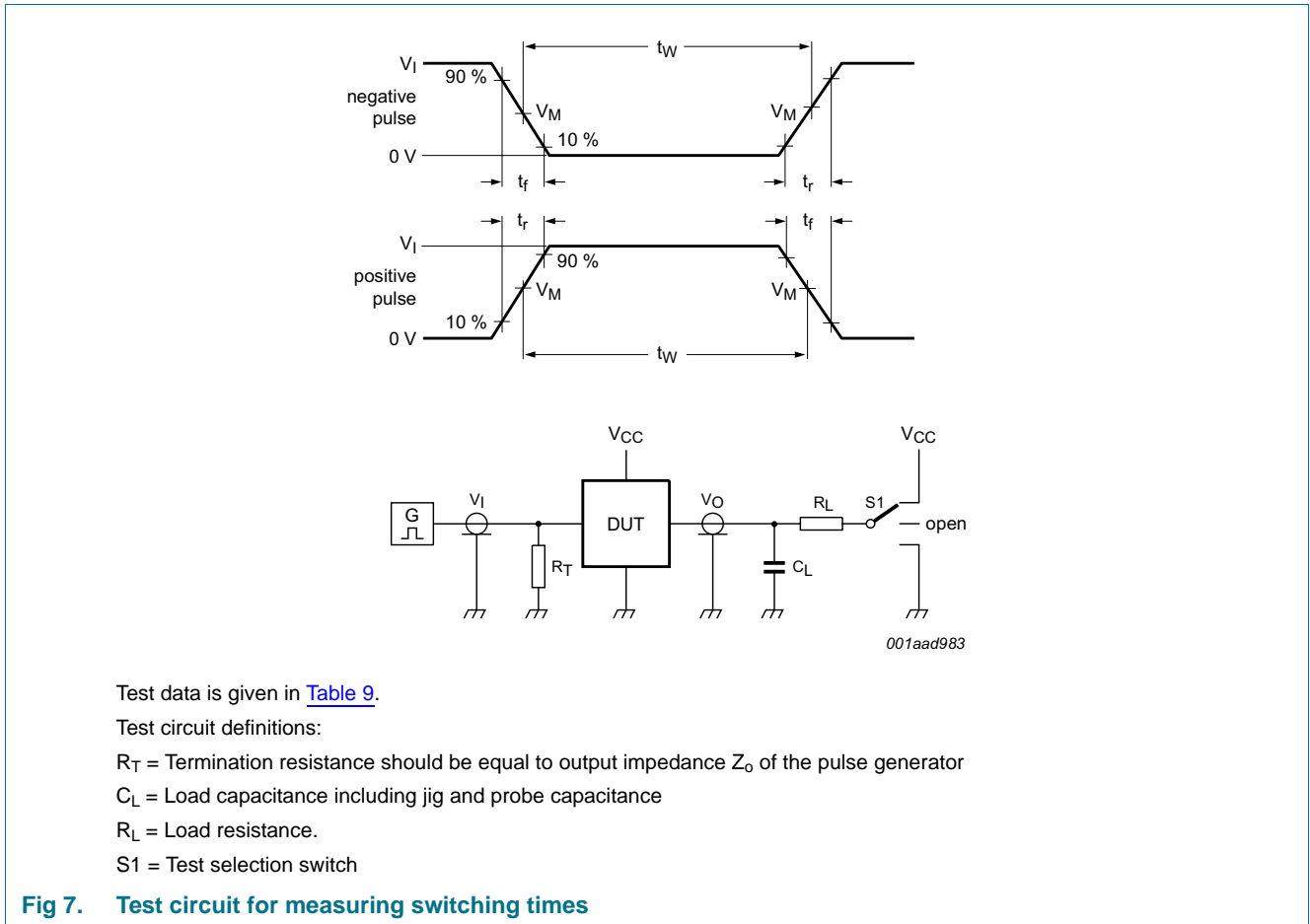
Measurement points are given in [Table 8](#).

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

Fig 6. Waveforms showing measurements for switching times

**Table 8. Measurement points**

| Type           | Input               |                 | Output              |
|----------------|---------------------|-----------------|---------------------|
|                | $V_M$               | $V_I$           | $V_M$               |
| 74HC4520-Q100  | $0.5 \times V_{CC}$ | GND to $V_{CC}$ | $0.5 \times V_{CC}$ |
| 74HCT4520-Q100 | 1.3 V               | GND to 3 V      | 1.3 V               |



**Table 9. Test data**

| Type           | Input    |            | Load         |              | S1 position        |
|----------------|----------|------------|--------------|--------------|--------------------|
|                | $V_I$    | $t_r, t_f$ | $C_L$        | $R_L$        | $t_{PHL}, t_{PLH}$ |
| 74HC4520-Q100  | $V_{CC}$ | 6 ns       | 15 pF, 50 pF | 1 k $\Omega$ | open               |
| 74HCT4520-Q100 | 3 V      | 6 ns       | 15 pF, 50 pF | 1 k $\Omega$ | open               |

## 13. Package outline

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

SOT109-1

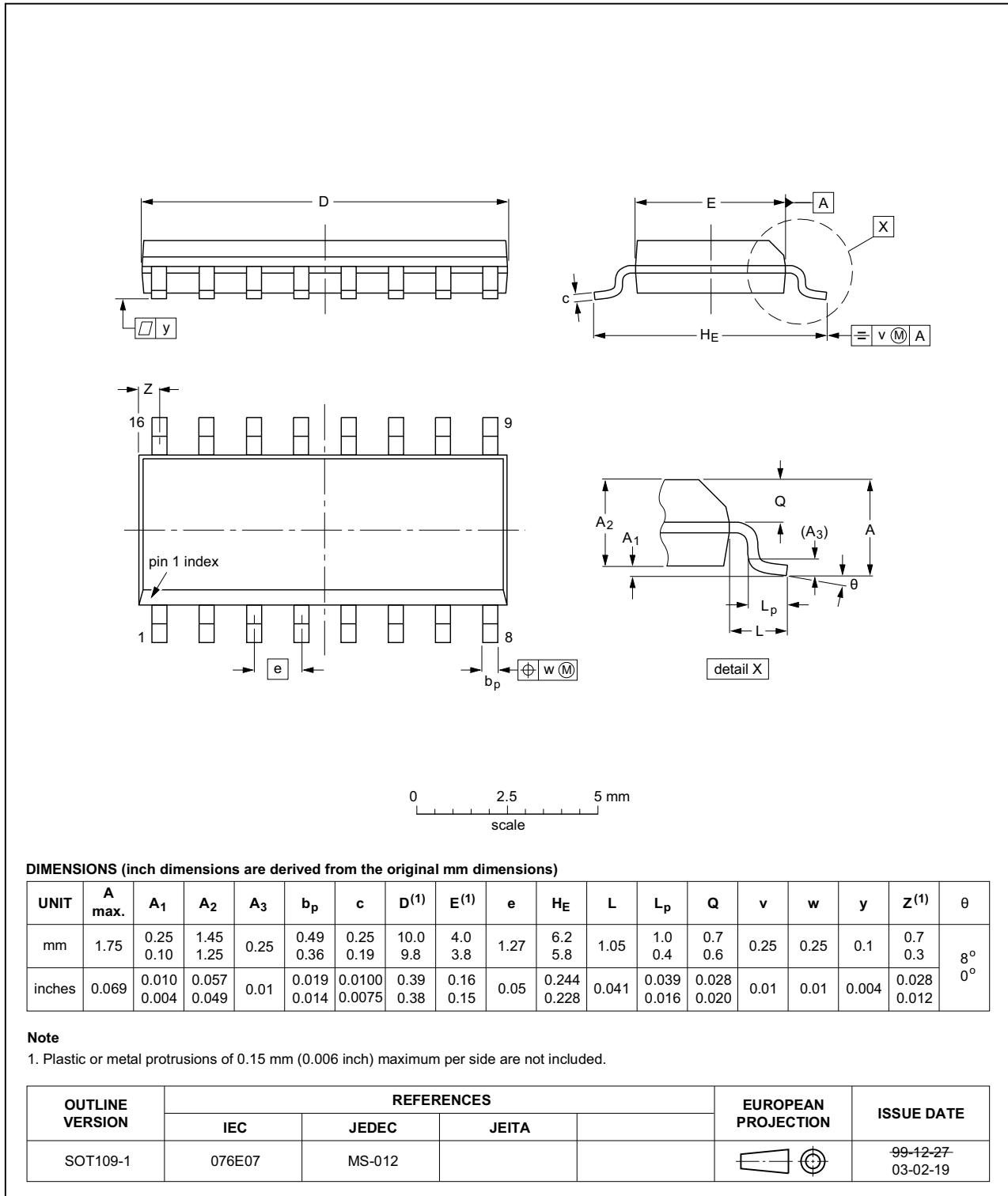


Fig 8. Package outline SOT109-1 (SO16)

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

SOT403-1

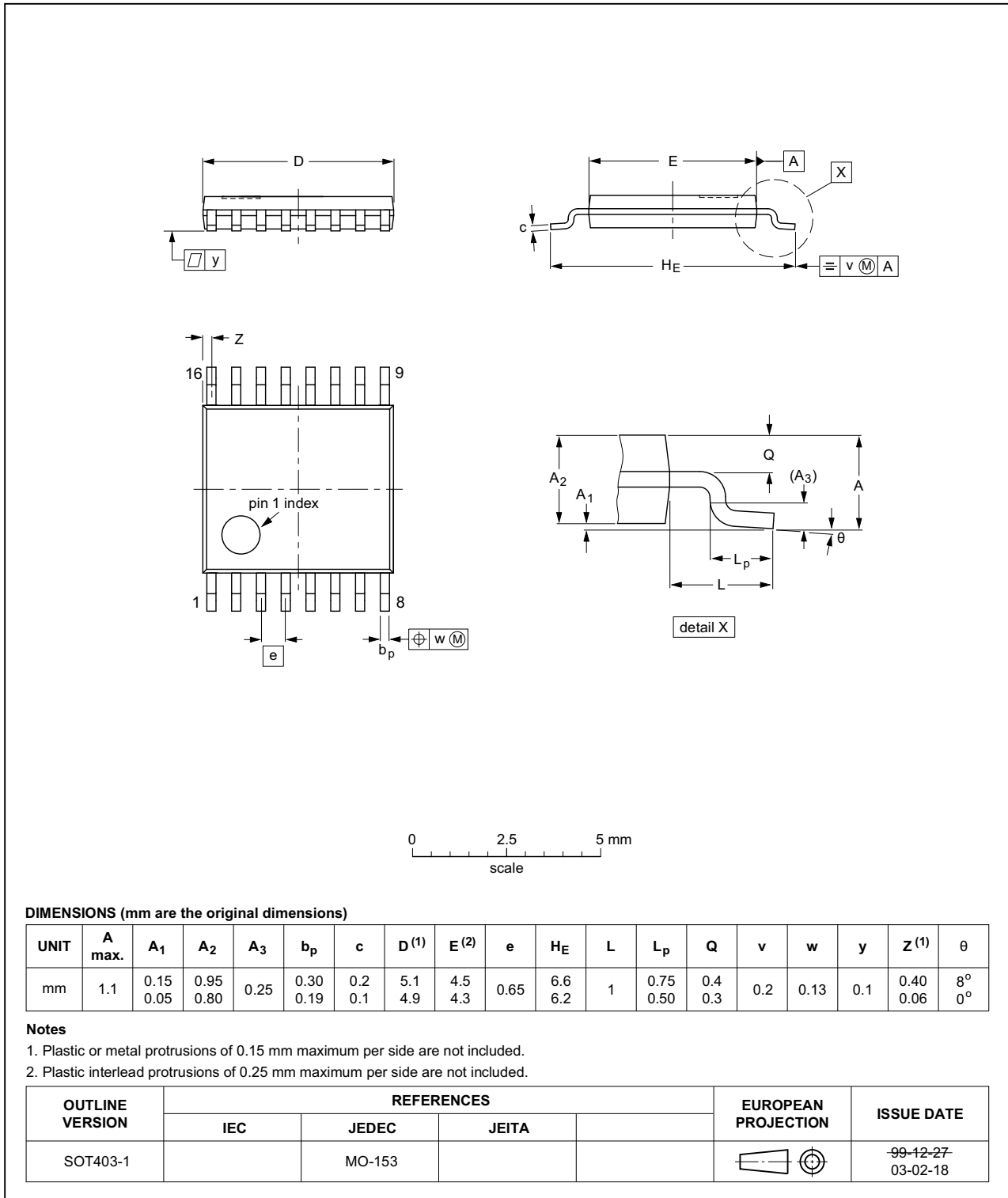


Fig 9. Package outline SOT403-1 (TSSOP16)

## 14. 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                                  |
| TTL     | Transistor-Transistor Logic                    |

## 15. Revision history

Table 11. Revision history

| Document ID           | Release date | Data sheet status  | Change notice | Supersedes |
|-----------------------|--------------|--------------------|---------------|------------|
| 74HC_HCT4520_Q100 v.1 | 20141204     | Product data sheet | -             | -          |

## 16. Legal information

### 16.1 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".

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