

# 74HC109; 74HCT109

Dual JK flip-flop with set and reset; positive-edge-trigger

Rev. 4 — 1 April 2020

Product data sheet

## 1. General description

The 74HC109; 74HCT109 is a dual positive edge triggered  $\overline{JK}$  flip-flop featuring individual nJ and n $\overline{K}$  inputs. It has clock (nCP) inputs, set (n $\overline{SD}$ ) and reset (n $\overline{RD}$ ) inputs and complementary nQ and n $\overline{Q}$  outputs. The set and reset are asynchronous active LOW inputs and operate independently of the clock input. The nJ and n $\overline{K}$  inputs control the state changes of the flip-flops as described in the mode select function table. The nJ and n $\overline{K}$  inputs must be stable one set-up time prior to the LOW-to-HIGH clock transition for predictable operation. The  $\overline{JK}$  design allows operation as a D-type flip-flop by connecting the nJ and n $\overline{K}$  inputs together. Inputs include clamp diodes. It enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

Schmitt-trigger action in the clock input makes the circuit highly tolerant to slower clock rise and fall times.

## 2. Features and benefits

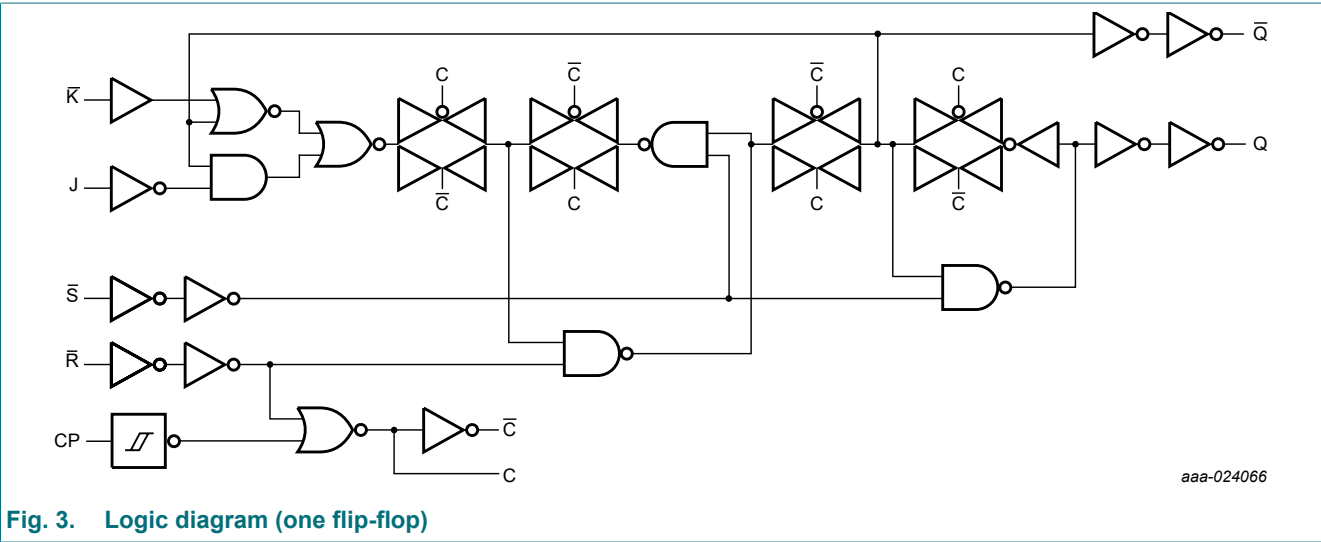
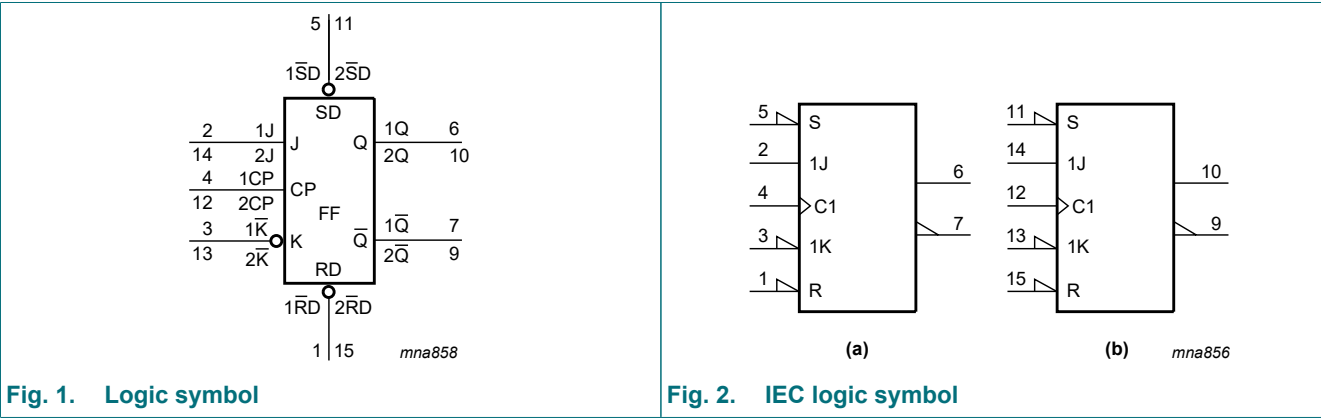
- Input levels:
  - For 74HC109: CMOS level
  - For 74HCT109: TTL level
- J and  $\overline{K}$  inputs for easy D-type flip-flop
- Toggle flip-flop or "do nothing" mode
- Specified in compliance with JEDEC standard no. 7A
- ESD protection:
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

## 3. Ordering information

Table 1. Ordering information

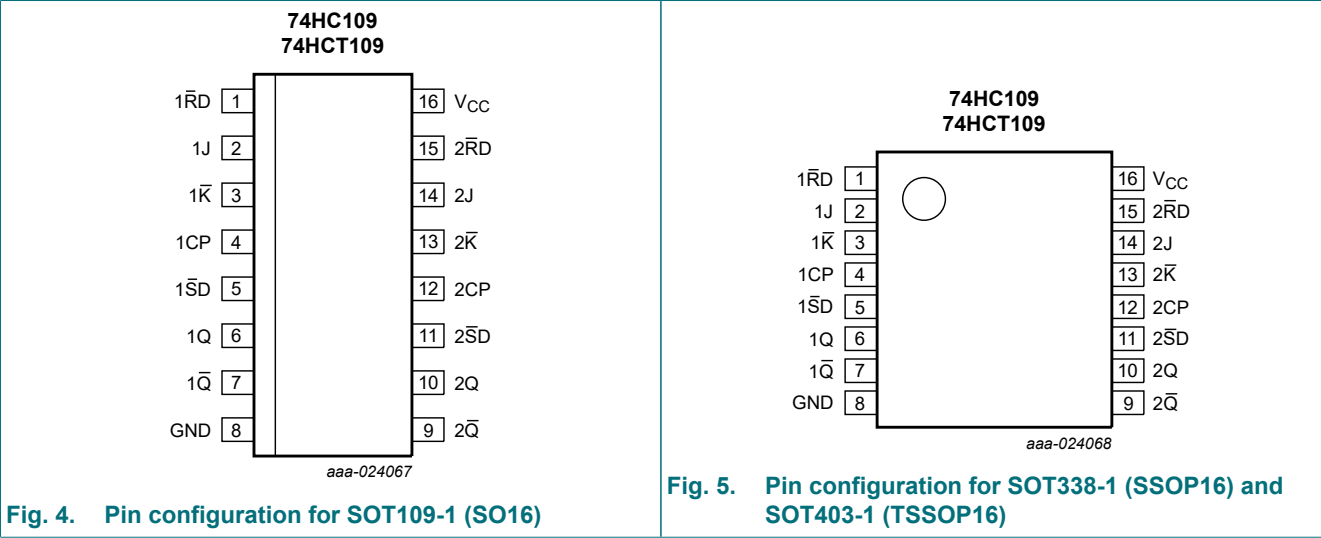
| Type number | Package           |         |                                                                           |          |
|-------------|-------------------|---------|---------------------------------------------------------------------------|----------|
|             | Temperature range | Name    | Description                                                               | Version  |
| 74HC109D    | -40 °C to +125 °C | SO16    | plastic small outline package; 16 leads;<br>body width 3.9 mm             | SOT109-1 |
| 74HCT109D   |                   |         |                                                                           |          |
| 74HC109DB   | -40 °C to +125 °C | SSOP16  | plastic shrink small outline package; 16 leads;<br>body width 5.3 mm      | SOT338-1 |
| 74HCT109DB  |                   |         |                                                                           |          |
| 74HCT109PW  | -40 °C to +125 °C | TSSOP16 | plastic thin shrink small outline package; 16 leads;<br>body width 4.4 mm | SOT403-1 |

4. Functional diagram



5. Pinning information

5.1. Pinning



5.2. Pin description

Table 2. Pin description

| Symbol         | Pin   | Description                               |
|----------------|-------|-------------------------------------------|
| 1RD, 2RD       | 1, 15 | asynchronous reset input (active LOW)     |
| 1J, 2J         | 2, 14 | synchronous input                         |
| 1K, 2K         | 3, 13 | synchronous input                         |
| 1CP, 2CP       | 4, 12 | clock input (LOW-to-HIGH; edge-triggered) |
| 1SD, 2SD       | 5, 11 | asynchronous set input (active LOW)       |
| 1Q, 2Q         | 6, 10 | true flip-flop output                     |
| 1Q-bar, 2Q-bar | 7, 9  | complement flip-flop output               |
| GND            | 8     | ground (0 V)                              |
| VCC            | 16    | supply voltage                            |

## 6. Functional description

**Table 3. Function selection**

*H = HIGH voltage level; h = HIGH voltage level one set-up time before the LOW-to-HIGH CP transition;*

*L = LOW voltage level; l = LOW voltage level one set-up time before the LOW-to-HIGH CP transition;*

*q = lower case letters indicate the state of the referenced output one set-up time before the LOW-to-HIGH CP transition;*

*X = don't care; ↑ = LOW-to-HIGH CP transition*

| Operating modes    | Input |     |     |    |    | Output    |           |
|--------------------|-------|-----|-----|----|----|-----------|-----------|
|                    | nSD   | nRD | nCP | nJ | nK | nQ        | nQ̄       |
| Asynchronous set   | L     | H   | X   | X  | X  | H         | L         |
| Asynchronous reset | H     | L   | X   | X  | X  | L         | H         |
| Undetermined       | L     | L   | X   | X  | X  | H         | H         |
| Toggle             | H     | H   | ↑   | h  | l  | $\bar{q}$ | q         |
| Load 0 (reset)     | H     | H   | ↑   | l  | l  | L         | H         |
| Load 1 (set)       | H     | H   | ↑   | h  | h  | H         | L         |
| Hold no change     | H     | H   | ↑   | l  | h  | q         | $\bar{q}$ |

## 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          | -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   |
| P <sub>tot</sub> | total power dissipation | [1]                                                                 | -    | 500  | mW   |

- [1] For SOT109-1 (SO16) package: P<sub>tot</sub> derates linearly with 12.4 mW/K above 110 °C.  
 For SOT338-1 (SSOP16) package: P<sub>tot</sub> derates linearly with 8.5 mW/K above 91 °C.  
 For SOT403-1 (TSSOP16) package: P<sub>tot</sub> derates linearly with 8.5 mW/K above 91 °C.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

Voltages are referenced to GND (ground = 0 V)

| Symbol           | Parameter                           | Conditions              | 74HC109 |      |                 | 74HCT109 |      |                 | 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                                                                             | 25 °C |      |      | -40 °C to +85 °C |      | -40 °C to +125 °C |      | Unit |
|-----------------|---------------------------|----------------------------------------------------------------------------------------|-------|------|------|------------------|------|-------------------|------|------|
|                 |                           |                                                                                        | Min   | Typ  | Max  | Min              | Max  | Min               | Max  |      |
| 74HC109         |                           |                                                                                        |       |      |      |                  |      |                   |      |      |
| 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 mA; V <sub>CC</sub> = 4.5 V                                      | 3.98  | 4.32 | -    | 3.84             | -    | 3.7               | -    | V    |
| V <sub>OL</sub> | LOW-level output voltage  | 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>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>I</sub>  | input leakage current     | I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V                                       | -     | 0.16 | 0.26 | -                | 0.33 | -                 | 0.4  | V    |
|                 |                           | V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V                       | -     | -    | ±0.1 | -                | ±1   | -                 | ±1   | 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 | -     | -    | 4.0  | -                | 40   | -                 | 80   | μA   |
| C <sub>I</sub>  | input capacitance         |                                                                                        | -     | 3.5  | -    | -                | -    | -                 | -    | pF   |

## Dual JK flip-flop with set and reset; positive-edge-trigger

| Symbol           | Parameter                 | Conditions                                                                                                                        | 25 °C |      |      | -40 °C to +85 °C |       | -40 °C to +125 °C |       | Unit |
|------------------|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------|------|------|------------------|-------|-------------------|-------|------|
|                  |                           |                                                                                                                                   | Min   | Typ  | Max  | Min              | Max   | Min               | Max   |      |
| 74HCT109         |                           |                                                                                                                                   |       |      |      |                  |       |                   |       |      |
| 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; V <sub>CC</sub> = 4.5 V                                                                                   | -     | 0    | 0.1  | -                | 0.1   | -                 | 0.1   | V    |
|                  |                           | I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 5.5 V                                                                                  | -     | 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    | -                 | ±1    | 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                                            | -     | -    | 4.0  | -                | 40    | -                 | 80    | 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 |       |      |      |                  |       |                   |       |      |
|                  |                           | nJ, nK, nSD, nRD and nCP inputs                                                                                                   | -     | 35   | 126  | -                | 157.5 | -                 | 171.5 | µA   |
| C <sub>I</sub>   | input capacitance         |                                                                                                                                   | -     | 3.5  | -    | -                | -     | -                 | -     | pF   |

## 10. 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 Fig. 8.

| Symbol           | Parameter                     | Conditions                                    | 25 °C |         |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|------------------|-------------------------------|-----------------------------------------------|-------|---------|-----|------------------|-----|-------------------|-----|------|
|                  |                               |                                               | Min   | Typ [1] | Max | Min              | Max | Min               | Max |      |
| 74HC109          |                               |                                               |       |         |     |                  |     |                   |     |      |
| t <sub>pd</sub>  | propagation delay             | nCP to nQ, nQ̄; see Fig. 6 [2]                |       |         |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 2.0 V                       | -     | 50      | 175 | -                | 220 | -                 | 265 | ns   |
|                  |                               | V <sub>CC</sub> = 4.5 V                       | -     | 18      | 35  | -                | 44  | -                 | 53  | ns   |
|                  |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF | -     | 15      | -   | -                | -   | -                 | -   | ns   |
|                  |                               | V <sub>CC</sub> = 6.0 V                       | -     | 14      | 30  | -                | 37  | -                 | 45  | ns   |
| t <sub>PLH</sub> | LOW to HIGH propagation delay | nSD to nQ, see Fig. 7                         |       |         |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 2.0 V                       | -     | 30      | 120 | -                | 150 | -                 | 180 | ns   |
|                  |                               | V <sub>CC</sub> = 4.5 V                       | -     | 11      | 24  | -                | 30  | -                 | 36  | ns   |
|                  |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF | -     | 12      | -   | -                | -   | -                 | -   | ns   |
|                  |                               | V <sub>CC</sub> = 6.0 V                       | -     | 9       | 20  | -                | 26  | -                 | 31  | ns   |

## Dual JK flip-flop with set and reset; positive-edge-trigger

| Symbol           | Parameter                     | Conditions                                                                  | 25 °C |         |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|------------------|-------------------------------|-----------------------------------------------------------------------------|-------|---------|-----|------------------|-----|-------------------|-----|------|
|                  |                               |                                                                             | Min   | Typ [1] | Max | Min              | Max | Min               | Max |      |
| t <sub>PHL</sub> | HIGH to LOW propagation delay | n $\overline{\text{SD}}$ to n $\overline{\text{Q}}$ ; see Fig. 7            |       |         |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 2.0 V                                                     | -     | 41      | 155 | -                | 195 | -                 | 235 | ns   |
|                  |                               | V <sub>CC</sub> = 4.5 V                                                     | -     | 15      | 31  | -                | 39  | -                 | 47  | 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  | -                 | 40  | ns   |
| t <sub>PHL</sub> | HIGH to LOW propagation delay | n $\overline{\text{RD}}$ to n $\overline{\text{Q}}$ ; see Fig. 7            |       |         |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 2.0 V                                                     | -     | 41      | 185 | -                | 230 | -                 | 280 | ns   |
|                  |                               | V <sub>CC</sub> = 4.5 V                                                     | -     | 15      | 37  | -                | 46  | -                 | 56  | ns   |
|                  |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF                               | -     | 12      | -   | -                | -   | -                 | -   | ns   |
|                  |                               | V <sub>CC</sub> = 6.0 V                                                     | -     | 12      | 31  | -                | 39  | -                 | 48  | ns   |
| t <sub>PLH</sub> | LOW to HIGH propagation delay | n $\overline{\text{RD}}$ to n $\overline{\text{Q}}$ ; see Fig. 7            |       |         |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 2.0 V                                                     | -     | 39      | 170 | -                | 215 | -                 | 255 | ns   |
|                  |                               | V <sub>CC</sub> = 4.5 V                                                     | -     | 14      | 34  | -                | 43  | -                 | 51  | ns   |
|                  |                               | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF                               | -     | 12      | -   | -                | -   | -                 | -   | ns   |
|                  |                               | V <sub>CC</sub> = 6.0 V                                                     | -     | 11      | 29  | -                | 37  | -                 | 43  | ns   |
| t <sub>t</sub>   | transition time               | n $\overline{\text{Q}}$ , n $\overline{\text{Q}}$ ; see Fig. 6 [3]          |       |         |     |                  |     |                   |     |      |
|                  |                               | 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                   | nCP HIGH or LOW; see Fig. 6                                                 |       |         |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 2.0 V                                                     | 80    | 19      | -   | 100              | -   | 120               | -   | ns   |
|                  |                               | V <sub>CC</sub> = 4.5 V                                                     | 16    | 7       | -   | 20               | -   | 24                | -   | ns   |
|                  |                               | V <sub>CC</sub> = 6.0 V                                                     | 14    | 6       | -   | 17               | -   | 20                | -   | ns   |
|                  |                               | n $\overline{\text{SD}}$ , n $\overline{\text{RD}}$ HIGH or LOW; see Fig. 7 |       |         |     |                  |     |                   |     |      |
|                  |                               | 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   |
| t <sub>rec</sub> | recovery time                 | n $\overline{\text{SD}}$ , n $\overline{\text{RD}}$ to nCP; see Fig. 7      |       |         |     |                  |     |                   |     |      |
|                  |                               | V <sub>CC</sub> = 2.0 V                                                     | 70    | 19      | -   | 90               | -   | 105               | -   | ns   |
|                  |                               | V <sub>CC</sub> = 4.5 V                                                     | 14    | 7       | -   | 18               | -   | 21                | -   | ns   |
|                  |                               | V <sub>CC</sub> = 6.0 V                                                     | 12    | 6       | -   | 15               | -   | 18                | -   | ns   |

## Dual JK flip-flop with set and reset; positive-edge-trigger

| Symbol          | Parameter                     | Conditions                                                                            | 25 °C |         |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------|-------|---------|-----|------------------|-----|-------------------|-----|------|
|                 |                               |                                                                                       | Min   | Typ [1] | Max | Min              | Max | Min               | Max |      |
| $t_{su}$        | set-up time                   | nJ and $\overline{nK}$ to nCP; see Fig. 6                                             |       |         |     |                  |     |                   |     |      |
|                 |                               | $V_{CC} = 2.0\text{ V}$                                                               | 70    | 17      | -   | 90               | -   | 105               | -   | ns   |
|                 |                               | $V_{CC} = 4.5\text{ V}$                                                               | 14    | 6       | -   | 18               | -   | 21                | -   | ns   |
|                 |                               | $V_{CC} = 6.0\text{ V}$                                                               | 12    | 5       | -   | 15               | -   | 18                | -   | ns   |
| $t_h$           | hold time                     | nJ and $\overline{nK}$ to nCP; see Fig. 6                                             |       |         |     |                  |     |                   |     |      |
|                 |                               | $V_{CC} = 2.0\text{ V}$                                                               | 5     | 0       | -   | 5                | -   | 5                 | -   | ns   |
|                 |                               | $V_{CC} = 4.5\text{ V}$                                                               | 5     | 0       | -   | 5                | -   | 5                 | -   | ns   |
|                 |                               | $V_{CC} = 6.0\text{ V}$                                                               | 5     | 0       | -   | 5                | -   | 5                 | -   | ns   |
| $f_{max}$       | maximum frequency             | nCP; see Fig. 6                                                                       |       |         |     |                  |     |                   |     |      |
|                 |                               | $V_{CC} = 2.0\text{ V}$                                                               | 6     | 22      | -   | 5                | -   | 4                 | -   | MHz  |
|                 |                               | $V_{CC} = 4.5\text{ V}$                                                               | 30    | 68      | -   | 24               | -   | 20                | -   | MHz  |
|                 |                               | $V_{CC} = 5\text{ V}; C_L = 15\text{ pF}$                                             | -     | 75      | -   | -                | -   | -                 | -   | MHz  |
|                 |                               | $V_{CC} = 6.0\text{ V}$                                                               | 35    | 81      | -   | 28               | -   | 24                | -   | MHz  |
| $C_{PD}$        | power dissipation capacitance | $C_L = 50\text{ pF}; f = 1\text{ MHz}; V_I = \text{GND to } V_{CC}$ [4]               | -     | 20      | -   | -                | -   | -                 | -   | pF   |
| <b>74HCT109</b> |                               |                                                                                       |       |         |     |                  |     |                   |     |      |
| $t_{pd}$        | propagation delay             | nCP to nQ, $\overline{nQ}$ ; see Fig. 6 [2]                                           |       |         |     |                  |     |                   |     |      |
|                 |                               | $V_{CC} = 4.5\text{ V}$                                                               | -     | 20      | 35  | -                | 44  | -                 | 53  | ns   |
|                 |                               | $V_{CC} = 5\text{ V}; C_L = 15\text{ pF}$                                             | -     | 17      | -   | -                | -   | -                 | -   | ns   |
| $t_{PLH}$       | LOW to HIGH propagation delay | $\overline{nSD}$ to nQ, see Fig. 7                                                    |       |         |     |                  |     |                   |     |      |
|                 |                               | $V_{CC} = 4.5\text{ V}$                                                               | -     | 13      | 26  | -                | 33  | -                 | 39  | ns   |
|                 |                               | $V_{CC} = 5\text{ V}; C_L = 15\text{ pF}$                                             | -     | 14      | -   | -                | -   | -                 | -   | ns   |
| $t_{PHL}$       | HIGH to LOW propagation delay | $\overline{nSD}$ to $\overline{nQ}$ ; see Fig. 7                                      |       |         |     |                  |     |                   |     |      |
|                 |                               | $V_{CC} = 4.5\text{ V}$                                                               | -     | 19      | 35  | -                | 44  | -                 | 53  | ns   |
|                 |                               | $V_{CC} = 5\text{ V}; C_L = 15\text{ pF}$                                             | -     | 14      | -   | -                | -   | -                 | -   | ns   |
| $t_{PHL}$       | HIGH to LOW propagation delay | $\overline{nRD}$ to nQ; see Fig. 7                                                    |       |         |     |                  |     |                   |     |      |
|                 |                               | $V_{CC} = 4.5\text{ V}$                                                               | -     | 19      | 35  | -                | 44  | -                 | 53  | ns   |
|                 |                               | $V_{CC} = 5\text{ V}; C_L = 15\text{ pF}$                                             | -     | 15      | -   | -                | -   | -                 | -   | ns   |
| $t_{PLH}$       | LOW to HIGH propagation delay | $\overline{nRD}$ to $\overline{nQ}$ ; see Fig. 7                                      |       |         |     |                  |     |                   |     |      |
|                 |                               | $V_{CC} = 4.5\text{ V}$                                                               | -     | 16      | 32  | -                | 40  | -                 | 48  | ns   |
|                 |                               | $V_{CC} = 5\text{ V}; C_L = 15\text{ pF}$                                             | -     | 15      | -   | -                | -   | -                 | -   | ns   |
| $t_t$           | transition time               | nQ, $\overline{nQ}$ ; $V_{CC} = 4.5\text{ V}$ ; see Fig. 6 [3]                        | -     | 7       | 15  | -                | 19  | -                 | 22  | ns   |
| $t_W$           | pulse width                   | nCP HIGH or LOW; $V_{CC} = 4.5\text{ V}$ ; see Fig. 6                                 | 18    | 9       | -   | 23               | -   | 27                | -   | ns   |
|                 |                               | $\overline{nSD}$ , $\overline{nRD}$ HIGH or LOW; $V_{CC} = 4.5\text{ V}$ ; see Fig. 7 | 16    | 8       | -   | 20               | -   | 24                | -   | ns   |
| $t_{rec}$       | recovery time                 | $\overline{nSD}$ , $\overline{nRD}$ to nCP; $V_{CC} = 4.5\text{ V}$ ; see Fig. 7      | 16    | 8       | -   | 20               | -   | 24                | -   | ns   |

| Symbol    | Parameter                     | Conditions                                                                                      | 25 °C |         |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|-----------|-------------------------------|-------------------------------------------------------------------------------------------------|-------|---------|-----|------------------|-----|-------------------|-----|------|
|           |                               |                                                                                                 | Min   | Typ [1] | Max | Min              | Max | Min               | Max |      |
| $t_{su}$  | set-up time                   | nJ and $\overline{nK}$ to nCP;<br>$V_{CC} = 4.5\text{ V}$ ; see Fig. 6                          | 18    | 8       | -   | 23               | -   | 27                | -   | ns   |
| $t_h$     | hold time                     | nJ and $\overline{nK}$ to nCP;<br>$V_{CC} = 4.5\text{ V}$ ; see Fig. 6                          | 3     | -3      | -   | 3                | -   | 3                 | -   | ns   |
| $f_{max}$ | maximum frequency             | nCP; see Fig. 6                                                                                 |       |         |     |                  |     |                   |     |      |
|           |                               | $V_{CC} = 4.5\text{ V}$                                                                         | 27    | 55      | -   | 22               | -   | 18                | -   | MHz  |
|           |                               | $V_{CC} = 5\text{ V}$ ; $C_L = 15\text{ pF}$                                                    | -     | 61      | -   | -                | -   | -                 | -   | MHz  |
| $C_{PD}$  | power dissipation capacitance | $C_L = 50\text{ pF}$ ; $f = 1\text{ MHz}$ ;<br>$V_I = \text{GND to } V_{CC} - 1.5\text{ V}$ [4] | -     | 22      | -   | -                | -   | -                 | -   | pF   |

[1] All typical values are measured at  $T_{amb} = 25\text{ °C}$ .

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

[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  $\mu\text{W}$ ).

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

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

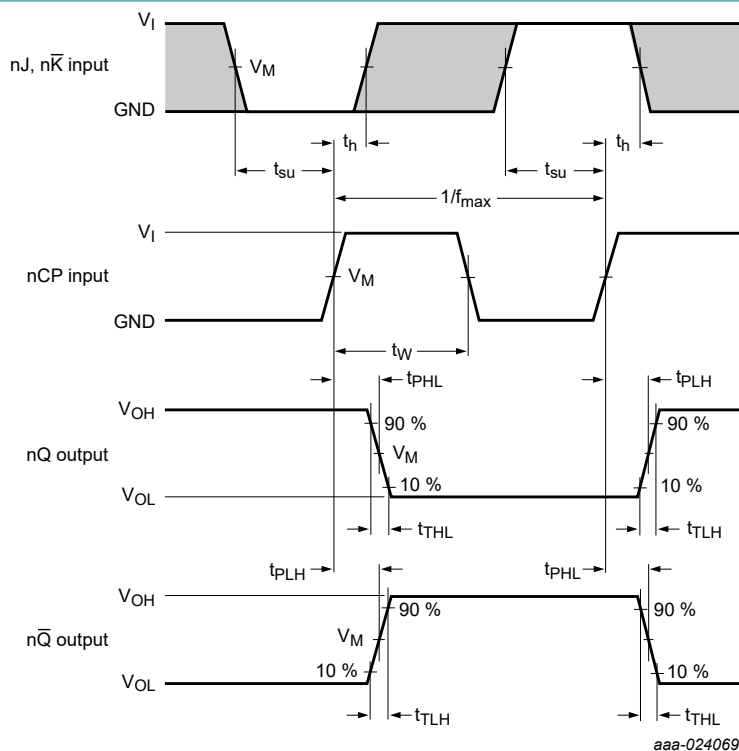
$C_L$  = output load capacitance in pF;

$V_{CC}$  = supply voltage in V;

$N$  = number of inputs switching;

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

## 10.1. Waveforms and test circuit



Measurement points are given in Table 8.

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

**Fig. 6. Clock propagation delays, output transition time, pulse width, set-up, hold times, and maximum frequency**

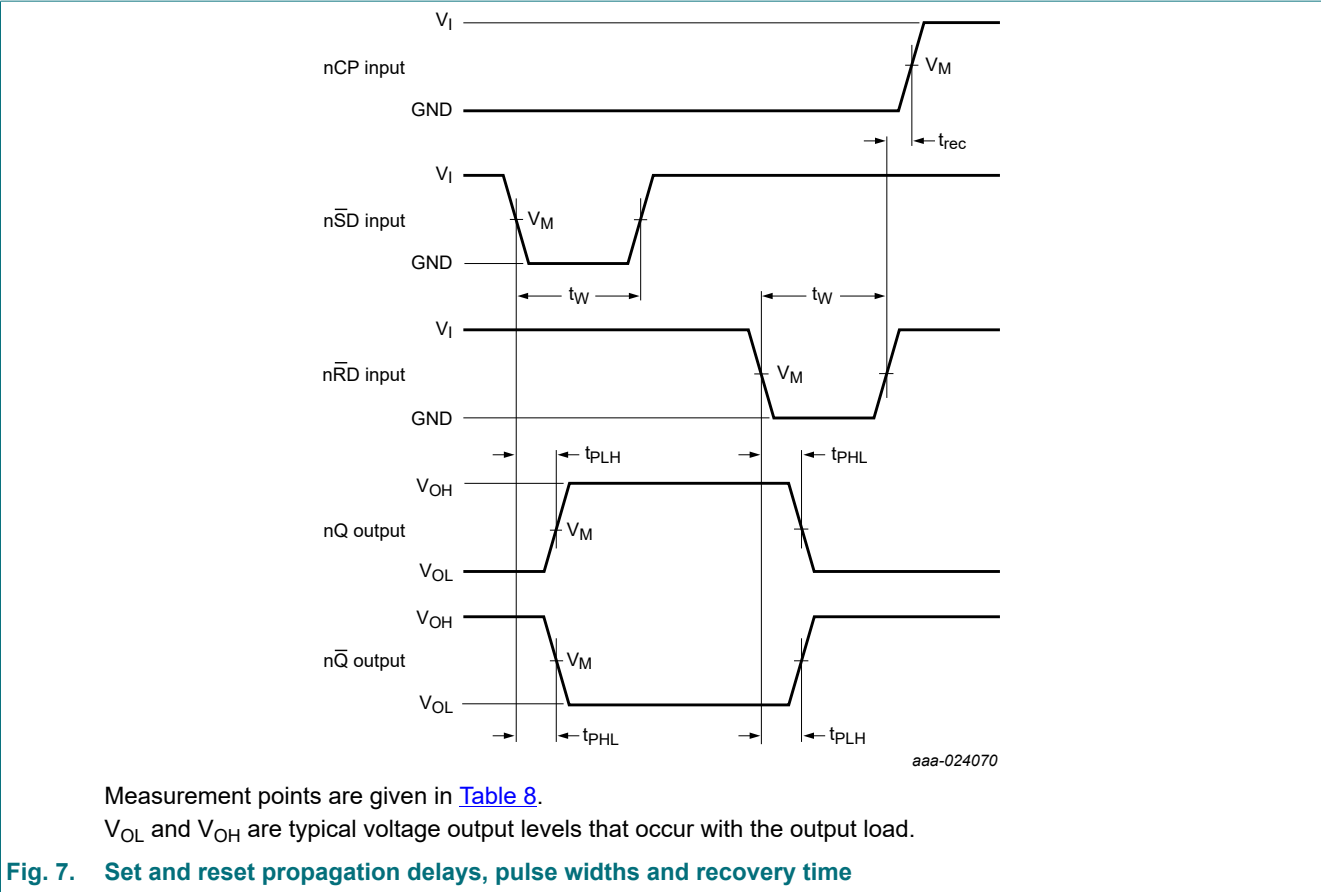
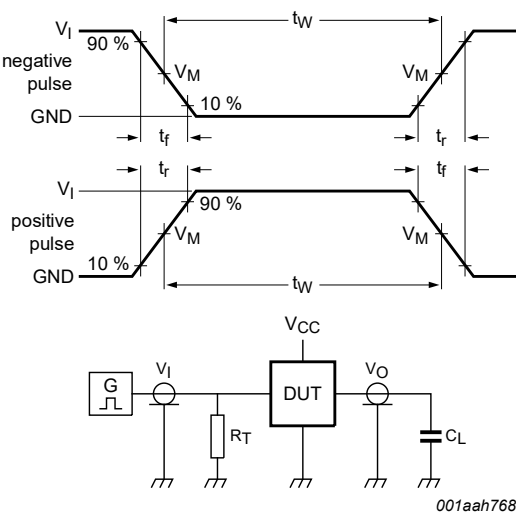


Table 8. Measurement points

| Type     | Input       | Output      |
|----------|-------------|-------------|
|          | $V_M$       | $V_M$       |
| 74HC109  | $0.5V_{CC}$ | $0.5V_{CC}$ |
| 74HCT109 | 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.

Fig. 8. Test circuit for measuring switching times

Table 9. Test data

| Type     | Input    |            | Load         | Test               |
|----------|----------|------------|--------------|--------------------|
|          | $V_I$    | $t_r, t_f$ | $C_L$        |                    |
| 74HC109  | $V_{CC}$ | 6 ns       | 15 pF, 50 pF | $t_{PLH}, t_{PHL}$ |
| 74HCT109 | 3 V      | 6 ns       | 15 pF, 50 pF | $t_{PLH}, t_{PHL}$ |

11. Package outline

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

SOT109-1

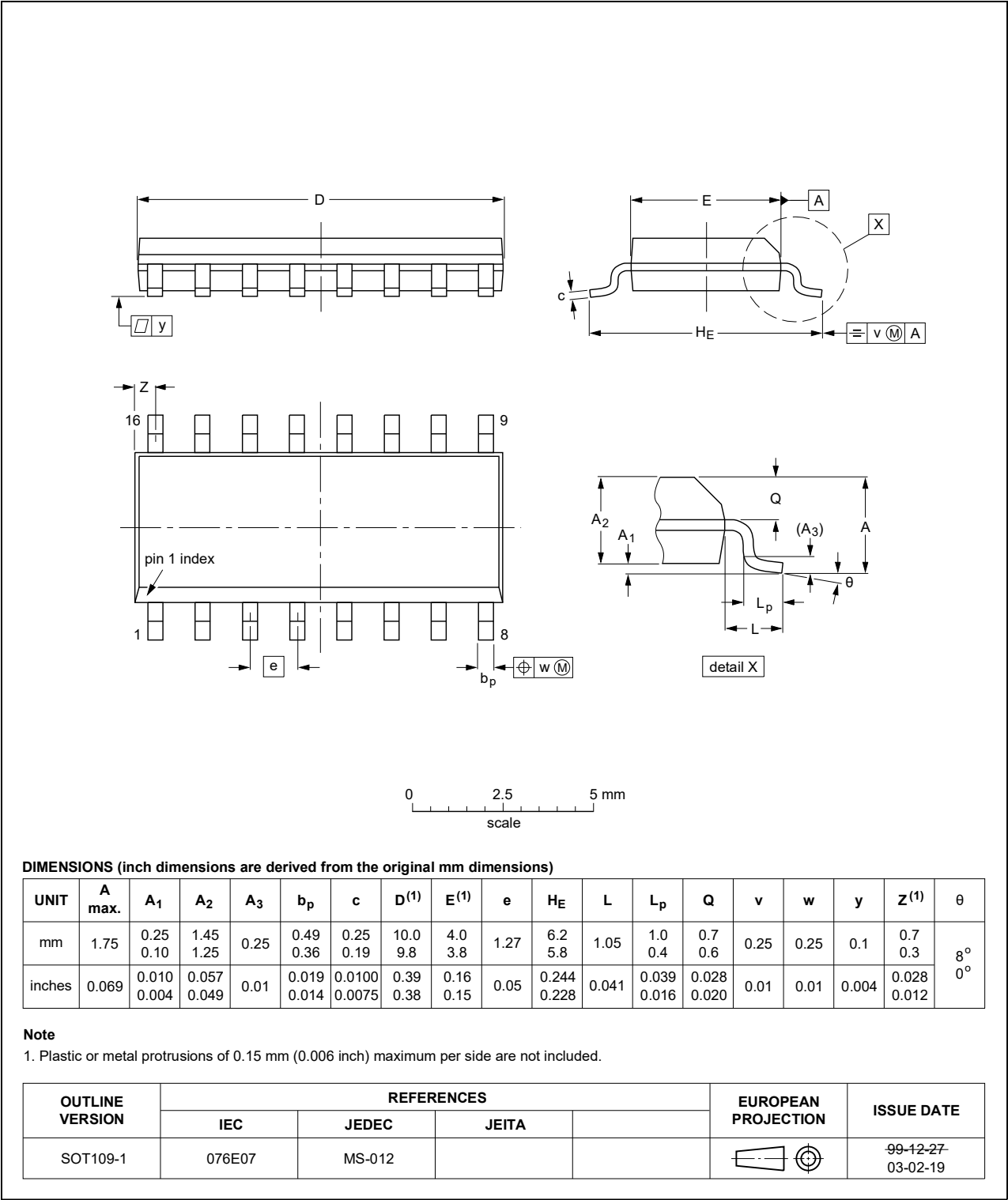


Fig. 9. Package outline SOT109-1 (SO16)

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

SOT338-1

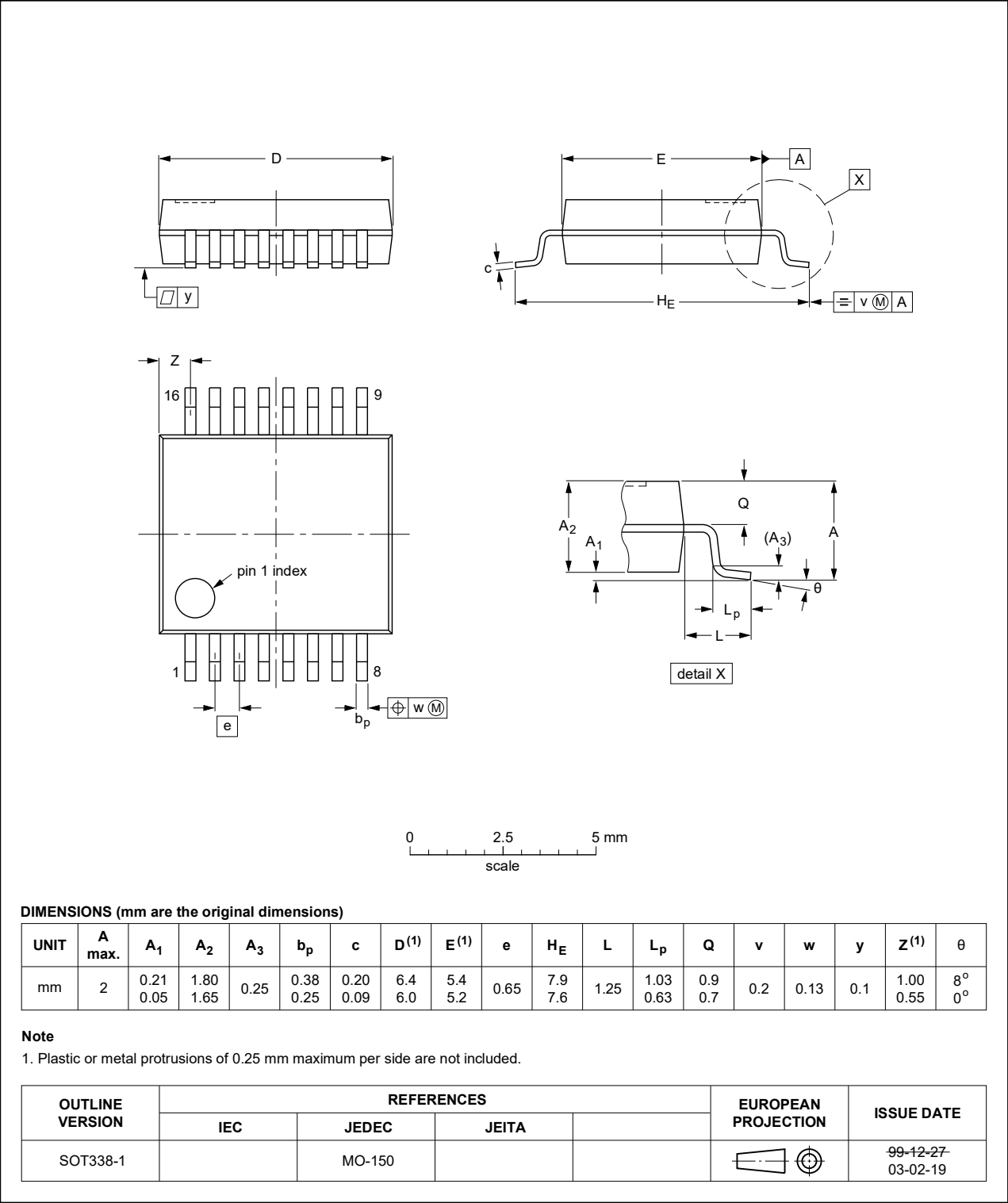


Fig. 10. Package outline SOT338-1 (SSOP16)

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

SOT403-1

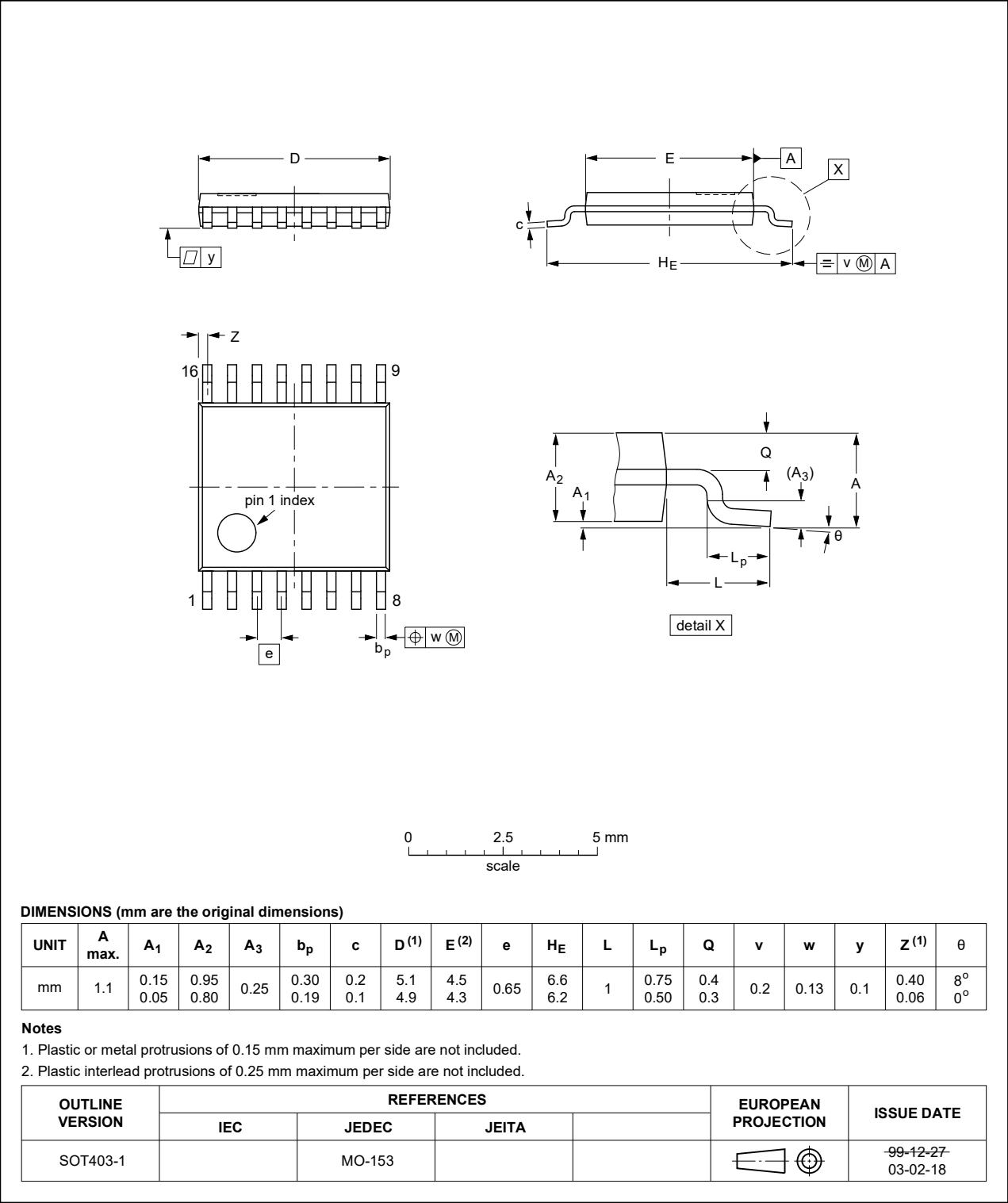


Fig. 11. Package outline SOT403-1 (TSSOP16)

## 12. Abbreviations

Table 10. Abbreviations

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

## 13. Revision history

Table 11. Revision history

| Document ID         | Release date                                                                                                                                                                                                                                                                                                                                      | Data sheet status     | Change notice | Supersedes          |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|---------------------|
| 74HC_HCT109 v.4     | 20200401                                                                                                                                                                                                                                                                                                                                          | Product data sheet    | -             | 74HC_HCT109 v.3     |
| Modifications:      | <ul style="list-style-type: none"><li>The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li><li>Legal texts have been adapted to the new company name where appropriate.</li><li><a href="#">Table 4</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li></ul> |                       |               |                     |
| 74HC_HCT109 v.3     | 20160801                                                                                                                                                                                                                                                                                                                                          | Product data sheet    | -             | 74HC_HCT109_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 identity guidelines of NXP Semiconductors.</li><li>Legal texts have been adapted to the new company name where appropriate.</li></ul>                                                                                              |                       |               |                     |
| 74HC_HCT109_CNV v.2 | 19971125                                                                                                                                                                                                                                                                                                                                          | Product specification | -             | -                   |

## 14. Legal information

### Data sheet status

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

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

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Date of release: 1 April 2020