

# 74HC191

## Presetable synchronous 4-bit binary up/down counter

Rev. 5 — 13 August 2019

Product data sheet

### 1. General description

The 74HC191 is an asynchronously presetable 4-bit binary up/down counter. It contains four master/slave flip-flops with internal gating and steering logic to provide asynchronous preset and synchronous count-up and count-down operation. Asynchronous parallel load capability permits the counter to be preset to any desired value. Information present on the parallel data inputs (D0 to D3) is loaded into the counter and appears on the outputs when the parallel load ( $\overline{PL}$ ) input is LOW. This operation overrides the counting function. Counting is inhibited by a HIGH level on the count enable ( $\overline{CE}$ ) input. When  $\overline{CE}$  is LOW internal state changes are initiated synchronously by the LOW-to-HIGH transition of the clock input. The up/down ( $\overline{U/D}$ ) input signal determines the direction of counting as indicated in the function table. The  $\overline{CE}$  input may go LOW when the clock is in either state, however, the LOW-to-HIGH  $\overline{CE}$  transition must occur only when the clock is HIGH. Also, the  $\overline{U/D}$  input should be changed only when either  $\overline{CE}$  or CP is HIGH. Overflow/underflow indications are provided by two types of outputs, the terminal count (TC) and ripple clock ( $\overline{RC}$ ). The TC output is normally LOW and goes HIGH when a circuit reaches zero in the count-down mode or reaches '15' in the count-up-mode. The TC output will remain HIGH until a state change occurs, either by counting or presetting, or until  $\overline{U/D}$  is changed. Do not use the TC output as a clock signal because it is subject to decoding spikes. The TC signal is used internally to enable the  $\overline{RC}$  output. When TC is HIGH and  $\overline{CE}$  is LOW, the  $\overline{RC}$  output follows the clock pulse (CP). This feature simplifies the design of multistage counters as shown in [Fig. 5](#) and [Fig. 6](#). In [Fig. 5](#), each  $\overline{RC}$  output is used as the clock input to the next higher stage. It is only necessary to inhibit the first stage to prevent counting in all stages, since a HIGH on  $\overline{CE}$  inhibits the  $\overline{RC}$  output pulse. The timing skew between state changes in the first and last stages is represented by the cumulative delay of the clock as it ripples through the preceding stages. This can be a disadvantage of this configuration in some applications. [Fig. 6](#) shows a method of causing state changes to occur simultaneously in all stages. The  $\overline{RC}$  outputs propagate the carry/borrow signals in ripple fashion and all clock inputs are driven in parallel. In this configuration the duration of the clock LOW state must be long enough to allow the negative-going edge of the carry/borrow signal to ripple through to the last stage before the clock goes HIGH. Since the  $\overline{RC}$  output of any package goes HIGH shortly after its CP input goes HIGH there is no such restriction on the HIGH-state duration of the clock. In [Fig. 7](#), the configuration shown avoids ripple delays and their associated restrictions. Combining the TC signals from all the preceding stages forms the  $\overline{CE}$  input for a given stage. An enable must be included in each carry gate in order to inhibit counting. The TC output of a given stage is not affected by its own  $\overline{CE}$  signal therefore the simple inhibit scheme of [Fig. 5](#) and [Fig. 6](#) does not apply. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

### 2. Features and benefits

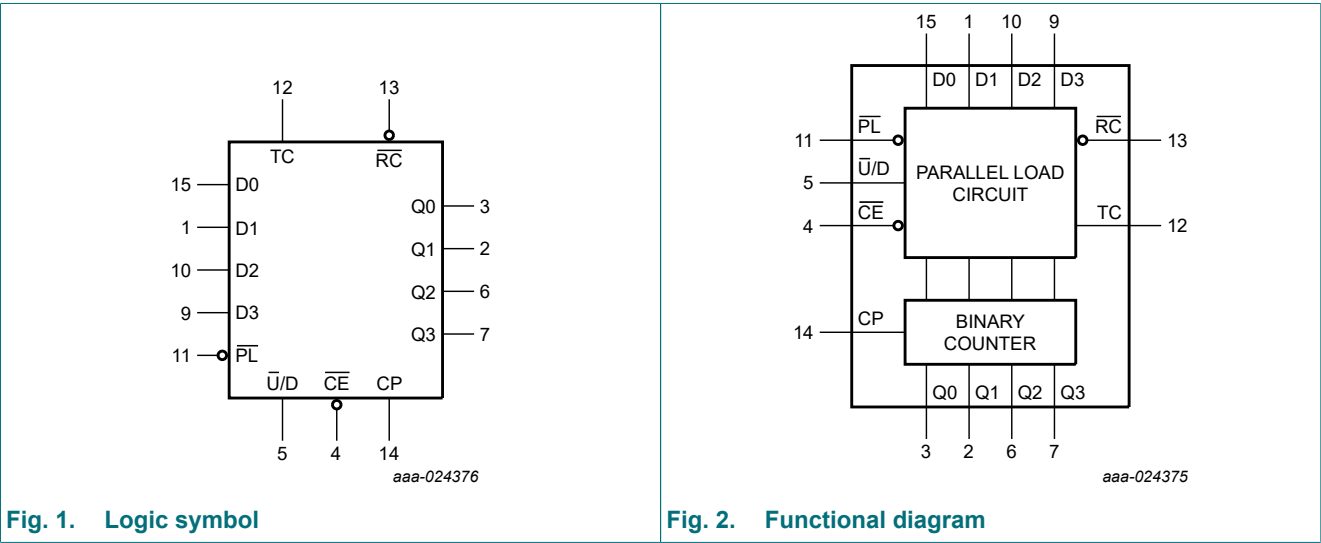
- Complies with JEDEC standard no. 7A
- CMOS input levels:
- Synchronous reversible counting
- Asynchronous parallel load
- Count enable control for synchronous expansion
- Single up/down control input
- ESD protection:
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V
- Specified from -40 °C to +85 °C and -40 °C to +125 °C

3. Ordering information

Table 1. Ordering information

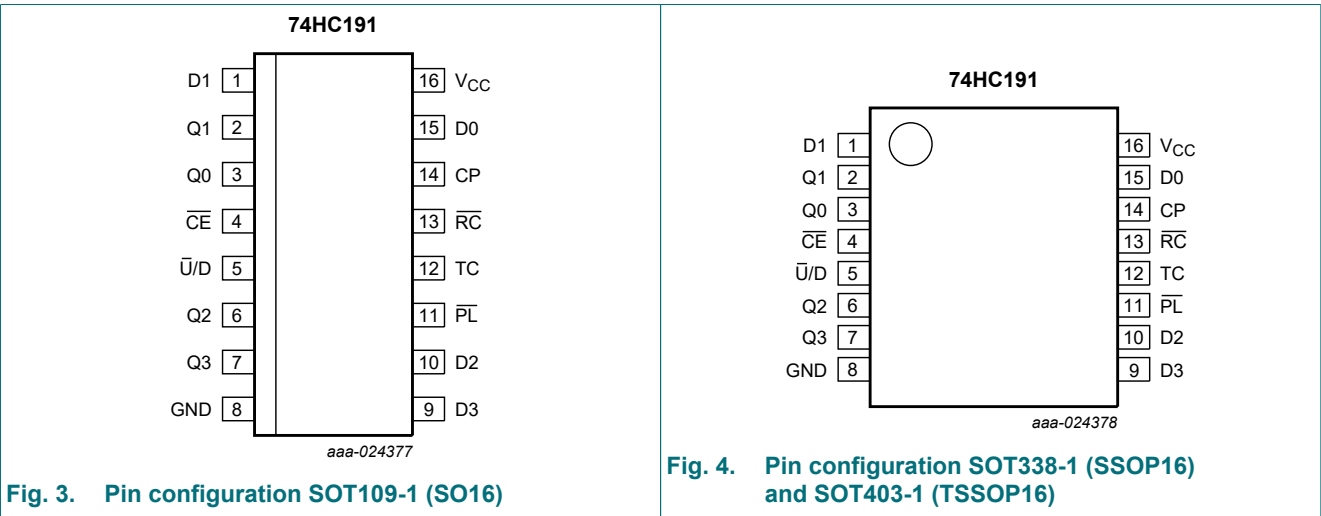
| Type number | Package           |         |                                                                        | Version  |
|-------------|-------------------|---------|------------------------------------------------------------------------|----------|
|             | Temperature range | Name    | Description                                                            |          |
| 74HC191D    | -40 °C to +125 °C | SO16    | plastic small outline package; 16 leads; body width 3.9 mm             | SOT109-1 |
| 74HC191DB   | -40 °C to +125 °C | SSOP16  | plastic shrink small outline package; 16 leads; body width 5.3 mm      | SOT338-1 |
| 74HC191PW   | -40 °C to +125 °C | TSSOP16 | plastic thin shrink small outline package; 16 leads; 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                               |
|-------------------------|--------------|-------------------------------------------|
| D0, D1, D2, D3          | 15, 1, 10, 9 | data input                                |
| Q0, Q1, Q2, Q3          | 3, 2, 6, 7   | flip-flop output                          |
| $\overline{\text{CE}}$  | 4            | count enable input (active LOW)           |
| $\overline{\text{U/D}}$ | 5            | up/down input                             |
| GND                     | 8            | ground (0 V)                              |
| $\overline{\text{PL}}$  | 11           | parallel load input (active LOW)          |
| TC                      | 12           | terminal count output                     |
| $\overline{\text{RC}}$  | 13           | ripple clock output (active LOW)          |
| CP                      | 14           | clock input (LOW-to-HIGH, edge-triggered) |
| V <sub>CC</sub>         | 16           | supply voltage                            |

## 6. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level;

I = LOW voltage level one set-up time prior to the LOW-to-HIGH clock transition; X = don't care;

↑ = LOW-to-HIGH clock transition

| Operating mode    | Input |                         |                        |    |    | Output     |
|-------------------|-------|-------------------------|------------------------|----|----|------------|
|                   | PL    | $\overline{\text{U/D}}$ | $\overline{\text{CE}}$ | CP | Dn | Qn         |
| parallel load     | L     | X                       | X                      | X  | L  | L          |
|                   | L     | X                       | X                      | X  | H  | H          |
| count up          | H     | L                       | I                      | ↑  | X  | count up   |
| count down        | H     | H                       | I                      | ↑  | X  | count down |
| Hold (do nothing) | H     | X                       | H                      | X  | X  | no change  |

Table 4. TC and RC Function table

H = HIGH voltage level; L = LOW voltage level; X = don't care;  = one LOW level pulse;

$\overline{\text{L}}$  = TC goes LOW on a LOW-to-HIGH clock transition.

| Input                   |                        |                                                                                     | Terminal count state |    |    |    | Output                                                                                |                                                                                       |
|-------------------------|------------------------|-------------------------------------------------------------------------------------|----------------------|----|----|----|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| $\overline{\text{U/D}}$ | $\overline{\text{CE}}$ | CP                                                                                  | Q0                   | Q1 | Q2 | Q3 | TC                                                                                    | $\overline{\text{RC}}$                                                                |
| H                       | H                      | X                                                                                   | H                    | H  | H  | H  | L                                                                                     | H                                                                                     |
| L                       | H                      | X                                                                                   | H                    | H  | H  | H  | H                                                                                     | H                                                                                     |
| L                       | L                      |  | H                    | H  | H  | H  |  |  |
| L                       | H                      | X                                                                                   | L                    | L  | L  | L  | L                                                                                     | H                                                                                     |
| H                       | H                      | X                                                                                   | L                    | L  | L  | L  | H                                                                                     | H                                                                                     |
| H                       | L                      |  | L                    | L  | L  | L  |  |  |

Presettable synchronous 4-bit binary up/down counter

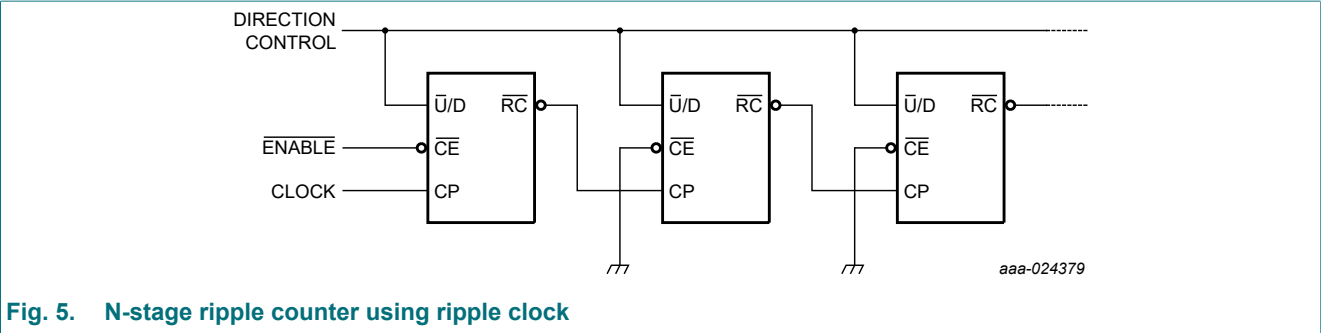


Fig. 5. N-stage ripple counter using ripple clock

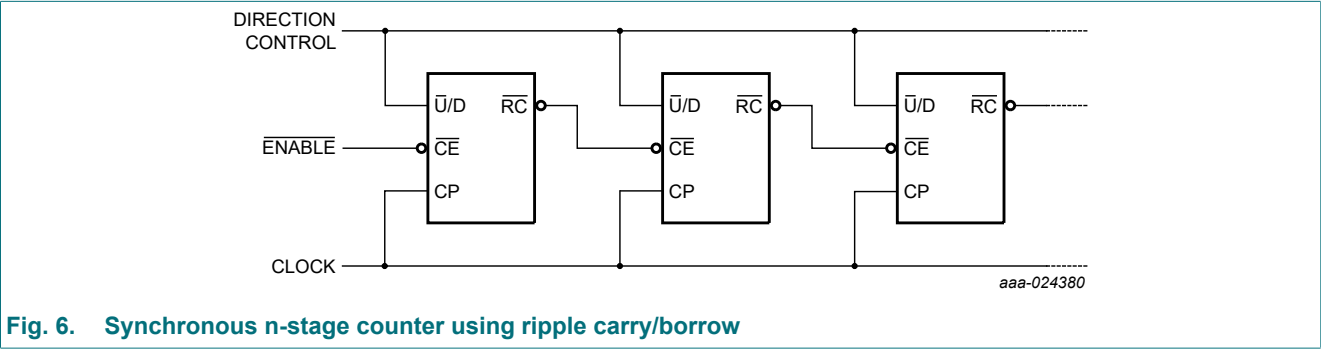


Fig. 6. Synchronous n-stage counter using ripple carry/borrow

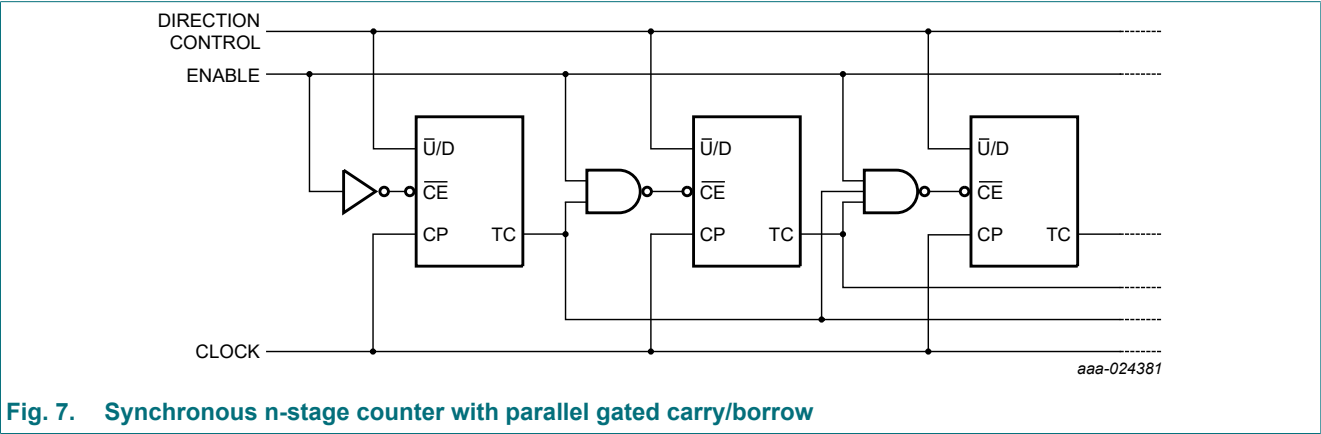


Fig. 7. Synchronous n-stage counter with parallel gated carry/borrow

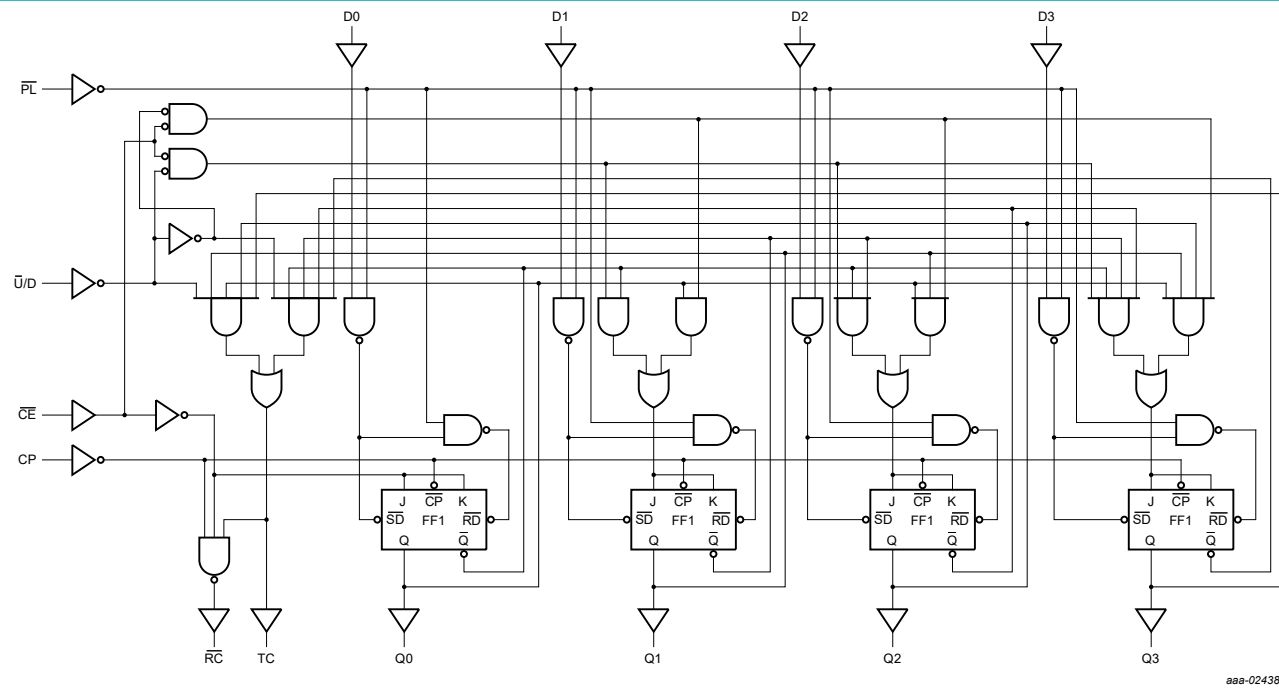
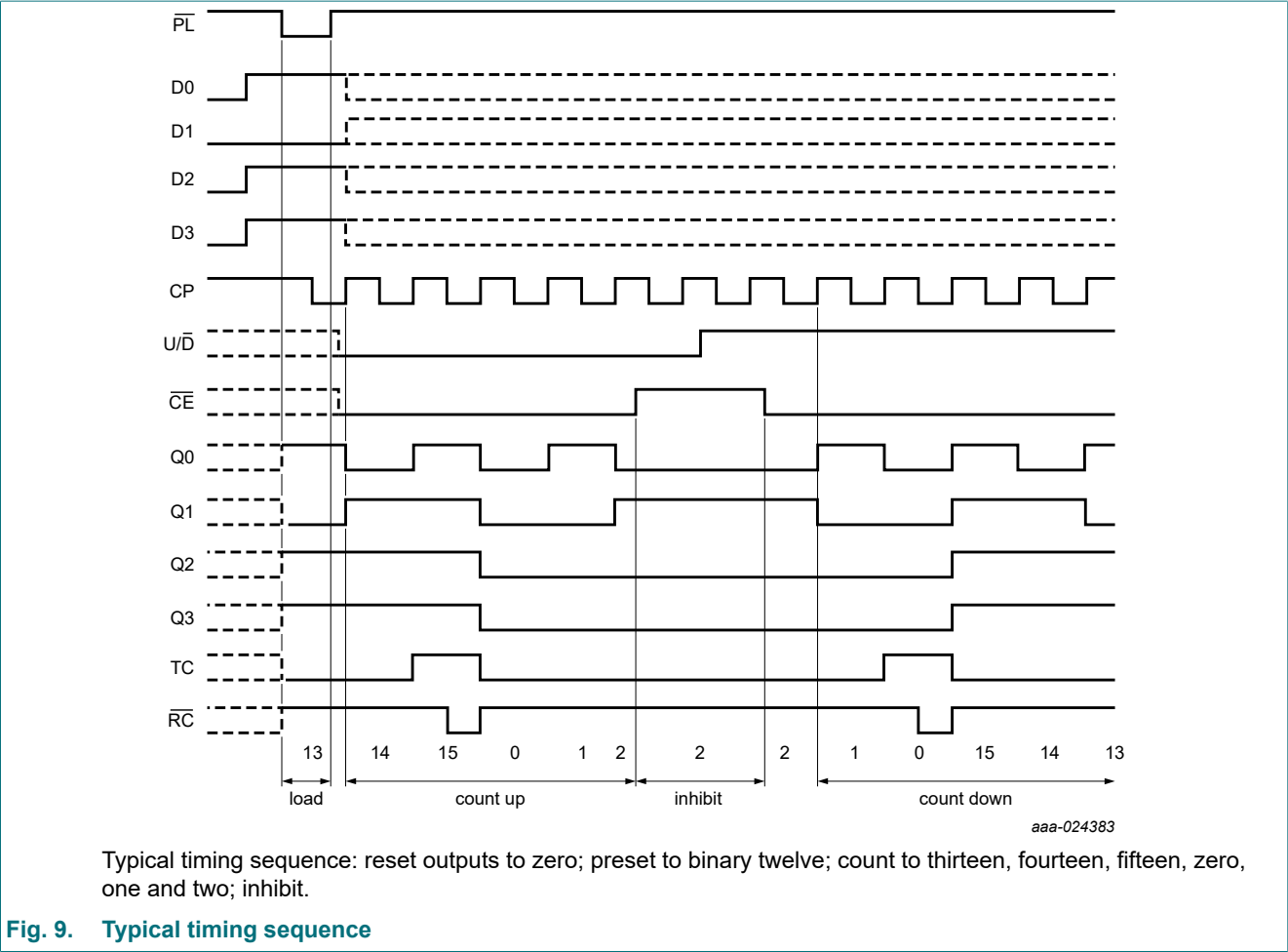


Fig. 8. Logic diagram



7. Limiting values

Table 5. 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 $V_I > V_{CC} + 0.5\text{ V}$ | -    | $\pm 20$ | mA   |
| $I_{OK}$  | output clamping current | $V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ | -    | $\pm 20$ | mA   |
| $I_O$     | output current          | $V_O = -0.5\text{ V}$ to $V_{CC} + 0.5\text{ V}$       | -    | $\pm 25$ | 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 | [1]                                                    | -    | 500      | mW   |

[1] For SOT109-1 (SO16) packages:  $P_{tot}$  derates linearly with 12.4 mW/K above 110 °C.  
For SOT338-1 (SSOP16) packages:  $P_{tot}$  derates linearly with 8.5 mW/K above 91 °C.  
For SOT403-1 (TSSOP16) packages:  $P_{tot}$  derates linearly with 8.5 mW/K above 91 °C.

## 8. Recommended operating conditions

**Table 6. Recommended operating conditions**

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

| Symbol              | Parameter                           | Conditions              | Min | Typ  | Max      | Unit |
|---------------------|-------------------------------------|-------------------------|-----|------|----------|------|
| $V_{CC}$            | supply voltage                      |                         | 2.0 | 5.0  | 6.0      | V    |
| $V_I$               | input voltage                       |                         | 0   | -    | $V_{CC}$ | V    |
| $V_O$               | output voltage                      |                         | 0   | -    | $V_{CC}$ | V    |
| $T_{amb}$           | ambient temperature                 |                         | -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      | ns/V |
|                     |                                     | $V_{CC} = 6.0\text{ V}$ | -   | -    | 83       | ns/V |

## 9. Static characteristics

**Table 7. 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       |               |
| $V_{IH}$ | HIGH-level input voltage  | $V_{CC} = 2.0\text{ V}$                                          | 1.5   | 1.2  | -         | 1.5              | -         | 1.5               | -         | V             |
|          |                           | $V_{CC} = 4.5\text{ V}$                                          | 3.15  | 2.4  | -         | 3.15             | -         | 3.15              | -         | V             |
|          |                           | $V_{CC} = 6.0\text{ V}$                                          | 4.2   | 3.2  | -         | 4.2              | -         | 4.2               | -         | V             |
| $V_{IL}$ | LOW-level input voltage   | $V_{CC} = 2.0\text{ V}$                                          | -     | 0.8  | 0.5       | -                | 0.5       | -                 | 0.5       | V             |
|          |                           | $V_{CC} = 4.5\text{ V}$                                          | -     | 2.1  | 1.35      | -                | 1.35      | -                 | 1.35      | V             |
|          |                           | $V_{CC} = 6.0\text{ V}$                                          | -     | 2.8  | 1.8       | -                | 1.8       | -                 | 1.8       | V             |
| $V_{OH}$ | HIGH-level output voltage | $V_I = V_{IH}$ or $V_{IL}$                                       |       |      |           |                  |           |                   |           |               |
|          |                           | $I_O = -20\text{ }\mu\text{A}; V_{CC} = 2.0\text{ V}$            | 1.9   | 2.0  | -         | 1.9              | -         | 1.9               | -         | V             |
|          |                           | $I_O = -20\text{ }\mu\text{A}; V_{CC} = 4.5\text{ V}$            | 4.4   | 4.5  | -         | 4.4              | -         | 4.4               | -         | V             |
|          |                           | $I_O = -20\text{ }\mu\text{A}; V_{CC} = 6.0\text{ V}$            | 5.9   | 6.0  | -         | 5.9              | -         | 5.9               | -         | V             |
|          |                           | $I_O = -4.0; V_{CC} = 4.5\text{ V}$                              | 3.98  | 4.32 | -         | 3.84             | -         | 3.7               | -         | V             |
| $V_{OL}$ | LOW-level output voltage  | $V_I = V_{IH}$ or $V_{IL}$                                       |       |      |           |                  |           |                   |           |               |
|          |                           | $I_O = 20\text{ }\mu\text{A}; V_{CC} = 2.0\text{ V}$             | -     | 0    | 0.1       | -                | 0.1       | -                 | 0.1       | V             |
|          |                           | $I_O = 20\text{ }\mu\text{A}; V_{CC} = 4.5\text{ V}$             | -     | 0    | 0.1       | -                | 0.1       | -                 | 0.1       | V             |
|          |                           | $I_O = 20\text{ }\mu\text{A}; V_{CC} = 6.0\text{ V}$             | -     | 0    | 0.1       | -                | 0.1       | -                 | 0.1       | V             |
|          |                           | $I_O = 4.0\text{ mA}; V_{CC} = 4.5\text{ V}$                     | -     | 0.15 | 0.26      | -                | 0.33      | -                 | 0.4       | V             |
| $I_I$    | input leakage current     | $V_I = V_{CC}$ or $GND; V_{CC} = 6.0\text{ V}$                   | -     | -    | $\pm 0.1$ | -                | $\pm 1.0$ | -                 | $\pm 1.0$ | $\mu\text{A}$ |
|          |                           | $V_I = V_{CC}$ or $GND; I_O = 0\text{ A}; V_{CC} = 6.0\text{ V}$ | -     | -    | 8.0       | -                | 80.0      | -                 | 160.0     | $\mu\text{A}$ |
|          |                           |                                                                  | -     | -    |           | -                |           | -                 |           |               |
|          |                           |                                                                  | -     | -    |           | -                |           | -                 |           |               |
|          |                           |                                                                  | -     | -    |           | -                |           | -                 |           |               |
| $C_I$    | input capacitance         |                                                                  | -     | 3.5  | -         | -                | -         | -                 | -         | pF            |

## 10. Dynamic characteristics

**Table 8. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50$  pF unless otherwise specified; for test circuit see Fig. 18.

| Symbol   | Parameter         | Conditions                      | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|----------|-------------------|---------------------------------|-------|-----|-----|------------------|-----|-------------------|-----|------|
|          |                   |                                 | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| $t_{pd}$ | propagation delay | CP to Qn; see Fig. 10 [1]       |       |     |     |                  |     |                   |     |      |
|          |                   | $V_{CC} = 2.0$ V                | -     | 72  | 220 | -                | 275 | -                 | 330 | ns   |
|          |                   | $V_{CC} = 4.5$ V                | -     | 26  | 44  | -                | 55  | -                 | 66  | ns   |
|          |                   | $V_{CC} = 5.0$ V; $C_L = 15$ pF | -     | 22  | -   | -                | -   | -                 | -   | ns   |
|          |                   | $V_{CC} = 6.0$ V                | -     | 21  | 37  | -                | 47  | -                 | 56  | ns   |
|          |                   | CP to TC; see Fig. 10           |       |     |     |                  |     |                   |     |      |
|          |                   | $V_{CC} = 2.0$ V                | -     | 83  | 255 | -                | 320 | -                 | 395 | ns   |
|          |                   | $V_{CC} = 4.5$ V                | -     | 30  | 51  | -                | 64  | -                 | 77  | ns   |
|          |                   | $V_{CC} = 6.0$ V                | -     | 24  | 43  | -                | 54  | -                 | 65  | ns   |
|          |                   | CP to RC; see Fig. 11           |       |     |     |                  |     |                   |     |      |
|          |                   | $V_{CC} = 2.0$ V                | -     | 47  | 150 | -                | 190 | -                 | 225 | ns   |
|          |                   | $V_{CC} = 4.5$ V                | -     | 17  | 30  | -                | 38  | -                 | 45  | ns   |
|          |                   | $V_{CC} = 6.0$ V                | -     | 14  | 26  | -                | 33  | -                 | 38  | ns   |
|          |                   | CE to RC; see Fig. 11           |       |     |     |                  |     |                   |     |      |
|          |                   | $V_{CC} = 2.0$ V                | -     | 33  | 130 | -                | 165 | -                 | 195 | ns   |
|          |                   | $V_{CC} = 4.5$ V                | -     | 12  | 26  | -                | 33  | -                 | 39  | ns   |
|          |                   | $V_{CC} = 6.0$ V                | -     | 10  | 22  | -                | 28  | -                 | 33  | ns   |
|          |                   | Dn to Qn; see Fig. 12           |       |     |     |                  |     |                   |     |      |
|          |                   | $V_{CC} = 2.0$ V                | -     | 61  | 220 | -                | 275 | -                 | 330 | ns   |
|          |                   | $V_{CC} = 4.5$ V                | -     | 22  | 44  | -                | 55  | -                 | 66  | ns   |
|          |                   | $V_{CC} = 6.0$ V                | -     | 18  | 37  | -                | 47  | -                 | 56  | ns   |
|          |                   | PL to Qn; see Fig. 13           |       |     |     |                  |     |                   |     |      |
|          |                   | $V_{CC} = 2.0$ V                | -     | 61  | 220 | -                | 275 | -                 | 330 | ns   |
|          |                   | $V_{CC} = 4.5$ V                | -     | 22  | 44  | -                | 55  | -                 | 66  | ns   |
|          |                   | $V_{CC} = 6.0$ V                | -     | 18  | 37  | -                | 47  | -                 | 56  | ns   |
|          |                   | U/D to TC; see Fig. 14          |       |     |     |                  |     |                   |     |      |
|          |                   | $V_{CC} = 2.0$ V                | -     | 44  | 190 | -                | 240 | -                 | 285 | ns   |
|          |                   | $V_{CC} = 4.5$ V                | -     | 16  | 38  | -                | 48  | -                 | 57  | ns   |
|          |                   | $V_{CC} = 6.0$ V                | -     | 13  | 32  | -                | 41  | -                 | 48  | ns   |
|          |                   | U/D to RC; see Fig. 14          |       |     |     |                  |     |                   |     |      |
|          |                   | $V_{CC} = 2.0$ V                | -     | 50  | 210 | -                | 265 | -                 | 315 | ns   |
|          |                   | $V_{CC} = 4.5$ V                | -     | 18  | 42  | -                | 53  | -                 | 63  | ns   |
|          |                   | $V_{CC} = 6.0$ V                | -     | 14  | 36  | -                | 45  | -                 | 54  | ns   |
| $t_t$    | transition time   | see Fig. 15 [2]                 |       |     |     |                  |     |                   |     |      |
|          |                   | $V_{CC} = 2.0$ V                | -     | 19  | 75  | -                | 95  | -                 | 110 | ns   |
|          |                   | $V_{CC} = 4.5$ V                | -     | 7   | 15  | -                | 19  | -                 | 22  | ns   |
|          |                   | $V_{CC} = 6.0$ V                | -     | 6   | 13  | -                | 16  | -                 | 19  | ns   |

## Presettable synchronous 4-bit binary up/down counter

| Symbol    | Parameter         | Conditions                                          | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|-----------|-------------------|-----------------------------------------------------|-------|-----|-----|------------------|-----|-------------------|-----|------|
|           |                   |                                                     | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| $t_W$     | pulse width       | CP; HIGH or LOW; see <a href="#">Fig. 10</a>        |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 125   | 28  | -   | 155              | -   | 195               | -   | ns   |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 25    | 10  | -   | 31               | -   | 39                | -   | ns   |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 21    | 8   | -   | 26               | -   | 33                | -   | ns   |
|           |                   | $\overline{PL}$ ; LOW; see <a href="#">Fig. 15</a>  |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 100   | 22  | -   | 125              | -   | 150               | -   | ns   |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 20    | 8   | -   | 25               | -   | 30                | -   | ns   |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 17    | 6   | -   | 21               | -   | 26                | -   | ns   |
| $t_{rec}$ | recovery time     | $\overline{PL}$ to CP; see <a href="#">Fig. 15</a>  |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 35    | 8   | -   | 45               | -   | 55                | -   | ns   |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 7     | 3   | -   | 9                | -   | 11                | -   | ns   |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 6     | 2   | -   | 8                | -   | 9                 | -   | ns   |
| $t_{su}$  | set-up time       | $\overline{U/D}$ to CP; see <a href="#">Fig. 16</a> |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 205   | 50  | -   | 255              | -   | 310               | -   | ns   |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 41    | 18  | -   | 51               | -   | 62                | -   | ns   |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 35    | 14  | -   | 43               | -   | 53                | -   | ns   |
|           |                   | Dn to $\overline{PL}$ ; see <a href="#">Fig. 17</a> |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 100   | 19  | -   | 125              | -   | 150               | -   | ns   |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 20    | 7   | -   | 25               | -   | 30                | -   | ns   |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 17    | 6   | -   | 21               | -   | 26                | -   | ns   |
|           |                   | $\overline{CE}$ to CP; see <a href="#">Fig. 16</a>  |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 140   | 44  | -   | 175              | -   | 210               | -   | ns   |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 28    | 16  | -   | 35               | -   | 42                | -   | ns   |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 24    | 13  | -   | 30               | -   | 36                | -   | ns   |
| $t_h$     | hold time         | $\overline{U/D}$ to CP; see <a href="#">Fig. 16</a> |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 0     | -39 | -   | 0                | -   | 0                 | -   | ns   |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 0     | -14 | -   | 0                | -   | 0                 | -   | ns   |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 0     | -11 | -   | 0                | -   | 0                 | -   | ns   |
|           |                   | Dn to $\overline{PL}$ ; see <a href="#">Fig. 17</a> |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 0     | -11 | -   | 0                | -   | 0                 | -   | ns   |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 0     | -4  | -   | 0                | -   | 0                 | -   | ns   |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 0     | -3  | -   | 0                | -   | 0                 | -   | ns   |
|           |                   | $\overline{CE}$ to CP; see <a href="#">Fig. 16</a>  |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 0     | -28 | -   | 0                | -   | 0                 | -   | ns   |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 0     | -10 | -   | 0                | -   | 0                 | -   | ns   |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 0     | -8  | -   | 0                | -   | 0                 | -   | ns   |
| $f_{max}$ | maximum frequency | CP; see <a href="#">Fig. 10</a>                     |       |     |     |                  |     |                   |     |      |
|           |                   | $V_{CC} = 2.0\text{ V}$                             | 4.0   | 11  | -   | 3.2              | -   | 2.6               | -   | MHz  |
|           |                   | $V_{CC} = 4.5\text{ V}$                             | 20    | 33  | -   | 16               | -   | 13                | -   | MHz  |
|           |                   | $V_{CC} = 5.0\text{ V}$ ; $C_L = 15\text{ pF}$      | -     | 36  | -   | -                | -   | -                 | -   | MHz  |
|           |                   | $V_{CC} = 6.0\text{ V}$                             | 24    | 39  | -   | 19               | -   | 15                | -   | MHz  |

## Presettable synchronous 4-bit binary up/down counter

| Symbol          | Parameter                     | Conditions                                                                                  | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------|-------|-----|-----|------------------|-----|-------------------|-----|------|
|                 |                               |                                                                                             | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| C <sub>PD</sub> | power dissipation capacitance | V <sub>I</sub> = GND to V <sub>CC</sub> ; V <sub>CC</sub> = 5 V; f <sub>i</sub> = 1 MHz [3] | -     | 31  | -   | -                | -   | -                 | -   | pF   |

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

[2] t<sub>i</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;

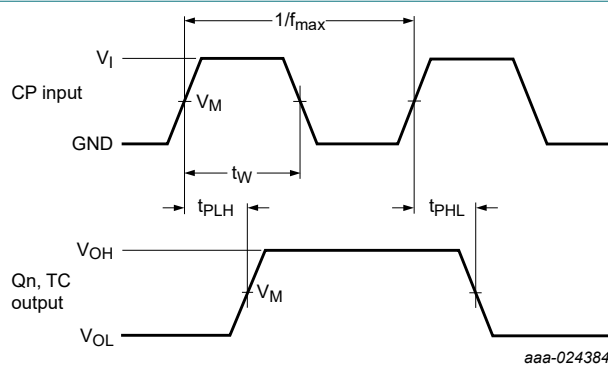
C<sub>L</sub> = output load capacitance in pF;

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

N = number of inputs switching;

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

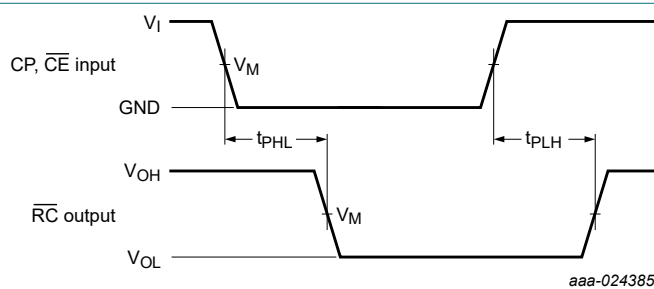
## 10.1. Waveforms and test circuit



Measurement points are given in Table 9.

Logic levels V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage levels that occur with the output load.

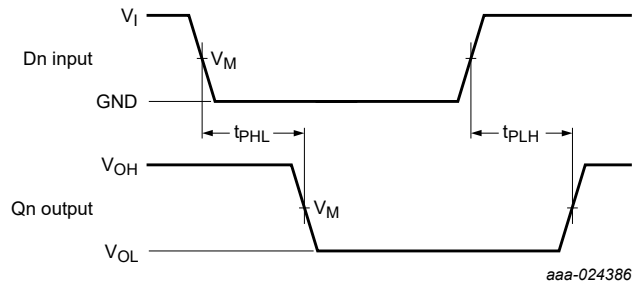
**Fig. 10. The clock input (CP) to outputs (Qn, TC) propagation delays, clock pulse width and maximum clock frequency**



Measurement points are given in Table 9.

Logic levels V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage levels that occur with the output load.

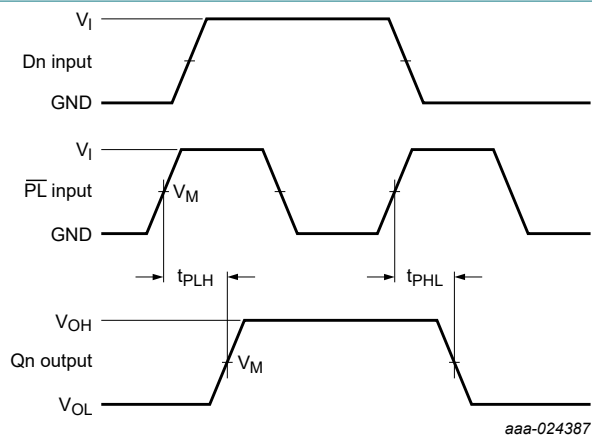
**Fig. 11. The clock and count enable inputs (CP, CE) to ripple clock output (RC) propagation delays**



Measurement points are given in [Table 9](#).

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

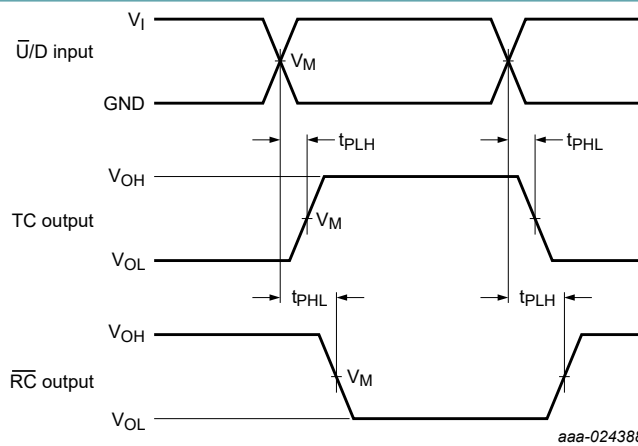
**Fig. 12. The input (Dn) to output (Qn) propagation delays**



Measurement points are given in [Table 9](#).

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

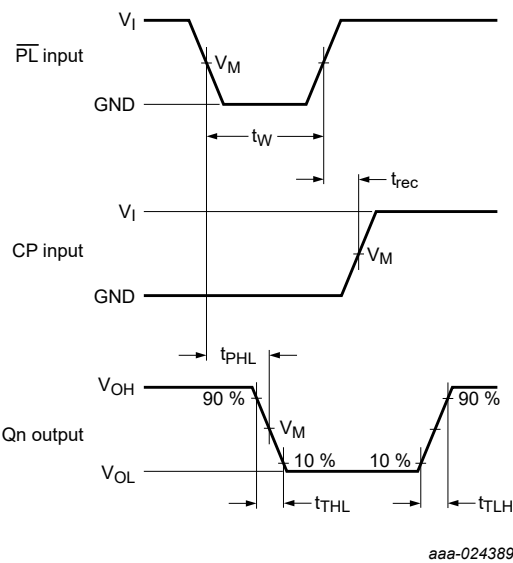
**Fig. 13. The parallel load input ( $\overline{PL}$ ) to output (Qn) propagation delays**



Measurement points are given in [Table 9](#).

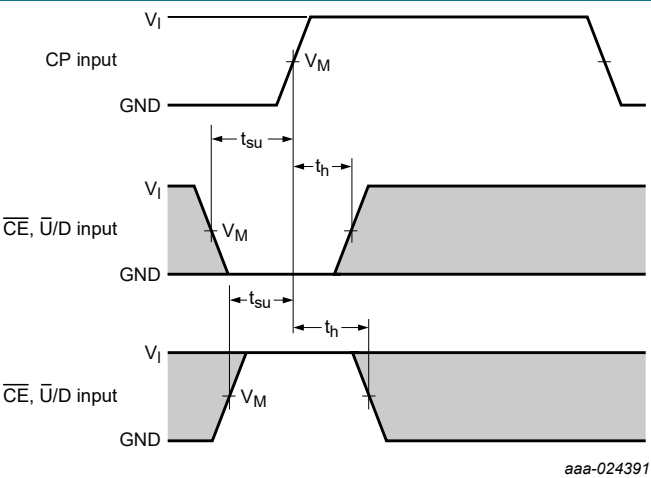
Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig. 14. The up/down count input ( $\overline{U/D}$ ) to terminal count and ripple clock output (TC,  $\overline{RC}$ ) propagation delays**



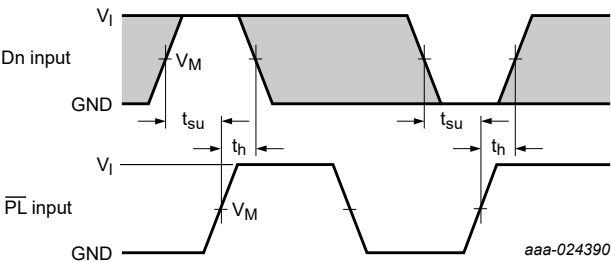
Measurement points are given in [Table 9](#).  
Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig. 15. The parallel load input ( $\overline{PL}$ ) to clock ( $CP$ ) recovery times, parallel load pulse width and output ( $Qn$ ) transition times**



Measurement points are given in [Table 9](#).  
The shaded areas indicate when the input is permitted to change for predictable output performance.

**Fig. 16. The count enable and up/down count inputs ( $\overline{CE}$ ,  $\overline{U/D}$ ) to clock input ( $CP$ ) set-up and hold times**

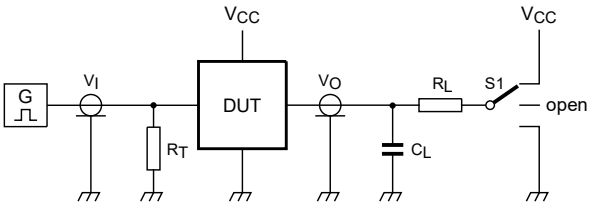
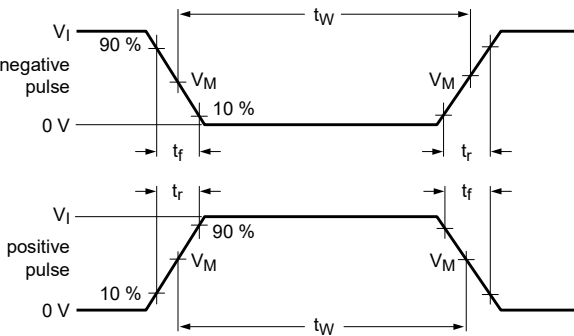


Measurement points are given in [Table 9](#).  
The shaded areas indicate when the input is permitted to change for predictable output performance.

Fig. 17. The parallel load input (PL) to data input (Dn) set-up and hold times

Table 9. Measurement points

| Input               |                 | Output              |
|---------------------|-----------------|---------------------|
| $V_M$               | $V_I$           | $V_M$               |
| $0.5 \times V_{CC}$ | GND to $V_{CC}$ | $0.5 \times V_{CC}$ |



Test data is given in [Table 10](#).  
Test circuit definitions:  
 $R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator  
 $C_L$  = Load capacitance including jig and probe capacitance  
 $R_L$  = Load resistance.  
 $S1$  = Test selection switch

Fig. 18. Test circuit for measuring switching times

Table 10. Test data

| Input    |            | Load         |       | S1 position        |
|----------|------------|--------------|-------|--------------------|
| $V_I$    | $t_r, t_f$ | $C_L$        | $R_L$ | $t_{PHL}, t_{PLH}$ |
| $V_{CC}$ | 6 ns       | 15 pF, 50 pF | 1 kΩ  | open               |

11. Package outline

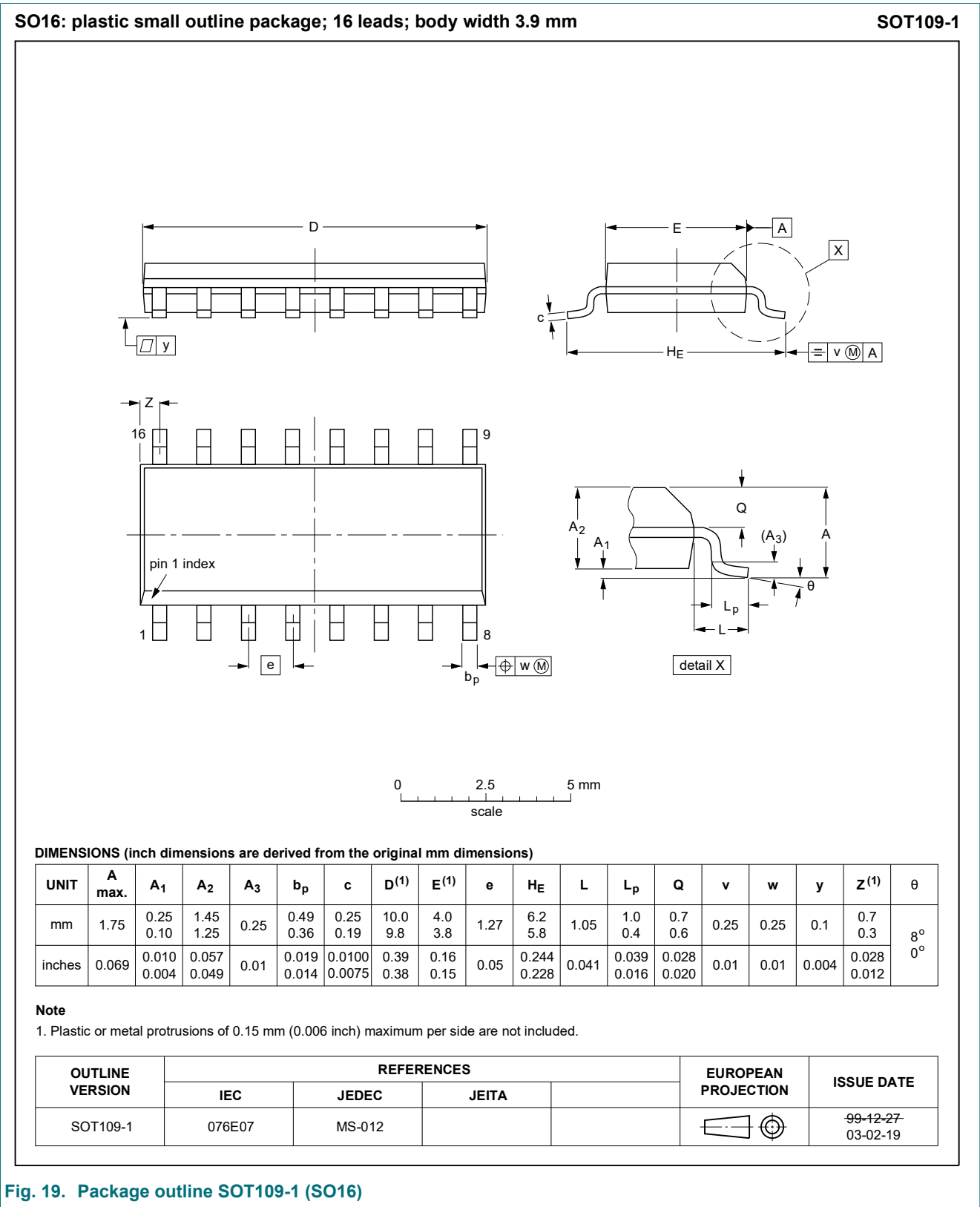


Fig. 19. Package outline SOT109-1 (SO16)

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

SOT338-1

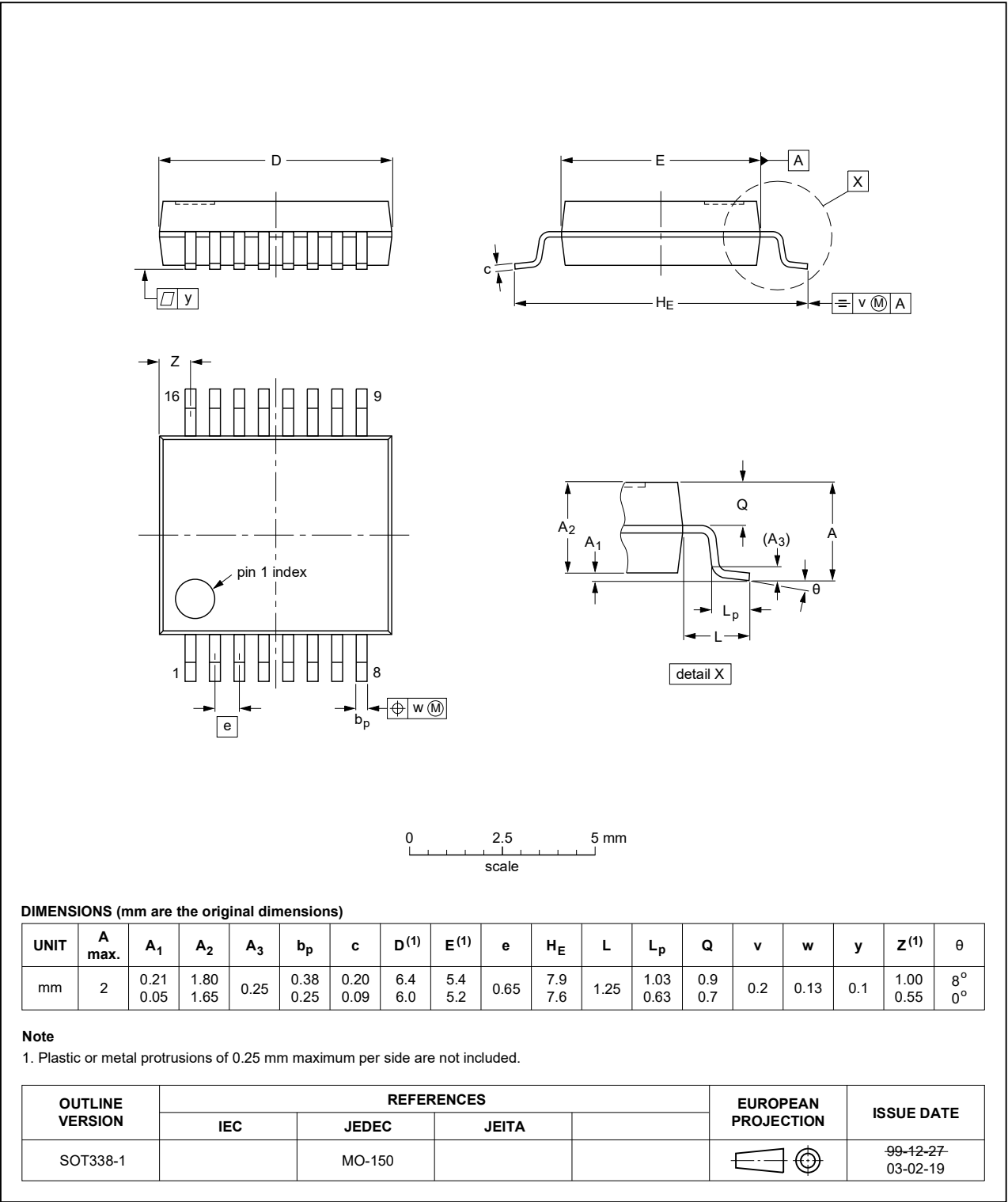
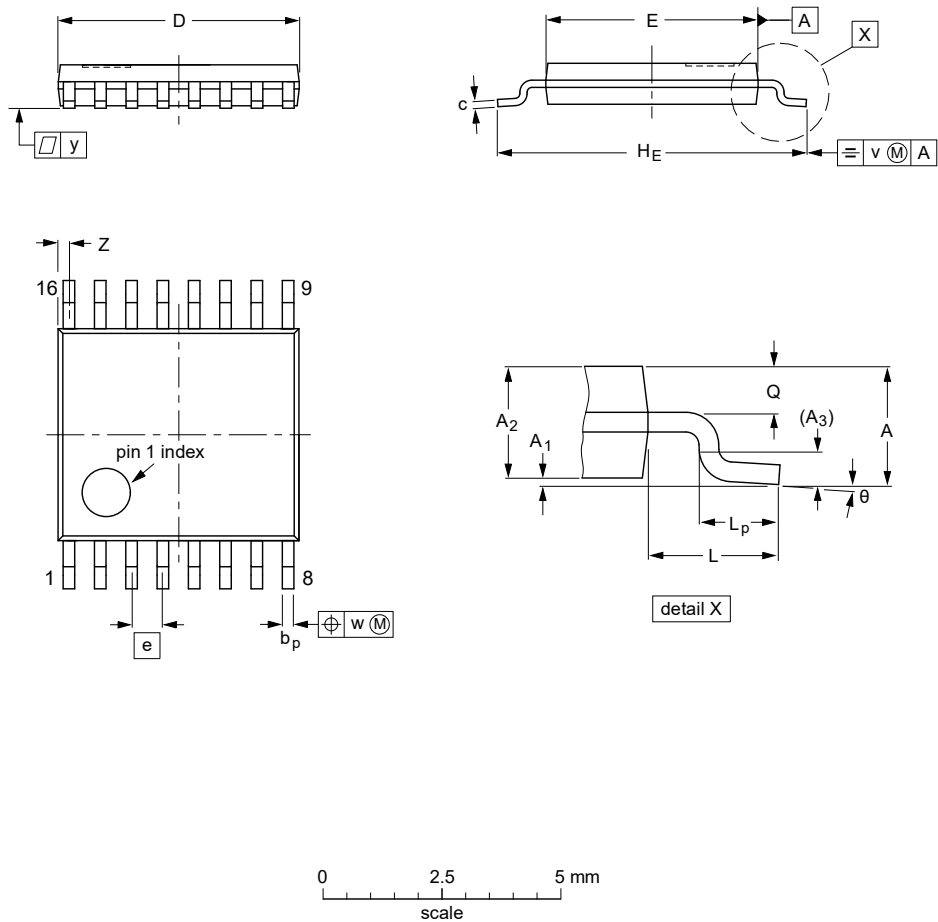


Fig. 20. Package outline SOT338-1 (SSOP16)

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

SOT403-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A<br>max. | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | b <sub>p</sub> | c          | D <sup>(1)</sup> | E <sup>(2)</sup> | e    | H <sub>E</sub> | L | L <sub>p</sub> | Q          | v   | w    | y   | Z <sup>(1)</sup> | θ        |
|------|-----------|----------------|----------------|----------------|----------------|------------|------------------|------------------|------|----------------|---|----------------|------------|-----|------|-----|------------------|----------|
| mm   | 1.1       | 0.15<br>0.05   | 0.95<br>0.80   | 0.25           | 0.30<br>0.19   | 0.2<br>0.1 | 5.1<br>4.9       | 4.5<br>4.3       | 0.65 | 6.6<br>6.2     | 1 | 0.75<br>0.50   | 0.4<br>0.3 | 0.2 | 0.13 | 0.1 | 0.40<br>0.06     | 8°<br>0° |

Notes

- 1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
- 2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

| OUTLINE<br>VERSION | REFERENCES |        |       |  | EUROPEAN<br>PROJECTION                                                                | ISSUE DATE           |
|--------------------|------------|--------|-------|--|---------------------------------------------------------------------------------------|----------------------|
|                    | IEC        | JEDEC  | JEITA |  |                                                                                       |                      |
| SOT403-1           |            | MO-153 |       |  |  | 99-12-27<br>03-02-18 |

Fig. 21. Package outline SOT403-1 (TSSOP16)

## 12. Abbreviations

Table 11. Abbreviations

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

## 13. Revision history

Table 12. Revision history

| Document ID         | Release date                                                                                                                                                                                                                                                                                                             | Data sheet status     | Change notice | Supersedes      |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|-----------------|
| 74HC191 v.5         | 20190813                                                                                                                                                                                                                                                                                                                 | Product data sheet    | -             | 74HC191 v.4     |
| Modifications:      | <ul style="list-style-type: none"> <li>Type number 74HC191DB (SOT338-1 / SSOP16) added.</li> <li><a href="#">Table 5</a>: Derating values for <math>P_{tot}</math> total power dissipation updated</li> </ul>                                                                                                            |                       |               |                 |
| 74HC191 v.4         | 20181005                                                                                                                                                                                                                                                                                                                 | Product data sheet    | -             | 74HC191 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>Type number 74HC191DB (SOT338-1 / SSOP16) removed.</li> </ul>                    |                       |               |                 |
| 74HC191 v.3         | 20170103                                                                                                                                                                                                                                                                                                                 | Product data sheet    | -             | 74HC_HCT191 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> <li>Type numbers 74HCT191D, 74HCT191DB, 74HCT191PW removed.</li> </ul> |                       |               |                 |
| 74HC_HCT191_CNV v.2 | 19901201                                                                                                                                                                                                                                                                                                                 | 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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