

74HC161

Presettable synchronous 4-bit binary counter; asynchronous reset

Rev. 5 — 16 March 2021

Product data sheet

1. General description

The 74HC161 is a synchronous presettable binary counter with an internal look-ahead carry. Synchronous operation is provided by having all flip-flops clocked simultaneously on the positive-going edge of the clock (CP). The outputs (Q0 to Q3) of the counters may be preset HIGH or LOW. A LOW at the parallel enable input (PE) disables the counting action and causes the data at the data inputs (D0 to D3) to be loaded into the counter on the positive-going edge of the clock. Preset takes place regardless of the levels at count enable inputs (CEP and CET). A LOW at the master reset input (\overline{MR}) sets Q0 to Q3 LOW regardless of the levels at input pins CP, PE, CET and CEP (thus providing an asynchronous clear function). The look-ahead carry simplifies serial cascading of the counters. Both CEP and CET must be HIGH to count. The CET input is fed forward to enable the terminal count output (TC). The TC output thus enabled will produce a HIGH output pulse of a duration approximately equal to a HIGH output of Q0. This pulse can be used to enable the next cascaded stage. The maximum clock frequency for the cascaded counters is determined by the CP to TC propagation delay and CEP to CP set-up time, according to the following formula:

$$f_{\max} = \frac{1}{t_{P(\max)}(\text{CP to TC}) + t_{\text{SU}}(\text{CEP to CP})}$$

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

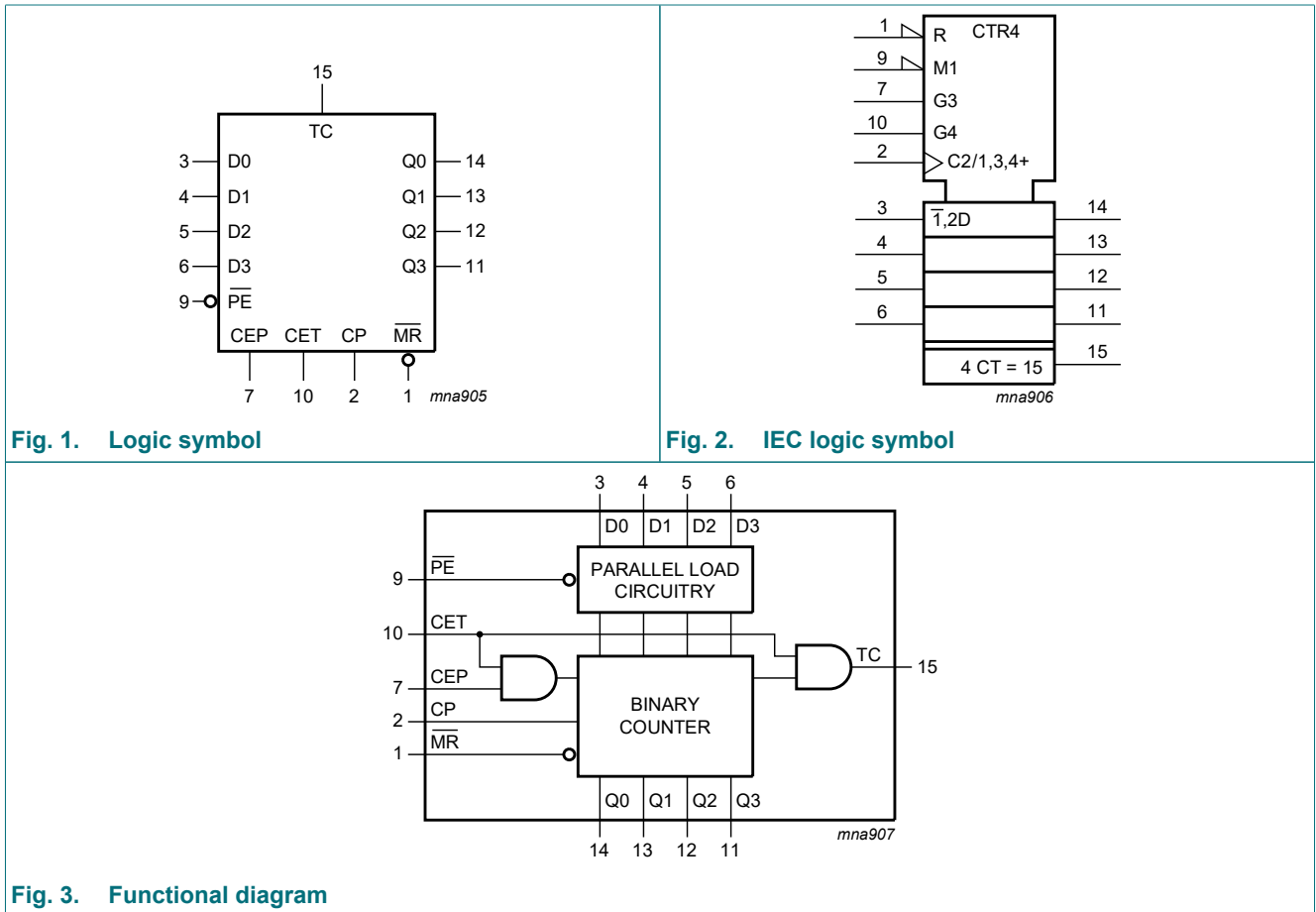
- Wide supply voltage range from 2.0 V to 6.0 V
- CMOS low power dissipation
- High noise immunity
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Complies with JEDEC standards:
 - JESD8C (2.7 V to 3.6 V)
 - JESD7A (2.0 V to 6.0 V)
- CMOS input levels
- Synchronous counting and loading
- 2 count enable inputs for n-bit cascading
- Asynchronous reset
- Positive-edge triggered clock
- 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 | |
| 74HC161D | -40 °C to +125 °C | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |
| 74HC161PW | -40 °C to +125 °C | TSSOP16 | plastic thin shrink small outline package; 16 leads; body width 4.4 mm | SOT403-1 |

4. Functional diagram



Pre-settable synchronous 4-bit binary counter; asynchronous reset

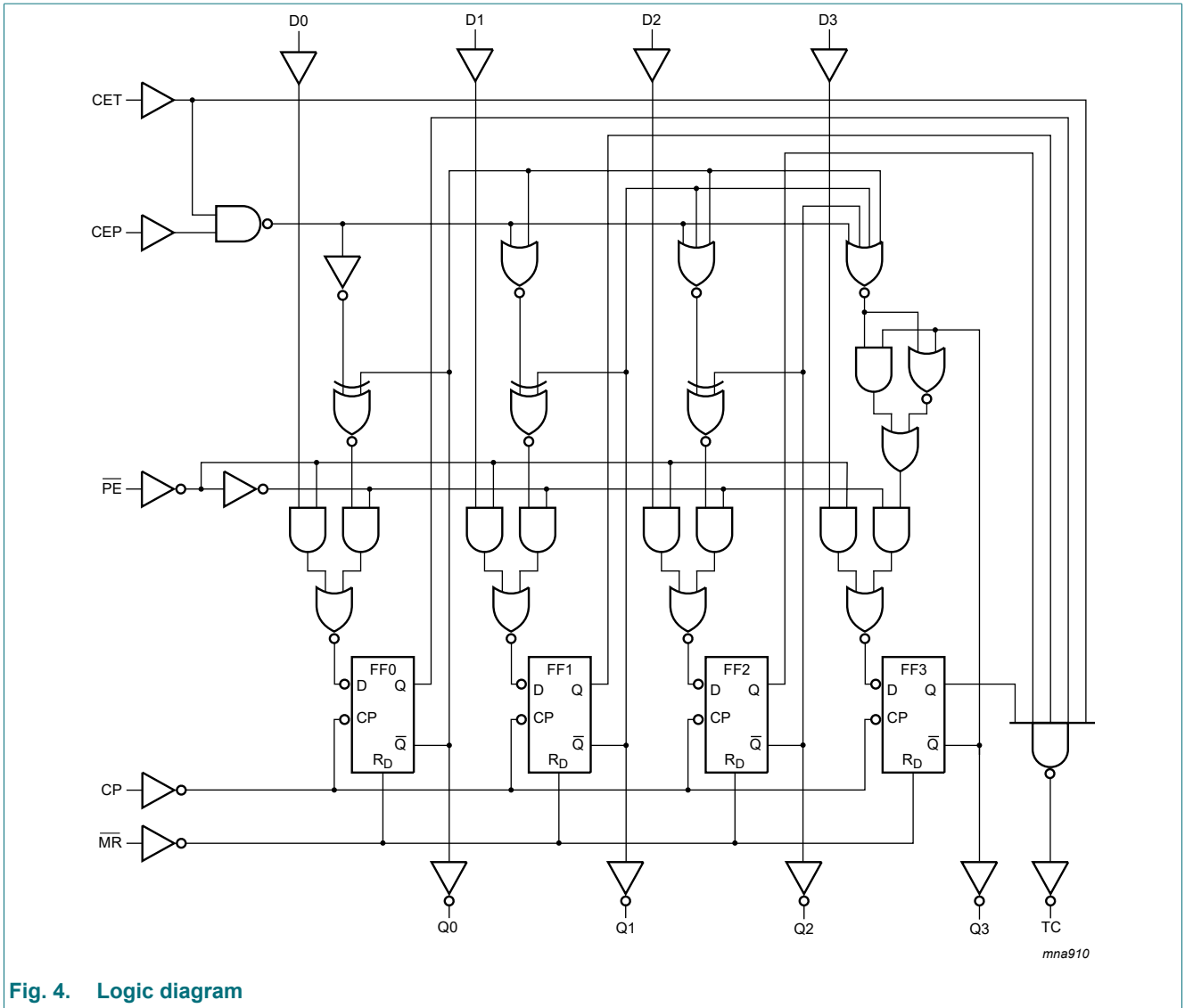


Fig. 4. Logic diagram

5. Pinning information

5.1. Pinning

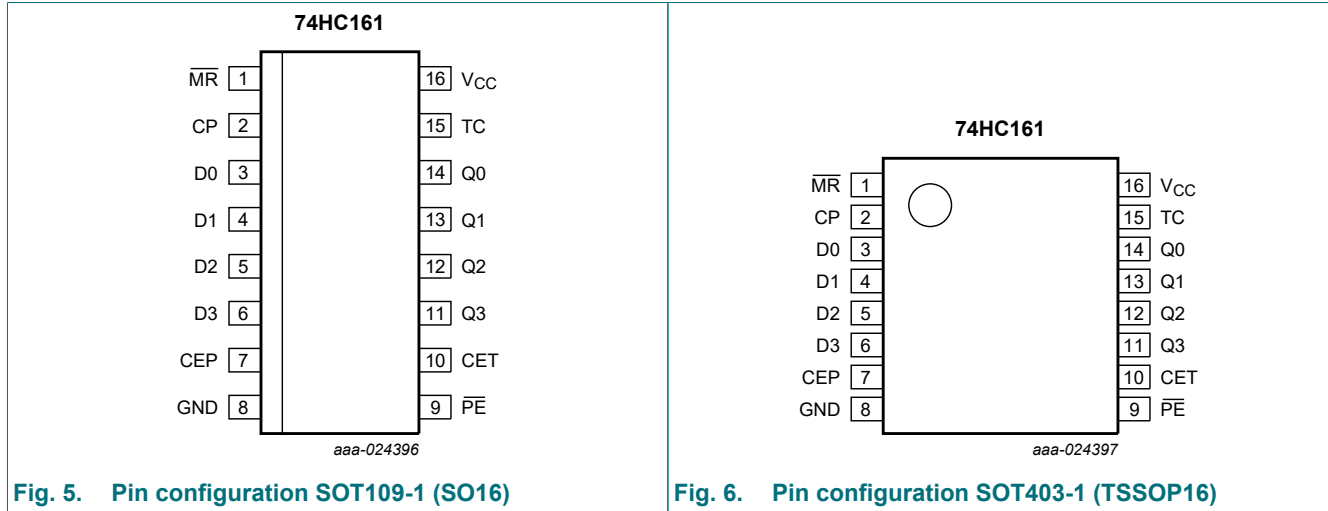


Fig. 5. Pin configuration SOT109-1 (SO16)

Fig. 6. Pin configuration SOT403-1 (TSSOP16)

5.2. Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|-----------------|----------------|---|
| MR | 1 | asynchronous master reset (active LOW) |
| CP | 2 | clock input (LOW-to-HIGH, edge-triggered) |
| D0, D1, D2, D3 | 3, 4, 5, 6 | data input |
| CEP | 7 | count enable input |
| GND | 8 | ground (0 V) |
| PE | 9 | parallel enable input (active LOW) |
| CET | 10 | count enable carry input |
| Q0, Q1, Q2, Q3 | 14, 13, 12, 11 | flip-flop output |
| TC | 15 | terminal count output |
| V _{CC} | 16 | supply voltage |

6. Functional description

Table 3. Function table

*H = HIGH voltage level; h = HIGH voltage level one set-up time prior to the LOW-to-HIGH clock transition;
 L = LOW voltage level; l = LOW voltage level one set-up time prior to the LOW-to-HIGH clock transition;
 q_n = lower case letters indicate the state of the referenced output one set-up time prior to the LOW-to-HIGH clock transition;
 X = don't care; ↑ = LOW-to-HIGH clock transition.*

| Operating modes | Input | | | | | | Output | |
|-------------------|-------|----|-----|-----|----|----|----------------|-----|
| | MR | CP | CEP | CET | PE | Dn | Qn | TC |
| Reset (clear) | L | X | X | X | X | X | L | L |
| Parallel load | H | ↑ | X | X | l | l | L | L |
| | H | ↑ | X | X | l | h | H | [1] |
| Count | H | ↑ | h | h | h | X | count | [1] |
| Hold (do nothing) | H | X | l | X | h | X | q _n | [1] |
| | H | X | X | l | h | X | q _n | L |

[1] The TC output is HIGH when CET is HIGH and the counter is at terminal count (HHHH)

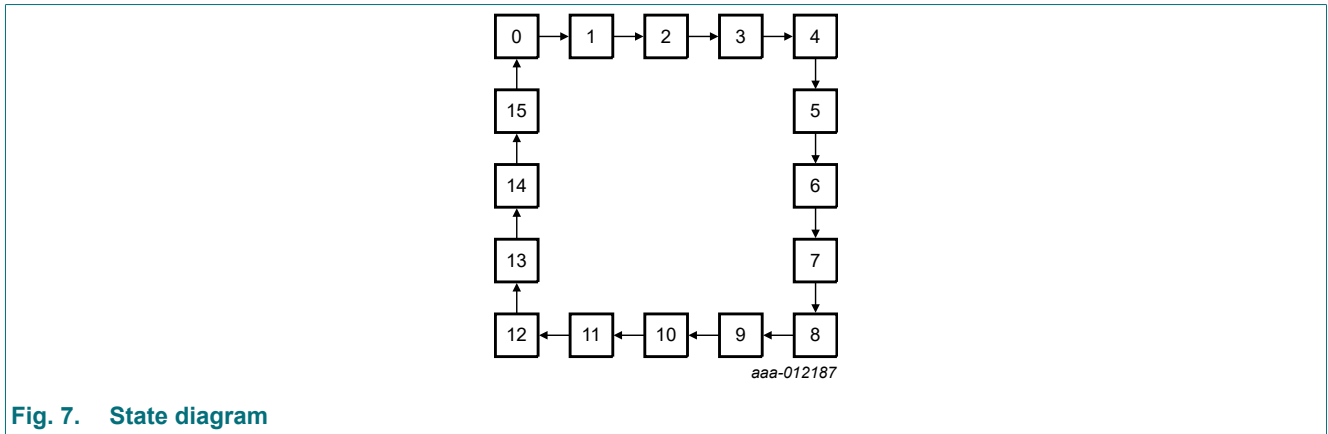
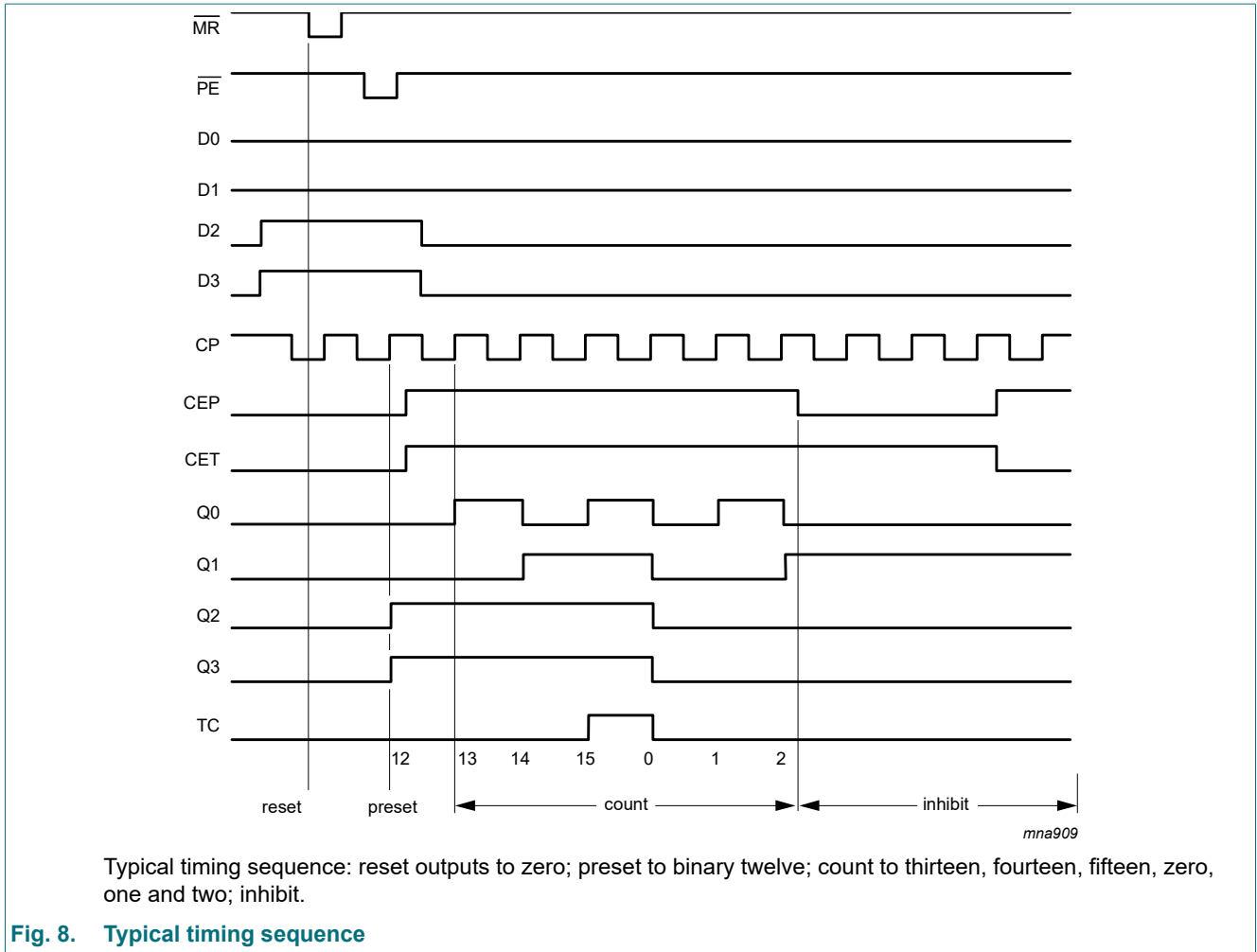


Fig. 7. State diagram



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

[1] For SOT109-1 (SO16) package: P_{tot} derates linearly with 12.4 mW/K above 110 °C.
 For SOT403-1 (TSSOP16) package: P_{tot} 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 | 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 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 | |
| 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 |
| | | $I_O = -4.0\text{ mA}$; $V_{CC} = 4.5\text{ V}$ | 3.98 | 4.32 | - | 3.84 | - | 3.7 | - | V |
| | | $I_O = -5.2\text{ mA}$; $V_{CC} = 6.0\text{ V}$ | 5.48 | 5.81 | - | 5.34 | - | 5.2 | - | 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 |
| | | $I_O = 5.2\text{ mA}$; $V_{CC} = 6.0\text{ V}$ | - | 0.16 | 0.26 | - | 0.33 | - | 0.4 | V |
| I_I | input leakage current | $V_I = V_{CC}$ or GND; $V_{CC} = 6.0\text{ V}$ | - | - | ± 0.1 | - | ± 1.0 | - | ± 1.0 | μA |
| I_{CC} | supply current | $V_I = V_{CC}$ or GND; $I_O = 0\text{ A}$; $V_{CC} = 6.0\text{ V}$ | - | - | 8.0 | - | 80.0 | - | 160.0 | μA |
| C_I | input capacitance | | - | 3.5 | - | - | - | - | - | pF |

10. Dynamic characteristics

Table 7. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit see Fig. 14.

| 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. 9 [1] | | | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 61 | 190 | - | 240 | - | 285 | ns |
| | | $V_{CC} = 4.5$ V | - | 22 | 38 | - | 48 | - | 57 | ns |
| | | $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 19 | - | - | - | - | - | ns |
| | | $V_{CC} = 6.0$ V | - | 18 | 32 | - | 41 | - | 48 | ns |
| | | CP to TC; see Fig. 9 | | | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 69 | 215 | - | 270 | - | 325 | ns |
| | | $V_{CC} = 4.5$ V | - | 25 | 43 | - | 54 | - | 65 | ns |
| | | $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 21 | - | - | - | - | - | ns |
| | | $V_{CC} = 6.0$ V | - | 20 | 37 | - | 46 | - | 55 | ns |
| | | CET to TC; see Fig. 10 | | | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 33 | 150 | - | 190 | - | 225 | ns |
| | | $V_{CC} = 4.5$ V | - | 12 | 30 | - | 38 | - | 45 | ns |
| $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 10 | - | - | - | - | - | ns | | |
| $V_{CC} = 6.0$ V | - | 10 | 26 | - | 38 | - | 31 | ns | | |
| t_{PHL} | HIGH to LOW propagation delay | MR to Qn; see Fig. 11 | | | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 63 | 210 | - | 265 | - | 315 | ns |
| | | $V_{CC} = 4.5$ V | - | 23 | 42 | - | 53 | - | 63 | ns |
| | | $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 20 | - | - | - | - | - | ns |
| | | $V_{CC} = 6.0$ V | - | 18 | 36 | - | 45 | - | 54 | ns |
| | | MR to TC; see Fig. 11 | | | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 63 | 220 | - | 275 | - | 330 | ns |
| | | $V_{CC} = 4.5$ V | - | 23 | 44 | - | 55 | - | 66 | ns |
| | | $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 20 | - | - | - | - | - | ns |
| $V_{CC} = 6.0$ V | - | 18 | 37 | - | 47 | - | 56 | ns | | |
| t_t | transition time | see Fig. 9 and Fig. 10 [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 |
| t_w | pulse width | CP; HIGH or LOW; see Fig. 9 | | | | | | | | |
| | | $V_{CC} = 2.0$ V | 80 | 22 | - | 100 | - | 120 | - | ns |
| | | $V_{CC} = 4.5$ V | 16 | 8 | - | 20 | - | 24 | - | ns |
| | | $V_{CC} = 6.0$ V | 14 | 6 | - | 17 | - | 20 | - | ns |
| | | MR; LOW; see Fig. 11 | | | | | | | | |
| | | $V_{CC} = 2.0$ V | 80 | 19 | - | 100 | - | 120 | - | ns |
| | | $V_{CC} = 4.5$ V | 16 | 7 | - | 20 | - | 24 | - | ns |
| $V_{CC} = 6.0$ V | 14 | 6 | - | 17 | - | 20 | - | ns | | |

Presettable synchronous 4-bit binary counter; asynchronous reset

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|------------------|-------------------------------|--|-------|-----|-----|------------------|-----|-------------------|-----|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| t _{rec} | recovery time | M \bar{R} to CP; see Fig. 11 | | | | | | | | |
| | | V _{CC} = 2.0 V | 100 | 19 | - | 125 | - | 150 | - | ns |
| | | V _{CC} = 4.5 V | 20 | 7 | - | 25 | - | 30 | - | ns |
| | | V _{CC} = 6.0 V | 17 | 6 | - | 21 | - | 26 | - | ns |
| t _{su} | set-up time | Dn to CP; see Fig. 12 | | | | | | | | |
| | | V _{CC} = 2.0 V | 80 | 25 | - | 100 | - | 120 | - | ns |
| | | V _{CC} = 4.5 V | 16 | 9 | - | 20 | - | 24 | - | ns |
| | | V _{CC} = 6.0 V | 14 | 7 | - | 17 | - | 20 | - | ns |
| | | PE to CP; see Fig. 12 | | | | | | | | |
| | | V _{CC} = 2.0 V | 100 | 30 | - | 125 | - | 150 | - | ns |
| | | V _{CC} = 4.5 V | 20 | 11 | - | 25 | - | 30 | - | ns |
| | | V _{CC} = 6.0 V | 17 | 9 | - | 21 | - | 26 | - | ns |
| | | CEP, CET to CP; see Fig. 13 | | | | | | | | |
| | | V _{CC} = 2.0 V | 170 | 47 | - | 215 | - | 255 | - | ns |
| | | V _{CC} = 4.5 V | 34 | 17 | - | 43 | - | 51 | - | ns |
| | | V _{CC} = 6.0 V | 29 | 14 | - | 37 | - | 43 | - | ns |
| t _h | hold time | Dn, PE, CEP, CET to CP; see Fig. 12 and Fig. 13 | | | | | | | | |
| | | V _{CC} = 2.0 V | 0 | -14 | - | 0 | - | 0 | - | ns |
| | | V _{CC} = 4.5 V | 0 | -5 | - | 0 | - | 0 | - | ns |
| | | V _{CC} = 6.0 V | 0 | -4 | - | 0 | - | 0 | - | ns |
| f _{max} | maximum frequency | CP; see Fig. 9 | | | | | | | | |
| | | V _{CC} = 2.0 V | 4.6 | 13 | - | 3.6 | - | 3.0 | - | MHz |
| | | V _{CC} = 4.5 V | 23 | 40 | - | 18 | - | 15 | - | MHz |
| | | V _{CC} = 5.0 V; C _L = 15 pF | - | 44 | - | - | - | - | - | MHz |
| | | V _{CC} = 6.0 V | 27 | 48 | - | 21 | - | 18 | - | MHz |
| C _{PD} | power dissipation capacitance | V _I = GND to V _{CC} ; V _{CC} = 5 V; [3] f _i = 1 MHz | - | 33 | - | - | - | - | - | pF |

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

[2] t_i is the same as t_{THL} and t_{TLH}.

[3] C_{PD} is used to determine the dynamic power dissipation (P_D 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_i = input frequency in MHz;

f_o = output frequency in MHz;

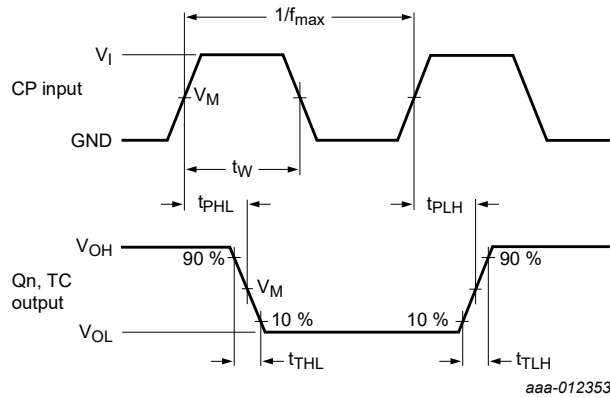
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

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

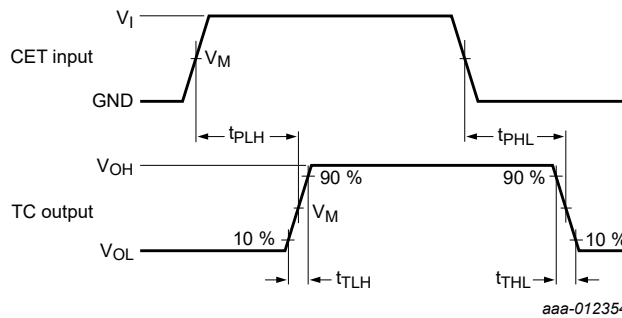
10.1. Waveforms and test circuit



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

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

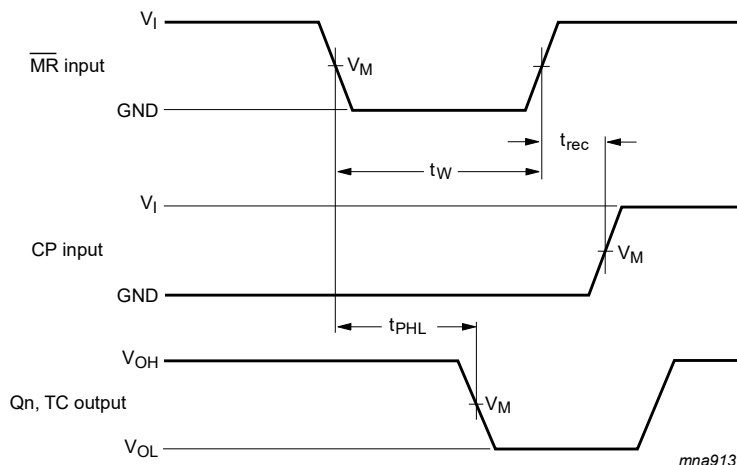
Fig. 9. The clock (CP) to outputs (Qn, TC) propagation delays, pulse width, output transition times and maximum frequency



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

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

Fig. 10. The count enable carry input (CET) to terminal count output (TC) propagation delays and output transition times



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

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

Fig. 11. The master reset (\overline{MR}) pulse width, master reset to output (Qn, TC) propagation delays, and the master reset to clock (CP) recovery times

Presettable synchronous 4-bit binary counter; asynchronous reset

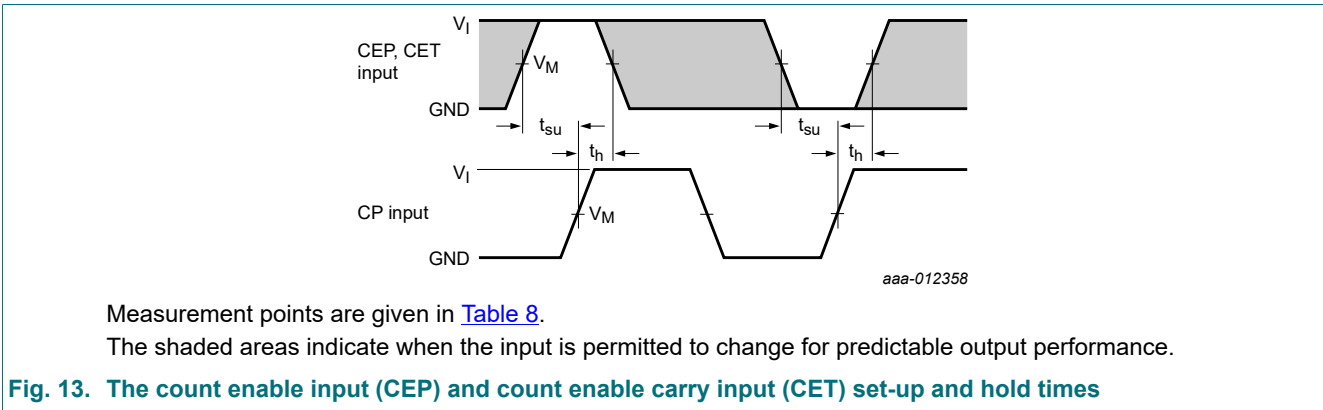
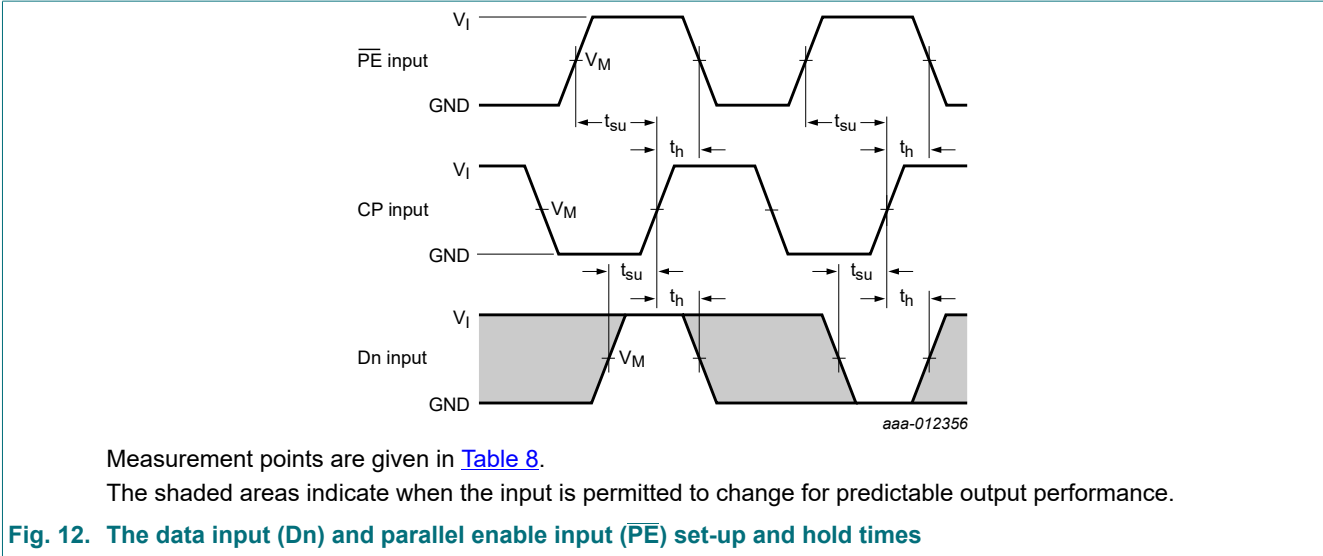


Table 8. Measurement points

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

Presettable synchronous 4-bit binary counter; asynchronous reset

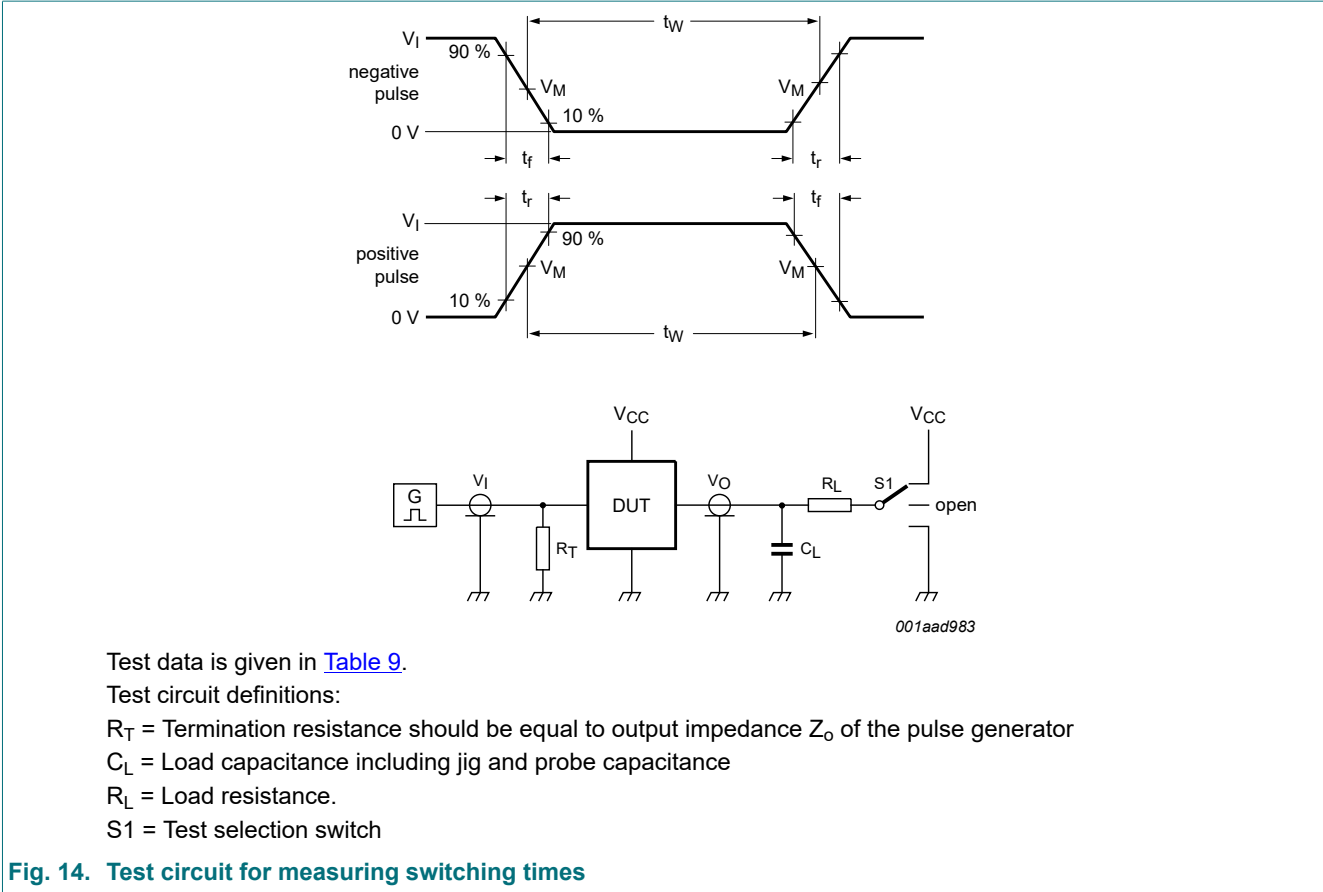


Fig. 14. Test circuit for measuring switching times

Table 9. 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

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

SOT109-1



Fig. 15. Package outline SOT109-1 (SO16)

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

SOT403-1



Fig. 16. 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 |

13. Revision history

Table 11. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|-----------------|--|-----------------------|---------------|-----------------|
| 74HC161 v.5 | 20210316 | Product data sheet | - | 74HC161 v.4 |
| Modifications: | <ul style="list-style-type: none"> • Section 2 updated. • Section 7: Derating values for P_{tot} total power dissipation updated. • Type number 74HC161DB (SOT338-1 / SSOP16) removed. | | | |
| 74HC161 v.4 | 20181004 | Product data sheet | - | 74HC161 v.3 |
| Modifications: | <ul style="list-style-type: none"> • The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. • Legal texts have been adapted to the new company name where appropriate. | | | |
| 74HC161 v.3 | 20170104 | Product data sheet | - | 74HC_HCT161 v.2 |
| Modifications: | <ul style="list-style-type: none"> • The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate. • Type numbers 74HCT161D, 74HCT161DB, 74HCT161PW removed. | | | |
| 74HC_HCT161 v.2 | 19901201 | Product specification | - | - |

14. Legal information

Data sheet status

| Document status [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>.

Definitions

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Date of release: 16 March 2021
