



# SN74LS161 (LX) Presettable Synchronous 4-bit Binary Counter; Asynchronous Reset

## Product Specification

### Specification Revision History:

| Version    | Date    | Description         |
|------------|---------|---------------------|
| 2021-06-A1 | 2021-06 | New                 |
| 2023-04-B1 | 2023-04 | Update the template |
|            |         |                     |
|            |         |                     |



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## 1、 General Description

The SN74LS161 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 ( $\overline{PE}$ ) 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,  $\overline{PE}$ , 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:

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

Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

### Features:

- Synchronous counting and loading
- 2 count enable inputs for n-bit cascading
- Asynchronous reset
- Positive-edge triggered clock
- Specified from -40°C to +125°C
- Packaging information: DIP16/SOP16/TSSOP16



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**Ordering Information:**

**Tube packing specifications:**

| Part number     | Packaging form | Marking code | Tube quantity  | Boxed tube quantity | Boxed quantity   | Notes  |
|-----------------|----------------|--------------|----------------|---------------------|------------------|--|
| SN74LS161N(LX)  | DIP16          | SN74LS161N   | 25<br>PCS/tube | 40<br>tube/box      | 1000<br>PCS/box  | Dimensions of plastic enclosure: 19.0mm×6.4mm<br>Pin spacing: 2.54mm |
| SN74LS161AD(LX) | SOP16          | LS161A       | 50<br>PCS/tube | 200<br>tube/box     | 10000<br>PCS/box | Dimensions of plastic enclosure: 10.0mm×3.9mm<br>Pin spacing: 1.27mm |
| SN74LS161PW(LX) | TSSOP16        | LS161        | 96<br>PCS/tube | 200<br>tube/box     | 19200<br>PCS/box | Dimensions of plastic enclosure: 5.0mm×4.4mm<br>Pin spacing: 0.65mm  |



**Reel packing specifications:**

| Part number      | Packaging form | Marking code | Reel quantity    | Boxed reel quantity | Notes  |
|------------------|----------------|--------------|------------------|---------------------|--|
| SN74LS161ADR(LX) | SOP16          | LS161A       | 2500<br>PCS/reel | 5000<br>PCS/box     | Dimensions of plastic enclosure:<br>10.0mm×3.9mm<br>Pin spacing:1.27mm |
| SN74LS161PW(LX)  | TSSOP16        | LS161        | 5000<br>PCS/reel | 10000<br>PCS/box    | Dimensions of plastic enclosure:<br>5.0mm×4.4mm<br>Pin spacing:0.65mm  |

Note: If the physical information is inconsistent with the ordering information, please refer to the actual product.



## 2、Block Diagram And Pin Description

### 2.1、Block Diagram

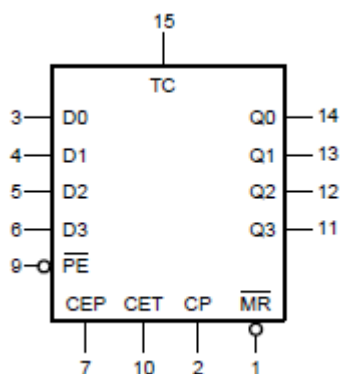


Figure 1. Logic symbol

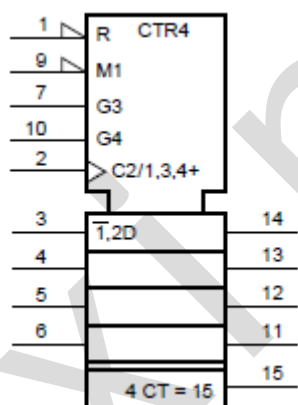


Figure 2. IEC logic symbol

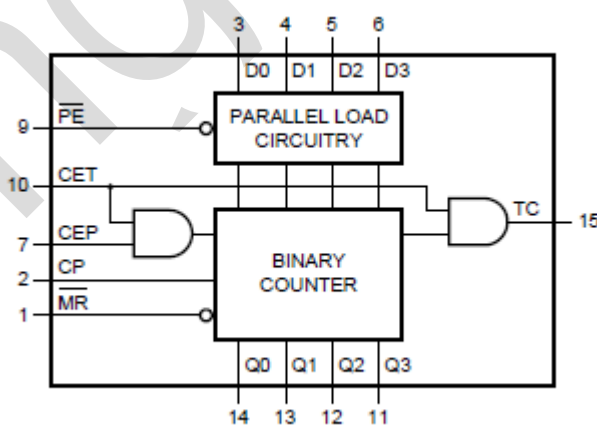


Figure 3. Functional diagram

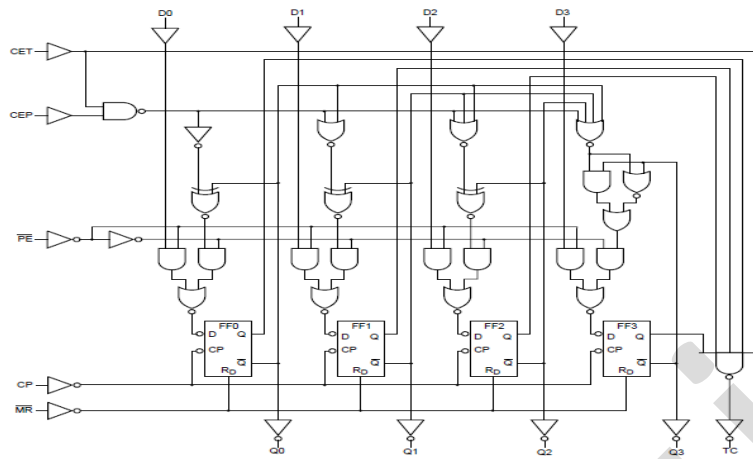


Figure 4. Logic diagram

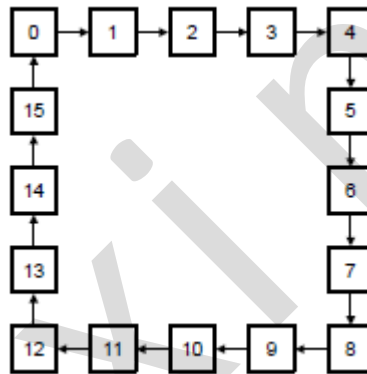


Figure 5. State diagram

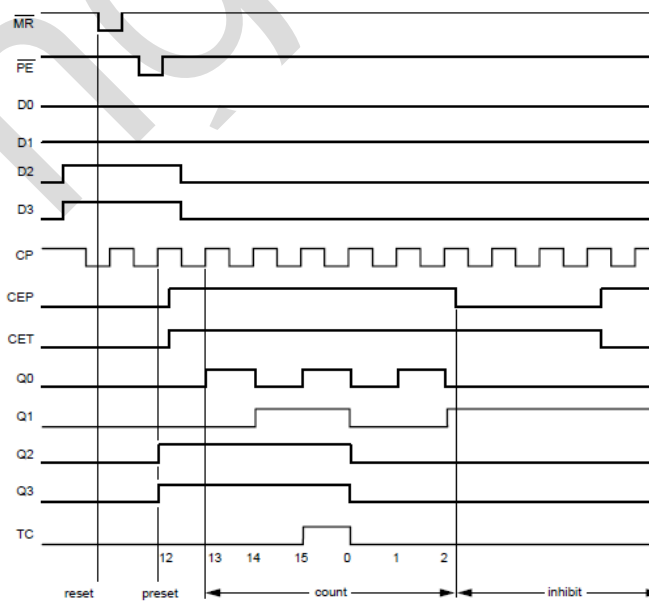
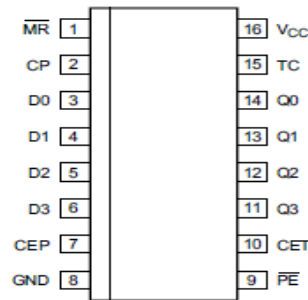


Figure 6. Typical timing sequence



## 2.2、Pin Configurations



## 2.3、Pin Description

| Pin No. | Pin Name               | Description                               |
|---------|------------------------|---|
| 1       | $\overline{\text{MR}}$ | asynchronous master reset (active LOW)    |
| 2       | CP                     | clock input (LOW-to-HIGH, edge triggered) |
| 3       | D0                     | data input                                |
| 4       | D1                     | data input                                |
| 5       | D2                     | data input                                |
| 6       | D3                     | data input                                |
| 7       | CEP                    | count enable input                        |
| 8       | GND                    | ground (0V)                               |
| 9       | $\overline{\text{PE}}$ | parallel enable input (active LOW)        |
| 10      | CET                    | count enable carry input                  |
| 11      | Q3                     | flip-flop output                          |
| 12      | Q2                     | flip-flop output                          |
| 13      | Q1                     | flip-flop output                          |
| 14      | Q0                     | flip-flop output                          |
| 15      | TC                     | terminal count output                     |
| 16      | V <sub>CC</sub>        | supply voltage                            |

## 2.4、Function Table

| Operating mode    | Input                  |    |     |     |                        |                | Output         |     |
|-------------------|------------------------|----|-----|-----|------------------------|----------------|----------------|-----|
|                   | $\overline{\text{MR}}$ | CP | CEP | CET | $\overline{\text{PE}}$ | D <sub>n</sub> | Q <sub>n</sub> | 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              | [2] |
| count             | H                      | ↑  | h   | h   | h                      | X              | count          | [2] |
| hold (do nothing) | H                      | X  | l   | X   | h                      | X              | q <sub>n</sub> | [2] |
|                   | H                      | X  | X   | l   | h                      | X              | q <sub>n</sub> | L   |

Note:

[1] H=HIGH voltage level; L=LOW voltage level; X=don't care; ↑=LOW-to-HIGH clock transition;

l=LOW voltage level one set-up time prior to the LOW-to-HIGH clock transition;

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





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

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

### 3、Electrical Parameter

#### 3.1、Absolute Maximum Ratings

(Voltages are referenced to GND(ground=0V), unless otherwise specified.)

| Parameter               | Symbol    | Conditions                           | Min.      | Max.     | Unit |
|-------------------------|-----------|--------------------------------------|-----------|----------|------|
| supply voltage          | $V_{CC}$  | -                                    | -0.5      | +7.0     | V    |
| input clamping current  | $I_{IK}$  | $V_I < -0.5V$ or $V_I > V_{CC}+0.5V$ | -         | $\pm 20$ | mA   |
| output clamping current | $I_{OK}$  | $V_O < -0.5V$ or $V_O > V_{CC}+0.5V$ | -         | $\pm 20$ | mA   |
| output current          | $I_O$     | $-0.5V < V_O < V_{CC}+0.5V$          | -         | $\pm 25$ | mA   |
| supply current          | $I_{CC}$  | -                                    | -         | +50      | mA   |
| ground current          | $I_{GND}$ | -                                    | -50       | -        | mA   |
| storage temperature     | $T_{stg}$ | -                                    | -65       | +150     | °C   |
| total power dissipation | $P_{tot}$ | -                                    | -         | 500      | mW   |
| Soldering temperature   | $T_L$     | 10s                                  | DIP       | 245      | °C   |
|                         |           |                                      | SOP/TSSOP | 260      |      |

#### 3.2、Recommended Operating Conditions

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



### 3.3、Electrical Characteristics

#### 3.3.1、DC Characteristics 1

( $T_{amb}=25^{\circ}\text{C}$ , voltages are referenced to GND (ground=0V), unless otherwise specified.)

| Parameter                 | Symbol   | Conditions   | Min.                                     | Typ. | Max.      | Unit          |   |
|---------------------------|----------|--|--|------|-----------|---------------|---|
| <b>SN74LS161</b>          |          |  |  |      |           |               |   |
| HIGH-level input voltage  | $V_{IH}$ | $V_{CC}=2.0\text{V}$   | 1.5                                      | 1.2  | -         | V             |   |
|                           |          | $V_{CC}=4.5\text{V}$   | 3.15                                     | 2.4  | -         | V             |   |
|                           |          | $V_{CC}=6.0\text{V}$   | 4.2                                      | 3.2  | -         | V             |   |
| LOW-level input voltage   | $V_{IL}$ | $V_{CC}=2.0\text{V}$   | -  | 0.8  | 0.5       | V             |   |
|                           |          | $V_{CC}=4.5\text{V}$   | -  | 2.1  | 1.35      | V             |   |
|                           |          | $V_{CC}=6.0\text{V}$   | -  | 2.8  | 1.8       | V             |   |
| HIGH-level output voltage | $V_{OH}$ | $V_I = V_{IH} \text{ or } V_{IL}$                                      | $I_O=-20\mu\text{A}; V_{CC}=2.0\text{V}$ | 1.9  | 2.0       | -             | V |
|                           |          |  | $I_O=-20\mu\text{A}; V_{CC}=4.5\text{V}$ | 4.4  | 4.5       | -             | V |
|                           |          |  | $I_O=-20\mu\text{A}; V_{CC}=6.0\text{V}$ | 5.9  | 6.0       | -             | V |
|                           |          |  | $I_O=-4.0\text{mA}; V_{CC}=4.5\text{V}$  | 3.98 | 4.32      | -             | V |
|                           |          |  | $I_O=-5.2\text{mA}; V_{CC}=6.0\text{V}$  | 5.48 | 5.81      | -             | V |
| LOW-level output voltage  | $V_{OL}$ | $V_I = V_{IH} \text{ or } V_{IL}$                                      | $I_O=20\mu\text{A}; V_{CC}=2.0\text{V}$  | -    | 0         | 0.1           | V |
|                           |          |  | $I_O=20\mu\text{A}; V_{CC}=4.5\text{V}$  | -    | 0         | 0.1           | V |
|                           |          |  | $I_O=20\mu\text{A}; V_{CC}=6.0\text{V}$  | -    | 0         | 0.1           | V |
|                           |          |  | $I_O=4.0\text{mA}; V_{CC}=4.5\text{V}$   | -    | 0.15      | 0.26          | V |
|                           |          |  | $I_O=5.2\text{mA}; V_{CC}=6.0\text{V}$   | -    | 0.16      | 0.26          | V |
| input leakage current     | $I_I$    | $V_I=V_{CC} \text{ or } \text{GND}; V_{CC}=6.0\text{V}$                | -  | -    | $\pm 1.0$ | $\mu\text{A}$ |   |
| supply current            | $I_{CC}$ | $V_I=V_{CC} \text{ or } \text{GND}; I_O=0\text{A}; V_{CC}=6.0\text{V}$ | -  | -    | 8.0       | $\mu\text{A}$ |   |
| input capacitance         | $C_I$    | -  | -  | 3.5  | -         | pF            |   |



### 3.3.2、DC Characteristics 2

( $T_{amb}=-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , voltages are referenced to GND (ground=0V), unless otherwise specified.)

| Parameter                 | Symbol   | Conditions   | Min.                                     | Typ. | Max.      | Unit          |   |
|---------------------------|----------|--|--|------|-----------|---------------|---|
| HIGH-level input voltage  | $V_{IH}$ | $V_{CC}=2.0\text{V}$   | 1.5                                      | -    | -         | V             |   |
|                           |          | $V_{CC}=4.5\text{V}$   | 3.15                                     | -    | -         | V             |   |
|                           |          | $V_{CC}=6.0\text{V}$   | 4.2                                      | -    | -         | V             |   |
| LOW-level input voltage   | $V_{IL}$ | $V_{CC}=2.0\text{V}$   | -  | -    | 0.5       | V             |   |
|                           |          | $V_{CC}=4.5\text{V}$   | -  | -    | 1.35      | V             |   |
|                           |          | $V_{CC}=6.0\text{V}$   | -  | -    | 1.8       | V             |   |
| HIGH-level output voltage | $V_{OH}$ | $V_I = V_{IH} \text{ or } V_{IL}$                                      | $I_O=-20\mu\text{A}; V_{CC}=2.0\text{V}$ | 1.9  | -         | -             | V |
|                           |          |  | $I_O=-20\mu\text{A}; V_{CC}=4.5\text{V}$ | 4.4  | -         | -             | V |
|                           |          |  | $I_O=-20\mu\text{A}; V_{CC}=6.0\text{V}$ | 5.9  | -         | -             | V |
|                           |          |  | $I_O=-4.0\text{mA}; V_{CC}=4.5\text{V}$  | 3.84 | -         | -             | V |
|                           |          |  | $I_O=-5.2\text{mA}; V_{CC}=6.0\text{V}$  | 5.34 | -         | -             | V |
| LOW-level output voltage  | $V_{OL}$ | $V_I = V_{IH} \text{ or } V_{IL}$                                      | $I_O=20\mu\text{A}; V_{CC}=2.0\text{V}$  | -    | -         | 0.1           | V |
|                           |          |  | $I_O=20\mu\text{A}; V_{CC}=4.5\text{V}$  | -    | -         | 0.1           | V |
|                           |          |  | $I_O=20\mu\text{A}; V_{CC}=6.0\text{V}$  | -    | -         | 0.1           | V |
|                           |          |  | $I_O=4.0\text{mA}; V_{CC}=4.5\text{V}$   | -    | -         | 0.33          | V |
|                           |          |  | $I_O=5.2\text{mA}; V_{CC}=6.0\text{V}$   | -    | -         | 0.33          | V |
| input leakage current     | $I_I$    | $V_I=V_{CC} \text{ or } \text{GND}; V_{CC}=6.0\text{V}$                | -  | -    | $\pm 1.0$ | $\mu\text{A}$ |   |
| supply current            | $I_{CC}$ | $V_I=V_{CC} \text{ or } \text{GND}; I_O=0\text{A}; V_{CC}=6.0\text{V}$ | -  | -    | 80        | $\mu\text{A}$ |   |



### 3.3.3、DC Characteristics 3

( $T_{amb}=-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , voltages are referenced to GND (ground=0V), unless otherwise specified.)

| Parameter                 | Symbol   | Conditions   | Min.                                     | Typ. | Max.      | Unit          |   |
|---------------------------|----------|--|--|------|-----------|---------------|---|
| HIGH-level input voltage  | $V_{IH}$ | $V_{CC}=2.0\text{V}$   | 1.5                                      | -    | -         | V             |   |
|                           |          | $V_{CC}=4.5\text{V}$   | 3.15                                     | -    | -         | V             |   |
|                           |          | $V_{CC}=6.0\text{V}$   | 4.2                                      | -    | -         | V             |   |
| LOW-level input voltage   | $V_{IL}$ | $V_{CC}=2.0\text{V}$   | -  | -    | 0.5       | V             |   |
|                           |          | $V_{CC}=4.5\text{V}$   | -  | -    | 1.35      | V             |   |
|                           |          | $V_{CC}=6.0\text{V}$   | -  | -    | 1.8       | V             |   |
| HIGH-level output voltage | $V_{OH}$ | $V_I = V_{IH} \text{ or } V_{IL}$                                      | $I_O=-20\mu\text{A}; V_{CC}=2.0\text{V}$ | 1.9  | -         | -             | V |
|                           |          |  | $I_O=-20\mu\text{A}; V_{CC}=4.5\text{V}$ | 4.4  | -         | -             | V |
|                           |          |  | $I_O=-20\mu\text{A}; V_{CC}=6.0\text{V}$ | 5.9  | -         | -             | V |
|                           |          |  | $I_O=-4.0\text{mA}; V_{CC}=4.5\text{V}$  | 3.7  | -         | -             | V |
|                           |          |  | $I_O=-5.2\text{mA}; V_{CC}=6.0\text{V}$  | 5.2  | -         | -             | V |
| LOW-level output voltage  | $V_{OL}$ | $V_I = V_{IH} \text{ or } V_{IL}$                                      | $I_O=20\mu\text{A}; V_{CC}=2.0\text{V}$  | -    | -         | 0.1           | V |
|                           |          |  | $I_O=20\mu\text{A}; V_{CC}=4.5\text{V}$  | -    | -         | 0.1           | V |
|                           |          |  | $I_O=20\mu\text{A}; V_{CC}=6.0\text{V}$  | -    | -         | 0.1           | V |
|                           |          |  | $I_O=4.0\text{mA}; V_{CC}=4.5\text{V}$   | -    | -         | 0.4           | V |
|                           |          |  | $I_O=5.2\text{mA}; V_{CC}=6.0\text{V}$   | -    | -         | 0.4           | V |
| input leakage current     | $I_I$    | $V_I=V_{CC} \text{ or } \text{GND}; V_{CC}=6.0\text{V}$                | -  | -    | $\pm 1.0$ | $\mu\text{A}$ |   |
| supply current            | $I_{CC}$ | $V_I=V_{CC} \text{ or } \text{GND}; I_O=0\text{A}; V_{CC}=6.0\text{V}$ | -  | -    | 160       | $\mu\text{A}$ |   |



### 3.3.4、AC Characteristics 1

( $T_{amb}=25^{\circ}C$ ,  $GND=0V$ ;  $t_r=t_f=6ns$ ;  $C_L=50pF$ , unless otherwise specified.)

| Parameter                     | Symbol    | Conditions                              | Min.                       | Typ. | Max. | Unit |    |
|-------------------------------|-----------|---|----------------------------|------|------|------|----|
| propagation delay             | $t_{pd}$  | CP to Qn;<br>see Figure 8               | $V_{CC}=2.0V$              | -    | 61   | 190  | ns |
|                               |           |   | $V_{CC}=4.5V$              | -    | 22   | 38   | ns |
|                               |           |   | $V_{CC}=5.0V$ ; $C_L=15pF$ | -    | 19   | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | -    | 18   | 32   | ns |
|                               |           | CP to TC;<br>see Figure 8               | $V_{CC}=2.0V$              | -    | 69   | 215  | ns |
|                               |           |   | $V_{CC}=4.5V$              | -    | 25   | 43   | ns |
|                               |           |   | $V_{CC}=5.0V$ ; $C_L=15pF$ | -    | 21   | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | -    | 20   | 37   | ns |
|                               |           | CET to TC;<br>see Figure 9              | $V_{CC}=2.0V$              | -    | 33   | 150  | ns |
|                               |           |   | $V_{CC}=4.5V$              | -    | 12   | 30   | ns |
|                               |           |   | $V_{CC}=5.0V$ ; $C_L=15pF$ | -    | 10   | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | -    | 10   | 26   | ns |
| High to LOW propagation delay | $t_{PHL}$ | $\overline{MR}$ to Qn;<br>see Figure 10 | $V_{CC}=2.0V$              | -    | 63   | 210  | ns |
|                               |           |   | $V_{CC}=4.5V$              | -    | 23   | 42   | ns |
|                               |           |   | $V_{CC}=5.0V$ ; $C_L=15pF$ | -    | 20   | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | -    | 18   | 36   | ns |
|                               |           | $\overline{MR}$ to TC;<br>see Figure 10 | $V_{CC}=2.0V$              | -    | 63   | 220  | ns |
|                               |           |   | $V_{CC}=4.5V$              | -    | 23   | 44   | ns |
|                               |           |   | $V_{CC}=5.0V$ ; $C_L=15pF$ | -    | 20   | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | -    | 18   | 37   | ns |
| transition time               | $t_t$     | see Figure 8 and<br>Figure 9            | $V_{CC}=2.0V$              | -    | 19   | 75   | ns |
|                               |           |   | $V_{CC}=4.5V$              | -    | 7    | 15   | ns |
|                               |           |   | $V_{CC}=6.0V$              | -    | 6    | 13   | ns |
| pulse width                   | $t_w$     | CP HIGH or<br>LOW; see Figure 8         | $V_{CC}=2.0V$              | 80   | 22   | -    | ns |
|                               |           |   | $V_{CC}=4.5V$              | 16   | 8    | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | 14   | 6    | -    | ns |
|                               |           | $\overline{MR}$ LOW;<br>see Figure 10   | $V_{CC}=2.0V$              | 80   | 19   | -    | ns |
|                               |           |   | $V_{CC}=4.5V$              | 16   | 7    | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | 14   | 6    | -    | ns |
| recovery time                 | $t_{rec}$ | $\overline{MR}$ to CP;<br>see Figure 10 | $V_{CC}=2.0V$              | 100  | 19   | -    | ns |
|                               |           |   | $V_{CC}=4.5V$              | 20   | 7    | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | 17   | 6    | -    | ns |
| set-up time                   | $t_{su}$  | Dn to CP;<br>see Figure 11              | $V_{CC}=2.0V$              | 80   | 25   | -    | ns |
|                               |           |   | $V_{CC}=4.5V$              | 16   | 9    | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | 14   | 7    | -    | ns |
|                               |           | $\overline{PE}$ to CP;<br>see Figure 11 | $V_{CC}=2.0V$              | 100  | 30   | -    | ns |
|                               |           |   | $V_{CC}=4.5V$              | 20   | 11   | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | 17   | 9    | -    | ns |
|                               |           | CEP, CET to CP;<br>see Figure 12        | $V_{CC}=2.0V$              | 170  | 47   | -    | ns |
|                               |           |   | $V_{CC}=4.5V$              | 34   | 17   | -    | ns |
|                               |           |   | $V_{CC}=6.0V$              | 29   | 14   | -    | ns |



|                               |           |   |                         |     |     |    |     |
|-------------------------------|-----------|---|-------------------------|-----|-----|----|-----|
| hold time                     | $t_h$     | Dn, PE, CEP,<br>CET to CP;<br>see Figure 11, 12 | $V_{CC}=2.0V$           | 0   | -14 | -  | ns  |
|                               |           |   | $V_{CC}=4.5V$           | 0   | -5  | -  | ns  |
|                               |           |   | $V_{CC}=6.0V$           | 0   | -4  | -  | ns  |
| maximum frequency             | $f_{max}$ | CP; see Figure 8                                | $V_{CC}=2.0V$           | 4.6 | 13  | -  | MHz |
|                               |           |   | $V_{CC}=4.5V$           | 23  | 40  | -  | MHz |
|                               |           |   | $V_{CC}=5.0V; C_L=15pF$ | -   | 44  | -  | MHz |
|                               |           |   | $V_{CC}=6.0V$           | 27  | 48  | -  | MHz |
| power dissipation capacitance | $C_{PD}$  | $f_i=1MHz; V_i=GND \text{ to } V_{CC}$          | -                       | 33  | -   | pF |     |

Note:

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

[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 uW).

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

$f_i$ =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.



3.3.5、AC Characteristics 2

( $T_{amb}=-40^{\circ}C$  to  $+85^{\circ}C$ ,  $GND=0V$ ;  $t_r=t_f=6ns$ ;  $C_L=50pF$ , unless otherwise specified.)

| Parameter                     | Symbol    | Conditions   | Min.          | Typ. | Max. | Unit |     |
|-------------------------------|-----------|--|---------------|------|------|------|-----|
| propagation delay             | $t_{pd}$  | CP to Qn;<br>see Figure 8                                  | $V_{CC}=2.0V$ | -    | -    | 240  | ns  |
|                               |           |  | $V_{CC}=4.5V$ | -    | -    | 48   | ns  |
|                               |           |  | $V_{CC}=6.0V$ | -    | -    | 41   | ns  |
|                               |           | CP to TC;<br>see Figure 8                                  | $V_{CC}=2.0V$ | -    | -    | 270  | ns  |
|                               |           |  | $V_{CC}=4.5V$ | -    | -    | 54   | ns  |
|                               |           |  | $V_{CC}=6.0V$ | -    | -    | 46   | ns  |
|                               |           | CET to TC;<br>see Figure 9                                 | $V_{CC}=2.0V$ | -    | -    | 190  | ns  |
|                               |           |  | $V_{CC}=4.5V$ | -    | -    | 38   | ns  |
|                               |           |  | $V_{CC}=6.0V$ | -    | -    | 33   | ns  |
| High to LOW propagation delay | $t_{PHL}$ | $\overline{MR}$ to Qn;<br>see Figure 10                    | $V_{CC}=2.0V$ | -    | -    | 265  | ns  |
|                               |           |  | $V_{CC}=4.5V$ | -    | -    | 53   | ns  |
|                               |           |  | $V_{CC}=6.0V$ | -    | -    | 45   | ns  |
|                               |           | $\overline{MR}$ to TC;<br>see Figure 10                    | $V_{CC}=2.0V$ | -    | -    | 275  | ns  |
|                               |           |  | $V_{CC}=4.5V$ | -    | -    | 55   | ns  |
|                               |           |  | $V_{CC}=6.0V$ | -    | -    | 47   | ns  |
| transition time               | $t_t$     | see Figure 8 and Figure 9                                  | $V_{CC}=2.0V$ | -    | -    | 95   | ns  |
|                               |           |  | $V_{CC}=4.5V$ | -    | -    | 19   | ns  |
|                               |           |  | $V_{CC}=6.0V$ | -    | -    | 16   | ns  |
| pulse width                   | $t_w$     | CP HIGH or LOW;<br>see Figure 8                            | $V_{CC}=2.0V$ | 100  | -    | -    | ns  |
|                               |           |  | $V_{CC}=4.5V$ | 20   | -    | -    | ns  |
|                               |           |  | $V_{CC}=6.0V$ | 17   | -    | -    | ns  |
|                               |           | $\overline{MR}$ LOW;<br>see Figure 10                      | $V_{CC}=2.0V$ | 100  | -    | -    | ns  |
|                               |           |  | $V_{CC}=4.5V$ | 20   | -    | -    | ns  |
|                               |           |  | $V_{CC}=6.0V$ | 17   | -    | -    | ns  |
| recovery time                 | $t_{rec}$ | $\overline{MR}$ to CP;<br>see Figure 10                    | $V_{CC}=2.0V$ | 125  | -    | -    | ns  |
|                               |           |  | $V_{CC}=4.5V$ | 25   | -    | -    | ns  |
|                               |           |  | $V_{CC}=6.0V$ | 21   | -    | -    | ns  |
| set-up time                   | $t_{su}$  | Dn to CP;<br>see Figure 11                                 | $V_{CC}=2.0V$ | 100  | -    | -    | ns  |
|                               |           |  | $V_{CC}=4.5V$ | 20   | -    | -    | ns  |
|                               |           |  | $V_{CC}=6.0V$ | 17   | -    | -    | ns  |
|                               |           | $\overline{PE}$ to CP;<br>see Figure 11                    | $V_{CC}=2.0V$ | 125  | -    | -    | ns  |
|                               |           |  | $V_{CC}=4.5V$ | 25   | -    | -    | ns  |
|                               |           |  | $V_{CC}=6.0V$ | 21   | -    | -    | ns  |
|                               |           | CEP, CET to CP;<br>see Figure 12                           | $V_{CC}=2.0V$ | 215  | -    | -    | ns  |
|                               |           |  | $V_{CC}=4.5V$ | 43   | -    | -    | ns  |
|                               |           |  | $V_{CC}=6.0V$ | 37   | -    | -    | ns  |
| hold time                     | $t_h$     | Dn, $\overline{PE}$ , CEP, CET to CP;<br>see Figure 11, 12 | $V_{CC}=2.0V$ | 0    | -    | -    | ns  |
|                               |           |  | $V_{CC}=4.5V$ | 0    | -    | -    | ns  |
|                               |           |  | $V_{CC}=6.0V$ | 0    | -    | -    | ns  |
| maximum frequency             | $f_{max}$ | CP; see Figure 8   | $V_{CC}=2.0V$ | 3.6  | -    | -    | MHz |
|                               |           |  | $V_{CC}=4.5V$ | 18   | -    | -    | MHz |



|  |  |  |               |    |   |   |     |
|--|--|--|---------------|----|---|---|-----|
|  |  |  | $V_{CC}=6.0V$ | 21 | - | - | MHz |
|--|--|--|---------------|----|---|---|-----|

Note:

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

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

### 3.3.6、AC Characteristics 3

( $T_{amb}=-40^{\circ}C$  to  $+125^{\circ}C$ ,  $GND=0V$ ;  $t_i=t_f=6ns$ ;  $C_L=50pF$ , unless otherwise specified.)

| Parameter                     | Symbol    | Conditions                              | Min.          | Typ. | Max. | Unit |    |
|-------------------------------|-----------|---|---------------|------|------|------|----|
| propagation delay             | $t_{pd}$  | CP to Qn;<br>see Figure 8               | $V_{CC}=2.0V$ | -    | -    | 248  | ns |
|                               |           |   | $V_{CC}=4.5V$ | -    | -    | 57   | ns |
|                               |           |   | $V_{CC}=6.0V$ | -    | -    | 48   | ns |
|                               |           | CP to TC;<br>see Figure 8               | $V_{CC}=2.0V$ | -    | -    | 325  | ns |
|                               |           |   | $V_{CC}=4.5V$ | -    | -    | 65   | ns |
|                               |           |   | $V_{CC}=6.0V$ | -    | -    | 55   | ns |
|                               |           | CET to TC;<br>see Figure 9              | $V_{CC}=2.0V$ | -    | -    | 225  | ns |
|                               |           |   | $V_{CC}=4.5V$ | -    | -    | 45   | ns |
|                               |           |   | $V_{CC}=6.0V$ | -    | -    | 38   | ns |
| High to LOW propagation delay | $t_{PHL}$ | $\overline{MR}$ to Qn;<br>see Figure 10 | $V_{CC}=2.0V$ | -    | -    | 315  | ns |
|                               |           |   | $V_{CC}=4.5V$ | -    | -    | 63   | ns |
|                               |           |   | $V_{CC}=6.0V$ | -    | -    | 54   | ns |
|                               |           | $\overline{MR}$ to TC;<br>see Figure 10 | $V_{CC}=2.0V$ | -    | -    | 330  | ns |
|                               |           |   | $V_{CC}=4.5V$ | -    | -    | 66   | ns |
|                               |           |   | $V_{CC}=6.0V$ | -    | -    | 56   | ns |





|                   |           |   |               |     |   |     |     |
|-------------------|-----------|---|---------------|-----|---|-----|-----|
| transition time   | $t_t$     | see Figure 8 and Figure 9                               | $V_{CC}=2.0V$ | -   | - | 110 | ns  |
|                   |           |   | $V_{CC}=4.5V$ | -   | - | 22  | ns  |
|                   |           |   | $V_{CC}=6.0V$ | -   | - | 19  | ns  |
| pulse width       | $t_w$     | CP HIGH or LOW; see Figure 8                            | $V_{CC}=2.0V$ | 120 | - | -   | ns  |
|                   |           |   | $V_{CC}=4.5V$ | 24  | - | -   | ns  |
|                   |           |   | $V_{CC}=6.0V$ | 20  | - | -   | ns  |
|                   |           | $\overline{MR}$ LOW; see Figure 10                      | $V_{CC}=2.0V$ | 120 | - | -   | ns  |
|                   |           |   | $V_{CC}=4.5V$ | 24  | - | -   | ns  |
|                   |           |   | $V_{CC}=6.0V$ | 20  | - | -   | ns  |
| recovery time     | $t_{rec}$ | $\overline{MR}$ to CP; see Figure 10                    | $V_{CC}=2.0V$ | 150 | - | -   | ns  |
|                   |           |   | $V_{CC}=4.5V$ | 30  | - | -   | ns  |
|                   |           |   | $V_{CC}=6.0V$ | 26  | - | -   | ns  |
| set-up time       | $t_{su}$  | Dn to CP; see Figure 11                                 | $V_{CC}=2.0V$ | 120 | - | -   | ns  |
|                   |           |   | $V_{CC}=4.5V$ | 24  | - | -   | ns  |
|                   |           |   | $V_{CC}=6.0V$ | 20  | - | -   | ns  |
|                   |           | $\overline{PE}$ to CP; see Figure 11                    | $V_{CC}=2.0V$ | 150 | - | -   | ns  |
|                   |           |   | $V_{CC}=4.5V$ | 30  | - | -   | ns  |
|                   |           |   | $V_{CC}=6.0V$ | 26  | - | -   | ns  |
|                   |           | CEP, CET to CP; see Figure 12                           | $V_{CC}=2.0V$ | 255 | - | -   | ns  |
|                   |           |   | $V_{CC}=4.5V$ | 51  | - | -   | ns  |
|                   |           |   | $V_{CC}=6.0V$ | 43  | - | -   | ns  |
| hold time         | $t_h$     | Dn, $\overline{PE}$ , CEP, CET to CP; see Figure 11, 12 | $V_{CC}=2.0V$ | 0   | - | -   | ns  |
|                   |           |   | $V_{CC}=4.5V$ | 0   | - | -   | ns  |
|                   |           |   | $V_{CC}=6.0V$ | 0   | - | -   | ns  |
| maximum frequency | $f_{max}$ | CP; see Figure 8  | $V_{CC}=2.0V$ | 3.0 | - | -   | MHz |
|                   |           |   | $V_{CC}=4.5V$ | 15  | - | -   | MHz |
|                   |           |   | $V_{CC}=6.0V$ | 18  | - | -   | MHz |

Note:

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

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

## 4、Testing Circuit

### 4.1、AC Testing Circuit

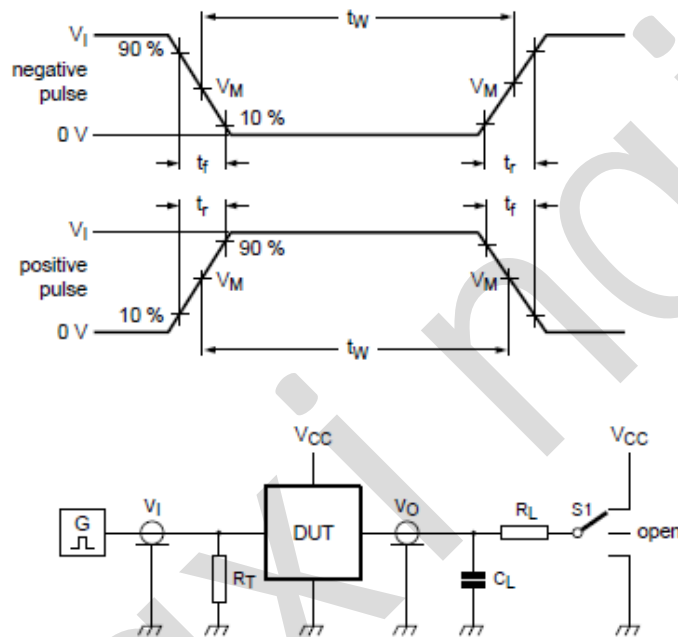


Figure 7. Test circuit for measuring switching times

Definitions for test circuit:

$C_L$ =Load capacitance including jig and probe capacitance.

$R_T$ =Termination resistance should be equal to the output impedance  $Z_o$  of the pulse generator.

$R_L$ =Load resistance.

S1=Test selection switch



## 4.2、AC Testing Waveforms

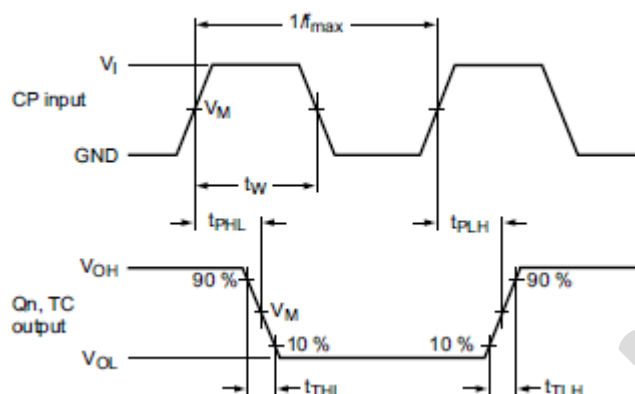


Figure 8. The clock (CP) to outputs (Qn, TC) propagation delays, pulse width, output transition times and maximum frequency

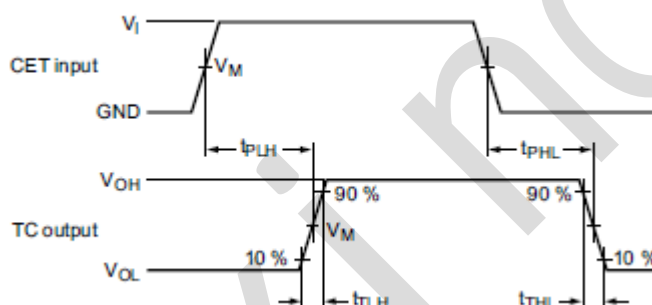


Figure 9. The count enable carry input (CET) to terminal count output (TC) propagation delays and output transition times

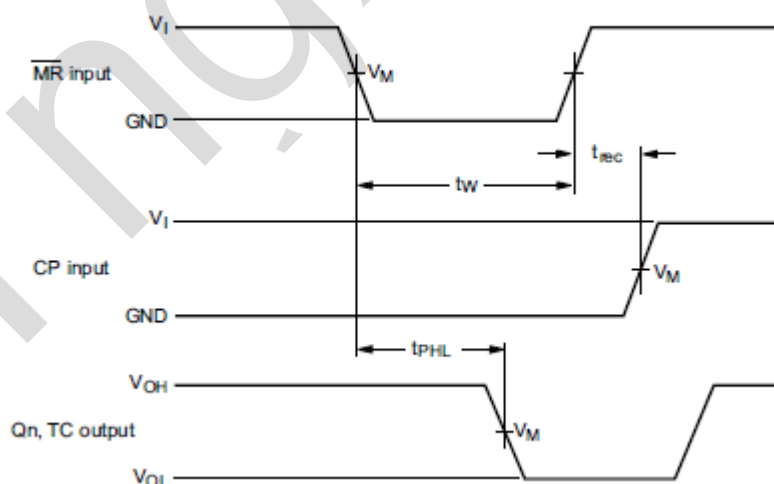


Figure 10. The master reset ( $\overline{MR}$ ) pulse width, master reset to output (Qn, TC) propagation delays, and the master reset to clock (CP) recovery times

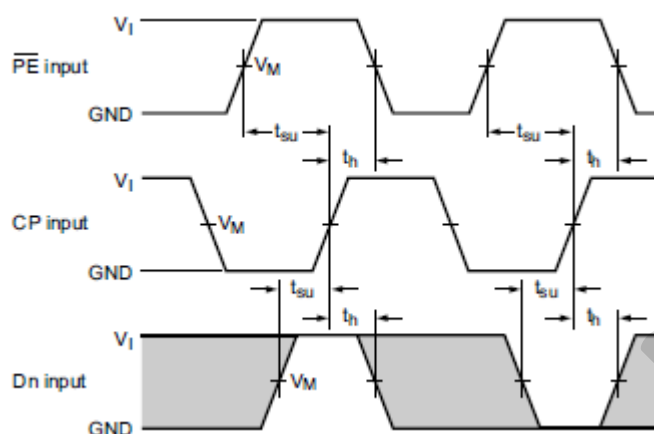


Figure 11. The data input (Dn) and parallel enable input (PE) set-up and hold times

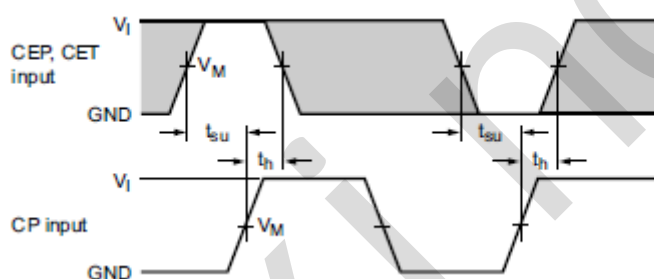


Figure 12. The count enable input (CEP) and count enable carry input (CET) set-up and hold times

#### 4.3. Measurement Points

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

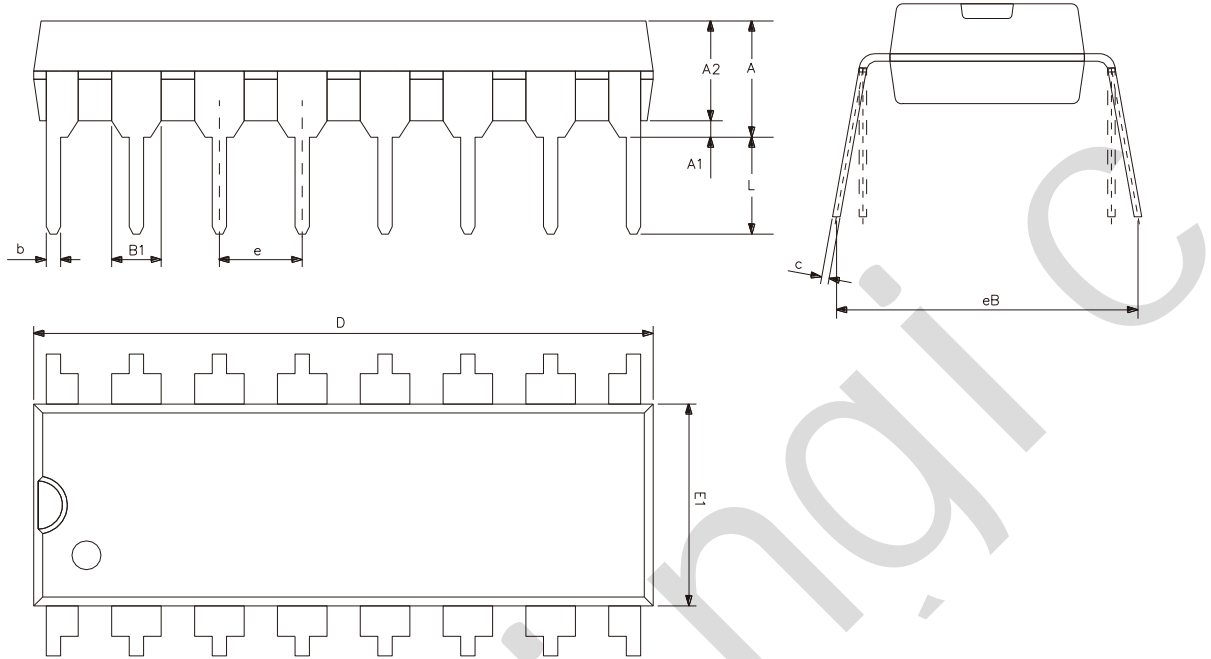
#### 4.4. Test Data

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



## 5、Package Information

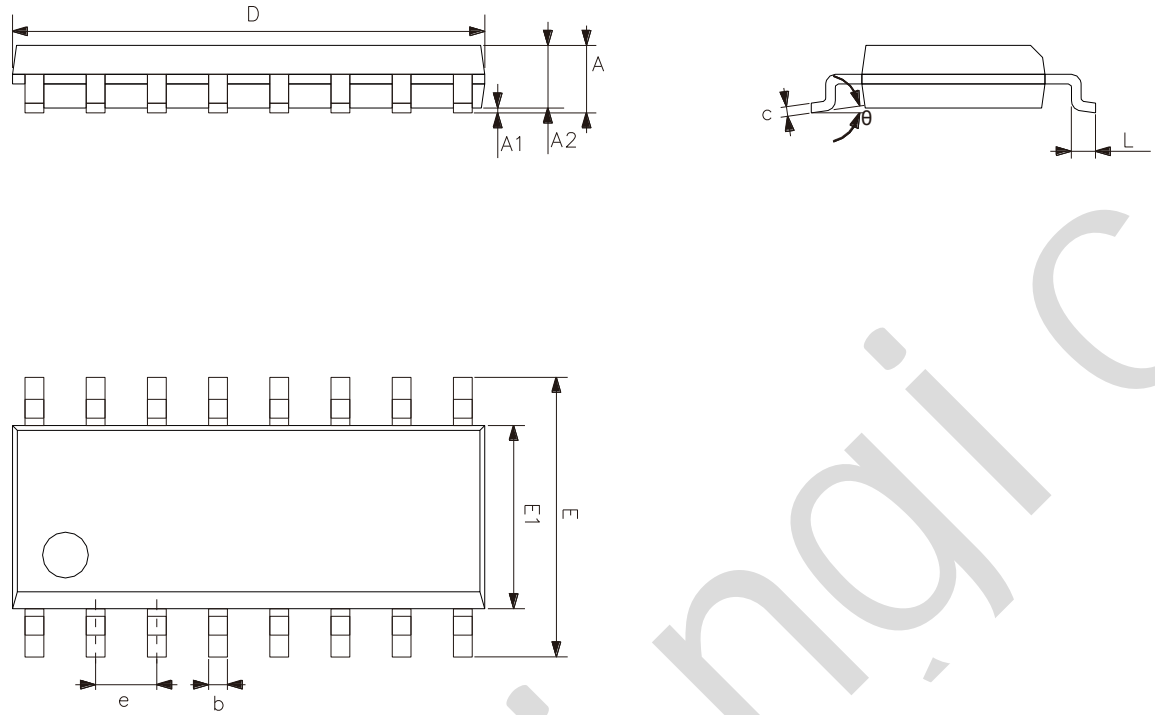
### 5.1、DIP16



| Symbol | Dimensions (mm) |       |
|--------|-----------------|-------|
|        | Min.            | Max.  |
| A2     | 3.20            | 3.60  |
| A1     | 0.51            | -     |
| A      | 3.60            | 5.33  |
| L      | 3.00            | 3.60  |
| b      | 0.36            | 0.56  |
| B1     | 1.52            |       |
| D      | 18.80           | 19.94 |
| E1     | 6.20            | 6.60  |
| e      | 2.54            |       |
| c      | 0.20            | 0.36  |
| eB     | 7.62            | 9.30  |



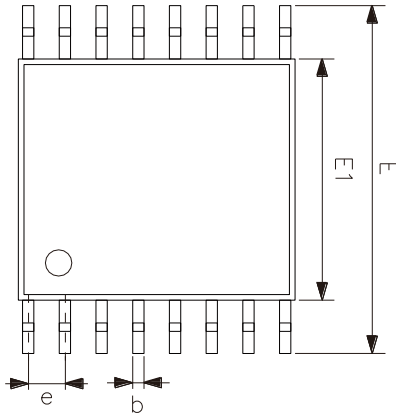
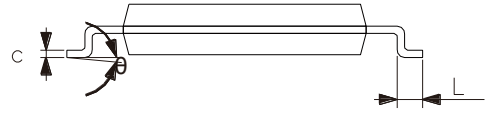
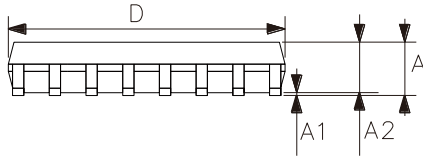
## 5.2、SOP16



| Symbol   | Dimensions (mm) |       |
|----------|-----------------|-------|
|          | Min.            | Max.  |
| A        | 1.35            | 1.80  |
| A1       | 0.10            | 0.25  |
| A2       | 1.25            | 1.55  |
| b        | 0.33            | 0.51  |
| c        | 0.19            | 0.25  |
| D        | 9.50            | 10.10 |
| E        | 5.80            | 6.30  |
| E1       | 3.70            | 4.10  |
| e        | 1.27            |       |
| L        | 0.35            | 0.89  |
| $\theta$ | 0°              | 8°    |



### 5.3、TSSOP16



| Symbol   | Dimensions (mm) |      |
|----------|-----------------|------|
|          | Min.            | Max. |
| A        | -               | 1.20 |
| A1       | 0.05            | 0.15 |
| A2       | 0.80            | 1.05 |
| b        | 0.19            | 0.30 |
| c        | 0.09            | 0.20 |
| D        | 4.90            | 5.10 |
| E1       | 4.30            | 4.50 |
| E        | 6.20            | 6.60 |
| e        | 0.65            |      |
| L        | 0.45            | 0.75 |
| $\theta$ | 0°              | 8°   |



## 6、 Statements And Notes

### 6.1、 The name and content of Hazardous substances or Elements in the product

| Part name               | Hazardous substances or Elements  |                               |                               |                               |                          |                                |                   |                       |                           |                      |
|-------------------------|---|-------------------------------|-------------------------------|-------------------------------|--------------------------|--------------------------------|-------------------|-----------------------|---------------------------|----------------------|
|                         | Lead and lead compounds   | Mercury and mercury compounds | Cadmium and cadmium compounds | Hexavalent chromium compounds | Polybrominated biphenyls | Polybrominated biphenyl ethers | Dibutyl phthalate | Butylbenzyl phthalate | Di-2-ethylhexyl phthalate | Diisobutyl phthalate |
| Lead frame              | ○   | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| Plastic resin           | ○   | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| Chip                    | ○   | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| The lead                | ○   | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| Plastic sheet installed | ○   | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| explanation             | ○: Indicates that the content of hazardous substances or elements in the detection limit of the following the SJ/T11363-2006 standard.<br>×: Indicates that the content of hazardous substances or elements exceeding the SJ/T11363-2006 Standard limit requirements. |                               |                               |                               |                          |                                |                   |                       |                           |                      |

### 6.2、 Notes

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[74HC161DT](#) [CD4028BM/TR](#) [CD4060DM/TR](#) [CD4022BE](#) [CD4060DMT/TR](#) [CD4020BE](#) [CD4060BMT/TR](#) [74HC192M/TR](#)  
[CD4020BMT/TR](#) [CD4017CMT/TR](#) [74HC193M/TR](#) [CD4017CM/TR](#) [AiP74HC193SA16.TB](#) [CD4518BM/TR](#) [CD4060TA16.TB](#) [CD4060DE](#)  
[CD4017CN](#) [CD4017BMT/TR](#) [U74HC4060G-S16-R](#) [CD4017SA.TB](#) [XD74LS160](#) [CD4017BM-MS](#) [CD4022BM/TR](#) [CD4022BMT/TR](#)  
[CD4028BDRG](#) [CD4060BDRG](#) [CD4017DA.TB](#) [CD4520BDRG](#) [CD4520BM\(LX\)](#) [CD4518BM\(LX\)](#) [SN74HC393DR\(LX\)](#) [SN74HC393N\(LX\)](#)  
[CD4060BM\(LX\)](#) [CD4060BE\(LX\)](#) [CD4518BE\(LX\)](#) [CD4520BE\(LX\)](#) [SN74HC192N\(XBLW\)](#) [CD4040BM\(LX\)](#) [CD4026BM\(LX\)](#)  
[CD40103BDR\(LX\)](#) [SN74LS192DR\(LX\)](#) [SN74HC161DR \(LX\)](#)