



# SN74HC/HCT190

## Presettable Synchronous BCD Decade up/down Counter

### Product Specification

#### Specification Revision History:

| Version    | Date    | Description         |
|------------|---------|---------------------|
| 2022-06-A1 | 2022-06 | New                 |
| 2023-04-B1 | 2023-04 | Update the template |
|            |         |                     |
|            |         |                     |



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## 1、General Description

The SN74HC/HCT190 are asynchronously presettable up/down BCD decade counters. They contain 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 number. 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. As indicated in the function table, 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 “9” 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 Figure 5 and 6.

In Figure 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 as indicated in the function table. 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.

Figure 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 Figure.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 Figure 5 and 6 does not apply.



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**Features:**

- Input levels:  
For SN74HC190: CMOS level  
For SN74HCT190: TTL level
- Synchronous reversible counting
- Asynchronous parallel load
- Count enable control for synchronous expansion
- Single up/down control input
- Specified from -40°C to +125°C
- Packaging information: DIP16/SOP16/TSSOP16

**Ordering Information:**

**Tube packing specifications:**

| Part number      | Packaging form | Marking code | Tube quantity  | Boxed tube quantity | Boxed quantity   | Notes  |
|------------------|----------------|--------------|----------------|---------------------|------------------|--|
| SN74HC190N(LX)   | DIP16          | SN74HC190N   | 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 |
| SN74HCT190N(LX)  | DIP16          | SN74HCT190N  | 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 |
| SN74HC190DR(LX)  | SOP16          | HC190        | 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 |
| SN74HCT190DR(LX) | SOP16          | HCT190       | 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 |
| SN74HC190PW(LX)  | TSSOP16        | HC190        | 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  |
| SN74HCT190PW(LX) | TSSOP16        | HCT190       | 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  |



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**Reel packing specifications:**

| Part number      | Packaging form | Marking code | Reel quantity    | Boxed reel quantity | Notes  |
|------------------|----------------|--------------|------------------|---------------------|--|
| SN74HC190DR(LX)  | SOP16          | HC190        | 4000<br>PCS/reel | 8000<br>PCS/box     | Dimensions of plastic enclosure:<br>10.0mm×3.9mm<br>Pin spacing:1.27mm |
| SN74HCT190DR(LX) | SOP16          | HCT190       | 4000<br>PCS/reel | 8000<br>PCS/box     | Dimensions of plastic enclosure:<br>10.0mm×3.9mm<br>Pin spacing:1.27mm |
| SN74HC190PW(LX)  | TSSOP16        | HC190        | 5000<br>PCS/reel | 10000<br>PCS/box    | Dimensions of plastic enclosure:<br>5.0mm×4.4mm<br>Pin spacing:0.65mm  |
| SN74HCT190PW(LX) | TSSOP16        | HCT190       | 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

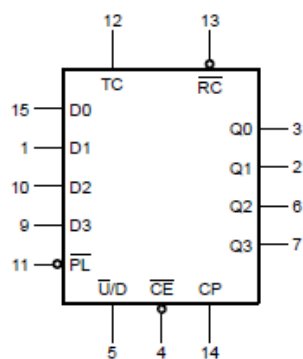


Figure 1. Logic symbol

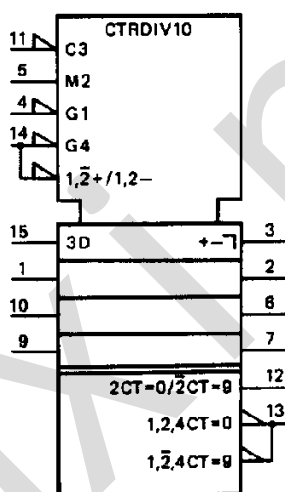


Figure 2. IEC logic symbol

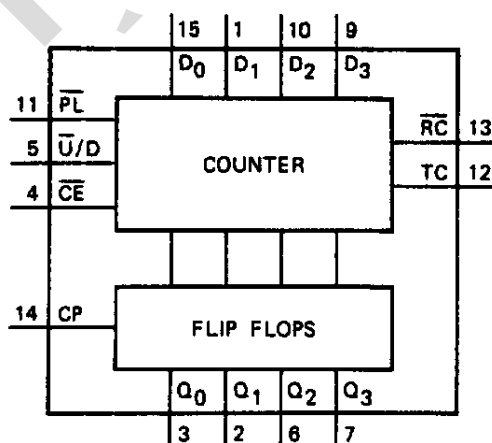


Figure 3. Functional diagram

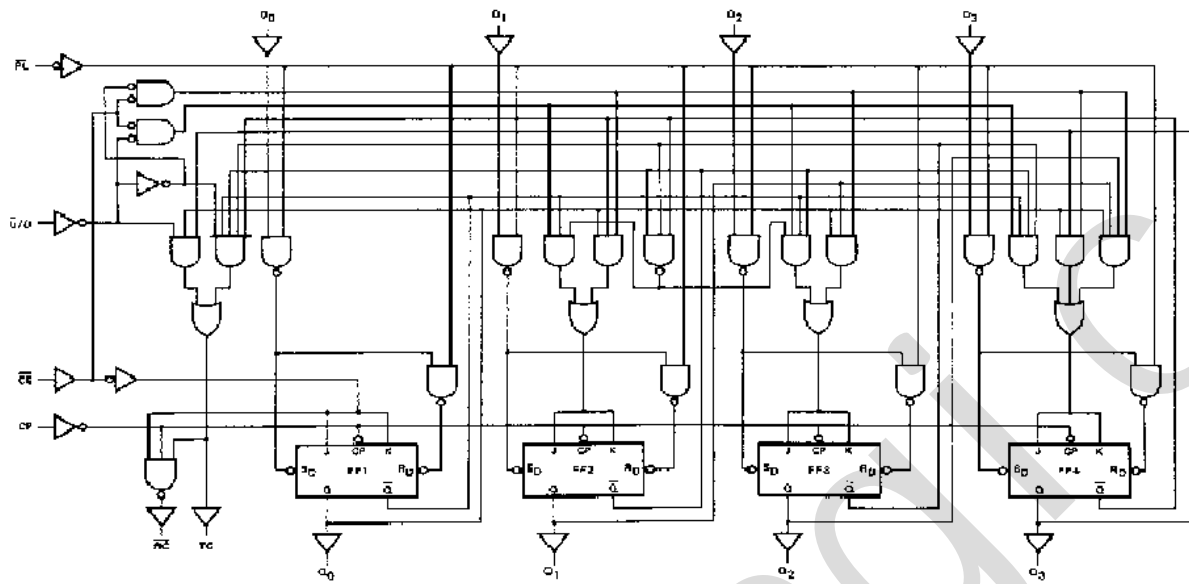


Figure 4. Logic diagram

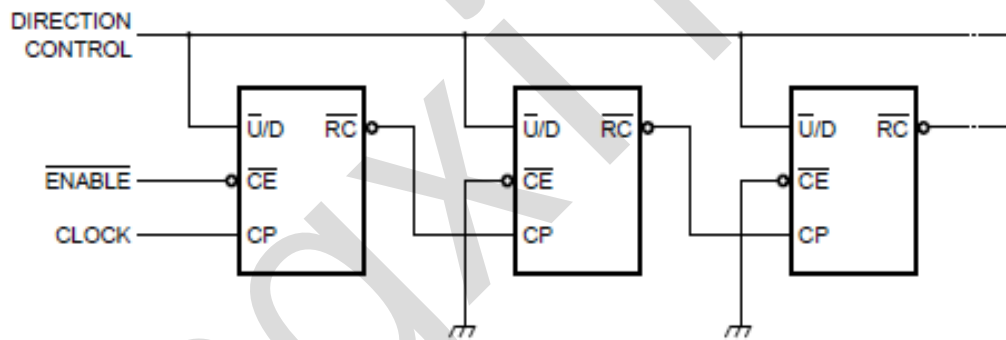


Figure 5. N-stage ripple counter using ripple clock

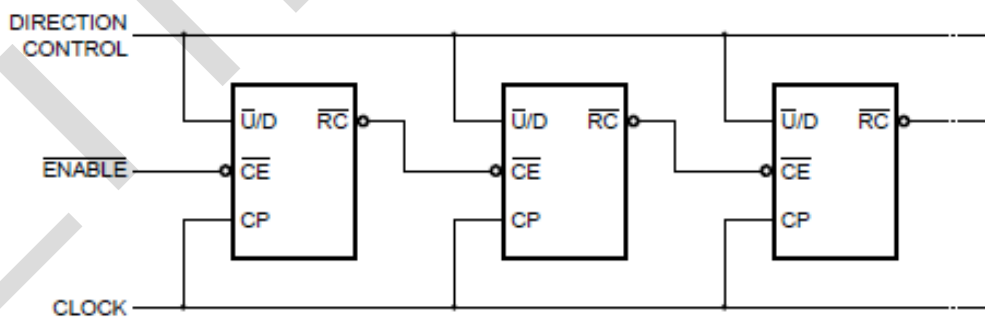


Figure 6. Synchronous n-stage counter using ripple carry/borrow

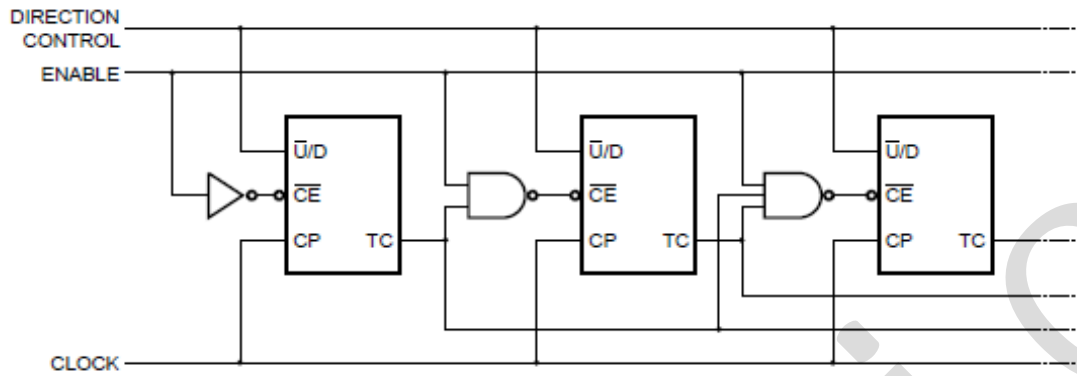


Figure 7. Synchronous n-stage counter with parallel gated carry/borrow

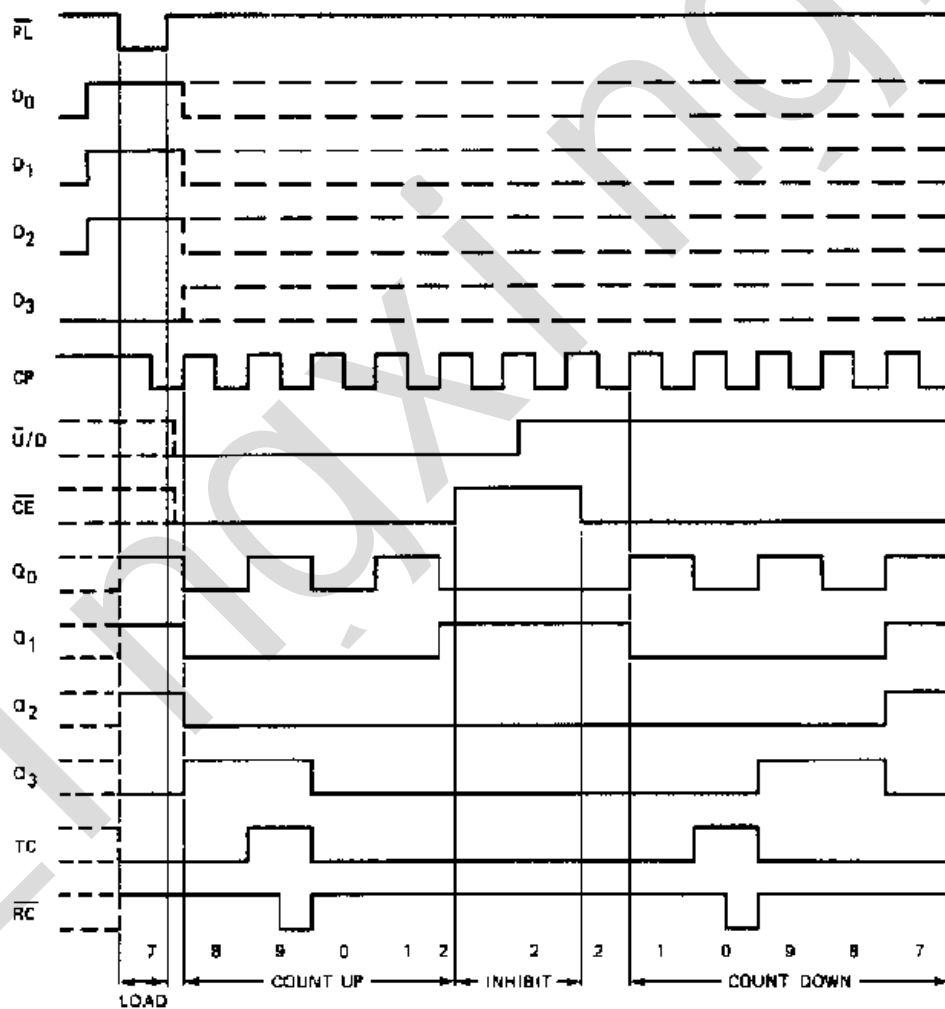
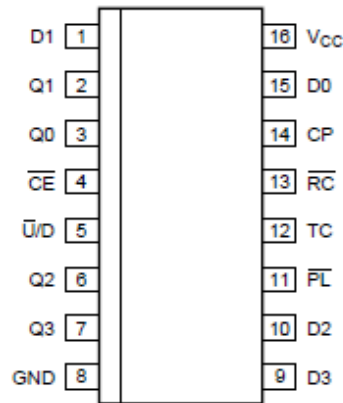


Figure 8. Typical timing sequence





## 2.2、Pin Configurations



## 2.3、Pin Description







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

## 2.4、Function Table

| Operating mode    | Input                  |                         |                        |    |    | Output     |
|-------------------|------------------------|-------------------------|------------------------|----|----|------------|
|                   | $\overline{\text{PL}}$ | $\overline{\text{U/D}}$ | $\overline{\text{CE}}$ | CP | Dn | Qn         |
| parallel load     | L                      | X                       | X                      | X  | L  | L          |
|                   | L                      | X                       | X                      | X  | H  | H          |
| count up          | H                      | L                       | 1                      | ↑  | X  | count up   |
| count down        | H                      | H                       | 1                      | ↑  | X  | count down |
| hold (do nothing) | H                      | X                       | H                      | X  | X  | no change  |

Note: H=HIGH voltage level; L=LOW voltage level; X=don't care; ↑=LOW-to-HIGH clock transition;  
1=LOW voltage level one set-up time prior to the LOW-to-HIGH clock transition.




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

Note:

[1] H=HIGH voltage level; L=LOW voltage level; X=don't care.

[2]  =one LOW level output pulse.

[3]  =TC goes LOW on a LOW-to-HIGH clock transition.

### 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          | $I_O$     | $V_O = -0.5V$ to $V_{CC}+0.5V$       | -         | $\pm 25$ | mA          |
| supply current          | $I_{CC}$  | -                                    | -         | +50      | mA          |
| ground current          | $I_{GND}$ | -                                    | -50       | -        | mA          |
| storage temperature     | $T_{stg}$ | -                                    | -65       | +150     | $^{\circ}C$ |
| total power dissipation | $P_{tot}$ | -                                    | -         | 500      | mW          |
| Soldering temperature   | $T_L$     | 10s                                  | DIP       | 245      | $^{\circ}C$ |
|                         |           |                                      | SOP/TSSOP | 260      |             |



### 3.2、Recommended Operating Conditions

| Parameter                           | Symbol              | Conditions    | Min. | Typ. | Max.     | Unit |
|-------------------------------------|---------------------|---------------|------|------|----------|------|
| <b>SN74HC190</b>                    |                     |               |      |      |          |      |
| 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   |
| <b>SN74HCT190</b>                   |                     |               |      |      |          |      |
| supply voltage                      | $V_{CC}$            | -             | 4.5  | 5.0  | 5.5      | V    |
| input voltage                       | $V_I$               | -             | 0    | -    | $V_{CC}$ | V    |
| output voltage                      | $V_O$               | -             | 0    | -    | $V_{CC}$ | V    |
| input transition rise and fall rate | $\Delta t/\Delta V$ | $V_{CC}=2.0V$ | -    | -    | -        | ns/V |
|                                     |                     | $V_{CC}=4.5V$ | -    | 1.67 | 139      | ns/V |
|                                     |                     | $V_{CC}=6.0V$ | -    | -    | -        | ns/V |
| ambient temperature                 | $T_{amb}$           | -             | -40  | -    | +125     | °C   |

### 3.3、Electrical Characteristics

#### 3.3.1、DC Characteristics 1

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

| Parameter                 | Symbol   | Conditions  | Min.                        | Typ. | Max.      | Unit    |   |
|---------------------------|----------|---|-----------------------------|------|-----------|---------|---|
| <b>SN74HC190</b>          |          |   |                             |      |           |         |   |
| HIGH-level input voltage  | $V_{IH}$ | $V_{CC}=2.0V$                                     | 1.5                         | 1.2  | -         | V       |   |
|                           |          | $V_{CC}=4.5V$                                     | 3.15                        | 2.4  | -         | V       |   |
|                           |          | $V_{CC}=6.0V$                                     | 4.2                         | 3.2  | -         | V       |   |
| LOW-level input voltage   | $V_{IL}$ | $V_{CC}=2.0V$                                     | -                           | 0.8  | 0.5       | V       |   |
|                           |          | $V_{CC}=4.5V$                                     | -                           | 2.1  | 1.35      | V       |   |
|                           |          | $V_{CC}=6.0V$                                     | -                           | 2.8  | 1.8       | V       |   |
| HIGH-level output voltage | $V_{OH}$ | $V_I = V_{IH} \text{ or } V_{IL}$                 | $I_O=-20\mu A; V_{CC}=2.0V$ | 1.9  | 2.0       | -       | V |
|                           |          |   | $I_O=-20\mu A; V_{CC}=4.5V$ | 4.4  | 4.5       | -       | V |
|                           |          |   | $I_O=-20\mu A; V_{CC}=6.0V$ | 5.9  | 6.0       | -       | V |
|                           |          |   | $I_O=-4.0mA; V_{CC}=4.5V$   | 3.98 | 4.32      | -       | V |
|                           |          |   | $I_O=-5.2mA; V_{CC}=6.0V$   | 5.48 | 5.81      | -       | V |
| LOW-level output voltage  | $V_{OL}$ | $V_I = V_{IH} \text{ or } V_{IL}$                 | $I_O=20\mu A; V_{CC}=2.0V$  | -    | 0         | 0.1     | V |
|                           |          |   | $I_O=20\mu A; V_{CC}=4.5V$  | -    | 0         | 0.1     | V |
|                           |          |   | $I_O=20\mu A; V_{CC}=6.0V$  | -    | 0         | 0.1     | V |
|                           |          |   | $I_O=4.0mA; V_{CC}=4.5V$    | -    | 0.15      | 0.26    | V |
|                           |          |   | $I_O=5.2mA; V_{CC}=6.0V$    | -    | 0.16      | 0.26    | V |
| input leakage current     | $I_I$    | $V_I=V_{CC} \text{ or } GND; V_{CC}=6.0V$         | -                           | -    | $\pm 1.0$ | $\mu A$ |   |
| supply current            | $I_{CC}$ | $V_I=V_{CC} \text{ or } GND; I_O=0A; V_{CC}=6.0V$ | -                           | -    | 8.0       | $\mu A$ |   |
| input                     | $C_I$    | -   | -                           | 3.5  | -         | pF      |   |



| capacitance               |                 |   |                |      |           |         |   |
|---------------------------|-----------------|---|----------------|------|-----------|---------|---|
| <b>SN74HCT190</b>         |                 |   |                |      |           |         |   |
| HIGH-level input voltage  | $V_{IH}$        | $V_{CC}=4.5V$ to $5.5V$   | 2.0            | 1.6  | -         | V       |   |
| LOW-level input voltage   | $V_{IL}$        | $V_{CC}=4.5V$ to $5.5V$   | -              | 1.2  | 0.8       | V       |   |
| HIGH-level output voltage | $V_{OH}$        | $V_I = V_{IH}$ or $V_{IL}; V_{CC}=4.5V$   | $I_O=-20\mu A$ | 4.4  | 4.5       | -       | V |
|                           |                 |   | $I_O=-4.0mA$   | 3.98 | 4.32      | -       | V |
| LOW-level output voltage  | $V_{OL}$        | $V_I = V_{IH}$ or $V_{IL}; V_{CC}=4.5V$   | $I_O=20\mu A$  | -    | 0         | 0.1     | V |
|                           |                 |   | $I_O=4.0mA$    | -    | 0.16      | 0.26    | V |
| input leakage current     | $I_I$           | $V_I=V_{CC}$ or GND; $V_{CC}=5.5V$  | -              | -    | $\pm 1.0$ | $\mu A$ |   |
| supply current            | $I_{CC}$        | $V_I=V_{CC}$ or GND; $I_O=0A; V_{CC}=5.5V$  | -              | -    | 8.0       | $\mu A$ |   |
| additional supply current | $\Delta I_{CC}$ | $V_I=V_{CC}-2.1V;$<br>other inputs at $V_{CC}$ or GND; $I_O=0A;$<br>$V_{CC}=4.5V$ to $5.5V$ | -              | -    | 360       | $\mu A$ |   |
| input capacitance         | $C_I$           | -   | -              | 3.5  | -         | pF      |   |

### 3.3.2、DC Characteristics 2

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

| Parameter                 | Symbol   | Conditions                                 | Min.                        | Typ. | Max.      | Unit    |   |
|---------------------------|----------|--|-----------------------------|------|-----------|---------|---|
| <b>SN74HC190</b>          |          |  |                             |      |           |         |   |
| HIGH-level input voltage  | $V_{IH}$ | $V_{CC}=2.0V$                              | 1.5                         | -    | -         | V       |   |
|                           |          | $V_{CC}=4.5V$                              | 3.15                        | -    | -         | V       |   |
|                           |          | $V_{CC}=6.0V$                              | 4.2                         | -    | -         | V       |   |
| LOW-level input voltage   | $V_{IL}$ | $V_{CC}=2.0V$                              | -                           | -    | 0.5       | V       |   |
|                           |          | $V_{CC}=4.5V$                              | -                           | -    | 1.35      | V       |   |
|                           |          | $V_{CC}=6.0V$                              | -                           | -    | 1.8       | V       |   |
| HIGH-level output voltage | $V_{OH}$ | $V_I = V_{IH}$ or $V_{IL}$                 | $I_O=-20\mu A; V_{CC}=2.0V$ | 1.9  | -         | -       | V |
|                           |          |  | $I_O=-20\mu A; V_{CC}=4.5V$ | 4.4  | -         | -       | V |
|                           |          |  | $I_O=-20\mu A; V_{CC}=6.0V$ | 5.9  | -         | -       | V |
|                           |          |  | $I_O=-4.0mA; V_{CC}=4.5V$   | 3.84 | -         | -       | V |
|                           |          |  | $I_O=-5.2mA; V_{CC}=6.0V$   | 5.34 | -         | -       | V |
| LOW-level output voltage  | $V_{OL}$ | $V_I = V_{IH}$ or $V_{IL}$                 | $I_O=20\mu A; V_{CC}=2.0V$  | -    | -         | 0.1     | V |
|                           |          |  | $I_O=20\mu A; V_{CC}=4.5V$  | -    | -         | 0.1     | V |
|                           |          |  | $I_O=20\mu A; V_{CC}=6.0V$  | -    | -         | 0.1     | V |
|                           |          |  | $I_O=4.0mA; V_{CC}=4.5V$    | -    | -         | 0.33    | V |
|                           |          |  | $I_O=5.2mA; V_{CC}=6.0V$    | -    | -         | 0.33    | V |
| input leakage current     | $I_I$    | $V_I=V_{CC}$ or GND; $V_{CC}=6.0V$         | -                           | -    | $\pm 1.0$ | $\mu A$ |   |
| supply current            | $I_{CC}$ | $V_I=V_{CC}$ or GND; $I_O=0A; V_{CC}=6.0V$ | -                           | -    | 80        | $\mu A$ |   |
| <b>SN74HCT190</b>         |          |  |                             |      |           |         |   |
| HIGH-level input voltage  | $V_{IH}$ | $V_{CC}=4.5V$ to $5.5V$                    | 2.0                         | -    | -         | V       |   |
| LOW-level input voltage   | $V_{IL}$ | $V_{CC}=4.5V$ to $5.5V$                    | -                           | -    | 0.8       | V       |   |



|                           |                 |   |                |      |   |           |         |
|---------------------------|-----------------|---|----------------|------|---|-----------|---------|
| HIGH-level output voltage | $V_{OH}$        | $V_I = V_{IH} \text{ or } V_{IL}; V_{CC}=4.5V$  | $I_O=-20\mu A$ | 4.4  | - | -         | V       |
|                           |                 |   | $I_O=-4.0mA$   | 3.84 | - | -         | V       |
| LOW-level output voltage  | $V_{OL}$        | $V_I = V_{IH} \text{ or } V_{IL}; V_{CC}=4.5V$  | $I_O=20\mu A$  | -    | - | 0.1       | V       |
|                           |                 |   | $I_O=4.0mA$    | -    | - | 0.33      | V       |
| input leakage current     | $I_I$           | $V_I=V_{CC} \text{ or } GND; V_{CC}=5.5V$   |                | -    | - | $\pm 1.0$ | $\mu A$ |
| supply current            | $I_{CC}$        | $V_I=V_{CC} \text{ or } GND; I_O=0A; V_{CC}=5.5V$   |                | -    | - | 80        | $\mu A$ |
| additional supply current | $\Delta I_{CC}$ | $V_I=V_{CC}-2.1V;$<br>other inputs at $V_{CC} \text{ or } GND; I_O=0A;$<br>$V_{CC}=4.5V \text{ to } 5.5V$ |                | -    | - | 450       | $\mu A$ |

### 3.3.3、DC Characteristics 3

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

| Parameter                 | Symbol          | Conditions  | Min.                        | Typ. | Max. | Unit      |         |
|---------------------------|-----------------|---|-----------------------------|------|------|-----------|---------|
| <b>SN74HC190</b>          |                 |   |                             |      |      |           |         |
| HIGH-level input voltage  | $V_{IH}$        | $V_{CC}=2.0V$                                     | 1.5                         | -    | -    | V         |         |
|                           |                 | $V_{CC}=4.5V$                                     | 3.15                        | -    | -    | V         |         |
|                           |                 | $V_{CC}=6.0V$                                     | 4.2                         | -    | -    | V         |         |
| LOW-level input voltage   | $V_{IL}$        | $V_{CC}=2.0V$                                     | -                           | -    | 0.5  | V         |         |
|                           |                 | $V_{CC}=4.5V$                                     | -                           | -    | 1.35 | V         |         |
|                           |                 | $V_{CC}=6.0V$                                     | -                           | -    | 1.8  | V         |         |
| HIGH-level output voltage | $V_{OH}$        | $V_I = V_{IH} \text{ or } V_{IL}$                 | $I_O=-20\mu A; V_{CC}=2.0V$ | 1.9  | -    | -         | V       |
|                           |                 |   | $I_O=-20\mu A; V_{CC}=4.5V$ | 4.4  | -    | -         | V       |
|                           |                 |   | $I_O=-20\mu A; V_{CC}=6.0V$ | 5.9  | -    | -         | V       |
|                           |                 |   | $I_O=-4.0mA; V_{CC}=4.5V$   | 3.7  | -    | -         | V       |
|                           |                 |   | $I_O=-5.2mA; V_{CC}=6.0V$   | 5.2  | -    | -         | V       |
| LOW-level output voltage  | $V_{OL}$        | $V_I = V_{IH} \text{ or } V_{IL}$                 | $I_O=20\mu A; V_{CC}=2.0V$  | -    | -    | 0.1       | V       |
|                           |                 |   | $I_O=20\mu A; V_{CC}=4.5V$  | -    | -    | 0.1       | V       |
|                           |                 |   | $I_O=20\mu A; V_{CC}=6.0V$  | -    | -    | 0.1       | V       |
|                           |                 |   | $I_O=4.0mA; V_{CC}=4.5V$    | -    | -    | 0.4       | V       |
|                           |                 |   | $I_O=5.2mA; V_{CC}=6.0V$    | -    | -    | 0.4       | V       |
| input leakage current     | $I_I$           | $V_I=V_{CC} \text{ or } GND; V_{CC}=6.0V$         |                             | -    | -    | $\pm 1.0$ | $\mu A$ |
| supply current            | $I_{CC}$        | $V_I=V_{CC} \text{ or } GND; I_O=0A; V_{CC}=6.0V$ |                             | -    | -    | 160       | $\mu A$ |
| <b>SN74HCT190</b>         |                 |   |                             |      |      |           |         |
| HIGH-level input voltage  | $V_{IH}$        | $V_{CC}=4.5V \text{ to } 5.5V$                    |                             | 2.0  | -    | -         | V       |
| LOW-level input voltage   | $V_{IL}$        | $V_{CC}=4.5V \text{ to } 5.5V$                    |                             | -    | -    | 0.8       | V       |
| HIGH-level output voltage | $V_{OH}$        | $V_I = V_{IH} \text{ or } V_{IL}; V_{CC}=4.5V$    | $I_O=-20\mu A$              | 4.4  | -    | -         | V       |
|                           |                 |   | $I_O=-4.0mA$                | 3.7  | -    | -         | V       |
| LOW-level output voltage  | $V_{OL}$        | $V_I = V_{IH} \text{ or } V_{IL}; V_{CC}=4.5V$    | $I_O=20\mu A$               | -    | -    | 0.1       | V       |
|                           |                 |   | $I_O=4.0mA$                 | -    | -    | 0.4       | V       |
| input leakage current     | $I_I$           | $V_I=V_{CC} \text{ or } GND; V_{CC}=5.5V$         |                             | -    | -    | $\pm 1.0$ | $\mu A$ |
| supply current            | $I_{CC}$        | $V_I=V_{CC} \text{ or } GND; I_O=0A; V_{CC}=5.5V$ |                             | -    | -    | 160       | $\mu A$ |
| additional                | $\Delta I_{CC}$ | $V_I=V_{CC}-2.1V;$                                |                             | -    | -    | 490       | $\mu A$ |



|                |  |  |  |  |  |  |
|----------------|--|--|--|--|--|--|
| supply current |  | other inputs at $V_{CC}$ or GND; $I_O=0A$ ;<br>$V_{CC}=4.5V$ to $5.5V$ |  |  |  |  |
|----------------|--|--|--|--|--|--|

### 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 |    |
|-------------------|-----------|--|----------------------------|------|------|------|----|
| <b>SN74HC190</b>  |           |  |                            |      |      |      |    |
| propagation delay | $t_{pd}$  | CP to Qn;<br>see Figure 10                             | $V_{CC}=2.0V$              | -    | 72   | 220  | ns |
|                   |           |  | $V_{CC}=4.5V$              | -    | 26   | 44   | ns |
|                   |           |  | $V_{CC}=5.0V$ ; $C_L=15pF$ | -    | 22   | -    | ns |
|                   |           | CP to TC;<br>see Figure 10                             | $V_{CC}=2.0V$              | -    | 83   | 255  | ns |
|                   |           |  | $V_{CC}=4.5V$              | -    | 30   | 51   | ns |
|                   |           |  | $V_{CC}=6.0V$              | -    | 24   | 43   | ns |
|                   |           | CP to $\overline{RC}$ ;<br>see Figure 11               | $V_{CC}=2.0V$              | -    | 44   | 150  | ns |
|                   |           |  | $V_{CC}=4.5V$              | -    | 16   | 30   | ns |
|                   |           |  | $V_{CC}=6.0V$              | -    | 13   | 26   | ns |
|                   |           | $\overline{CE}$ to $\overline{RC}$ ;<br>see Figure 11  | $V_{CC}=2.0V$              | -    | 33   | 130  | ns |
|                   |           |  | $V_{CC}=4.5V$              | -    | 12   | 26   | ns |
|                   |           |  | $V_{CC}=6.0V$              | -    | 10   | 22   | ns |
|                   |           | Dn to Qn;<br>see Figure 12                             | $V_{CC}=2.0V$              | -    | 63   | 220  | ns |
|                   |           |  | $V_{CC}=4.5V$              | -    | 23   | 44   | ns |
|                   |           |  | $V_{CC}=6.0V$              | -    | 18   | 37   | ns |
|                   |           | $\overline{PL}$ to Qn;<br>see Figure 13                | $V_{CC}=2.0V$              | -    | 63   | 220  | ns |
|                   |           |  | $V_{CC}=4.5V$              | -    | 23   | 44   | ns |
|                   |           |  | $V_{CC}=6.0V$              | -    | 18   | 37   | ns |
|                   |           | $\overline{U/D}$ to TC;<br>see Figure 14               | $V_{CC}=2.0V$              | -    | 44   | 190  | ns |
|                   |           |  | $V_{CC}=4.5V$              | -    | 16   | 38   | ns |
|                   |           |  | $V_{CC}=6.0V$              | -    | 13   | 32   | ns |
|                   |           | $\overline{U/D}$ to $\overline{RC}$ ;<br>see Figure 14 | $V_{CC}=2.0V$              | -    | 50   | 210  | ns |
|                   |           |  | $V_{CC}=4.5V$              | -    | 18   | 42   | ns |
|                   |           |  | $V_{CC}=6.0V$              | -    | 14   | 36   | ns |
| transition time   | $t_t$     | see Figure 15  | $V_{CC}=2.0V$              | -    | 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;<br>see Figure 10                   | $V_{CC}=2.0V$              | 155  | 28   | -    | ns |
|                   |           |  | $V_{CC}=4.5V$              | 31   | 10   | -    | ns |
|                   |           |  | $V_{CC}=6.0V$              | 26   | 8    | -    | ns |
|                   |           | $\overline{PL}$ ; LOW;<br>see Figure 15                | $V_{CC}=2.0V$              | 100  | 25   | -    | ns |
|                   |           |  | $V_{CC}=4.5V$              | 20   | 9    | -    | ns |
| recovery time     | $t_{rec}$ | $\overline{PL}$ to CP;<br>see Figure 15                | $V_{CC}=2.0V$              | 35   | 8    | -    | ns |
|                   |           |  | $V_{CC}=4.5V$              | 7    | 3    | -    | ns |
|                   |           |  | $V_{CC}=6.0V$              | 6    | 2    | -    | ns |
| set-up time       | $t_{su}$  | $\overline{U/D}$ to CP;                                | $V_{CC}=2.0V$              | 205  | 61   | -    | ns |



|  |               |  |                         |  |               |    |     |
|--|---------------|--|-------------------------|--|---------------|----|-----|
|  |               | see Figure 16  | $V_{CC}=4.5V$           | 41                                       | 22            | -  | ns  |
|  |               |  | $V_{CC}=6.0V$           | 35                                       | 18            | -  | ns  |
|  |               | Dn to $\overline{PL}$ ;<br>see Figure 17             | $V_{CC}=2.0V$           | 100                                      | 19            | -  | ns  |
|  |               |  | $V_{CC}=4.5V$           | 20                                       | 7             | -  | ns  |
|  |               |  | $V_{CC}=6.0V$           | 17                                       | 6             | -  | ns  |
|  |               | $\overline{CE}$ to CP;<br>see Figure 16              | $V_{CC}=2.0V$           | 140                                      | 39            | -  | ns  |
|  |               |  | $V_{CC}=4.5V$           | 28                                       | 14            | -  | ns  |
|  |               |  | $V_{CC}=6.0V$           | 24                                       | 11            | -  | ns  |
|  |               | hold time  | $t_h$                   | $\overline{U/D}$ to CP;<br>see Figure 16 | $V_{CC}=2.0V$ | 0  | -44 |
| $V_{CC}=4.5V$                            | 0             |  |                         |  | -16           | -  | ns  |
| $V_{CC}=6.0V$                            | 0             |  |                         |  | -13           | -  | ns  |
| Dn to $\overline{PL}$ ;<br>see Figure 17 | $V_{CC}=2.0V$ |  |                         | 0  | -14           | -  | ns  |
|  | $V_{CC}=4.5V$ |  |                         | 0  | -5            | -  | ns  |
|  | $V_{CC}=6.0V$ |  |                         | 0  | -4            | -  | ns  |
| $\overline{CE}$ to CP;<br>see Figure 16  | $V_{CC}=2.0V$ |  |                         | 0  | -19           | -  | ns  |
|  | $V_{CC}=4.5V$ |  |                         | 0  | -7            | -  | ns  |
|  | $V_{CC}=6.0V$ |  |                         | 0  | -6            | -  | ns  |
| maximum frequency                        | $f_{max}$     | CP;<br>see Figure 10                                 | $V_{CC}=2.0V$           | 3.0                                      | 8.3           | -  | MHz |
|  |               |  | $V_{CC}=4.5V$           | 15                                       | 25            | -  | MHz |
|  |               |  | $V_{CC}=5.0V; C_L=15pF$ | -  | 28            | -  | MHz |
|  |               |  | $V_{CC}=6.0V$           | 18                                       | 30            | -  | MHz |
| power dissipation capacitance            | $C_{PD}$      | $V_I=GND$ to $V_{CC}$                                | -                       | 36                                       | -             | pF |     |
| <b>SN74HCT190</b>                        |               |  |                         |  |               |    |     |
| propagation delay                        | $t_{pd}$      | CP to Qn;<br>see Figure 10                           | $V_{CC}=4.5V$           | -  | 28            | 48 | ns  |
|  |               |  | $V_{CC}=5.0V; C_L=15pF$ | -  | 24            | -  | ns  |
|  |               | CP to TC;<br>see Figure 10                           | $V_{CC}=4.5V$           | -  | 34            | 58 | ns  |
|  |               | CP to RC;<br>see Figure 11                           | $V_{CC}=4.5V$           | -  | 20            | 35 | ns  |
|  |               | $\overline{CE}$ to RC;<br>see Figure 11              | $V_{CC}=4.5V$           | -  | 18            | 33 | ns  |
|  |               | Dn to Qn;<br>see Figure 12                           | $V_{CC}=4.5V$           | -  | 24            | 44 | ns  |
|  |               | $\overline{PL}$ to Qn;<br>see Figure 13              | $V_{CC}=4.5V$           | -  | 29            | 49 | ns  |
|  |               | $\overline{U/D}$ to TC;<br>see Figure 14             | $V_{CC}=4.5V$           | -  | 24            | 45 | ns  |
| $\overline{U/D}$ to RC;<br>see Figure 14 | $V_{CC}=4.5V$ | -  | 26                      | 45                                       | ns            |    |     |
| transition time                          | $t_t$         | $V_{CC}=4.5V$ ; see Figure 15                        | -                       | 7  | 15            | ns |     |
| pulse width                              | $t_w$         | CP; HIGH or LOW; $V_{CC}=4.5V$<br>see Figure 10      | 25                      | 10                                       | -             | ns |     |
|  |               | PL; LOW; $V_{CC}=4.5V$ ; see Figure 15               | 22                      | 12                                       | -             | ns |     |
| recovery time                            | $t_{rec}$     | $\overline{PL}$ to CP; $V_{CC}=4.5V$ ; see Figure 15 | 7                       | 1  | -             | ns |     |



|                               |           |  |                            |     |    |    |     |
|-------------------------------|-----------|--|----------------------------|-----|----|----|-----|
| set-up time                   | $t_{su}$  | $\bar{U}/D$ to CP; $V_{CC}=4.5V$ ; see Figure 16 | 42                         | 25  | -  | ns |     |
|                               |           | Dn to $\bar{P}L$ ; $V_{CC}=4.5V$ ; see Figure 17 | 20                         | 10  | -  | ns |     |
|                               |           | $\bar{C}E$ to CP; $V_{CC}=4.5V$ ; see Figure 16  | 31                         | 18  | -  | ns |     |
| hold time                     | $t_h$     | $\bar{U}/D$ to CP; $V_{CC}=4.5V$ ; see Figure 16 | 0                          | -18 | -  | ns |     |
|                               |           | Dn to $\bar{P}L$ ; $V_{CC}=4.5V$ ; see Figure 17 | 0                          | -6  | -  | ns |     |
|                               |           | $\bar{C}E$ to CP; $V_{CC}=4.5V$ ; see Figure 16  | 0                          | -10 | -  | ns |     |
| maximum frequency             | $f_{max}$ | CP;<br>see Figure 10                             | $V_{CC}=4.5V$              | 16  | 27 | -  | MHz |
|                               |           |  | $V_{CC}=5.0V$ ; $C_L=15pF$ | -   | 30 | -  | MHz |
| power dissipation capacitance | $C_{PD}$  | $V_I=GND$ to $V_{CC}-1.5V$                       | -                          | 38  | -  | 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).

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

$f_i$ =input frequency in MHz;

$f_o$ =output frequency in MHz;

$C_L$ =output load capacitance in pF;

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

$\sum (C_L \times V_{CC}^2 \times f_o)$ =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 |    |
|------------------------------------|---------------|---|---------------|------|------|------|----|
| <b>SN74HC190</b>                   |               |   |               |      |      |      |    |
| propagation delay                  | $t_{pd}$      | CP to Qn;<br>see Figure 10                  | $V_{CC}=2.0V$ | -    | -    | 275  | ns |
|                                    |               |   | $V_{CC}=4.5V$ | -    | -    | 55   | ns |
|                                    |               |   | $V_{CC}=6.0V$ | -    | -    | 47   | ns |
|                                    |               | CP to TC;<br>see Figure 10                  | $V_{CC}=2.0V$ | -    | -    | 320  | ns |
|                                    |               |   | $V_{CC}=4.5V$ | -    | -    | 64   | ns |
|                                    |               |   | $V_{CC}=6.0V$ | -    | -    | 54   | ns |
|                                    |               | CP to $\bar{R}C$ ;<br>see Figure 11         | $V_{CC}=2.0V$ | -    | -    | 190  | ns |
|                                    |               |   | $V_{CC}=4.5V$ | -    | -    | 38   | ns |
|                                    |               |   | $V_{CC}=6.0V$ | -    | -    | 33   | ns |
|                                    |               | $\bar{C}E$ to $\bar{R}C$ ;<br>see Figure 11 | $V_{CC}=2.0V$ | -    | -    | 165  | ns |
|                                    |               |   | $V_{CC}=4.5V$ | -    | -    | 33   | ns |
|                                    |               |   | $V_{CC}=6.0V$ | -    | -    | 28   | ns |
|                                    |               | Dn to Qn;<br>see Figure 12                  | $V_{CC}=2.0V$ | -    | -    | 275  | ns |
|                                    |               |   | $V_{CC}=4.5V$ | -    | -    | 55   | ns |
|                                    |               |   | $V_{CC}=6.0V$ | -    | -    | 47   | ns |
| $\bar{P}L$ to Qn;<br>see Figure 13 | $V_{CC}=2.0V$ | -   | -             | 275  | ns   |      |    |
|                                    | $V_{CC}=4.5V$ | -   | -             | 55   | ns   |      |    |
|                                    | $V_{CC}=6.0V$ | -   | -             | 47   | ns   |      |    |





|                      |           |  |               |     |   |     |     |
|----------------------|-----------|--|---------------|-----|---|-----|-----|
|                      |           | $\bar{U}/D$ to TC;<br>see Figure 14          | $V_{CC}=2.0V$ | -   | - | 240 | ns  |
|                      |           |  | $V_{CC}=4.5V$ | -   | - | 48  | ns  |
|                      |           |  | $V_{CC}=6.0V$ | -   | - | 41  | ns  |
|                      |           | $\bar{U}/D$ to $\bar{RC}$ ;<br>see Figure 14 | $V_{CC}=2.0V$ | -   | - | 265 | ns  |
|                      |           |  | $V_{CC}=4.5V$ | -   | - | 53  | ns  |
|                      |           |  | $V_{CC}=6.0V$ | -   | - | 45  | ns  |
| transition time      | $t_t$     | see Figure 15                                | $V_{CC}=2.0V$ | -   | - | 95  | ns  |
|                      |           |  | $V_{CC}=4.5V$ | -   | - | 19  | ns  |
|                      |           |  | $V_{CC}=6.0V$ | -   | - | 16  | ns  |
| pulse width          | $t_w$     | CP; HIGH or<br>LOW;<br>see Figure 10         | $V_{CC}=2.0V$ | 195 | - | -   | ns  |
|                      |           |  | $V_{CC}=4.5V$ | 39  | - | -   | ns  |
|                      |           |  | $V_{CC}=6.0V$ | 33  | - | -   | ns  |
|                      |           | $\bar{PL}$ ; LOW;<br>see Figure 15           | $V_{CC}=2.0V$ | 125 | - | -   | ns  |
|                      |           |  | $V_{CC}=4.5V$ | 25  | - | -   | ns  |
|                      |           |  | $V_{CC}=6.0V$ | 21  | - | -   | ns  |
| recovery time        | $t_{rec}$ | $\bar{PL}$ to CP;<br>see Figure 15           | $V_{CC}=2.0V$ | 45  | - | -   | ns  |
|                      |           |  | $V_{CC}=4.5V$ | 9   | - | -   | ns  |
|                      |           |  | $V_{CC}=6.0V$ | 8   | - | -   | ns  |
| set-up time          | $t_{su}$  | $\bar{U}/D$ to CP;<br>see Figure 16          | $V_{CC}=2.0V$ | 255 | - | -   | ns  |
|                      |           |  | $V_{CC}=4.5V$ | 51  | - | -   | ns  |
|                      |           |  | $V_{CC}=6.0V$ | 43  | - | -   | ns  |
|                      |           | Dn to $\bar{PL}$ ;<br>see Figure 17          | $V_{CC}=2.0V$ | 125 | - | -   | ns  |
|                      |           |  | $V_{CC}=4.5V$ | 25  | - | -   | ns  |
|                      |           |  | $V_{CC}=6.0V$ | 21  | - | -   | ns  |
|                      |           | $\bar{CE}$ to CP;<br>see Figure 16           | $V_{CC}=2.0V$ | 175 | - | -   | ns  |
|                      |           |  | $V_{CC}=4.5V$ | 35  | - | -   | ns  |
|                      |           |  | $V_{CC}=6.0V$ | 30  | - | -   | ns  |
| hold time            | $t_h$     | $\bar{U}/D$ to CP;<br>see Figure 16          | $V_{CC}=2.0V$ | 0   | - | -   | ns  |
|                      |           |  | $V_{CC}=4.5V$ | 0   | - | -   | ns  |
|                      |           |  | $V_{CC}=6.0V$ | 0   | - | -   | ns  |
|                      |           | Dn to $\bar{PL}$ ;<br>see Figure 17          | $V_{CC}=2.0V$ | 0   | - | -   | ns  |
|                      |           |  | $V_{CC}=4.5V$ | 0   | - | -   | ns  |
|                      |           |  | $V_{CC}=6.0V$ | 0   | - | -   | ns  |
|                      |           | $\bar{CE}$ to CP;<br>see Figure 16           | $V_{CC}=2.0V$ | 0   | - | -   | ns  |
|                      |           |  | $V_{CC}=4.5V$ | 0   | - | -   | ns  |
|                      |           |  | $V_{CC}=6.0V$ | 0   | - | -   | ns  |
| maximum<br>frequency | $f_{max}$ | CP;<br>see Figure 10                         | $V_{CC}=2.0V$ | 2.4 | - | -   | MHz |
|                      |           |  | $V_{CC}=4.5V$ | 12  | - | -   | MHz |
|                      |           |  | $V_{CC}=6.0V$ | 14  | - | -   | MHz |
| <b>SN74HCT190</b>    |           |  |               |     |   |     |     |
| propagation<br>delay | $t_{pd}$  | CP to Qn;<br>see Figure 10                   | $V_{CC}=4.5V$ | -   | - | 60  | ns  |
|                      |           | CP to TC;<br>see Figure 10                   | $V_{CC}=4.5V$ | -   | - | 73  | ns  |
|                      |           | CP to $\bar{RC}$ ;<br>see Figure 11          | $V_{CC}=4.5V$ | -   | - | 44  | ns  |



|                   |           |  |               |    |   |    |     |
|-------------------|-----------|--|---------------|----|---|----|-----|
|                   |           | $\overline{CE}$ to $\overline{RC}$ ;<br>see Figure 11  | $V_{CC}=4.5V$ | -  | - | 41 | ns  |
|                   |           | Dn to Qn;<br>see Figure 12                             | $V_{CC}=4.5V$ | -  | - | 55 | ns  |
|                   |           | $\overline{PL}$ to Qn;<br>see Figure 13                | $V_{CC}=4.5V$ | -  | - | 61 | ns  |
|                   |           | $\overline{U/D}$ to TC;<br>see Figure 14               | $V_{CC}=4.5V$ | -  | - | 56 | ns  |
|                   |           | $\overline{U/D}$ to $\overline{RC}$ ;<br>see Figure 14 | $V_{CC}=4.5V$ | -  | - | 56 | ns  |
| transition time   | $t_t$     | $V_{CC}=4.5V$ ; see Figure 15                          |               | -  | - | 19 | ns  |
| pulse width       | $t_w$     | CP; HIGH or LOW; $V_{CC}=4.5V$<br>see Figure 10        |               | 31 | - | -  | ns  |
|                   |           | $\overline{PL}$ ; LOW; $V_{CC}=4.5V$ ; see Figure 15   |               | 28 | - | -  | ns  |
| recovery time     | $t_{rec}$ | $\overline{PL}$ to CP; $V_{CC}=4.5V$ ; see Figure 15   |               | 9  | - | -  | ns  |
| set-up time       | $t_{su}$  | $\overline{U/D}$ to CP; $V_{CC}=4.5V$ ; see Figure 16  |               | 53 | - | -  | ns  |
|                   |           | Dn to $\overline{PL}$ ; $V_{CC}=4.5V$ ; see Figure 17  |               | 25 | - | -  | ns  |
|                   |           | $\overline{CE}$ to CP; $V_{CC}=4.5V$ ; see Figure 16   |               | 39 | - | -  | ns  |
| hold time         | $t_h$     | $\overline{U/D}$ to CP; $V_{CC}=4.5V$ ; see Figure 16  |               | 0  | - | -  | ns  |
|                   |           | Dn to $\overline{PL}$ ; $V_{CC}=4.5V$ ; see Figure 17  |               | 0  | - | -  | ns  |
|                   |           | $\overline{CE}$ to CP; $V_{CC}=4.5V$ ; see Figure 16   |               | 0  | - | -  | ns  |
| maximum frequency | $f_{max}$ | CP;<br>see Figure 10                                   | $V_{CC}=4.5V$ | 13 | - | -  | MHz |

Note:

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

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

### 3.3.6、AC Characteristics 3

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

| Parameter         | Symbol   | Conditions  | Min.          | Typ. | Max. | Unit |    |
|-------------------|----------|---|---------------|------|------|------|----|
| <b>SN74HC190</b>  |          |   |               |      |      |      |    |
| propagation delay | $t_{pd}$ | CP to Qn;<br>see Figure 10                            | $V_{CC}=2.0V$ | -    | -    | 330  | ns |
|                   |          |   | $V_{CC}=4.5V$ | -    | -    | 66   | ns |
|                   |          |   | $V_{CC}=6.0V$ | -    | -    | 56   | ns |
|                   |          | CP to TC;<br>see Figure 10                            | $V_{CC}=2.0V$ | -    | -    | 384  | ns |
|                   |          |   | $V_{CC}=4.5V$ | -    | -    | 77   | ns |
|                   |          |   | $V_{CC}=6.0V$ | -    | -    | 65   | ns |
|                   |          | CP to $\overline{RC}$ ;<br>see Figure 11              | $V_{CC}=2.0V$ | -    | -    | 228  | ns |
|                   |          |   | $V_{CC}=4.5V$ | -    | -    | 46   | ns |
|                   |          |   | $V_{CC}=6.0V$ | -    | -    | 40   | ns |
|                   |          | $\overline{CE}$ to $\overline{RC}$ ;<br>see Figure 11 | $V_{CC}=2.0V$ | -    | -    | 198  | ns |
|                   |          |   | $V_{CC}=4.5V$ | -    | -    | 40   | ns |
|                   |          |   | $V_{CC}=6.0V$ | -    | -    | 34   | ns |
|                   |          | Dn to Qn;<br>see Figure 12                            | $V_{CC}=2.0V$ | -    | -    | 330  | ns |
|                   |          |   | $V_{CC}=4.5V$ | -    | -    | 66   | ns |



|                      |           |  |               |               |               |     |     |     |    |
|----------------------|-----------|--|---------------|---------------|---------------|-----|-----|-----|----|
|                      |           | $\bar{P}L$ to Qn;<br>see Figure 13           | $V_{CC}=6.0V$ | -             | -             | 56  | ns  |     |    |
|                      |           |  | $V_{CC}=2.0V$ | -             | -             | 330 | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | -             | -             | 66  | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | -             | -             | 56  | ns  |     |    |
|                      |           | $\bar{U}/D$ to TC;<br>see Figure 14          | $V_{CC}=2.0V$ | -             | -             | 288 | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | -             | -             | 58  | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | -             | -             | 49  | ns  |     |    |
|                      |           | $\bar{U}/D$ to $\bar{R}C$ ;<br>see Figure 14 | $V_{CC}=2.0V$ | -             | -             | 318 | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | -             | -             | 64  | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | -             | -             | 54  | ns  |     |    |
|                      |           | transition time                              | $t_t$         | see Figure 15 | $V_{CC}=2.0V$ | -   | -   | 114 | ns |
|                      |           |  |               |               | $V_{CC}=4.5V$ | -   | -   | 23  | ns |
| $V_{CC}=6.0V$        | -         |  |               |               | -             | 19  | ns  |     |    |
| pulse width          | $t_w$     | CP; HIGH or<br>LOW;<br>see Figure 10         | $V_{CC}=2.0V$ | 234           | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 47            | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 40            | -             | -   | ns  |     |    |
|                      |           | $\bar{P}L$ ; LOW;<br>see Figure 15           | $V_{CC}=2.0V$ | 150           | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 30            | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 25            | -             | -   | ns  |     |    |
| recovery time        | $t_{rec}$ | $\bar{P}L$ to CP;<br>see Figure 15           | $V_{CC}=2.0V$ | 54            | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 11            | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 10            | -             | -   | ns  |     |    |
| set-up time          | $t_{su}$  | $\bar{U}/D$ to CP;<br>see Figure 16          | $V_{CC}=2.0V$ | 306           | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 61            | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 52            | -             | -   | ns  |     |    |
|                      |           | Dn to $\bar{P}L$ ;<br>see Figure 17          | $V_{CC}=2.0V$ | 150           | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 30            | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 25            | -             | -   | ns  |     |    |
|                      |           | $\bar{C}E$ to CP;<br>see Figure 16           | $V_{CC}=2.0V$ | 210           | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 42            | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 36            | -             | -   | ns  |     |    |
| hold time            | $t_h$     | $\bar{U}/D$ to CP;<br>see Figure 16          | $V_{CC}=2.0V$ | 0             | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 0             | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 0             | -             | -   | ns  |     |    |
|                      |           | Dn to $\bar{P}L$ ;<br>see Figure 17          | $V_{CC}=2.0V$ | 0             | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 0             | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 0             | -             | -   | ns  |     |    |
|                      |           | $\bar{C}E$ to CP;<br>see Figure 16           | $V_{CC}=2.0V$ | 0             | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 0             | -             | -   | ns  |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 0             | -             | -   | ns  |     |    |
| maximum<br>frequency | $f_{max}$ | CP;<br>see Figure 10                         | $V_{CC}=2.0V$ | 2             | -             | -   | MHz |     |    |
|                      |           |  | $V_{CC}=4.5V$ | 10            | -             | -   | MHz |     |    |
|                      |           |  | $V_{CC}=6.0V$ | 12            | -             | -   | MHz |     |    |
| <b>SN74HCT190</b>    |           |  |               |               |               |     |     |     |    |
| propagation          | $t_{pd}$  | CP to Qn;                                    | $V_{CC}=4.5V$ | -             | -             | 72  | ns  |     |    |



|                   |           |  |               |    |   |    |     |
|-------------------|-----------|--|---------------|----|---|----|-----|
| delay             |           | see Figure 10  |               |    |   |    |     |
|                   |           | CP to TC;<br>see Figure 10                             | $V_{CC}=4.5V$ | -  | - | 88 | ns  |
|                   |           | CP to RC;<br>see Figure 11                             | $V_{CC}=4.5V$ | -  | - | 53 | ns  |
|                   |           | $\overline{CE}$ to $\overline{RC}$ ;<br>see Figure 11  | $V_{CC}=4.5V$ | -  | - | 49 | ns  |
|                   |           | Dn to Qn;<br>see Figure 12                             | $V_{CC}=4.5V$ | -  | - | 66 | ns  |
|                   |           | $\overline{PL}$ to Qn;<br>see Figure 13                | $V_{CC}=4.5V$ | -  | - | 73 | ns  |
|                   |           | $\overline{U/D}$ to TC;<br>see Figure 14               | $V_{CC}=4.5V$ | -  | - | 67 | ns  |
|                   |           | $\overline{U/D}$ to $\overline{RC}$ ;<br>see Figure 14 | $V_{CC}=4.5V$ | -  | - | 67 | ns  |
| transition time   | $t_t$     | $V_{CC}=4.5V$ ; see Figure 15                          |               | -  | - | 23 | ns  |
| pulse width       | $t_w$     | CP; HIGH or LOW; $V_{CC}=4.5V$<br>see Figure 10        |               | 37 | - | -  | ns  |
|                   |           | $\overline{PL}$ ; LOW; $V_{CC}=4.5V$ ; see Figure 15   |               | 34 | - | -  | ns  |
| recovery time     | $t_{rec}$ | $\overline{PL}$ to CP; $V_{CC}=4.5V$ ; see Figure 15   |               | 11 | - | -  | ns  |
| set-up time       | $t_{su}$  | $\overline{U/D}$ to CP; $V_{CC}=4.5V$ ; see Figure 16  |               | 64 | - | -  | ns  |
|                   |           | Dn to $\overline{PL}$ ; $V_{CC}=4.5V$ ; see Figure 17  |               | 30 | - | -  | ns  |
|                   |           | $\overline{CE}$ to CP; $V_{CC}=4.5V$ ; see Figure 16   |               | 47 | - | -  | ns  |
| hold time         | $t_h$     | $\overline{U/D}$ to CP; $V_{CC}=4.5V$ ; see Figure 16  |               | 0  | - | -  | ns  |
|                   |           | Dn to $\overline{PL}$ ; $V_{CC}=4.5V$ ; see Figure 17  |               | 0  | - | -  | ns  |
|                   |           | $\overline{CE}$ to CP; $V_{CC}=4.5V$ ; see Figure 16   |               | 0  | - | -  | ns  |
| maximum frequency | $f_{max}$ | CP;<br>see Figure 10                                   | $V_{CC}=4.5V$ | 11 | - | -  | 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

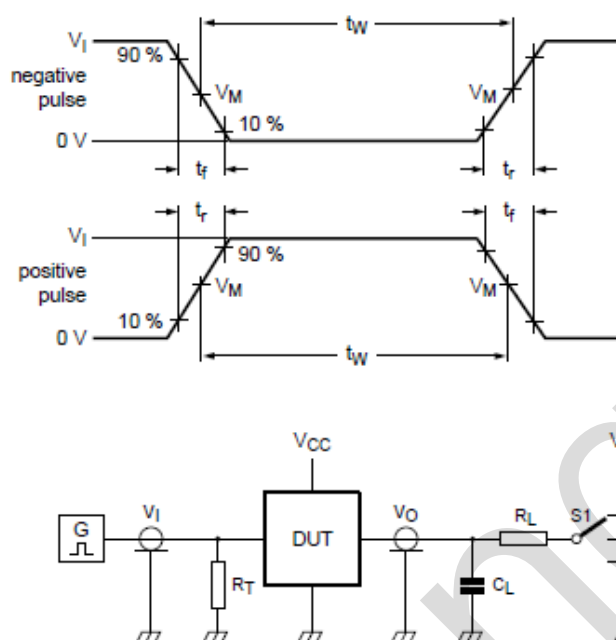


Figure 9. Test circuit for measuring switching times

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

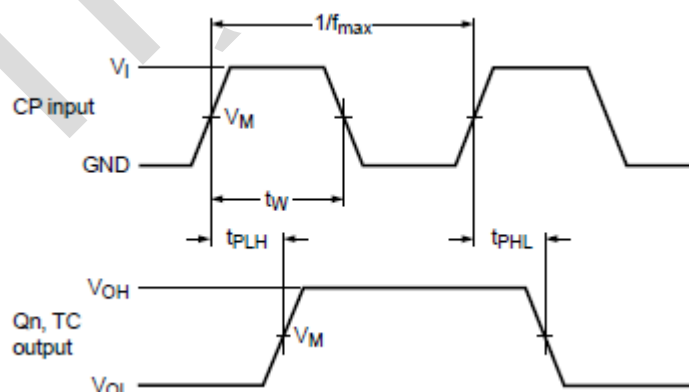


Figure 10. The clock input (CP) to outputs (Qn, TC) propagation delays, clock pulse width and maximum clock frequency

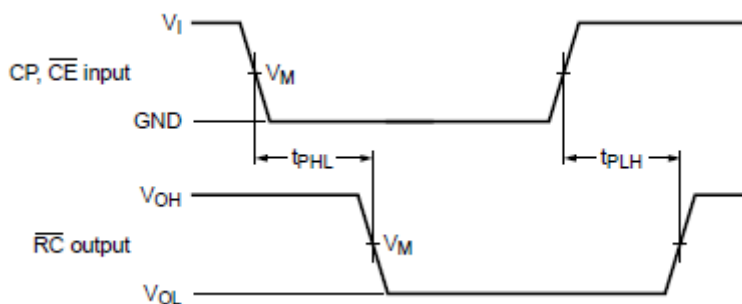


Figure 11. The clock and count enable inputs (CP,  $\overline{CE}$ ) to ripple clock output ( $\overline{RC}$ ) propagation delays

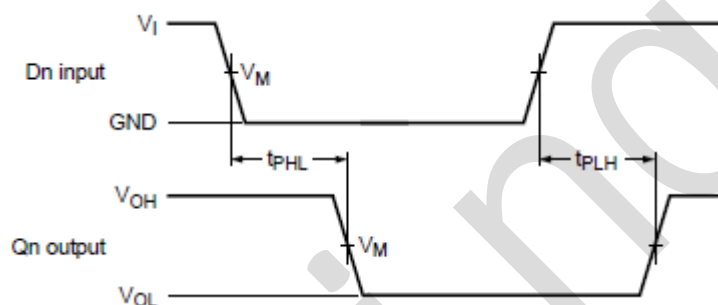


Figure 12. The input (Dn) to output (Qn) propagation delays

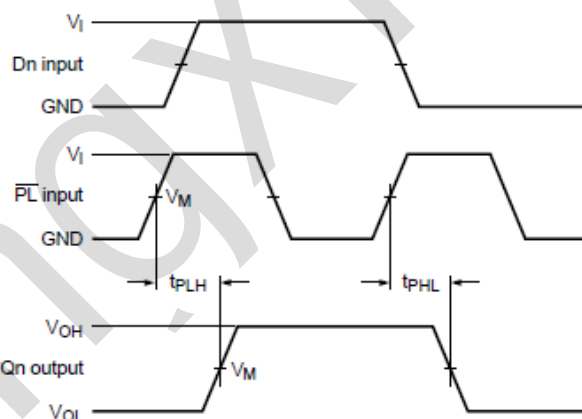


Figure 13. The parallel load input ( $\overline{PL}$ ) to output (Qn) propagation delays

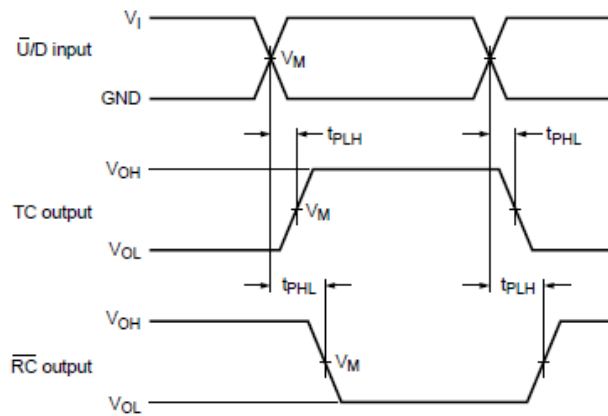


Figure 14. The up/down count input ( $\bar{U}/D$ ) to terminal count and ripple clock output (TC,  $\bar{RC}$ ) propagation delays

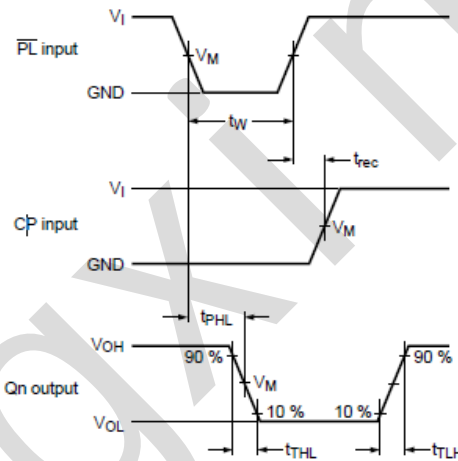


Figure 15. The parallel load input (PL) to clock (CP) recovery times, parallel load pulse width and output (Qn) transition times

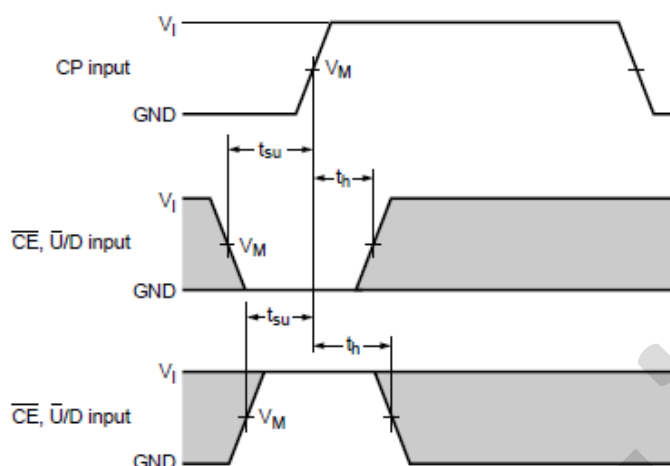


Figure 16. The count enable and up/down count inputs ( $\overline{CE}$ ,  $\overline{U/D}$ ) to clock input (CP) set-up and hold times

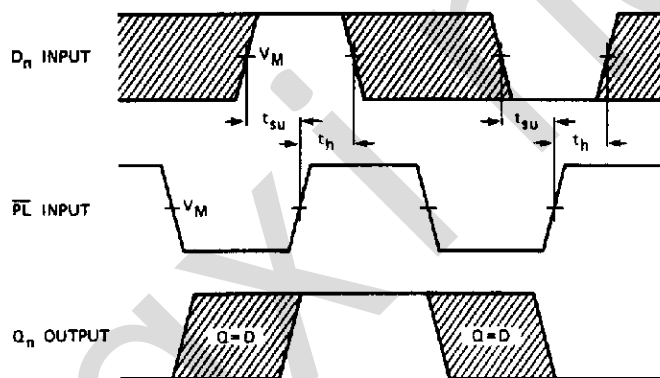


Figure 17. Waveforms showing the set-up and hold times from the parallel load input ( $\overline{PL}$ ) to the data input ( $D_n$ )

#### 4.3. Measurement Points

| Type       | Input               | Output              |
|------------|---------------------|---------------------|
|            | $V_M$               | $V_M$               |
| SN74HC190  | $0.5 \times V_{CC}$ | $0.5 \times V_{CC}$ |
| SN74HCT190 | 1.3V                | 1.3V                |

#### 4.4. Test Data

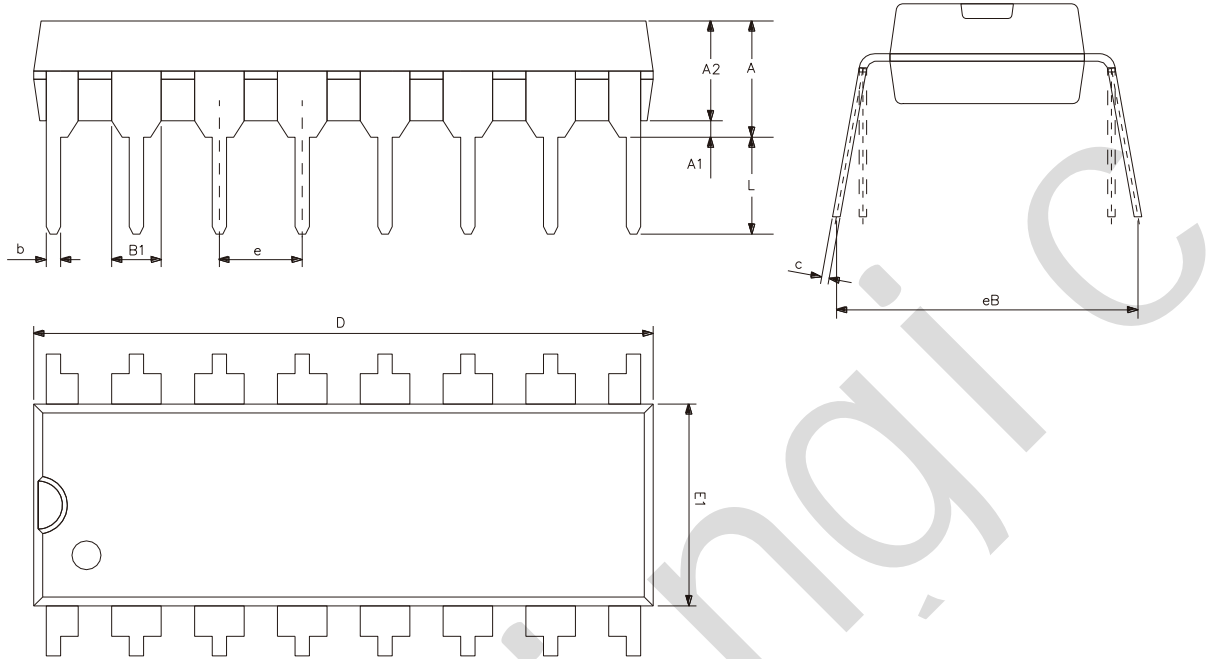
| Type       | Input    |            | Load       |             | S1 position        |
|------------|----------|------------|------------|-------------|--------------------|
|            | $V_I$    | $t_r, t_f$ | $C_L$      | $R_L$       | $t_{PLH}, t_{PHL}$ |
| SN74HC190  | $V_{CC}$ | 6ns        | 15pF, 50pF | 1k $\Omega$ | open               |
| SN74HCT190 | 3V       | 6ns        | 15pF, 50pF | 1k $\Omega$ | open               |





## 5、Package Information

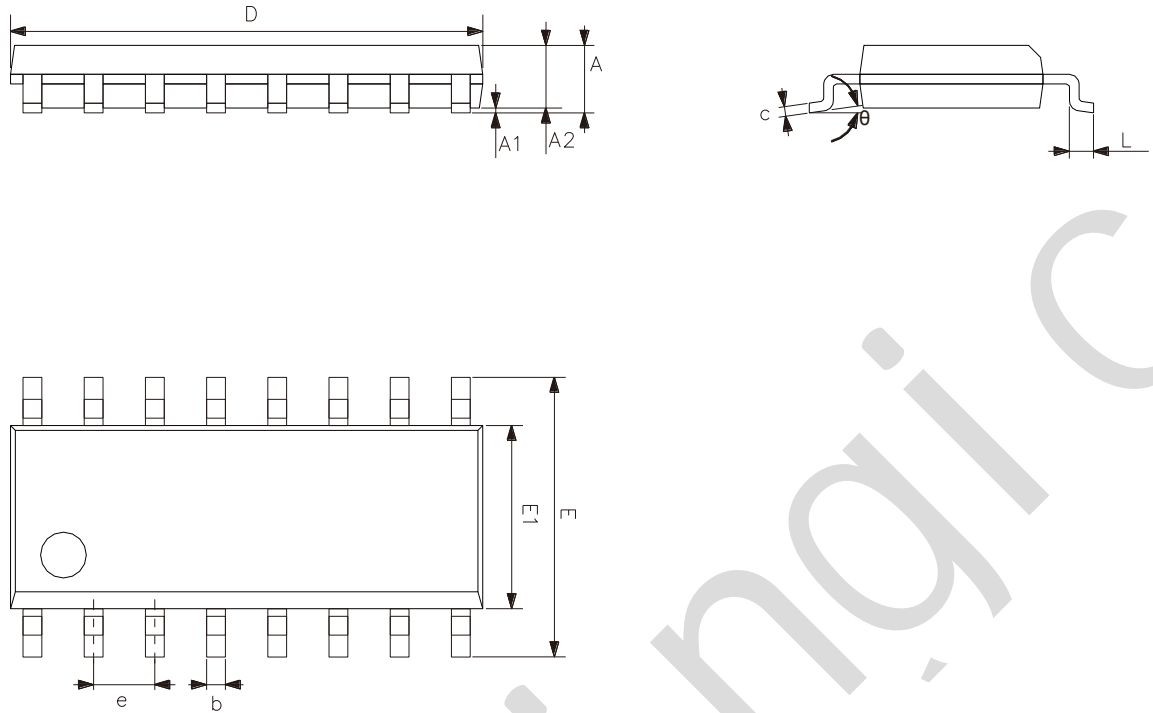
### 5.1、DIP16



| 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  |



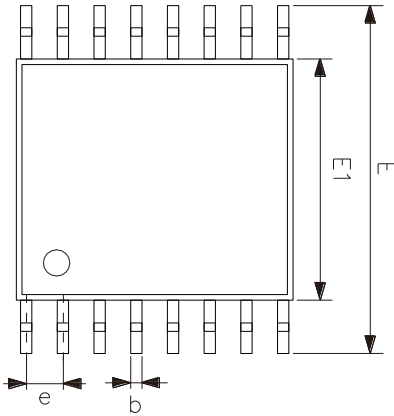
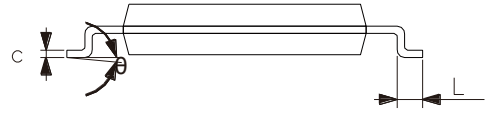
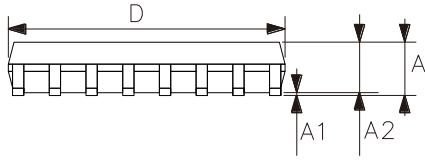
## 5.2、SOP16



| 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°   |



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## 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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