

CD54HC190, CD74HC190 CD54HC191, CD74HC191, CD54HCT191, CD74HCT191 SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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- 2-V to 6-V V_{CC} Operation ('HC190, 191)
- 4.5-V to 5.5-V V_{CC} Operation ('HCT191)
- Wide Operating Temperature Range of -55°C to 125°C
- Synchronous Counting and Asynchronous Loading
- Two Outputs for n-Bit Cascading
- Look-Ahead Carry for High-Speed Counting
- Balanced Propagation Delays and Transition Times
- Standard Outputs Drive Up To 15 LS-TTL Loads
- Significant Power Reduction Compared to LS-TTL Logic ICs

CD54HC190, 191; CD54HCT191 . . . F PACKAGE
CD74HC190 . . . E, NS, OR PW PACKAGE
CD74HC191, CD74HCT191 . . . E OR M PACKAGE
(TOP VIEW)



description/ordering information

The CD54/74HC190 are asynchronously presettable BCD decade counters, whereas the CD54/74HC191 and CD54/74HCT191 are asynchronously presettable binary counters.

Presetting the counter to the number on preset data inputs (A–D) is accomplished by a low asynchronous parallel load (LOAD) input. Counting occurs when LOAD is high, count enable (CTEN) is low, and the down/up (D/U) input is either high for down counting or low for up counting. The counter is decremented or incremented synchronously with the low-to-high transition of the clock.

ORDERING INFORMATION

| T_A | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|--|------------|---|-----------------------|------------------|
| -55°C to 125°C | PDIP – E | Tube of 25 | CD74HC190E | CD74HC190E |
| | | | CD74HC191E | CD74HC191E |
| | | | CD74HCT191E | CD74HCT191E |
| | SOIC – M | Tube of 40 Reel of 2500 Reel of 250 | CD74HC191M | HC191M |
| | | | CD74HC191M96 | |
| | | | CD74HC191MT | |
| | | | Tube of 40 | CD74HCT191M |
| | SOP – NS | Reel of 2000 | CD74HC190NSR | HC190M |
| | TSSOP – PW | Tube of 90 Reel of 2000 Reel of 250 | CD74HC190PW | HJ190 |
| | | | CD74HC190PWR | |
| | | | CD74HC190PWT | |
| | CDIP – F | Tube of 25 | CD54HC190F3A | CD54HC190F3A |
| | | | CD54HC191F3A | CD54HC191F3A |
| CD54HCT191F3A | | | CD54HCT191F3A | |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

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SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL



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description/ordering information (continued)

When an overflow or underflow of the counter occurs, the MAX/MIN output, which is low during counting, goes high and remains high for one clock cycle. This output can be used for look-ahead carry in high-speed cascading (see Figure 1). The MAX/MIN output also initiates the ripple clock (\overline{RCO}) output, which normally is high, goes low, and remains low for the low-level portion of the clock pulse. These counters can be cascaded using \overline{RCO} (see Figure 2).


If a decade counter is preset to an illegal state or assumes an illegal state when power is applied, it returns to the normal sequence in one or two counts, as shown in the state diagrams (see Figure 3).

FUNCTION TABLE

| INPUTS | | | | FUNCTION |
|-------------------|-------------------|------------------|---|---------------------|
| \overline{LOAD} | \overline{CTEN} | D/\overline{U} | CLK | |
| H | L | L |  | Count up |
| H | L | H |  | Count down |
| L | X | X | X | Asynchronous preset |
| H | H | X | X | No change |

$\overline{D/\overline{U}}$ or \overline{CTEN} should be changed only when clock is high.

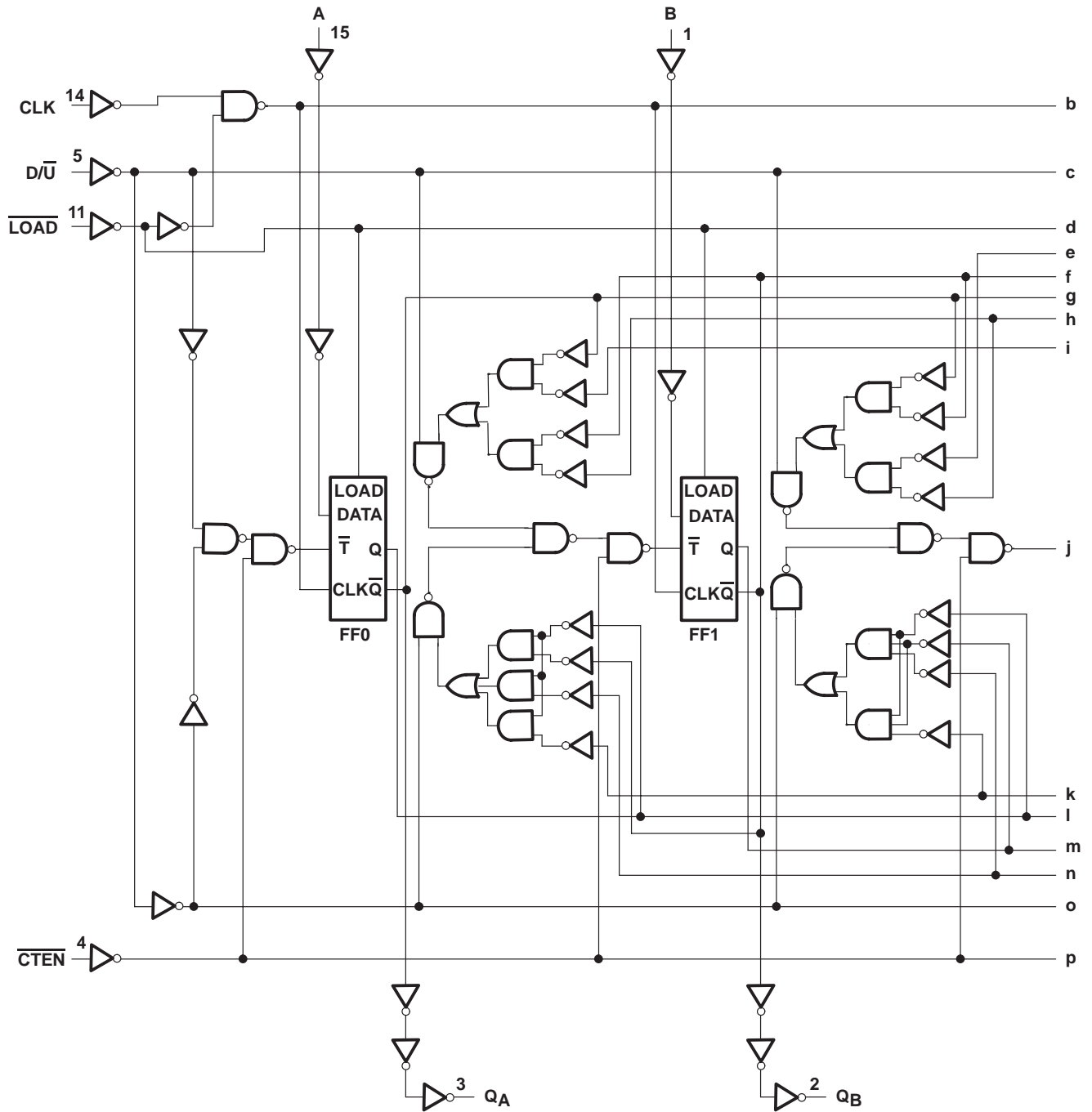
X = Don't care

 Low-to-high clock transition

CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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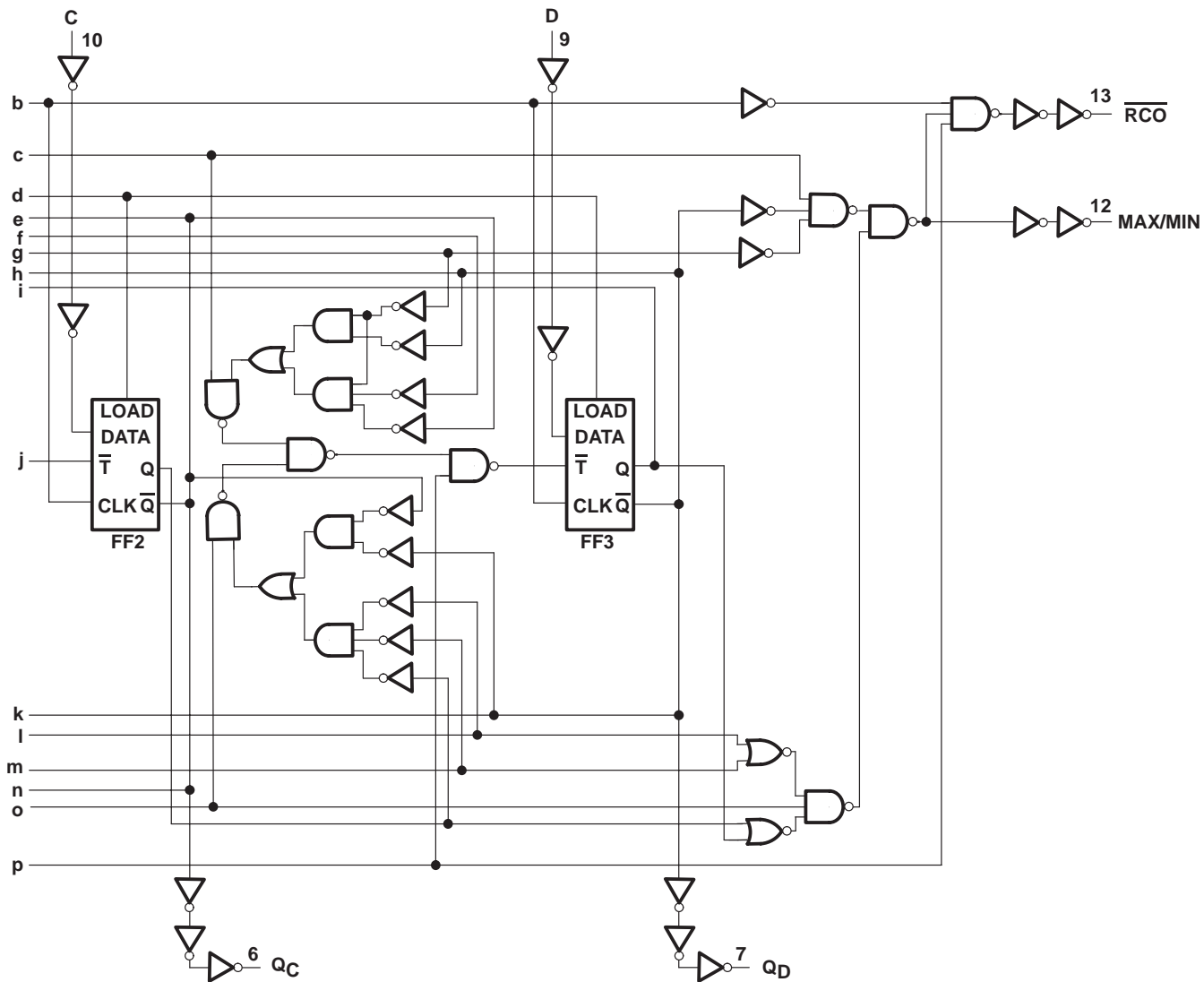
'HC190 logic diagram



CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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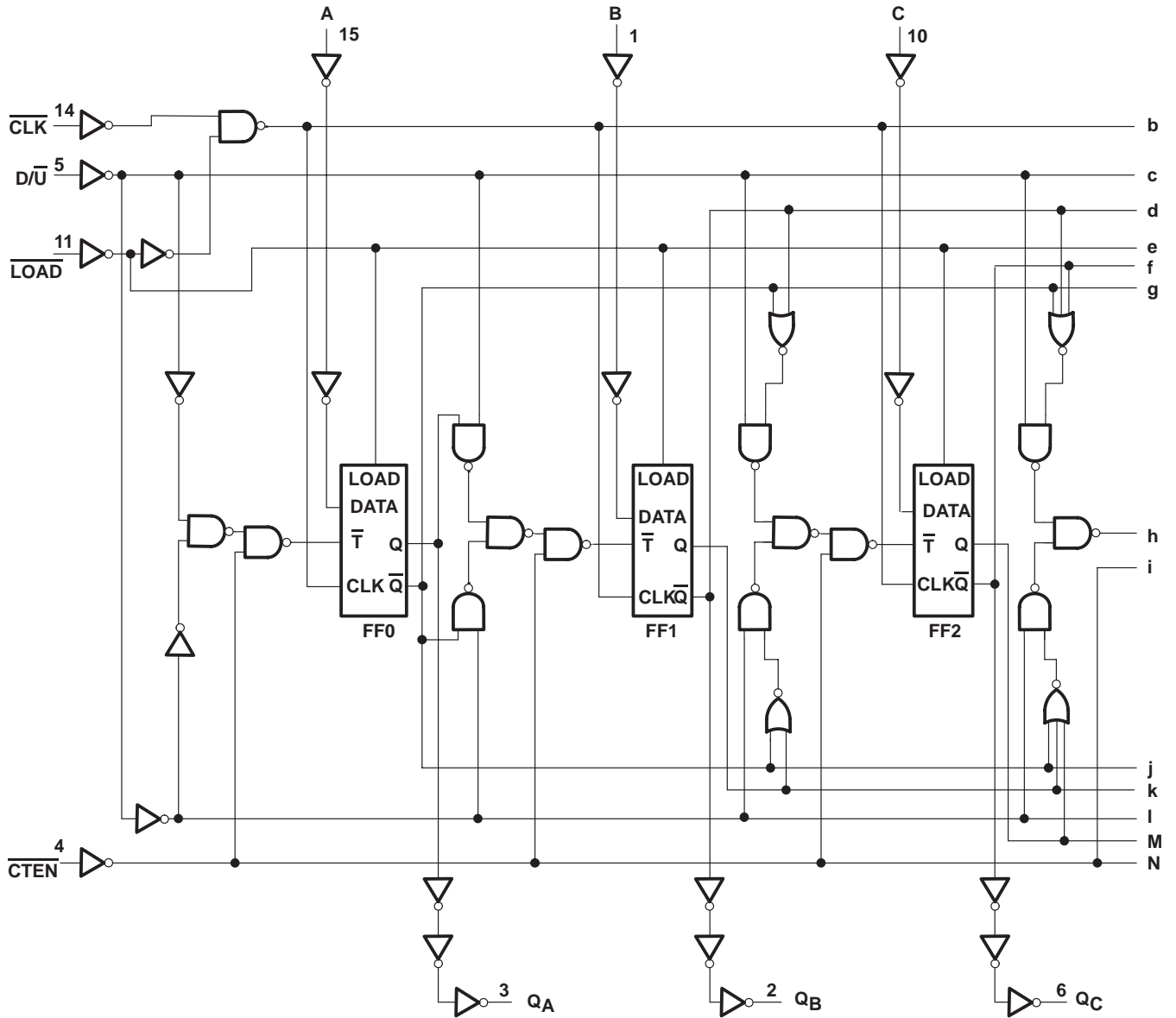
'HC190 logic diagram (continued)



CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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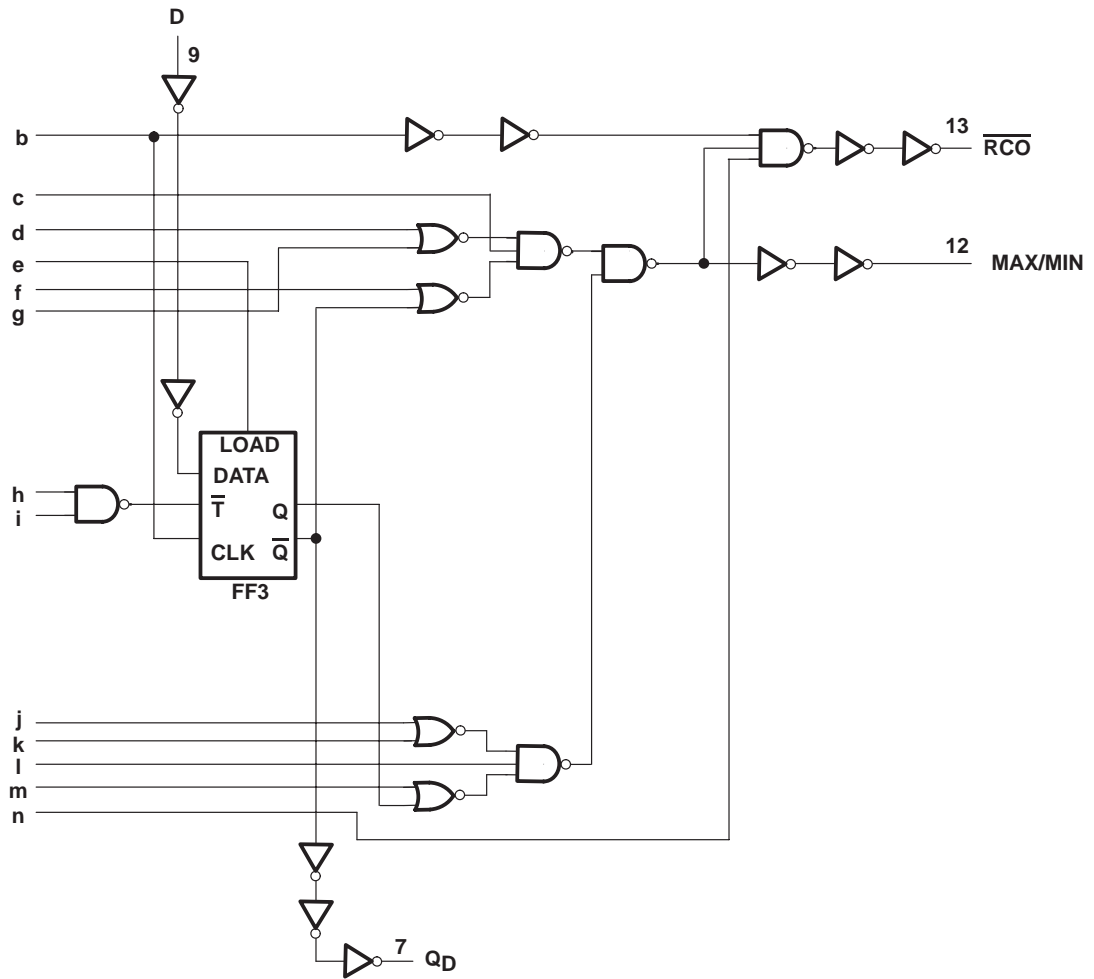
'HC191, 'HCT191 logic diagram



**CD54HC190, CD74HC190
 CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
 SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL**

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'HC191, 'HCT191 logic diagram (continued)



CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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'HC190 and 'HC191/HCT191 flip-flop



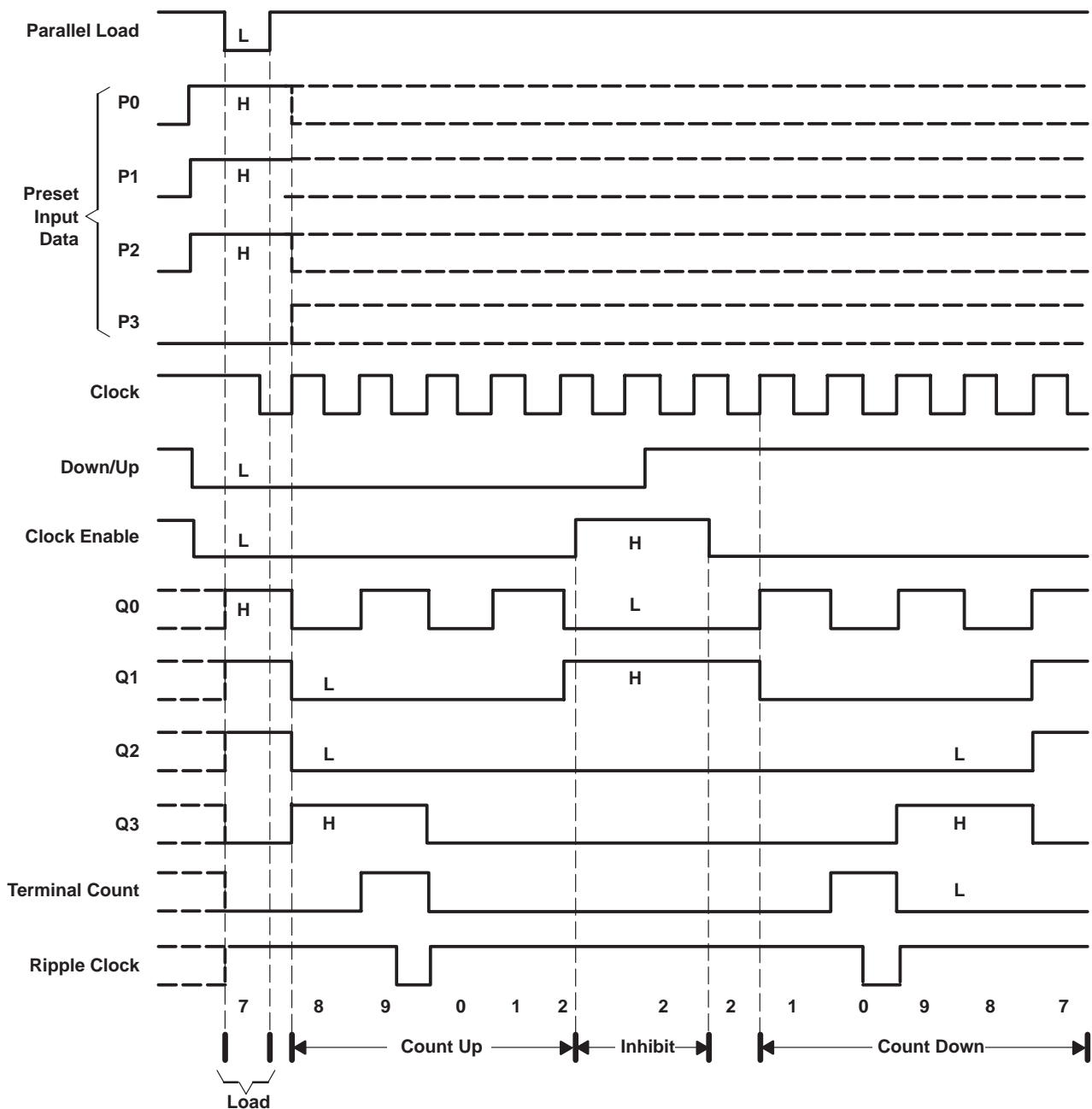
CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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typical load, count, and inhibit sequence for 'HC190

The following sequence is illustrated below:

1. Load (preset) to BCD 7
2. Count up to 8, 9 (maximum), 0, 1, and 2
3. Inhibit
4. Count down to 1, 0 (minimum), 9, 8, and 7



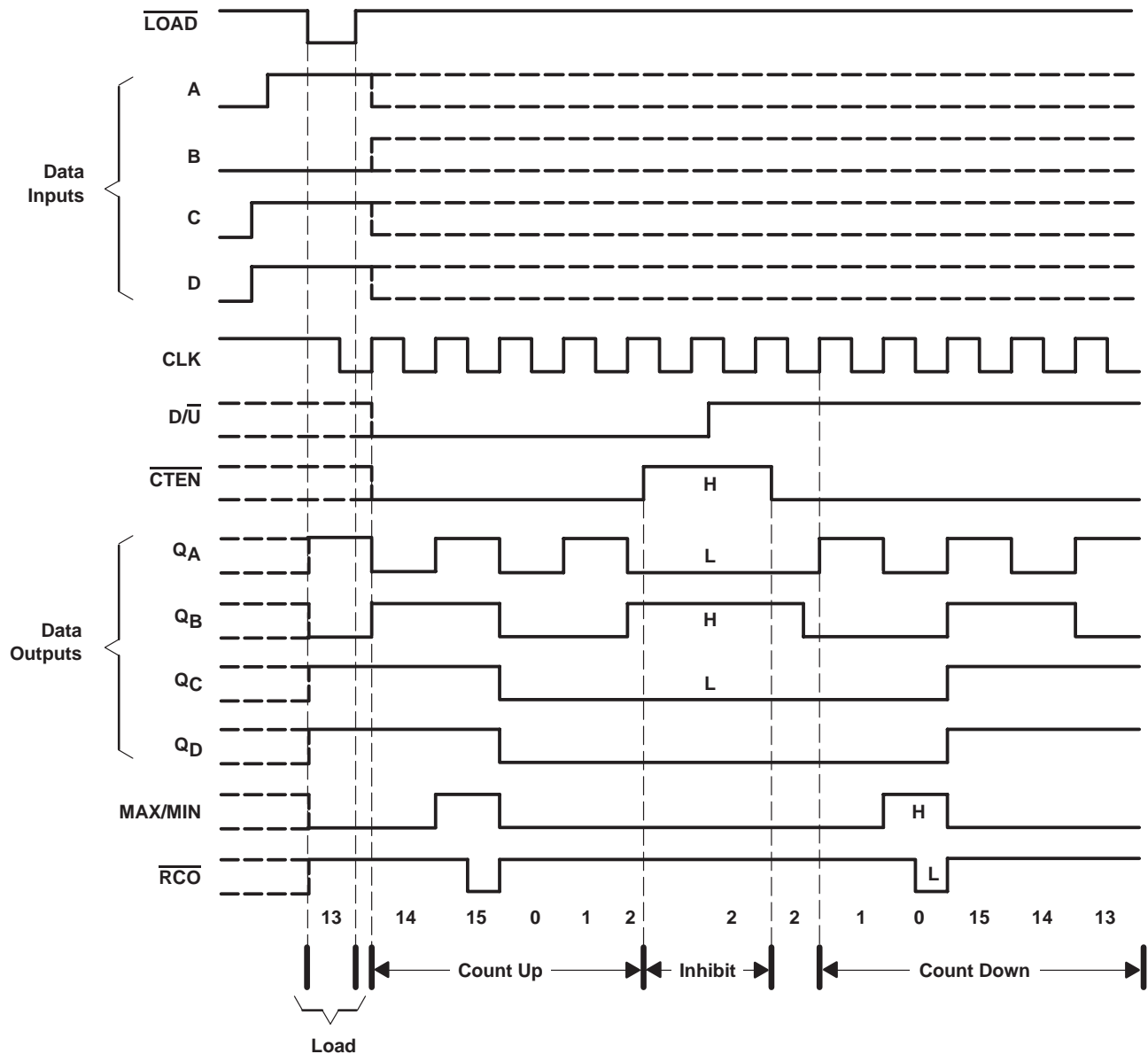
CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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typical load, count, and inhibit sequence for 'HC191 and 'HCT191

The following sequence is illustrated below:

1. Load (preset) to binary 13
2. Count up to 14, 15 (maximum), 0, 1, and 2
3. Inhibit
4. Count down to 1, 0 (minimum), 15, 14, and 13



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SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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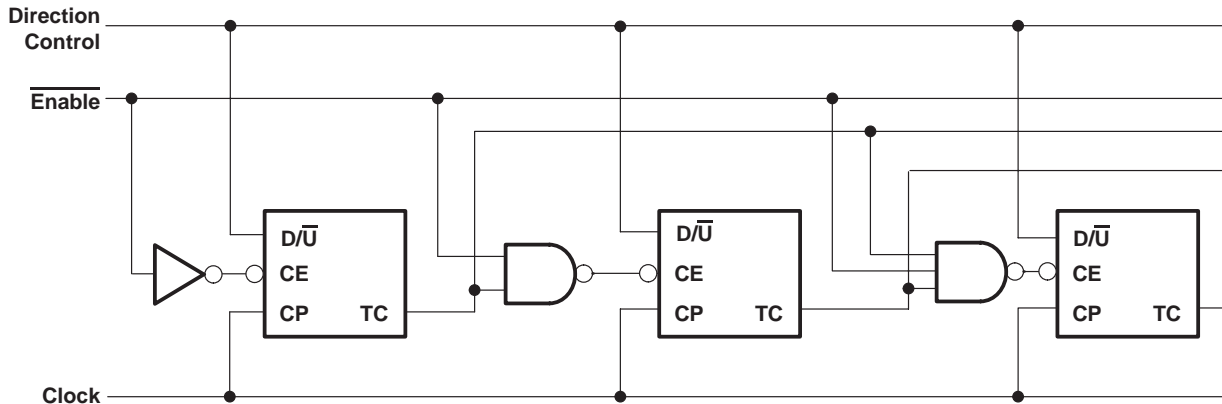


Figure 1. 'HC190 Synchronous n-Stage Counter With Parallel Gated Terminal Count

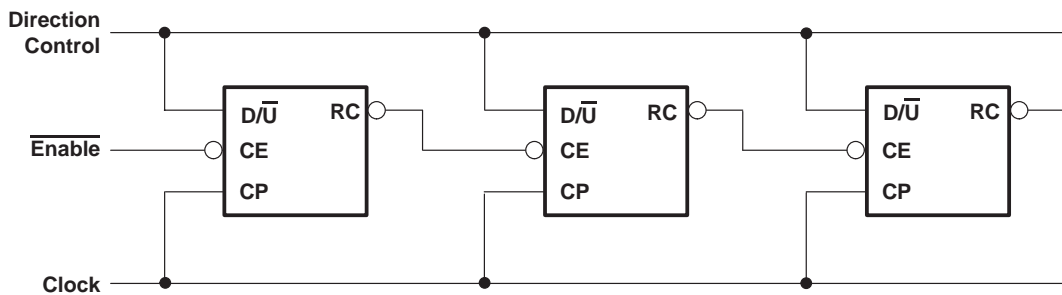
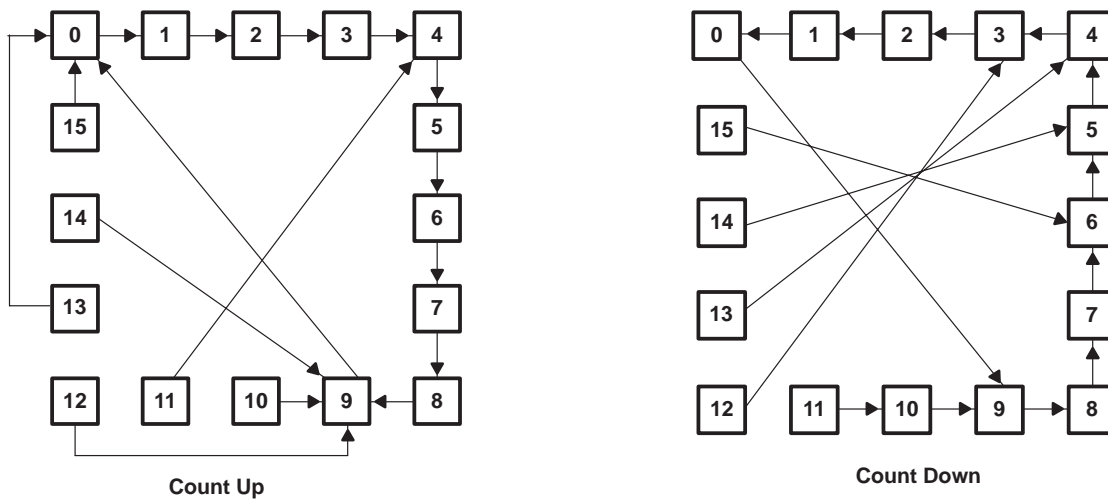


Figure 2. 'HC191, 'HCT191 Synchronous n-Stage Counter With Parallel Gated Terminal Count



NOTE: Illegal states in BCD counters corrected in one count

NOTE: Illegal states in BCD counters corrected in one or two counts

Figure 3. 'HC190 State Diagram

CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

| | |
|--|----------------|
| Supply voltage range, V_{CC} | –0.5 V to 7 V |
| Input clamp current, I_{IK} ($V_I < 0$ or $V_I > V_{CC}$) (see Note 1) | ±20 mA |
| Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) (see Note 1) | ±20 mA |
| Continuous output drain current per output, I_O ($V_O = 0$ to V_{CC}) | ±35 mA |
| Continuous output source or sink current per output, I_O ($V_O = 0$ to V_{CC}) | ±25 mA |
| Continuous current through V_{CC} or GND | ±50 mA |
| Package thermal impedance, θ_{JA} (see Note 2): E package | 67°C/W |
| M package | 73°C/W |
| NS package | 64°C/W |
| PW package | 108°C/W |
| Storage temperature range, T_{stg} | –65°C to 150°C |

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
 2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions for 'HC190 and 'HC191 (see Note 3)

| | | $T_A = 25^\circ\text{C}$ | | $T_A = -55^\circ\text{C}$ TO 125°C | | $T_A = -40^\circ\text{C}$ TO 85°C | | UNIT |
|----------|---------------------------------------|--------------------------|----------|---|----------|--|----------|------|
| | | MIN | MAX | MIN | MAX | MIN | MAX | |
| V_{CC} | Supply voltage | 2 | 6 | 2 | 6 | 2 | 6 | V |
| V_{IH} | High-level input voltage | $V_{CC} = 2\text{ V}$ | | 1.5 | 1.5 | 1.5 | | V |
| | | $V_{CC} = 4.5\text{ V}$ | | 3.15 | 3.15 | 3.15 | | |
| | | $V_{CC} = 6\text{ V}$ | | 4.2 | 4.2 | 4.2 | | |
| V_{IL} | Low-level input voltage | $V_{CC} = 2\text{ V}$ | | 0.5 | | 0.5 | | V |
| | | $V_{CC} = 4.5\text{ V}$ | | 1.35 | | 1.35 | | |
| | | $V_{CC} = 6\text{ V}$ | | 1.8 | | 1.8 | | |
| V_I | Input voltage | 0 | V_{CC} | 0 | V_{CC} | 0 | V_{CC} | V |
| V_O | Output voltage | 0 | V_{CC} | 0 | V_{CC} | 0 | V_{CC} | V |
| t_t | Input transition (rise and fall) time | $V_{CC} = 2\text{ V}$ | | 1000 | | 1000 | | ns |
| | | $V_{CC} = 4.5\text{ V}$ | | 500 | | 500 | | |
| | | $V_{CC} = 6\text{ V}$ | | 400 | | 400 | | |

NOTE 3: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

recommended operating conditions for 'HCT191 (see Note 4)

| | | $T_A = 25^\circ\text{C}$ | | $T_A = -55^\circ\text{C}$ TO 125°C | | $T_A = -40^\circ\text{C}$ TO 85°C | | UNIT |
|----------|---------------------------------------|--------------------------|-----|---|-----|--|-----|------|
| | | MIN | MAX | MIN | MAX | MIN | MAX | |
| V_{CC} | Supply voltage | 4.5 | 5.5 | 4.5 | 5.5 | 4.5 | 5.5 | V |
| V_{IH} | High-level input voltage | 2 | | 2 | | 2 | | V |
| V_{IL} | Low-level input voltage | 0.8 | | 0.8 | | 0.8 | | V |
| V_I | Input voltage | V_{CC} | | V_{CC} | | V_{CC} | | V |
| V_O | Output voltage | V_{CC} | | V_{CC} | | V_{CC} | | V |
| t_t | Input transition (rise and fall) time | 500 | | 500 | | 500 | | ns |

NOTE 4: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.



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SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

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'HC190, 'HC191

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | | V _{CC} | T _A = 25°C | | T _A = -55°C TO 125°C | | T _A = -40°C TO 85°C | | UNIT |
|-----------------|---|---------------------------|-----------------|-----------------------|-----|---------------------------------|-----|--------------------------------|-----|------|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| V _{OH} | V _I = V _{IH} or V _{IL} | I _{OH} = -20 μA | 2 V | 1.9 | 1.9 | 1.9 | | | V | |
| | | | 4.5 V | 4.4 | 4.4 | 4.4 | | | | |
| | | | 6 V | 5.9 | 5.9 | 5.9 | | | | |
| | | I _{OH} = -4 mA | 4.5 V | 3.98 | 3.7 | 3.84 | | | | |
| | | I _{OH} = -5.2 mA | 6 V | 5.48 | 5.2 | 5.34 | | | | |
| V _{OL} | V _I = V _{IH} or V _{IL} | I _{OL} = 20 μA | 2 V | 0.1 | 0.1 | 0.1 | | | V | |
| | | | 4.5 V | 0.1 | 0.1 | 0.1 | | | | |
| | | | 6 V | 0.1 | 0.1 | 0.1 | | | | |
| | | I _{OL} = 4 mA | 4.5 V | 0.26 | 0.4 | 0.33 | | | | |
| | | I _{OL} = 5.2 mA | 6 V | 0.26 | 0.4 | 0.33 | | | | |
| I _I | V _I = V _{CC} or 0 | | 6 V | ±0.1 | | ±1 | ±1 | ±1 | μA | |
| I _{CC} | V _I = V _{CC} or 0, I _O = 0 | | 6 V | 8 | | 160 | 80 | 80 | μA | |
| C _i | | | | 10 | | 10 | 10 | 10 | pF | |

'HCT191

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | | V _{CC} | T _A = 25°C | | | T _A = -55°C TO 125°C | | T _A = -40°C TO 85°C | | UNIT |
|--------------------|--|--------------------------|-----------------|-----------------------|-----|-----|---------------------------------|-----|--------------------------------|-----|------|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| V _{OH} | V _I = V _{IH} or V _{IL} | I _{OH} = -20 μA | 4.5 V | 4.4 | | | 4.4 | | 4.4 | V | |
| | | I _{OH} = -4 mA | | 3.98 | | | 3.7 | | 3.84 | | |
| V _{OL} | V _I = V _{IH} or V _{IL} | I _{OL} = 20 μA | 4.5 V | | | | 0.1 | | 0.1 | V | |
| | | I _{OL} = 4 mA | | | | | 0.26 | | 0.4 | | 0.33 |
| I _I | V _I = V _{CC} to GND | | 5.5 V | | | | ±0.1 | | ±1 | ±1 | μA |
| I _{CC} | V _I = V _{CC} or 0, I _O = 0 | | 5.5 V | | | | 8 | | 160 | 80 | μA |
| ΔI _{CC} † | One input at V _{CC} - 2.1 V, Other inputs at 0 or V _{CC} | | 4.5 V to 5.5 V | | 100 | 360 | | | 490 | 450 | μA |
| C _i | | | | | | | 10 | | 10 | 10 | pF |

† Additional quiescent supply current per input pin, TTL inputs high, 1 unit load

HCT INPUT LOADING TABLE

| INPUTS | UNIT LOADS |
|--------|------------|
| A-D | 0.4 |
| CLK | 1.5 |
| LOAD | 1.5 |
| D/Ū | 1.2 |
| CTEN | 1.5 |

Unit load is ΔI_{CC} limit specified in electrical characteristics table, (e.g., 360 μA max at 25°C).



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'HC190, 'HC191 timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 4)

| | | V _{CC} | T _A = 25°C | | T _A = -55°C TO 125°C | | T _A = -40°C TO 85°C | | UNIT |
|--------------------|---|-----------------|-----------------------|-----|---------------------------------|-----|--------------------------------|-----|------|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| f _{clock} | Clock frequency† | 2 V | 6 | | 4 | | 5 | | MHz |
| | | 4.5 V | 30 | | 20 | | 25 | | |
| | | 6 V | 35 | | 23 | | 29 | | |
| t _w | $\overline{\text{LOAD}}$ low | 2 V | 80 | | 120 | | 100 | | ns |
| | | 4.5 V | 16 | | 24 | | 20 | | |
| | | 6 V | 14 | | 20 | | 17 | | |
| | CLK high or low | 2 V | 100 | | 150 | | 125 | | |
| | | 4.5 V | 20 | | 30 | | 25 | | |
| | | 6 V | 17 | | 26 | | 21 | | |
| t _{su} | Data before $\overline{\text{LOAD}}\uparrow$ | 2 V | 60 | | 90 | | 75 | | ns |
| | | 4.5 V | 12 | | 18 | | 15 | | |
| | | 6 V | 10 | | 15 | | 13 | | |
| | $\overline{\text{CTEN}}$ before CLK \uparrow | 2 V | 60 | | 90 | | 75 | | |
| | | 4.5 V | 12 | | 18 | | 15 | | |
| | | 6 V | 10 | | 15 | | 13 | | |
| | D/ $\overline{\text{U}}$ before CLK \uparrow | 2 V | 90 | | 135 | | 115 | | |
| | | 4.5 V | 18 | | 27 | | 23 | | |
| | | 6 V | 15 | | 23 | | 20 | | |
| t _h | Data before $\overline{\text{LOAD}}\uparrow$ | 2 V | 2 | | 2 | | 2 | | ns |
| | | 4.5 V | 2 | | 2 | | 2 | | |
| | | 6 V | 2 | | 2 | | 2 | | |
| | $\overline{\text{CTEN}}$ before CLK \uparrow | 2 V | 2 | | 2 | | 2 | | |
| | | 4.5 V | 2 | | 2 | | 2 | | |
| | | 6 V | 2 | | 2 | | 2 | | |
| | D/ $\overline{\text{U}}$ before CLK \uparrow | 2 V | 0 | | 0 | | 0 | | |
| | | 4.5 V | 0 | | 0 | | 0 | | |
| | | 6 V | 0 | | 0 | | 0 | | |
| t _{rec} | $\overline{\text{LOAD}}$ inactive before CLK \uparrow | 2 V | 60 | | 90 | | 75 | | ns |
| | | 4.5 V | 12 | | 18 | | 15 | | |
| | | 6 V | 10 | | 15 | | 13 | | |

† Applies to noncascaded operation only. With cascaded counters, clock-to-terminal count propagation delays, CTEN-to-clock setup times, and CTEN-to-clock hold times determine maximum clock frequency. For example, with these HC devices:

$$f_{\text{max}}(\text{CLK}) = \frac{1}{\text{CLK-to-MAX/MIN propagation delay} + \overline{\text{CTEN-to-CLK}} \text{ setup time} + \overline{\text{CTEN-to-CLK}} \text{ hold time}} = \frac{1}{42 + 12 + 2} \approx 18 \text{ MHz}$$



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'HC190, 'HC191

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 4)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE | V _{CC} | T _A = 25°C | | | T _A = -55°C TO 125°C | | T _A = -40°C TO 85°C | | UNIT | | | | | | | |
|------------------|--------------------------|-------------------------|------------------------|-----------------|-----------------------|-----|-----|---------------------------------|-----|--------------------------------|-----|------------------------|-----|----|----|------------------------|-----|-----|-----|
| | | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | | | | | | | | |
| f _{max} | | | | 2 V | 6 | | | 4 | | 5 | MHz | | | | | | | | |
| | | | | 4.5 V | 30 | | | 20 | | 25 | | | | | | | | | |
| | | | | 6 V | 35 | | | 23 | | 29 | | | | | | | | | |
| t _{pd} | $\overline{\text{LOAD}}$ | Q | C _L = 50 pF | 2 V | | 195 | | 295 | | 245 | ns | | | | | | | | |
| | | | | 4.5 V | | 39 | | 59 | | 49 | | | | | | | | | |
| | | | | 6 V | | 33 | | 50 | | 42 | | | | | | | | | |
| | A, B, C, or D | Q | C _L = 50 pF | 2 V | | 175 | | 265 | | 220 | | | | | | | | | |
| | | | | 4.5 V | | 35 | | 53 | | 44 | | | | | | | | | |
| | | | | 6 V | | 30 | | 45 | | 37 | | | | | | | | | |
| | CLK | Q | C _L = 50 pF | 2 V | | 170 | | 255 | | 215 | | | | | | | | | |
| | | | | 4.5 V | | 34 | | 51 | | 43 | | | | | | | | | |
| | | | | 6 V | | 29 | | 43 | | 37 | | | | | | | | | |
| | CLK | $\overline{\text{RCO}}$ | C _L = 50 pF | 2 V | | 125 | | 190 | | 155 | | | | | | | | | |
| | | | | 4.5 V | | 25 | | 38 | | 31 | | | | | | | | | |
| | | | | 6 V | | 21 | | 32 | | 26 | | | | | | | | | |
| | CLK | MAX/MIN | C _L = 50 pF | 2 V | | 210 | | 315 | | 265 | | | | | | | | | |
| | | | | 4.5 V | | 42 | | 63 | | 53 | | | | | | | | | |
| | | | | 6 V | | 36 | | 54 | | 45 | | | | | | | | | |
| | D/ $\overline{\text{U}}$ | $\overline{\text{RCO}}$ | C _L = 50 pF | 2 V | | 150 | | 225 | | 190 | | | | | | | | | |
| | | | | 4.5 V | | 30 | | 45 | | 38 | | | | | | | | | |
| | | | | 6 V | | 26 | | 38 | | 33 | | | | | | | | | |
| | D/ $\overline{\text{U}}$ | MAX/MIN | C _L = 50 pF | 2 V | | 165 | | 250 | | 205 | | | | | | | | | |
| | | | | 4.5 V | | 33 | | 50 | | 41 | | | | | | | | | |
| | | | | 6 V | | 28 | | 43 | | 35 | | | | | | | | | |
| | $\overline{\text{CTEN}}$ | $\overline{\text{RCO}}$ | C _L = 50 pF | 2 V | | 125 | | 190 | | 155 | | | | | | | | | |
| | | | | 4.5 V | | 25 | | 38 | | 31 | | | | | | | | | |
| | | | | 6 V | | 21 | | 32 | | 26 | | | | | | | | | |
| | C _L = 15 pF | 5 V | | | | 10 | | | | | | | | | | | | | |
| | | | | | | | | | | | | C _L = 50 pF | 2 V | | | 125 | | 190 | 155 |
| | | | | | | | | | | | | | | | | | | | |
| | 6 V | | | 21 | | 32 | 26 | | | | | | | | | | | | |
| | | | | | | | | 5 V | | | | 10 | | | | | | | |
| | | | | | | | | | | | | | | | | C _L = 50 pF | 2 V | | |
| | 4.5 V | | | 15 | | 22 | 19 | | | | | | | | | | | | |
| | | | | | | | | 6 V | | | | 13 | | 19 | 16 | | | | |



CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

SCHS275E – MARCH 2002 – REVISED OCTOBER 2003

'HCT191

timing requirements over recommended operating free-air temperature range $V_{CC} = 4.5\text{ V}$ (unless otherwise noted) (see Figure 5)

| | | $T_A = 25^\circ\text{C}$ | | $T_A = -55^\circ\text{C}$ TO 125°C | | $T_A = -40^\circ\text{C}$ TO 85°C | | UNIT |
|--------------------|-----------------|---|-----|---|-----|--|-----|------|
| | | MIN | MAX | MIN | MAX | MIN | MAX | |
| f_{clock} | Clock frequency | 30 | | 20 | | 25 | | MHz |
| t_w | Pulse duration | $\overline{\text{LOAD}}$ low | 16 | 24 | 20 | | | ns |
| | | CLK high or low | 20 | 30 | 25 | | | |
| t_{su} | Setup time | Data before $\overline{\text{LOAD}}\uparrow$ | 12 | 18 | 15 | | | ns |
| | | $\overline{\text{CTEN}}$ before $\text{CLK}\uparrow$ | 12 | 18 | 15 | | | |
| | | $\text{D}/\overline{\text{U}}$ before $\text{CLK}\uparrow$ | 18 | 27 | 23 | | | |
| t_h | Hold time | Data before $\overline{\text{LOAD}}\uparrow$ | 2 | 2 | 2 | | | ns |
| | | $\overline{\text{CTEN}}$ before $\text{CLK}\uparrow$ | 2 | 2 | 2 | | | |
| | | $\text{D}/\overline{\text{U}}$ before $\text{CLK}\uparrow$ | 0 | 0 | 0 | | | |
| t_{rec} | Recovery time | $\overline{\text{LOAD}}$ inactive before $\text{CLK}\uparrow$ | 12 | 18 | 15 | | | ns |

'HCT191

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 5)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE | V_{CC} | $T_A = 25^\circ\text{C}$ | | | $T_A = -55^\circ\text{C}$ TO 125°C | | $T_A = -40^\circ\text{C}$ TO 85°C | | UNIT |
|--------------------------|--------------------------------|-------------------------|----------------------|----------|--------------------------|-----|-----|---|-----|--|-----|------|
| | | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| f_{max} | | | | 4.5 V | 30 | | | 20 | | 25 | | MHz |
| t_{pd} | $\overline{\text{LOAD}}$ | Q | $C_L = 50\text{ pF}$ | 4.5 V | | | 40 | | 60 | | 50 | ns |
| | | | $C_L = 15\text{ pF}$ | 5 V | | 17 | | | | | | |
| | A, B, C, or D | Q | $C_L = 50\text{ pF}$ | 4.5 V | | | 38 | | 57 | | 48 | |
| | | | $C_L = 15\text{ pF}$ | 5 V | | 16 | | | | | | |
| | CLK | $\overline{\text{RCO}}$ | $C_L = 50\text{ pF}$ | 4.5 V | | | 35 | | 53 | | 44 | |
| | | | $C_L = 15\text{ pF}$ | 5 V | | 14 | | | | | | |
| | CLK | Q | $C_L = 50\text{ pF}$ | 4.5 V | | | 27 | | 41 | | 34 | |
| | | | $C_L = 15\text{ pF}$ | 5 V | | 11 | | | | | | |
| | CLK | MAX/MIN | $C_L = 50\text{ pF}$ | 4.5 V | | | 42 | | 63 | | 53 | |
| | | | $C_L = 15\text{ pF}$ | 5 V | | 18 | | | | | | |
| | $\text{D}/\overline{\text{U}}$ | $\overline{\text{RCO}}$ | $C_L = 50\text{ pF}$ | 4.5 V | | | 30 | | 45 | | 38 | |
| | | | $C_L = 15\text{ pF}$ | 5 V | | 12 | | | | | | |
| | $\text{D}/\overline{\text{U}}$ | MAX/MIN | $C_L = 50\text{ pF}$ | 4.5 V | | | 38 | | 57 | | 48 | |
| | | | $C_L = 15\text{ pF}$ | 5 V | | 16 | | | | | | |
| $\overline{\text{CTEN}}$ | $\overline{\text{RCO}}$ | $C_L = 50\text{ pF}$ | 4.5 V | | | 27 | | 41 | | 34 | | |
| | | $C_L = 15\text{ pF}$ | 5 V | | 11 | | | | | | | |
| t_t | | Any | $C_L = 50\text{ pF}$ | 4.5 V | | | 15 | | 22 | | 19 | ns |



CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

SCHS275E – MARCH 2002 – REVISED OCTOBER 2003

operating characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

| PARAMETER | | TYP | UNIT |
|--|---------|-----|------|
| C_{pd} Power dissipation capacitance | 'HC190 | 59 | pF |
| | 'HC191 | 55 | |
| | 'HCT191 | 68 | |

CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

SCHS275E – MARCH 2002 – REVISED OCTOBER 2003

PARAMETER MEASUREMENT INFORMATION – 'HC190, 'HC191



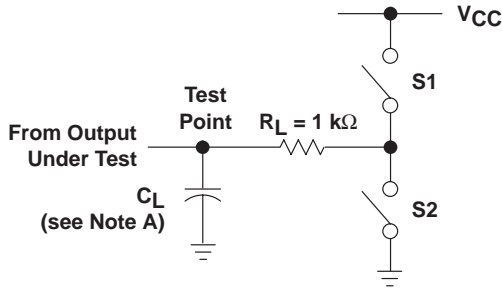
- NOTES: A. C_L includes probe and test-fixture capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 C. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r = 6\text{ ns}$, $t_f = 6\text{ ns}$.
 D. For clock inputs, f_{max} is measured with the input duty cycle at 50%.
 E. The outputs are measured one at a time with one input transition per measurement.
 F. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 G. t_{PZL} and t_{PZH} are the same as t_{en} .
 H. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 4. Load Circuit and Voltage Waveforms

CD54HC190, CD74HC190
CD54HC191, CD74HC191, CD54HCT191, CD74HCT191
SYNCHRONOUS UP/DOWN COUNTERS WITH DOWN/UP MODE CONTROL

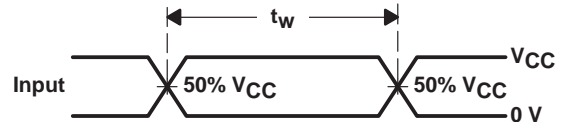
SCHS275E – MARCH 2002 – REVISED OCTOBER 2003

PARAMETER MEASUREMENT INFORMATION – 'HCT191

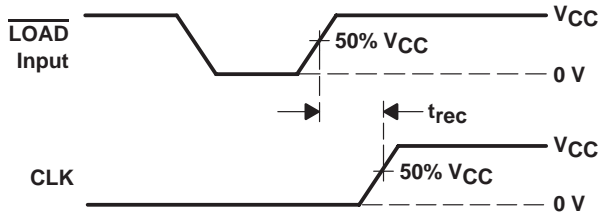


LOAD CIRCUIT

| PARAMETER | S1 | S2 | |
|-------------------|-----------|--------|--------|
| t_{en} | t_{PZH} | Open | Closed |
| | t_{PZL} | Closed | Open |
| t_{dis} | t_{PHZ} | Open | Closed |
| | t_{PLZ} | Closed | Open |
| t_{pd} or t_t | Open | Open | |



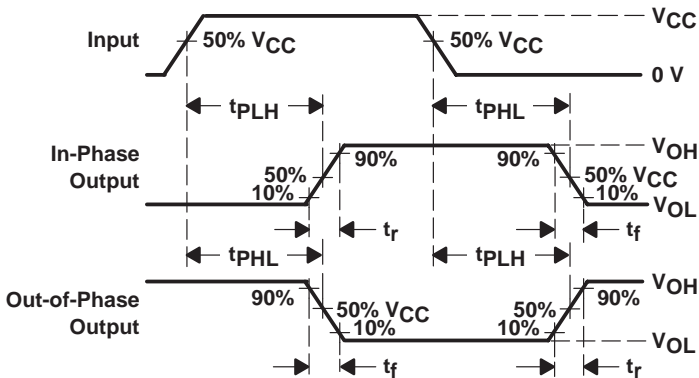
VOLTAGE WAVEFORMS
PULSE DURATION



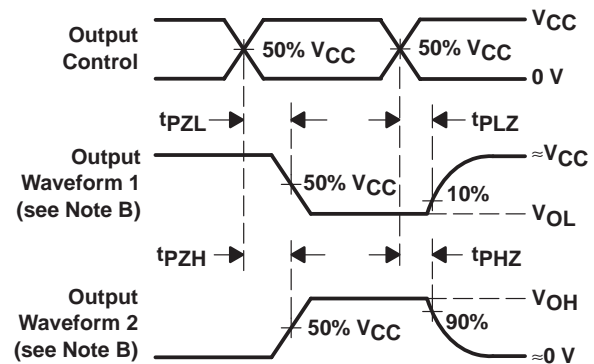
VOLTAGE WAVEFORMS
RECOVERY TIME



VOLTAGE WAVEFORMS
SETUP AND HOLD AND INPUT RISE AND FALL TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY AND OUTPUT TRANSITION TIMES



VOLTAGE WAVEFORMS
OUTPUT ENABLE AND DISABLE TIMES

- NOTES: A. C_L includes probe and test-fixture capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 C. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1$ MHz, $Z_O = 50 \Omega$, $t_r = 6$ ns, $t_f = 6$ ns.
 D. For clock inputs, f_{max} is measured with the input duty cycle at 50%.
 E. The outputs are measured one at a time with one input transition per measurement.
 F. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 G. t_{PZL} and t_{PZH} are the same as t_{en} .
 H. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 5. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package Pins | Package qty Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|--------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------------------|
| 5962-8867101EA | Active | Production | CDIP (J) 16 | 25 TUBE | No | SNPB | N/A for Pkg Type | -55 to 125 | 5962-8867101EA CD54HCT191F3A |
| 5962-8994601EA | Active | Production | CDIP (J) 16 | 25 TUBE | No | SNPB | N/A for Pkg Type | -55 to 125 | 5962-8994601EA CD54HC190F3A |
| CD54HC190F3A | Active | Production | CDIP (J) 16 | 25 TUBE | No | SNPB | N/A for Pkg Type | -55 to 125 | 5962-8994601EA CD54HC190F3A |
| CD54HC190F3A.A | Active | Production | CDIP (J) 16 | 25 TUBE | No | SNPB | N/A for Pkg Type | -55 to 125 | 5962-8994601EA CD54HC190F3A |
| CD54HC191F3A | Active | Production | CDIP (J) 16 | 25 TUBE | No | SNPB | N/A for Pkg Type | -55 to 125 | 5962-8689101EA CD54HC191F3A |
| CD54HC191F3A.A | Active | Production | CDIP (J) 16 | 25 TUBE | No | SNPB | N/A for Pkg Type | -55 to 125 | 5962-8689101EA CD54HC191F3A |
| CD54HCT191F3A | Active | Production | CDIP (J) 16 | 25 TUBE | No | SNPB | N/A for Pkg Type | -55 to 125 | 5962-8867101EA CD54HCT191F3A |
| CD54HCT191F3A.A | Active | Production | CDIP (J) 16 | 25 TUBE | No | SNPB | N/A for Pkg Type | -55 to 125 | 5962-8867101EA CD54HCT191F3A |
| CD74HC190E | Active | Production | PDIP (N) 16 | 25 TUBE | Yes | NIPDAU | N/A for Pkg Type | -55 to 125 | CD74HC190E |
| CD74HC190E.A | Active | Production | PDIP (N) 16 | 25 TUBE | Yes | NIPDAU | N/A for Pkg Type | -55 to 125 | CD74HC190E |
| CD74HC190NSR | Active | Production | SOP (NS) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -55 to 125 | HC190M |
| CD74HC190NSR.A | Active | Production | SOP (NS) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -55 to 125 | HC190M |
| CD74HC190PW | Obsolete | Production | TSSOP (PW) 16 | - | - | Call TI | Call TI | -55 to 125 | HJ190 |
| CD74HC190PWR | Active | Production | TSSOP (PW) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -55 to 125 | HJ190 |
| CD74HC190PWR.A | Active | Production | TSSOP (PW) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -55 to 125 | HJ190 |
| CD74HC191E | Active | Production | PDIP (N) 16 | 25 TUBE | Yes | NIPDAU | N/A for Pkg Type | -55 to 125 | CD74HC191E |
| CD74HC191E.A | Active | Production | PDIP (N) 16 | 25 TUBE | Yes | NIPDAU | N/A for Pkg Type | -55 to 125 | CD74HC191E |
| CD74HC191M | Obsolete | Production | SOIC (D) 16 | - | - | Call TI | Call TI | -55 to 125 | HC191M |
| CD74HC191M96 | Active | Production | SOIC (D) 16 | 2500 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -55 to 125 | HC191M |
| CD74HC191M96.A | Active | Production | SOIC (D) 16 | 2500 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -55 to 125 | HC191M |
| CD74HC191MT | Obsolete | Production | SOIC (D) 16 | - | - | Call TI | Call TI | -55 to 125 | HC191M |
| CD74HCT191E | Active | Production | PDIP (N) 16 | 25 TUBE | Yes | NIPDAU | N/A for Pkg Type | -55 to 125 | CD74HCT191E |
| CD74HCT191E.A | Active | Production | PDIP (N) 16 | 25 TUBE | Yes | NIPDAU | N/A for Pkg Type | -55 to 125 | CD74HCT191E |

| Orderable part number | Status (1) | Material type (2) | Package Pins | Package qty Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|-----------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| CD74HCT191M | Active | Production | SOIC (D) 16 | 40 TUBE | Yes | NIPDAU | Level-1-260C-UNLIM | -55 to 125 | HCT191M |
| CD74HCT191M.A | Active | Production | SOIC (D) 16 | 40 TUBE | Yes | NIPDAU | Level-1-260C-UNLIM | -55 to 125 | HCT191M |

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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OTHER QUALIFIED VERSIONS OF CD54HC190, CD54HC191, CD54HCT191, CD74HC190, CD74HC191, CD74HCT191 :

● Catalog : [CD74HC190](#), [CD74HC191](#), [CD74HCT191](#)

● Military : [CD54HC190](#), [CD54HC191](#), [CD54HCT191](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CD74HC190NSR | SOP | NS | 16 | 2000 | 330.0 | 16.4 | 8.1 | 10.4 | 2.5 | 12.0 | 16.0 | Q1 |
| CD74HC190PWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| CD74HC191M96 | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CD74HC190NSR | SOP | NS | 16 | 2000 | 353.0 | 353.0 | 32.0 |
| CD74HC190PWR | TSSOP | PW | 16 | 2000 | 353.0 | 353.0 | 32.0 |
| CD74HC191M96 | SOIC | D | 16 | 2500 | 353.0 | 353.0 | 32.0 |

TUBE


*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|---------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| CD74HC190E | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HC190E | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HC190E.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HC190E.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HC191E | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HC191E | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HC191E.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HC191E.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HCT191E | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HCT191E | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HCT191E.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HCT191E.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HCT191M | D | SOIC | 16 | 40 | 507 | 8 | 3940 | 4.32 |
| CD74HCT191M.A | D | SOIC | 16 | 40 | 507 | 8 | 3940 | 4.32 |

J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---------------|------------------------|------------------------|------------------------|------------------------|
| A | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC |
| B MAX | 0.785 (19,94) | .840 (21,34) | 0.960 (24,38) | 1.060 (26,92) |
| B MIN | — | — | — | — |
| C MAX | 0.300 (7,62) | 0.300 (7,62) | 0.310 (7,87) | 0.300 (7,62) |
| C MIN | 0.245 (6,22) | 0.245 (6,22) | 0.220 (5,59) | 0.245 (6,22) |



4040083/F 03/03

- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package is hermetically sealed with a ceramic lid using glass frit.
 - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



4040049/E 12/2002

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - $\triangle D$ The 20 pin end lead shoulder width is a vendor option, either half or full width.



PACKAGE OUTLINE

NS0016A

SOP - 2.00 mm max height

SOP



4220735/A 12/2021

NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.

EXAMPLE BOARD LAYOUT

NS0016A

SOP - 2.00 mm max height

SOP



4220735/A 12/2021

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

NS0016A

SOP - 2.00 mm max height

SOP



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

4220735/A 12/2021

NOTES: (continued)

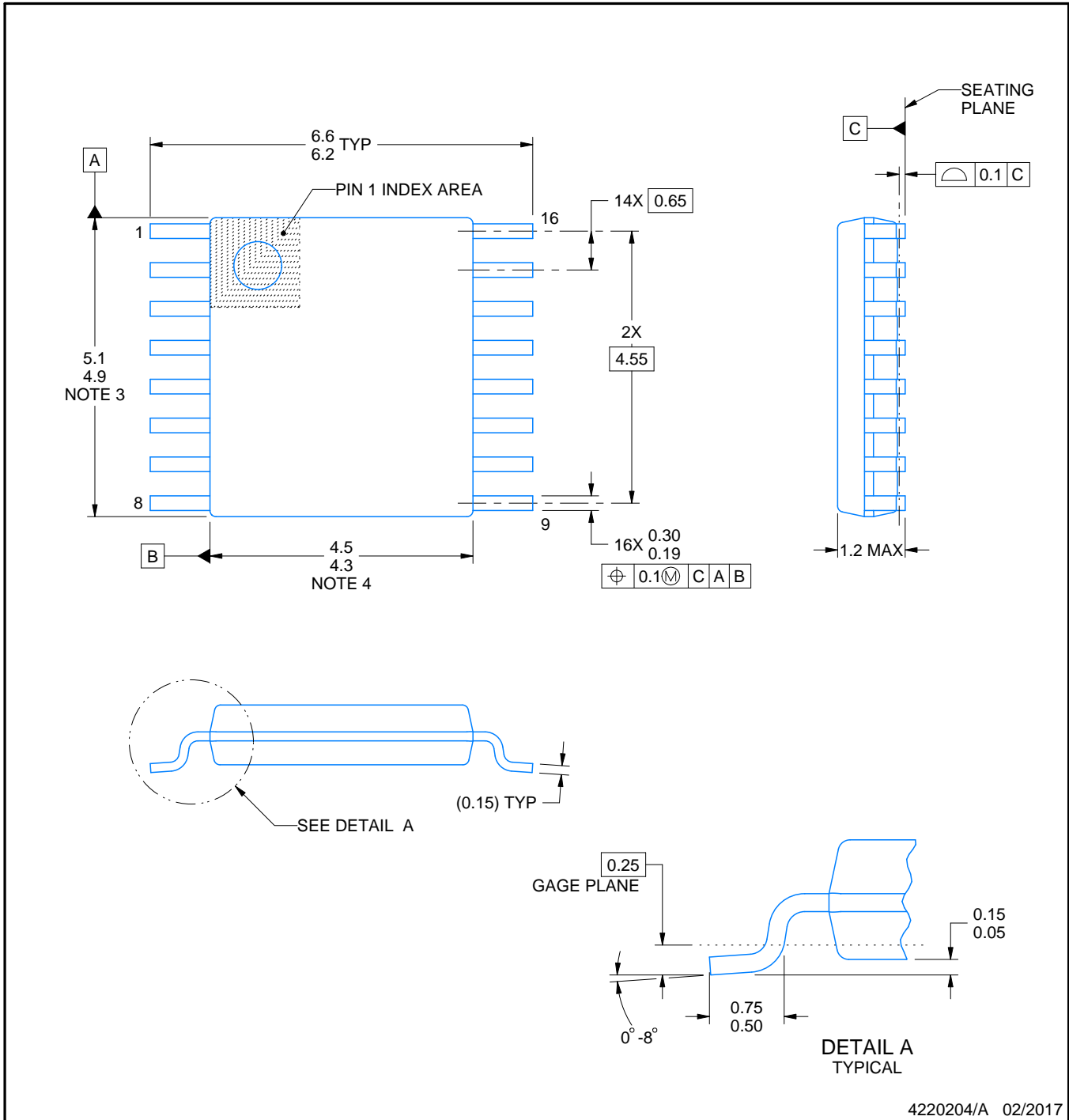
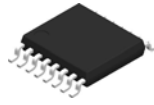
7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AC.



4220204/A 02/2017

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



4220204/A 02/2017

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220204/A 02/2017

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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