

### Features

- 'HC161, 'HCT161 4-Bit Binary Counter, Asynchronous Reset
- 'HC163, 'HCT163 4-Bit Binary Counter, Synchronous Reset
- Synchronous Counting and Loading
- Two Count Enable Inputs for n-Bit Cascading
- Look-Ahead Carry for High-Speed Counting
- Fanout (Over Temperature Range)
  - Standard Outputs . . . . . 10 LSTTL Loads
  - Bus Driver Outputs . . . . . 15 LSTTL Loads
- Wide Operating Temperature Range . . . -55°C to 125°C
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
  - 2V to 6V Operation
  - High Noise Immunity:  $N_{IL} = 30\%$ ,  $N_{IH} = 30\%$  of  $V_{CC}$  at  $V_{CC} = 5V$
- HCT Types
  - 4.5V to 5.5V Operation
  - Direct LSTTL Input Logic Compatibility,  $V_{IL} = 0.8V$  (Max),  $V_{IH} = 2V$  (Min)
  - CMOS Input Compatibility,  $I_I \leq 1\mu A$  at  $V_{OL}$ ,  $V_{OH}$

### Description

The 'HC161, 'HCT161, 'HC163, and 'HCT163 are presettable synchronous counters that feature look-ahead carry logic for use in high-speed counting applications. The 'HC161 and 'HCT161 are asynchronous reset decade and binary counters, respectively; the 'HC163 and 'HCT163 devices are decade and binary counters, respectively, that are reset synchronously with the clock. Counting and parallel presetting are both accomplished synchronously with the negative-to-positive transition of the clock.

A low level on the synchronous parallel enable input, SPE, disables counting operation and allows data at the P0 to P3 inputs to be loaded into the counter (provided that the setup and hold requirements for SPE are met).

All counters are reset with a low level on the Master Reset input, MR. In the 'HC163 and 'HCT163 counters (synchronous reset types), the requirements for setup and hold time with respect to the clock must be met.

Two count enables, PE and TE, in each counter are provided for n-bit cascading. In all counters reset action occurs regardless of the level of the  $\overline{SPE}$ , PE and TE inputs (and the clock input, CP, in the 'HC161 and 'HCT161 types).

If a decade counter is preset to an illegal state or assumes an illegal state when power is applied, it will return to the normal sequence in one count as shown in state diagram.

The look-ahead carry feature simplifies serial cascading of the counters. Both count enable inputs (PE and TE) must be high to count. The TE input is gated with the Q outputs of all four stages so that at the maximum count the terminal count (TC) output goes high for one clock period. This TC pulse is used to enable the next cascaded stage.

### Ordering Information

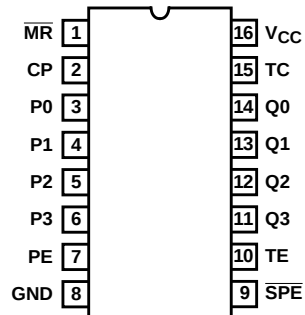
| PART NUMBER   | TEMP. RANGE (°C) | PACKAGE      |
|---------------|------------------|--------------|
| CD54HC161F3A  | -55 to 125       | 16 Ld CERDIP |
| CD54HC163F3A  | -55 to 125       | 16 Ld CERDIP |
| CD54HCT163F3A | -55 to 125       | 16 Ld CERDIP |
| CD74HC161E    | -55 to 125       | 16 Ld PDIP   |
| CD74HC161M    | -55 to 125       | 16 Ld SOIC   |
| CD74HC161MT   | -55 to 125       | 16 Ld SOIC   |
| CD74HC161M96  | -55 to 125       | 16 Ld SOIC   |
| CD74HC163E    | -55 to 125       | 16 Ld PDIP   |
| CD74HC163M    | -55 to 125       | 16 Ld SOIC   |
| CD74HC163MT   | -55 to 125       | 16 Ld SOIC   |
| CD74HC163M96  | -55 to 125       | 16 Ld SOIC   |
| CD74HCT161E   | -55 to 125       | 16 Ld PDIP   |
| CD74HCT161M   | -55 to 125       | 16 Ld SOIC   |
| CD74HCT161MT  | -55 to 125       | 16 Ld SOIC   |
| CD74HCT161M96 | -55 to 125       | 16 Ld SOIC   |
| CD74HCT163E   | -55 to 125       | 16 Ld PDIP   |
| CD74HCT163M   | -55 to 125       | 16 Ld SOIC   |
| CD74HCT163MT  | -55 to 125       | 16 Ld SOIC   |
| CD74HCT163M96 | -55 to 125       | 16 Ld SOIC   |

NOTE: When ordering, use the entire part number. The suffix 96 denotes tape and reel. The suffix T denotes a small-quantity reel of 250.

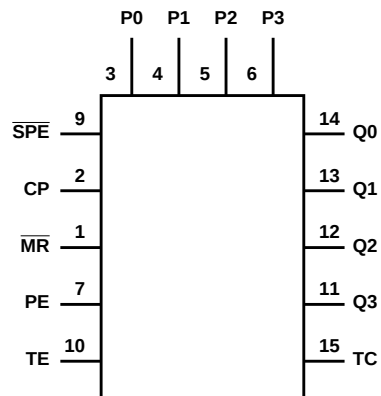
## CD54/74HC161, CD54/74HCT161, CD54/74HC163, CD54/74HCT163

### Pinout

CD54HC161, CD54HCT161, CD54HC163, CD54HCT163  
(CERDIP)  
CD74HC161, CD74HCT161, CD74HC163, CD74HCT163  
(PDIP, SOIC)  
TOP VIEW



### Functional Diagram



**CD54/74HC161, CD54/74HCT161, CD54/74HC163, CD54/74HCT163**

**MODE SELECT - FUNCTION TABLE FOR 'HC161 AND 'HCT161**

| OPERATING MODE | INPUTS          |    |            |            |                  |       | OUTPUTS |          |
|----------------|-----------------|----|------------|------------|------------------|-------|---------|----------|
|                | $\overline{MR}$ | CP | PE         | TE         | $\overline{SPE}$ | $P_n$ | $Q_n$   | TC       |
| Reset (Clear)  | L               | X  | X          | X          | X                | X     | L       | L        |
| Parallel Load  | H               | ↑  | X          | X          | l                | l     | L       | L        |
|                | H               | ↑  | X          | X          | l                | h     | H       | (Note 1) |
| Count          | H               | ↑  | h          | h          | h (Note 3)       | X     | Count   | (Note 1) |
| Inhibit        | H               | X  | l (Note 2) | X          | h (Note 3)       | X     | $q_n$   | (Note 1) |
|                | H               | X  | X          | l (Note 2) | h (Note 3)       | X     | $q_n$   | L        |

**MODE SELECT - FUNCTION TABLE FOR 'HC163 AND 'HCT163**

| OPERATING MODE | INPUTS          |    |            |            |                  |       | OUTPUTS |          |
|----------------|-----------------|----|------------|------------|------------------|-------|---------|----------|
|                | $\overline{MR}$ | CP | PE         | TE         | $\overline{SPE}$ | $P_n$ | $Q_n$   | TC       |
| Reset (Clear)  | l               | ↑  | X          | X          | X                | X     | L       | L        |
| Parallel Load  | h (Note 3)      | ↑  | X          | X          | l                | l     | L       | L        |
|                | h (Note 3)      | ↑  | X          | X          | l                | h     | H       | (Note 1) |
| Count          | h (Note 3)      | ↑  | h          | h          | h (Note 3)       | X     | Count   | (Note 1) |
| Inhibit        | h (Note 3)      | X  | l (Note 2) | X          | h (Note 3)       | X     | $q_n$   | (Note 1) |
|                | h (Note 3)      | X  | X          | l (Note 2) | h (Note 3)       | X     | $q_n$   | L        |

H = High voltage level steady state; L = Low voltage level steady state; h = High voltage level one setup time prior to the Low-to-High clock transition; l = Low voltage level one setup time prior to the Low-to-High clock transition; X = Don't Care; q = Lower case letters indicate the state of the referenced output prior to the Low-to-High clock transition; ↑ = Low-to-High clock transition.

**NOTES:**

1. The TC output is High when TE is High and the counter is at Terminal Count (HHHH for HC/HCT161 and 'HC/HCT163).
2. The High-to-Low transition of PE or TE on the 'HC/HCT161 and the 'HC/HCT163 should only occur while CP is HIGH for conventional operation.
3. The Low-to-High transition of  $\overline{SPE}$  on the 'HC/HCT161 and  $\overline{SPE}$  or  $\overline{MR}$  on the 'HC/HCT163 should only occur while CP is HIGH for conventional operation.

# CD54/74HC161, CD54/74HCT161, CD54/74HC163, CD54/74HCT163

## Absolute Maximum Ratings

DC Supply Voltage,  $V_{CC}$  ..... -0.5V to 7V  
 DC Input Diode Current,  $I_{IK}$   
 For  $V_I < -0.5V$  or  $V_I > V_{CC} + 0.5V$  .....  $\pm 20mA$   
 DC Output Diode Current,  $I_{OK}$   
 For  $V_O < -0.5V$  or  $V_O > V_{CC} + 0.5V$  .....  $\pm 20mA$   
 DC Drain Current, per Output,  $I_O$   
 For  $-0.5V < V_O < V_{CC} + 0.5V$  .....  $\pm 25mA$   
 DC Output Source or Sink Current per Output Pin,  $I_O$   
 For  $V_O > -0.5V$  or  $V_O < V_{CC} + 0.5V$  .....  $\pm 25mA$   
 DC  $V_{CC}$  or Ground Current,  $I_{CC}$  .....  $\pm 50mA$

## Thermal Information

Thermal Resistance (Typical, Note 4)  $\theta_{JA}$  ( $^{\circ}C/W$ )  
 E (PDIP) Package ..... 67  
 M (SOIC) Package ..... 73  
 Maximum Junction Temperature .....  $150^{\circ}C$   
 Maximum Storage Temperature Range .....  $-65^{\circ}C$  to  $150^{\circ}C$   
 Maximum Lead Temperature (Soldering 10s) .....  $300^{\circ}C$   
 (SOIC - Lead Tips Only)

## Operating Conditions

Temperature Range,  $T_A$  .....  $-55^{\circ}C$  to  $125^{\circ}C$   
 Supply Voltage Range,  $V_{CC}$   
 HC Types ..... 2V to 6V  
 HCT Types ..... 4.5V to 5.5V  
 DC Input or Output Voltage,  $V_I$ ,  $V_O$  ..... 0V to  $V_{CC}$   
 Input Rise and Fall Time  
 2V ..... 1000ns (Max)  
 4.5V ..... 500ns (Max)  
 6V ..... 400ns (Max)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

- The package thermal impedance is calculated in accordance with JESD 51-7.

## DC Electrical Specifications

| PARAMETER                               | SYMBOL          | TEST CONDITIONS                    |                     | V <sub>CC</sub> (V) | 25°C |     |      | -40°C TO 85°C |      | -55°C TO 125°C |      | UNITS |
|-----------------------------------------|-----------------|------------------------------------|---------------------|---------------------|------|-----|------|---------------|------|----------------|------|-------|
|                                         |                 | V <sub>I</sub> (V)                 | I <sub>O</sub> (mA) |                     | MIN  | TYP | MAX  | MIN           | MAX  | MIN            | MAX  |       |
| HC TYPES                                |                 |                                    |                     |                     |      |     |      |               |      |                |      |       |
| High Level Input Voltage                | V <sub>IH</sub> | -                                  | -                   | 2                   | 1.5  | -   | -    | 1.5           | -    | 1.5            | -    | V     |
|                                         |                 |                                    |                     | 4.5                 | 3.15 | -   | -    | 3.15          | -    | 3.15           | -    | V     |
|                                         |                 |                                    |                     | 6                   | 4.2  | -   | -    | 4.2           | -    | 4.2            | -    | V     |
| Low Level Input Voltage                 | V <sub>IL</sub> | -                                  | -                   | 2                   | -    | -   | 0.5  | -             | 0.5  | -              | 0.5  | V     |
|                                         |                 |                                    |                     | 4.5                 | -    | -   | 1.35 | -             | 1.35 | -              | 1.35 | V     |
|                                         |                 |                                    |                     | 6                   | -    | -   | 1.8  | -             | 1.8  | -              | 1.8  | V     |
| High Level Output Voltage<br>CMOS Loads | V <sub>OH</sub> | V <sub>IH</sub> or V <sub>IL</sub> | -0.02               | 2                   | 1.9  | -   | -    | 1.9           | -    | 1.9            | -    | V     |
|                                         |                 |                                    | -0.02               | 4.5                 | 4.4  | -   | -    | 4.4           | -    | 4.4            | -    | V     |
|                                         |                 |                                    | -0.02               | 6                   | 5.9  | -   | -    | 5.9           | -    | 5.9            | -    | V     |
| High Level Output Voltage<br>TTL Loads  | V <sub>OH</sub> | V <sub>IH</sub> or V <sub>IL</sub> | -                   | -                   | -    | -   | -    | -             | -    | -              | -    | V     |
|                                         |                 |                                    | -4                  | 4.5                 | 3.98 | -   | -    | 3.84          | -    | 3.7            | -    | V     |
|                                         |                 |                                    | -5.2                | 6                   | 5.48 | -   | -    | 5.34          | -    | 5.2            | -    | V     |
| Low Level Output Voltage<br>CMOS Loads  | V <sub>OL</sub> | V <sub>IH</sub> or V <sub>IL</sub> | 0.02                | 2                   | -    | -   | 0.1  | -             | 0.1  | -              | 0.1  | V     |
|                                         |                 |                                    | 0.02                | 4.5                 | -    | -   | 0.1  | -             | 0.1  | -              | 0.1  | V     |
|                                         |                 |                                    | 0.02                | 6                   | -    | -   | 0.1  | -             | 0.1  | -              | 0.1  | V     |
| Low Level Output Voltage<br>TTL Loads   | V <sub>OL</sub> | V <sub>IH</sub> or V <sub>IL</sub> | -                   | -                   | -    | -   | -    | -             | -    | -              | -    | V     |
|                                         |                 |                                    | 4                   | 4.5                 | -    | -   | 0.26 | -             | 0.33 | -              | 0.4  | V     |
|                                         |                 |                                    | 5.2                 | 6                   | -    | -   | 0.26 | -             | 0.33 | -              | 0.4  | V     |
| Input Leakage Current                   | I <sub>I</sub>  | V <sub>CC</sub> or GND             | -                   | 6                   | -    | -   | ±0.1 | -             | ±1   | -              | ±1   | μA    |

**CD54/74HC161, CD54/74HCT161, CD54/74HC163, CD54/74HCT163**

**DC Electrical Specifications (Continued)**

| PARAMETER                                                      | SYMBOL                    | TEST CONDITIONS                    |                     | V <sub>CC</sub> (V) | 25°C |     |      | -40°C TO 85°C |      | -55°C TO 125°C |     | UNITS |
|----------------------------------------------------------------|---------------------------|------------------------------------|---------------------|---------------------|------|-----|------|---------------|------|----------------|-----|-------|
|                                                                |                           | V <sub>I</sub> (V)                 | I <sub>O</sub> (mA) |                     | MIN  | TYP | MAX  | MIN           | MAX  | MIN            | MAX |       |
| Quiescent Device Current                                       | I <sub>CC</sub>           | V <sub>CC</sub> or GND             | 0                   | 6                   | -    | -   | 8    | -             | 80   | -              | 160 | μA    |
| <b>HCT TYPES</b>                                               |                           |                                    |                     |                     |      |     |      |               |      |                |     |       |
| High Level Input Voltage                                       | V <sub>IH</sub>           | -                                  | -                   | 4.5 to 5.5          | 2    | -   | -    | 2             | -    | 2              | -   | V     |
| Low Level Input Voltage                                        | V <sub>IL</sub>           | -                                  | -                   | 4.5 to 5.5          | -    | -   | 0.8  | -             | 0.8  | -              | 0.8 | V     |
| High Level Output Voltage<br>CMOS Loads                        | V <sub>OH</sub>           | V <sub>IH</sub> or V <sub>IL</sub> | -0.02               | 4.5                 | 4.4  | -   | -    | 4.4           | -    | 4.4            | -   | V     |
| High Level Output Voltage<br>TTL Loads                         |                           |                                    | -4                  | 4.5                 | 3.98 | -   | -    | 3.84          | -    | 3.7            | -   | V     |
| Low Level Output Voltage<br>CMOS Loads                         | V <sub>OL</sub>           | V <sub>IH</sub> or V <sub>IL</sub> | 0.02                | 4.5                 | -    | -   | 0.1  | -             | 0.1  | -              | 0.1 | V     |
| Low Level Output Voltage<br>TTL Loads                          |                           |                                    | 4                   | 4.5                 | -    | -   | 0.26 | -             | 0.33 | -              | 0.4 | V     |
| Input Leakage Current                                          | I <sub>I</sub>            | V <sub>CC</sub> and GND            | 0                   | 5.5                 | -    |     | ±0.1 | -             | ±1   | -              | ±1  | μA    |
| Quiescent Device Current                                       | I <sub>CC</sub>           | V <sub>CC</sub> or GND             | 0                   | 5.5                 | -    | -   | 8    | -             | 80   | -              | 160 | μA    |
| Additional Quiescent Device Current Per Input Pin: 1 Unit Load | ΔI <sub>CC</sub> (Note 5) | V <sub>CC</sub> -2.1               | -                   | 4.5 to 5.5          | -    | 100 | 360  | -             | 450  | -              | 490 | μA    |

NOTE:

5. For dual-supply systems theoretical worst case (V<sub>I</sub> = 2.4V, V<sub>CC</sub> = 5.5V) specification is 1.8mA.

**HCT Input Loading Table**

| INPUT   | UNIT LOADS |
|---------|------------|
| P0 - P3 | 0.25       |
| PE      | 0.65       |
| CP      | 1.05       |
| MR      | 0.8        |
| SPE     | 0.5        |
| TE      | 1.05       |

NOTE: Unit Load is ΔI<sub>CC</sub> limit specified in DC Electrical Table, e.g., 360μA max at 25°C.

**CD54/74HC161, CD54/74HCT161, CD54/74HC163, CD54/74HCT163**

**Prerequisite For Switching Specifications**

| PARAMETER                                  | SYMBOL            | TEST CONDITIONS | V <sub>CC</sub> (V) | 25°C |     |     | -40°C TO 85°C |     | -55°C TO 125°C |     | UNITS |
|--------------------------------------------|-------------------|-----------------|---------------------|------|-----|-----|---------------|-----|----------------|-----|-------|
|                                            |                   |                 |                     | MIN  | TYP | MAX | MIN           | MAX | MIN            | MAX |       |
| HC TYPES                                   |                   |                 |                     |      |     |     |               |     |                |     |       |
| Maximum CP Frequency (Note 6)              | f <sub>MAX</sub>  | -               | 2                   | 6    | -   | -   | 5             | -   | 4              | -   | MHz   |
|                                            |                   |                 | 4.5                 | 30   | -   | -   | 24            | -   | 20             | -   | MHz   |
|                                            |                   |                 | 6                   | 35   | -   | -   | 28            | -   | 24             | -   | MHz   |
| CP Width (Low)                             | t <sub>W(L)</sub> | -               | 2                   | 80   | -   | -   | 100           | -   | 120            | -   | ns    |
|                                            |                   |                 | 4.5                 | 16   | -   | -   | 20            | -   | 24             | -   | ns    |
|                                            |                   |                 | 6                   | 14   | -   | -   | 17            | -   | 20             | -   | ns    |
| MR Pulse Width (161)                       | t <sub>W</sub>    | -               | 2                   | 100  | -   | -   | 125           | -   | 150            | -   | ns    |
|                                            |                   |                 | 4.5                 | 20   | -   | -   | 25            | -   | 30             | -   | ns    |
|                                            |                   |                 | 6                   | 17   | -   | -   | 21            | -   | 26             | -   | ns    |
| Setup Time, Pn to CP                       | t <sub>SU</sub>   | -               | 2                   | 60   | -   | -   | 75            | -   | 90             | -   | ns    |
|                                            |                   |                 | 4.5                 | 12   | -   | -   | 15            | -   | 18             | -   | ns    |
|                                            |                   |                 | 6                   | 10   | -   | -   | 13            | -   | 15             | -   | ns    |
| Setup Time, PE or TE to CP                 | t <sub>SU</sub>   | -               | 2                   | 50   | -   | -   | 65            | -   | 75             | -   | ns    |
|                                            |                   |                 | 4.5                 | 10   | -   | -   | 13            | -   | 15             | -   | ns    |
|                                            |                   |                 | 6                   | 9    | -   | -   | 11            | -   | 13             | -   | ns    |
| Setup Time, $\overline{SPE}$ to CP         | t <sub>SU</sub>   | -               | 2                   | 60   | -   | -   | 75            | -   | 90             | -   | ns    |
|                                            |                   |                 | 4.5                 | 12   | -   | -   | 15            | -   | 18             | -   | ns    |
|                                            |                   |                 | 6                   | 10   | -   | -   | 13            | -   | 15             | -   | ns    |
| Setup Time, $\overline{MR}$ to CP (163)    | t <sub>SU</sub>   | -               | 2                   | 65   | -   | -   | 80            | -   | 100            | -   | ns    |
|                                            |                   |                 | 4.5                 | 13   | -   | -   | 16            | -   | 20             | -   | ns    |
|                                            |                   |                 | 6                   | 11   | -   | -   | 14            | -   | 17             | -   | ns    |
| Hold Time, PN to CP                        | t <sub>H</sub>    | -               | 2                   | 3    | -   | -   | 3             | -   | 3              | -   | ns    |
|                                            |                   |                 | 4.5                 | 3    | -   | -   | 3             | -   | 3              | -   | ns    |
|                                            |                   |                 | 6                   | 3    | -   | -   | 3             | -   | 3              | -   | ns    |
| Hold Time, TE or PE to CP                  | t <sub>H</sub>    | -               | 2                   | 0    | -   | -   | 0             | -   | 0              | -   | ns    |
|                                            |                   |                 | 4.5                 | 0    | -   | -   | 0             | -   | 0              | -   | ns    |
|                                            |                   |                 | 6                   | 0    | -   | -   | 0             | -   | 0              | -   | ns    |
| Hold Time, $\overline{SPE}$ to CP          | t <sub>H</sub>    | -               | 2                   | 0    | -   | -   | 0             | -   | 0              | -   | ns    |
|                                            |                   |                 | 4.5                 | 0    | -   | -   | 0             | -   | 0              | -   | ns    |
|                                            |                   |                 | 6                   | 0    | -   | -   | 0             | -   | 0              | -   | ns    |
| Recovery Time, $\overline{MR}$ to CP (161) | t <sub>REC</sub>  | -               | 2                   | 75   | -   | -   | 95            | -   | 110            | -   | ns    |
|                                            |                   |                 | 4.5                 | 15   | -   | -   | 19            | -   | 22             | -   | ns    |
|                                            |                   |                 | 6                   | 13   | -   | -   | 16            | -   | 19             | -   | ns    |

**CD54/74HC161, CD54/74HCT161, CD54/74HC163, CD54/74HCT163**

**Prerequisite For Switching Specifications (Continued)**

| PARAMETER                                         | SYMBOL            | TEST CONDITIONS | V <sub>CC</sub> (V) | 25°C |     |     | -40°C TO 85°C |     | -55°C TO 125°C |     | UNITS |
|---------------------------------------------------|-------------------|-----------------|---------------------|------|-----|-----|---------------|-----|----------------|-----|-------|
|                                                   |                   |                 |                     | MIN  | TYP | MAX | MIN           | MAX | MIN            | MAX |       |
| HCT TYPES                                         |                   |                 |                     |      |     |     |               |     |                |     |       |
| Maximum CP Frequency                              | f <sub>MAX</sub>  | -               | 4.5                 | 30   | -   | -   | 24            | -   | 20             | -   | MHz   |
| CP Width (Low) (Note 6)                           | t <sub>W(L)</sub> | -               | 4.5                 | 16   | -   | -   | 20            | -   | 24             | -   | ns    |
| $\overline{\text{MR}}$ Pulse Width (161)          | t <sub>W</sub>    | -               | 4.5                 | 20   | -   | -   | 25            | -   | 30             | -   | ns    |
| Setup Time, Pn to CP                              | t <sub>SU</sub>   | -               | 4.5                 | 10   | -   | -   | 13            | -   | 15             | -   | ns    |
| Setup Time, PE or TE to CP                        | t <sub>SU</sub>   | -               | 4.5                 | 13   | -   | -   | 16            | -   | 20             | -   | ns    |
| Setup Time, $\overline{\text{SPE}}$ to CP         | t <sub>SU</sub>   | -               | 4.5                 | 12   | -   | -   | 15            | -   | 18             | -   | ns    |
| Setup Time, $\overline{\text{MR}}$ to CP (163)    | t <sub>SU</sub>   | -               | 4.5                 | 13   | -   | -   | 16            | -   | 20             | -   | ns    |
| Hold Time, PN to CP                               | t <sub>H</sub>    | -               | 4.5                 | 5    | -   | -   | 5             | -   | 5              | -   | ns    |
| Hold Time, TE or PE to CP                         | t <sub>H</sub>    | -               | 4.5                 | 3    | -   | -   | 3             | -   | 3              | -   | ns    |
| Hold Time, $\overline{\text{SPE}}$ to CP          | t <sub>H</sub>    | -               | 4.5                 | 3    | -   | -   | 3             | -   | 3              | -   | ns    |
| Recovery Time, $\overline{\text{MR}}$ to CP (161) | t <sub>REC</sub>  | -               | 4.5                 | 15   | -   | -   | 19            | -   | 22             | -   | ns    |

NOTE:

6. Applies to non-cascaded operation only. With cascaded counters clock to terminal count propagation delays, count enables (PE or TE)-to-clock setup times, and count enables (PE or TE)-to-clock hold times determine maximum clock frequency. For example with these HC devices:

$$f_{\text{MAX}} (\text{CP}) = \frac{1}{\text{CP-to-TC prop. delay} + \text{TE-to-CP setup} + \text{TE-to-CP Hold}} = \frac{1}{37 + 10 + 0} \approx 21\text{MHz}(\text{min})$$

**Switching Specifications** C<sub>L</sub> = 50pF, Input t<sub>r</sub>, t<sub>f</sub> = 6ns

| PARAMETER                     | SYMBOL                              | TEST CONDITIONS       | V <sub>CC</sub> (V) | 25°C |     |     | -40°C TO 85°C |     | -55°C TO 125°C |     | UNITS |
|-------------------------------|-------------------------------------|-----------------------|---------------------|------|-----|-----|---------------|-----|----------------|-----|-------|
|                               |                                     |                       |                     | MIN  | TYP | MAX | MIN           | MAX | MIN            | MAX |       |
| HC TYPES                      |                                     |                       |                     |      |     |     |               |     |                |     |       |
| Propagation Delay<br>CP to TC | t <sub>PHL</sub> , t <sub>PLH</sub> | C <sub>L</sub> = 50pF | 2                   | -    | -   | 185 | -             | 230 | -              | 280 | ns    |
|                               |                                     |                       | 4.5                 | -    | -   | 37  | -             | 46  | -              | 56  | ns    |
|                               |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 15  | -   | -             | -   | -              | -   | ns    |
|                               |                                     | C <sub>L</sub> = 50pF | 6                   | -    | -   | 31  | -             | 39  | -              | 48  | ns    |
| CP to Qn                      | t <sub>PHL</sub> , t <sub>PLH</sub> | C <sub>L</sub> = 50pF | 2                   | -    | -   | 185 | -             | 230 | -              | 280 | ns    |
|                               |                                     |                       | 4.5                 | -    | -   | 37  | -             | 46  | -              | 56  | ns    |
|                               |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 15  | -   | -             | -   | -              | -   | ns    |
|                               |                                     | C <sub>L</sub> = 50pF | 6                   | -    | -   | 31  | -             | 39  | -              | 48  | ns    |
| TE to TC                      | t <sub>PHL</sub> , t <sub>PLH</sub> | C <sub>L</sub> = 50pF | 2                   | -    | -   | 120 | -             | 150 | -              | 180 | ns    |
|                               |                                     |                       | 4.5                 | -    | -   | 24  | -             | 30  | -              | 36  | ns    |
|                               |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 9   | -   | -             | -   | -              | -   | ns    |
|                               |                                     | C <sub>L</sub> = 50pF | 6                   | -    | -   | 20  | -             | 26  | -              | 31  | ns    |

**CD54/74HC161, CD54/74HCT161, CD54/74HC163, CD54/74HCT163**

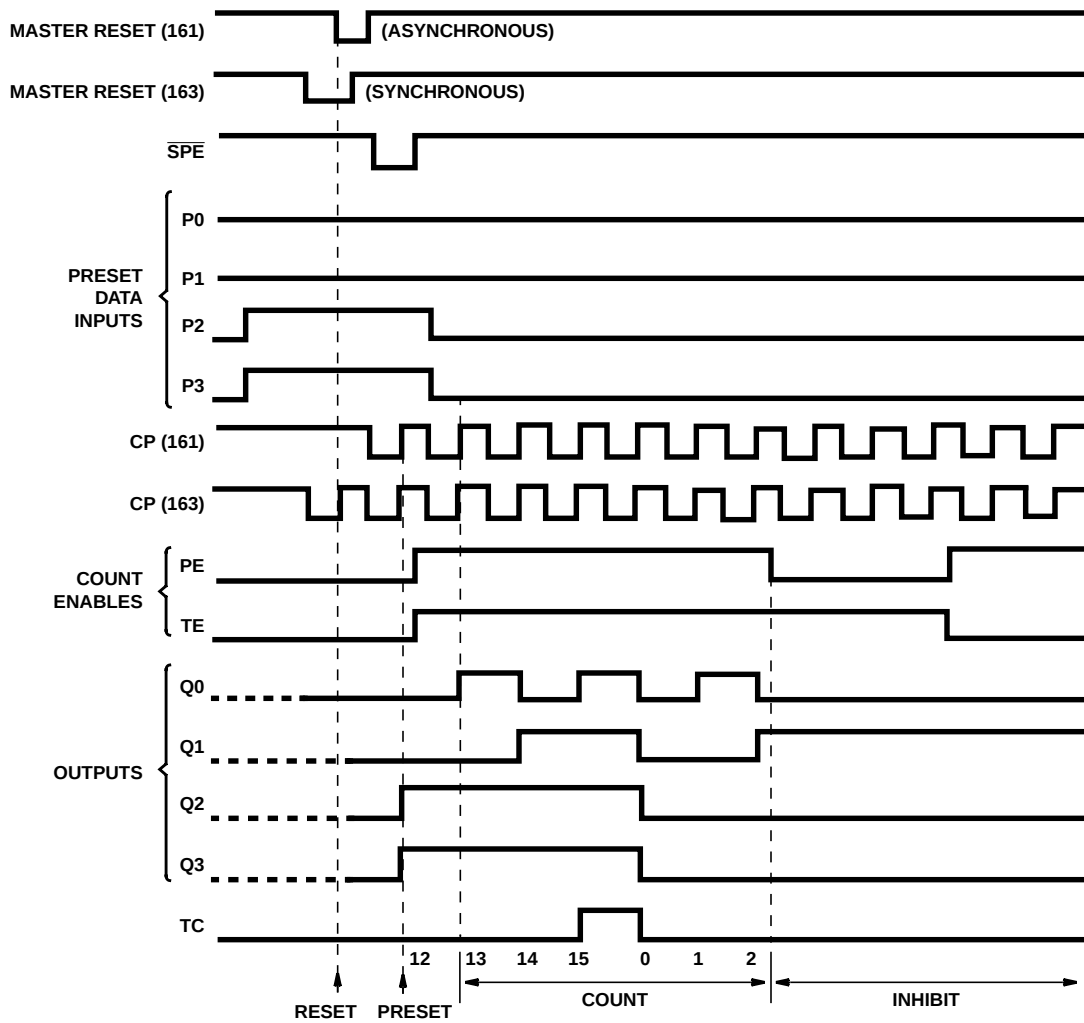
**Switching Specifications**  $C_L = 50\text{pF}$ , Input  $t_r$ ,  $t_f = 6\text{ns}$  (Continued)

| PARAMETER                                  | SYMBOL             | TEST CONDITIONS     | $V_{CC}$ (V) | 25°C |     |     | -40°C TO 85°C |     | -55°C TO 125°C |     | UNITS |
|--------------------------------------------|--------------------|---------------------|--------------|------|-----|-----|---------------|-----|----------------|-----|-------|
|                                            |                    |                     |              | MIN  | TYP | MAX | MIN           | MAX | MIN            | MAX |       |
| $\overline{MR}$ to Qn (161)                | $t_{PHL}$          | $C_L = 50\text{pF}$ | 2            | -    | -   | 210 | -             | 265 | -              | 315 | ns    |
|                                            |                    |                     | 4.5          | -    | -   | 42  | -             | 53  | -              | 63  | ns    |
|                                            |                    | $C_L = 15\text{pF}$ | 5            | -    | 18  | -   | -             | -   | -              | -   | ns    |
|                                            |                    | $C_L = 50\text{pF}$ | 6            | -    | -   | 36  | -             | 45  | -              | 54  | ns    |
| $\overline{MR}$ to TC (161)                | $t_{PHL}$          | $C_L = 50\text{pF}$ | 2            | -    | -   | 210 | -             | 265 | -              | 315 | ns    |
|                                            |                    |                     | 4.5          | -    | -   | 42  | -             | 53  | -              | 63  | ns    |
|                                            |                    | $C_L = 50\text{pF}$ | 6            | -    | -   | 36  | -             | 45  | -              | 54  | ns    |
| Output Transition Time                     | $t_{THL}, t_{TLH}$ | $C_L = 50\text{pF}$ | 2            | -    | -   | 75  | -             | 95  | -              | 110 | ns    |
|                                            |                    |                     | 4.5          | -    | -   | 15  | -             | 19  | -              | 22  | ns    |
|                                            |                    |                     | 6            | -    | -   | 13  | -             | 16  | -              | 19  | ns    |
| Power Dissipation Capacitance (Notes 7, 8) | $C_{PD}$           | -                   | 5            | -    | 60  | -   | -             | -   | -              | -   | pF    |
| Input Capacitance                          | $C_{IN}$           | $C_L = 50\text{pF}$ | -            | 10   | -   | 10  | -             | 10  | -              | 10  | pF    |
| <b>HCT TYPES</b>                           |                    |                     |              |      |     |     |               |     |                |     |       |
| Propagation Delay<br>CP to TC              | $t_{PHL}, t_{PLH}$ | $C_L = 50\text{pF}$ | 4.5          | -    | -   | 42  | -             | 53  | -              | 63  | ns    |
|                                            |                    | $C_L = 15\text{pF}$ | 5            | -    | 18  | -   | -             | -   | -              | -   | ns    |
| CP to Qn                                   | $t_{PHL}, t_{PLH}$ | $C_L = 50\text{pF}$ | 4.5          | -    | -   | 39  | -             | 49  | -              | 59  | ns    |
|                                            |                    | $C_L = 15\text{pF}$ | 5            | -    | 16  | -   | -             | -   | -              | -   | ns    |
| TE to TC                                   | $t_{PHL}, t_{PLH}$ | $C_L = 50\text{pF}$ | 4.5          | -    | -   | 32  | -             | 40  | -              | 48  | ns    |
|                                            |                    | $C_L = 15\text{pF}$ | 5            | -    | 13  | -   | -             | -   | -              | -   | ns    |
| $\overline{MR}$ to Qn (161)                | $t_{PHL}$          | $C_L = 50\text{pF}$ | 4.5          | -    | -   | 50  | -             | 63  | -              | 75  | ns    |
|                                            |                    | $C_L = 15\text{pF}$ | 5            | -    | 21  | -   | -             | -   | -              | -   | ns    |
| $\overline{MR}$ to TC (161)                | $t_{PHL}$          | $C_L = 50\text{pF}$ | 4.5          | -    | -   | 50  | -             | 63  | -              | 75  | ns    |
| Output Transition Time                     | $t_{THL}, t_{TLH}$ | $C_L = 50\text{pF}$ | 4.5          | -    | -   | 15  | -             | 19  | -              | 22  | ns    |
| Power Dissipation Capacitance (Notes 7, 8) | $C_{PD}$           | -                   | 5            | -    | 63  | -   | -             | -   | -              | -   | pF    |
| Input Capacitance                          | $C_{IN}$           | $C_L = 50\text{pF}$ | -            | 10   | -   | 10  | -             | 10  | -              | 10  | pF    |

**NOTES:**

- $C_{PD}$  is used to determine the dynamic power consumption, per package.
- $P_D = C_{PD} V_{CC}^2 f_i + \Sigma(C_L V_{CC}^2 f_O)$  where  $f_i$  = Input Frequency,  $f_O$  = Output Frequency,  $C_L$  = Output Load Capacitance,  $V_{CC}$  = Supply Voltage.

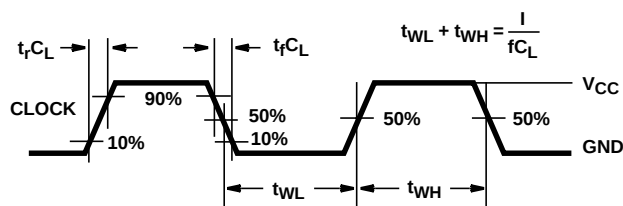
## Timing Diagram



Sequence illustrated on waveforms:

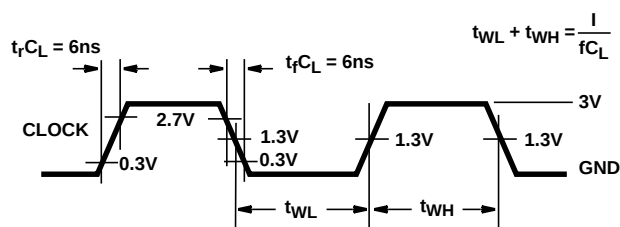
1. Reset outputs to zero.
2. Preset to binary twelve.
3. Count to thirteen, fourteen, fifteen, zero, one, and two.
4. Inhibit.

## Test Circuits and Waveforms



NOTE: Outputs should be switching from 10%  $V_{CC}$  to 90%  $V_{CC}$  in accordance with device truth table. For  $f_{MAX}$ , input duty cycle = 50%.

FIGURE 1. HC CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH



NOTE: Outputs should be switching from 10%  $V_{CC}$  to 90%  $V_{CC}$  in accordance with device truth table. For  $f_{MAX}$ , input duty cycle = 50%.

FIGURE 2. HCT CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH

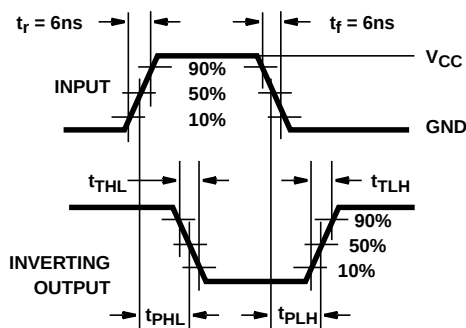


FIGURE 3. HC TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

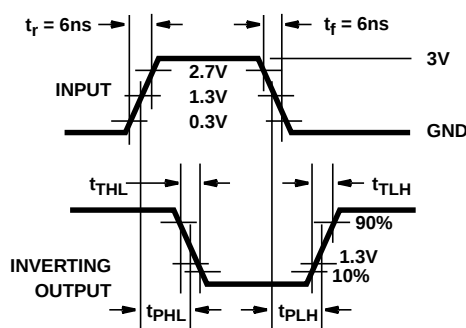


FIGURE 4. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

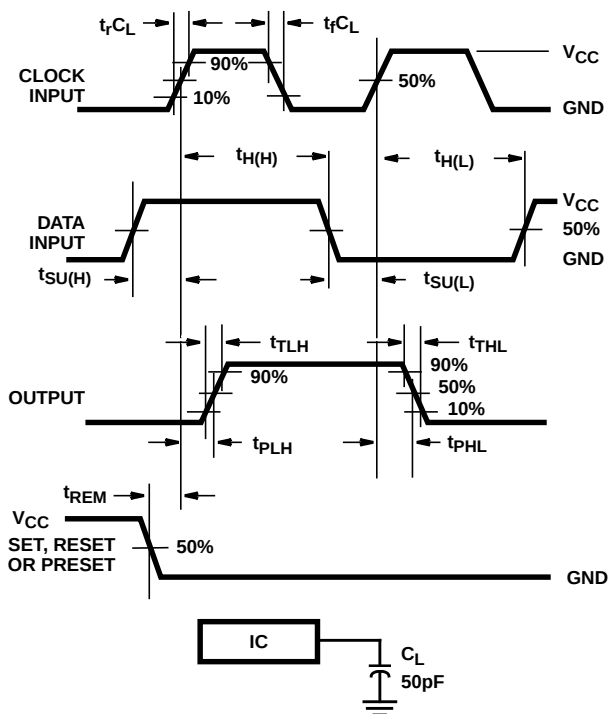


FIGURE 5. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

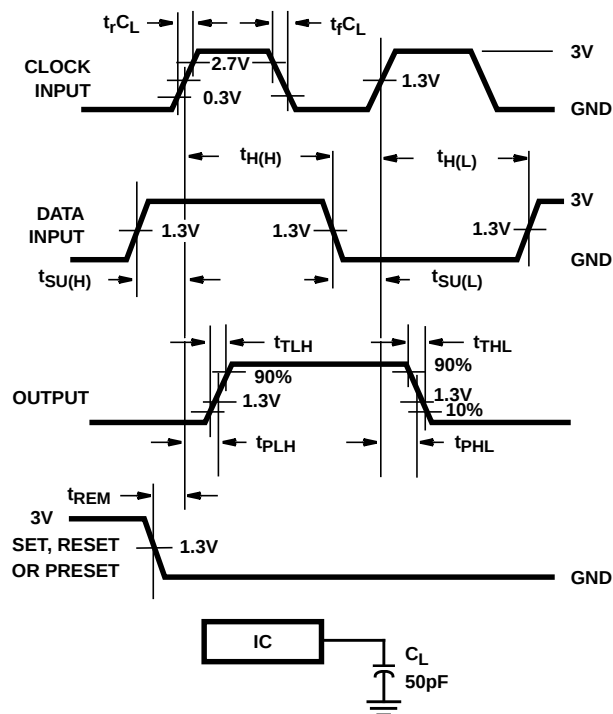


FIGURE 6. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| CD54HC161F       | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | Call TI          | N / A for Pkg Type           |
| CD54HC161F3A     | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | Call TI          | N / A for Pkg Type           |
| CD54HC163F3A     | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | Call TI          | N / A for Pkg Type           |
| CD54HCT161F3A    | OBSOLETE              | CDIP         | J               | 16   |             | TBD                     | Call TI          | Call TI                      |
| CD54HCT163F      | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | Call TI          | N / A for Pkg Type           |
| CD54HCT163F3A    | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | Call TI          | N / A for Pkg Type           |
| CD74HC161E       | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HC161EE4     | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HC161M       | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC161M96     | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC161M96E4   | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC161ME4     | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC161MT      | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC161MTE4    | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC163E       | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HC163EE4     | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HC163M       | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC163M96     | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC163M96E4   | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC163ME4     | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC163MT      | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC163MTE4    | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT161E      | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HCT161EE4    | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HCT161M      | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT161M96    | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT161M96E4  | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| CD74HCT161ME4    | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT161MT     | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT161MTE4   | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT163E      | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HCT163EE4    | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HCT163M      | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT163M96    | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT163M96E4  | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT163ME4    | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT163MT     | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT163MTE4   | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

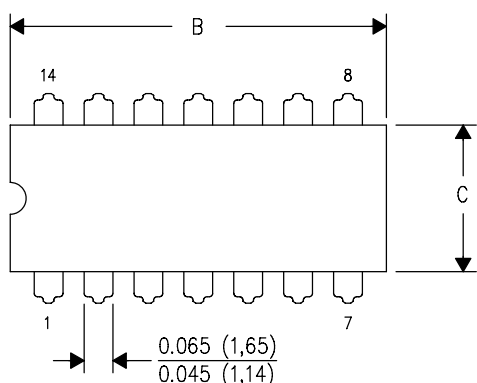
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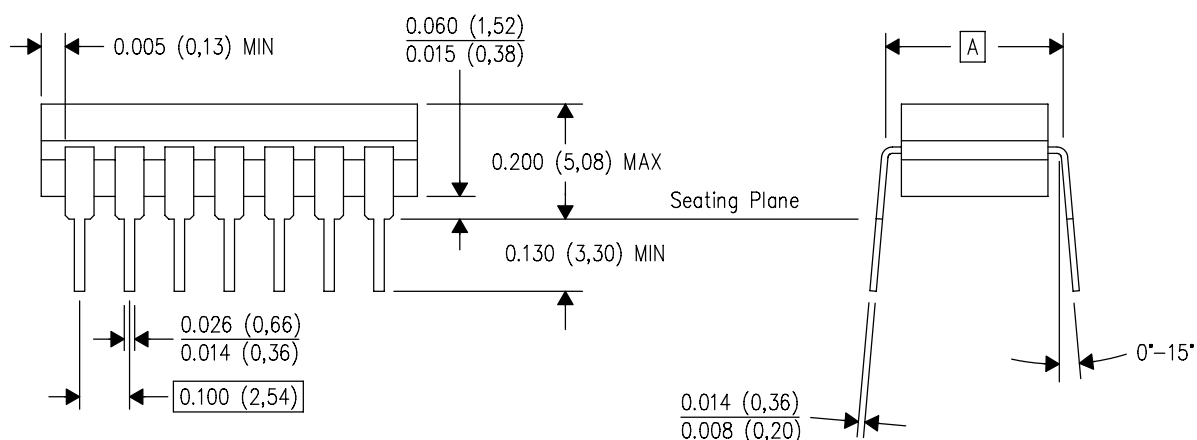
J (R-GDIP-T\*\*)

14 LEADS SHOWN

# CERAMIC DUAL IN-LINE PACKAGE



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



4040083/F 03/03

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

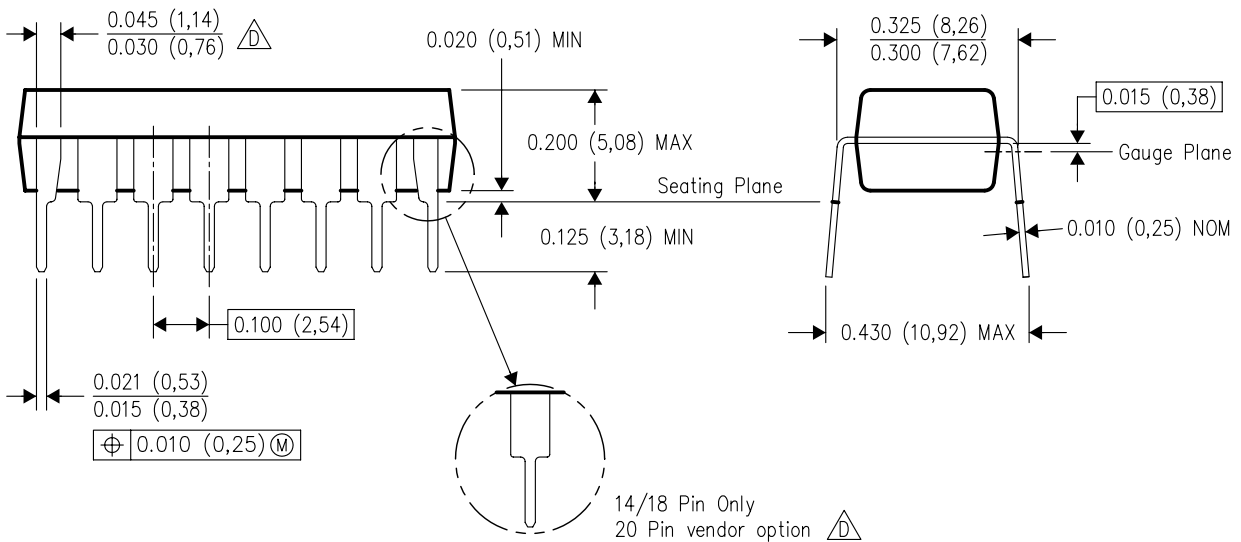
## N (R-PDIP-T\*\*)

16 PINS SHOWN

## PLASTIC DUAL-IN-LINE PACKAGE



| PINS **             | 14               | 16               | 18               | 20               |
|---------------------|------------------|------------------|------------------|------------------|
| DIM                 |                  |                  |                  |                  |
| A MAX               | 0.775<br>(19,69) | 0.775<br>(19,69) | 0.920<br>(23,37) | 1.060<br>(26,92) |
| A MIN               | 0.745<br>(18,92) | 0.745<br>(18,92) | 0.850<br>(21,59) | 0.940<br>(23,88) |
| MS-001<br>VARIATION | AA               | BB               | AC               | AD               |

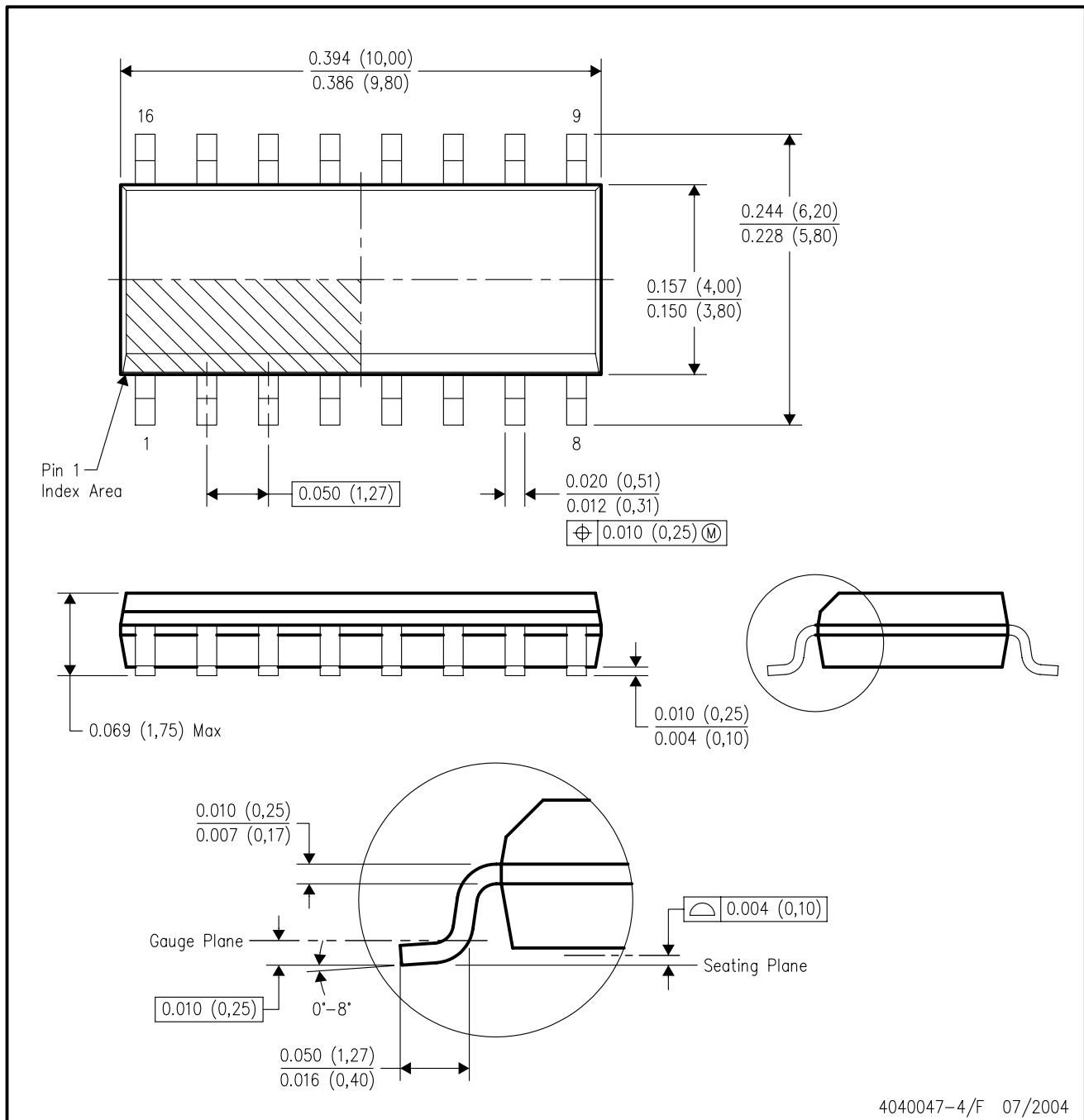


4040049/E 12/2002

- 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.

## D (R-PDSO-G16)

## PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - Falls within JEDEC MS-012 variation AC.

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