

**SPXXHC93**  
**SPXXHC161**  
**SPXXHC163**  
**SPXXHC177**  
**SPXXHC193**

**54/74 Series**  
**Binary Counters**

**Ordering Information**

| Plastic DIP,<br>Industrial Temp Range | Ceramic DIP,<br>Industrial Temp Range | Ceramic DIP,<br>Military Temp Range |
|---------------------------------------|---------------------------------------|-------------------------------------|
| SP74HCXXXN                            | SP74HCXXXJ                            | SP54HCXXXJ                          |

**Features**

- Utilizes SPI's Selective Oxidation, Silicon-Gate CMOS Process.
- Speed, function and pin-out compatible to 74LS series Logic.
- High Noise Immunity.
- Low quiescent power consumption.
- Wide power supply range.
- Operates over  $V_{CC}$  range of 2.0 to 6.0 Volts.
- Symmetric current drive.
- All Inputs are fully buffered.
- All devices have Input Protection diodes to  $V_{CC}$  and ground.
- All devices have Logic Input voltage levels consistent with CMOS.

All devices contain diodes to protect inputs against damage due to high static voltages or electric fields; however, it is advised that precautions be taken not to exceed the maximum recommended input voltages. All unused inputs must be connected to an appropriate logic voltage level (either  $V_{CC}$  or GND).

**Absolute Maximum Ratings**

| Parameter   | Min  | Max            | Units |
|---|------|----------------|-------|
| $V_{CC}$ DC Supply Voltage                                      | -0.5 | +7.0           | V     |
| $V_I, V_O$ Input or Output Voltage                              | -0.5 | $V_{CC} + 0.5$ | V     |
| $I_I$ DC Current Per Pin Any Input or Output                    | —    | 25             | mA    |
| $I_{CC}$ DC Current Drain, $V_{CC}$ or GND                      | —    | 50             | mA    |
| $T_S$ Storage Temperature                                       | -65  | +150           | °C    |
| $P_D$ Power Dissipation (Note 1)                                | —    | 500            | mW    |
| $T_L$ Lead Temperature (1/16" from mounting surface for 10 sec) | —    | +300           | °C    |

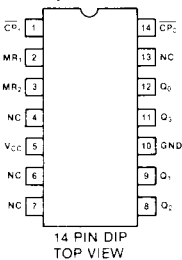
Note 1: Derate at 12mW/°C over +45 to +85°C for Plastic "N" Package.

**Recommended Operating Conditions**

| Parameter                                | SP74HCXXX |          | SP54HCXXX |          | Units |
|--|-----------|----------|-----------|----------|-------|
|  | Min       | Max      | Min       | Max      |       |
| $V_{CC}$ DC Supply Voltage Range         | 2.0       | 6.0      | 2.0       | 6.0      | V     |
| $V_I, V_O$ Input Voltage, Output Voltage | 0         | $V_{CC}$ | 0         | $V_{CC}$ | V     |
| $T_A$ Operating Temperature Range        | -40       | +85      | -55       | +125     | °C    |

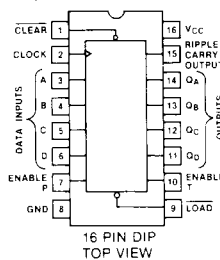
**SPXXHC93**

4-Bit Binary Counter, Divide-by-2<sup>1</sup> Synchronous Divide-by-8



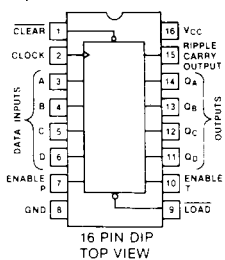
**SPXXHC161**

4-Bit Binary Counter Asynchronous Reset



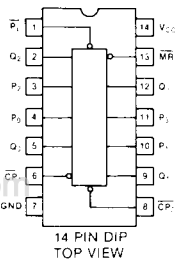
**SPXXHC163**

4-Bit Binary Counter Synchronous Reset



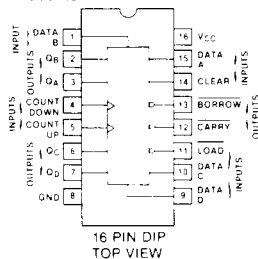
**SPXXHC177**

Presetable Binary Counter



**SPXXHC193**

4-Bit Binary Up/Down Counter



### DC Electrical Characteristics

| Symbol          | Parameter                         | Conditions  | V <sub>CC</sub> | Typ<br>T = 25 °C        | Guaranteed Limits       |                          | Units |      |    |      |
|-----------------|-----------------------------------|---|-----------------|-------------------------|-------------------------|--------------------------|-------|------|----|------|
|                 |                                   |   |                 |                         | SP74HC<br>-40 to +85 °C | SP54HC<br>-55 to +125 °C |       |      |    |      |
| V <sub>IH</sub> | Minimum High Level Input Voltage  | V <sub>O</sub> = 0.1V or V <sub>CC</sub> - 0.1V<br>I <sub>O</sub> ≤ 20 μA | 2.0V            |                         | 1.5                     | 1.5                      | V     |      |    |      |
|                 |                                   |   | 4.5V            |                         | 3.15                    | 3.15                     |       |      |    |      |
|                 |                                   |   | 6.0V            |                         | 4.2                     | 4.2                      |       |      |    |      |
| V <sub>IL</sub> | Maximum Low Level Input Voltage   | V <sub>O</sub> = 0.1V or V <sub>CC</sub> - 0.1V<br>I <sub>O</sub> ≤ 20 μA | 2.0V            |                         | 0.3                     | 0.3                      | V     |      |    |      |
|                 |                                   |   | 4.5V            |                         | 0.9                     | 0.9                      |       |      |    |      |
|                 |                                   |   | 6.0V            |                         | 1.2                     | 1.2                      |       |      |    |      |
| V <sub>OH</sub> | Minimum High Level Output Voltage | I <sub>OH</sub> = 20 μA<br>V <sub>I</sub> = V <sub>CC</sub> or GND        | 2.0V            | 2.0                     | 1.9                     | 1.9                      | V     |      |    |      |
|                 |                                   |   | 4.5V            | 4.5                     | 4.4                     | 4.4                      |       |      |    |      |
|                 |                                   |   | 6.0V            | 6.0                     | 5.9                     | 5.9                      |       |      |    |      |
|                 |                                   |   |                 |                         | 4.5V                    |                          | 3.7   | 3.7  | V  |      |
|                 |                                   |   |                 |                         | 6.0V                    |                          | 5.2   | 5.2  |    |      |
|                 |                                   |   |                 |                         | 6.0V                    |                          | 5.2   | 5.2  |    |      |
| V <sub>OL</sub> | Maximum Low Level Output Voltage  | I <sub>OL</sub> = 20 μA<br>V <sub>I</sub> = V <sub>CC</sub> or GND        | 2.0V            | 0                       | 0.1                     | 0.1                      | V     |      |    |      |
|                 |                                   |   | 4.5V            | 0                       | 0.1                     | 0.1                      |       |      |    |      |
|                 |                                   |   | 6.0V            | 0                       | 0.1                     | 0.1                      |       |      |    |      |
|                 |                                   |   |                 |                         | 4.5V                    | 0.1                      | 0.3   | 0.4  | V  |      |
|                 |                                   |   |                 |                         | 6.0V                    |                          | 0.3   | 0.4  |    |      |
|                 |                                   |   |                 |                         | 6.0V                    |                          | 0.3   | 0.4  |    |      |
| I <sub>IN</sub> | Input Leakage Current             | V <sub>I</sub> = V <sub>CC</sub> or GND<br>V <sub>CC</sub> = 2.0 to 6.0V  |                 |                         | ±1.0                    | ±1.0                     | μA    |      |    |      |
| I <sub>CC</sub> | Maximum Quiescent Supply Current  | V <sub>I</sub> = V <sub>CC</sub> or GND<br>I <sub>O</sub> = 0 μA          |                 | T <sub>A</sub> = 25 °C  | 5.0V                    | 0.1                      | 2.0   | 2.0  | μA |      |
|                 |                                   |   |                 | T <sub>A</sub> = 85 °C  | 5.0V                    |                          | 20.0  | 20.0 |    |      |
|                 |                                   |   |                 | T <sub>A</sub> = 125 °C | 5.0V                    |                          |       |      |    | 40.0 |
|                 |                                   |   |                 |                         | 5.0V                    |                          |       |      |    |      |

\* 4ma STD outputs 6ma Bus-Drivers

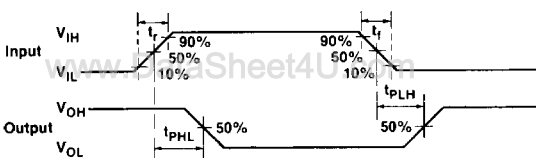
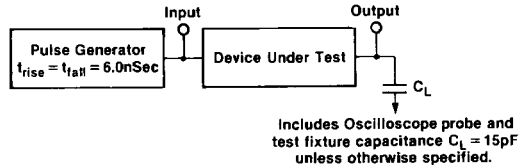
### AC Electrical Characteristics (V<sub>CC</sub> = 5.0V, t<sub>r</sub> = t<sub>f</sub> = 6ns, T<sub>A</sub> = 25 °C, unless otherwise specified)

| Device Type           | Symbol                              | Parameter                          | Conditions            | Typ | Guaranteed Limit | Units |
|-----------------------|-------------------------------------|------------------------------------|-----------------------|-----|------------------|-------|
| 93                    | t <sub>PHL</sub> , t <sub>PLH</sub> | C <sub>P0</sub> to Q <sub>0</sub>  | C <sub>L</sub> = 15pF | 19  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 21  |                  |       |
|                       | t <sub>PHL</sub> , t <sub>PLH</sub> | C <sub>P1</sub> to Q <sub>1</sub>  | C <sub>L</sub> = 15pF | 21  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 23  |                  |       |
|                       | t <sub>PHL</sub> , t <sub>PLH</sub> | C <sub>P0</sub> to Q <sub>3</sub>  | C <sub>L</sub> = 15pF | 37  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 40  |                  |       |
|                       | t <sub>PHL</sub>                    | M <sub>R</sub> to Q <sub>0</sub>   | C <sub>L</sub> = 15pF | 25  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 27  |                  |       |
|                       | t <sub>PHL</sub>                    | M <sub>R</sub> to Q <sub>1</sub>   | C <sub>L</sub> = 15pF | 24  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 26  |                  |       |
|                       | t <sub>PHL</sub>                    | M <sub>R1</sub> to Q <sub>2</sub>  | C <sub>L</sub> = 15pF | 24  |                  | ns    |
| C <sub>L</sub> = 50pF |                                     |                                    | 26                    |     |                  |       |
| t <sub>PHL</sub>      | M <sub>R</sub> to Q <sub>3</sub>    | C <sub>L</sub> = 15pF              | 24                    |     | ns               |       |
|                       |                                     | C <sub>L</sub> = 50pF              | 26                    |     |                  |       |
| f <sub>max</sub>      |                                     | C <sub>P0</sub> to C <sub>P1</sub> |                       | 30  |                  | MHz   |
| t <sub>w</sub>        |                                     | Minimum Clock Pulse Width          |                       | 10  |                  | ns    |
| t <sub>w</sub>        |                                     | Minimum Reset Low Pulse Width      |                       | 9   |                  | ns    |
| 161                   | t <sub>PHL</sub> , t <sub>PLH</sub> | Clock to Q <sub>0</sub>            | C <sub>L</sub> = 15pF | 17  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 20  |                  |       |
|                       | t <sub>PHL</sub> , t <sub>PLH</sub> | Clock to Q <sub>1</sub>            | C <sub>L</sub> = 15pF | 18  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 21  |                  |       |
|                       | t <sub>PHL</sub> , t <sub>PLH</sub> | Clock to Q <sub>2</sub>            | C <sub>L</sub> = 15pF | 19  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 22  |                  |       |
|                       | t <sub>PHL</sub> , t <sub>PLH</sub> | Clock to Q <sub>3</sub>            | C <sub>L</sub> = 15pF | 21  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 24  |                  |       |
|                       | t <sub>PHL</sub> , t <sub>PLH</sub> | Clock to T <sub>C</sub>            | C <sub>L</sub> = 15pF | 28  |                  | ns    |
|                       |                                     |                                    | C <sub>L</sub> = 50pF | 33  |                  |       |
|                       | t <sub>PHL</sub> , t <sub>PLH</sub> | Set to T <sub>C</sub>              | C <sub>L</sub> = 15pF | 18  |                  | ns    |
| C <sub>L</sub> = 50pF |                                     |                                    | 21                    |     |                  |       |
| f <sub>max</sub>      |                                     | Max Clock Frequency                |                       | 40  |                  | MHz   |
| t <sub>w</sub>        |                                     | Minimum Clock Pulse Width          |                       | 8   |                  | ns    |

CONTINUED ON NEXT PAGE

**AC Electrical Characteristics** ( $V_{CC} = 5.0V$ ,  $t_r = t_f = 6ns$ ,  $T_A = 25^\circ C$ , unless otherwise specified) CONTINUED

| Device Type        | Symbol             | Parameter  | Conditions                   | Typ                          | Guaranteed Limit | Units |
|--------------------|--------------------|--|------------------------------|------------------------------|------------------|-------|
| 163                | $t_{PHL}, t_{PLH}$ | Clock to Output $\overline{\overline{PE}} = \text{High}$ | $C_L = 15pF$<br>$C_L = 50pF$ | 23<br>26                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | Clock to Output $\overline{\overline{PE}} = \text{High}$ | $C_L = 15pF$<br>$C_L = 50pF$ | 23<br>26                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | Clock to TC  | $C_L = 15pF$<br>$C_L = 50pF$ | 35<br>40                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | CET to TC  | $C_L = 15pF$<br>$C_L = 50pF$ | 30<br>35                     |                  | ns    |
|                    | $f_{max}$          | Maximum Clock Frequency                                  |                              | 40                           |                  | Mhz   |
|                    | $t_w$              | Minimum Clock Width                                      |                              | 8                            |                  | ns    |
| 177                | $t_{PHL}, t_{PLH}$ | $C_{P1}$ to $Q_A$  | $C_L = 15pF$<br>$C_L = 50pF$ | 22<br>25                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | $C_{P2}$ to $Q_B$  | $C_L = 15pF$<br>$C_L = 50pF$ | 31<br>35                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | $C_{P2}$ to $Q_C$  | $C_L = 15pF$<br>$C_L = 50pF$ | 26<br>28                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | $C_{P2}$ to $Q_D$  | $C_L = 15pF$<br>$C_L = 50pF$ | 28<br>30                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | $D_A$ to $Q_A$   | $C_L = 15pF$<br>$C_L = 50pF$ | 22<br>24                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | $D_B$ to $Q_B$   | $C_L = 15pF$<br>$C_L = 50pF$ | 27<br>31                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | $D_C$ to $Q_C$   | $C_L = 15pF$<br>$C_L = 50pF$ | 24<br>26                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | $D_D$ to $Q_D$   | $C_L = 15pF$<br>$C_L = 50pF$ | 25<br>27                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | CLR to $Q_A$   | $C_L = 15pF$<br>$C_L = 50pF$ | 25<br>27                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | CLR to $Q_B$   | $C_L = 15pF$<br>$C_L = 50pF$ | 29<br>31                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | CLR to $Q_C$   | $C_L = 15pF$<br>$C_L = 50pF$ | 27<br>29                     |                  | ns    |
|                    | $t_{PHL}, t_{PLH}$ | CLR to $Q_D$   | $C_L = 15pF$<br>$C_L = 50pF$ | 28<br>30                     |                  | ns    |
|                    | $f_{max}$          |  |                              | 45                           |                  | MHz   |
|                    | $t_w$              |  |                              | 10                           |                  | ns    |
|                    | 193                | $t_{PHL}, t_{PLH}$                                       | $C_{PU}$ to $\overline{TCU}$ | $C_L = 15pF$<br>$C_L = 50pF$ | 25<br>28         |       |
| $t_{PHL}, t_{PLH}$ |                    | $C_{PD}$ to $\overline{TCD}$                             | $C_L = 15pF$<br>$C_L = 50pF$ | 25<br>28                     |                  | ns    |
| $t_{PHL}, t_{PLH}$ |                    | $C_{PU}$ or $C_{PD}$ to $Q_n$                            | $C_L = 15pF$<br>$C_L = 50pF$ | 28<br>31                     |                  | ns    |
| $t_{PHL}, t_{PLH}$ |                    | $\overline{P_L}$ to $Q_n$                                | $C_L = 15pF$<br>$C_L = 50pF$ | 16<br>19                     |                  | ns    |
| $t_{PHL}$          |                    | $M_R$ to Output  | $C_L = 15pF$<br>$C_L = 50pF$ | 13<br>16                     |                  | ns    |
| $f_{max}$          |                    | Maximum Clock Frequency                                  |                              | 40                           |                  | MHz   |
| $t_w$              |                    | Minimum Clock Pulse Width                                |                              | 10                           |                  | ns    |

**AC Waveforms**

**Propagation Time Test Circuit**




### Mode Select—Function Tables

#### HC161

| Operating Mode    | Inputs |    |      |      |      |                | Outputs        |     |
|-------------------|--------|----|------|------|------|----------------|----------------|-----|
|                   | MR     | CP | CEP  | CET  | PE   | D <sub>n</sub> | Q <sub>n</sub> | TC  |
| Reset (Clear)     | L      | X  | X    | X    | X    | X              | L              | L   |
| Parallel Load     | H      | ↑  | X    | X    | l    | l              | L              | L   |
|                   | H      | ↑  | X    | X    | l    | h              | H              | (b) |
| Count             | H      | ↑  | h    | h    | h(d) | X              | count          | (b) |
| Hold (do nothing) | H      | X  | l(c) | X    | h(d) | X              | q <sub>n</sub> | (b) |
|                   | H      | X  | X    | l(c) | h(d) | X              | q <sub>n</sub> | L   |

#### HC163

| Operating Mode    | Inputs |    |      |      |      | Outputs        |                |     |
|-------------------|--------|----|------|------|------|----------------|----------------|-----|
|                   | SR     | CP | CEP  | CET  | PE   | D <sub>n</sub> | Q <sub>n</sub> | TC  |
| Reset (Clear)     | l      | ↑  | X    | X    | X    | X              | L              | L   |
| Parallel Load     | h(d)   | ↑  | X    | X    | l    | l              | L              | L   |
|                   | h(d)   | ↑  | X    | X    | l    | h              | H              | (b) |
| Count             | h(d)   | ↑  | h    | h    | h(d) | X              | count          | (b) |
| Hold (do nothing) | h(d)   | X  | l(c) | X    | h(d) | X              | q <sub>n</sub> | (b) |
|                   | h(d)   | X  | X    | l(c) | h(d) | X              | q <sub>n</sub> | L   |

#### HC193

| Operating Mode | Inputs |    |                 |                 |                |                |                |                | Outputs        |                |                |                  |                  |                 |  |
|----------------|--------|----|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|------------------|------------------|-----------------|--|
|                | MR     | PL | CP <sub>U</sub> | CP <sub>D</sub> | D <sub>0</sub> | D <sub>1</sub> | D <sub>2</sub> | D <sub>3</sub> | Q <sub>0</sub> | Q <sub>1</sub> | Q <sub>2</sub> | Q <sub>3</sub>   | TC <sub>U</sub>  | TC <sub>D</sub> |  |
| Reset (clear)  | H      | X  | X               | L               | X              | X              | X              | X              | L              | L              | L              | L                | H                | L               |  |
|                | H      | X  | X               | H               | X              | X              | X              | X              | L              | L              | L              | L                | H                | H               |  |
| Parallel Load  | L      | L  | X               | L               | L              | L              | L              | L              | L              | L              | L              | L                | H                | L               |  |
|                | L      | L  | X               | H               | L              | L              | L              | L              | L              | L              | L              | L                | H                | H               |  |
|                | L      | L  | L               | X               | H              | H              | H              | H              | H              | H              | H              | H                | L                | H               |  |
|                | L      | L  | H               | X               | H              | H              | H              | H              | H              | H              | H              | H                | H                | H               |  |
| Count up       | L      | H  | ↑               | H               | X              | X              | X              | X              | Count up       |                |                | H <sup>(b)</sup> | H                |                 |  |
| Count down     | L      | H  | H               | ↑               | X              | X              | X              | X              | Count down     |                |                | H                | H <sup>(c)</sup> |                 |  |

#### HC93

| Reset Inputs    |                 | Outputs        |                |                |                |
|-----------------|-----------------|----------------|----------------|----------------|----------------|
| MR <sub>1</sub> | MR <sub>2</sub> | Q <sub>0</sub> | Q <sub>1</sub> | Q <sub>2</sub> | Q <sub>3</sub> |
| H               | H               | L              | L              | L              | L              |
| L               | H               | Count          |                |                |                |
| H               | L               | Count          |                |                |                |
| H               | L               | Count          |                |                |                |

#### HC177

| Inputs |    |    | Response                        |
|--------|----|----|---------------------------------|
| MR     | PL | CP | Response                        |
| L      | X  | X  | Q <sub>n</sub> forced LOW       |
| H      | L  | X  | P <sub>n</sub> → Q <sub>n</sub> |
| H      | H  | L  | Count Up                        |

H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Immaterial

#### Truth Table

| Count | Output         |                |                |                |
|-------|----------------|----------------|----------------|----------------|
|       | Q <sub>0</sub> | Q <sub>1</sub> | Q <sub>2</sub> | Q <sub>3</sub> |
| 0     | L              | L              | L              | L              |
| 1     | H              | L              | L              | L              |
| 2     | L              | H              | L              | L              |
| 3     | H              | H              | L              | L              |
| 4     | L              | L              | H              | L              |
| 5     | H              | L              | H              | L              |
| 6     | L              | H              | H              | L              |
| 7     | H              | H              | H              | L              |
| 8     | L              | L              | L              | H              |
| 9     | H              | L              | L              | H              |
| 10    | L              | H              | L              | H              |
| 11    | H              | H              | L              | H              |
| 12    | L              | L              | H              | H              |
| 13    | H              | L              | H              | H              |
| 14    | L              | H              | H              | H              |
| 15    | H              | H              | H              | H              |

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.