

5493  
Counter

4-Bit Binary Ripple Counter

Product Specification

Military Logic Products

DESCRIPTION

The 5493 is a 4-bit, ripple-type Binary Counter. The device consists of four master-slave flip-flops internally connected to provide a divide-by-two section and a divide-by-eight section. Each section has a separate Clock input to initiate state changes of the counter on the High-to-Low clock transition. State changes of the Q outputs do not occur simultaneously because of internal ripple delays. Therefore, decoded output signals are subject to decoding spikes and should not be used for clocks or strobes.

A gated AND asynchronous Master Reset ( $MR_1 \bullet MR_2$ ) is provided which overrides both clocks and resets (clears) all the flip-flops.

Since the output from the divide-by-two section is not internally connected to the succeeding stages, the device may be operated in various counting modes. In a 4-bit ripple counter the output  $Q_0$  must be connected externally to input  $CP_1$ .

The input count pulses are applied to input  $CP_0$ . Simultaneous divisions of 2, 4, 8 and 16 are performed at the  $Q_0, Q_1, Q_2$  and  $Q_3$  outputs as shown in the Function Table.

As a 3-bit ripple counter the input count pulses are applied to input  $CP_1$ . Simultaneous frequency divisions of 2, 4 and 8 are available at the  $Q_1, Q_2$  and  $Q_3$  outputs. Independent use of the first flip-flop is available if the reset function coincides with reset of the 3-bit ripple-through counter.

ORDERING INFORMATION

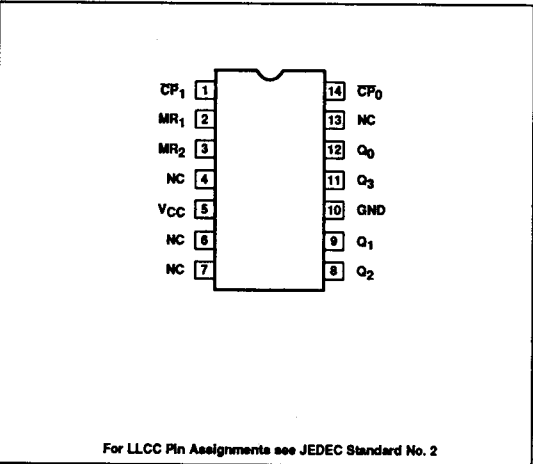
| DESCRIPTION             | ORDER CODE |
|-------------------------|------------|
| 14-Pin Ceramic DIP      | 5493/BCA   |
| 14-Pin Ceramic FlatPack | 5493/BDA   |

INPUT AND OUTPUT LOADING AND FAN-OUT TABLE

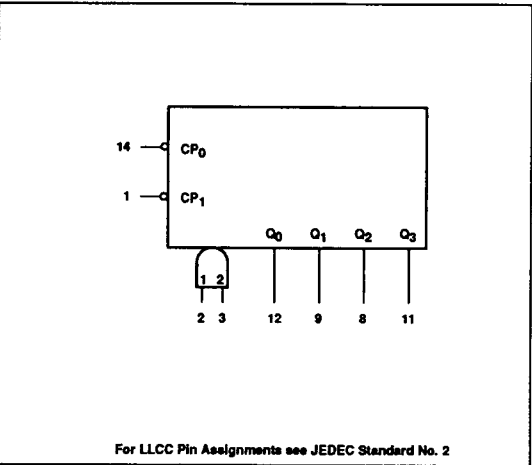
| PINS        | DESCRIPTION         | 54   |
|-------------|---------------------|------|
| MR          | Master reset inputs | 1UL  |
| $CP_0$      | Input               | 2UL  |
| $CP_1$      | Input               | 2UL  |
| $Q_0 - Q_3$ | Outputs             | 10UL |

NOTE: Where a 54 Unit Load (UL) is understood to be 40 $\mu$ A  $I_{IH}$  and -1.6mA  $I_{IL}$ .

PIN CONFIGURATION



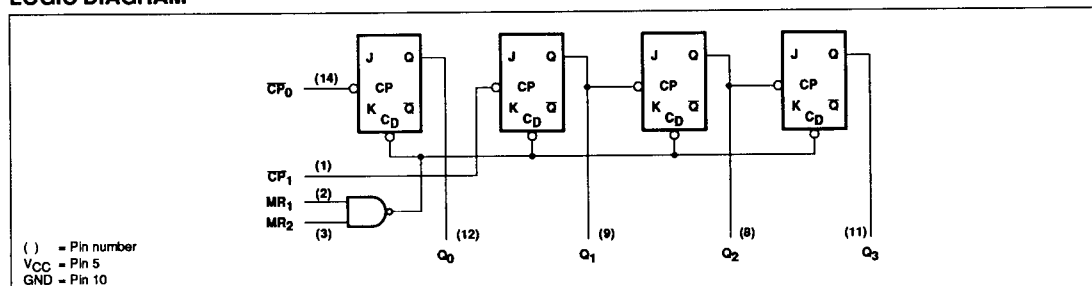
LOGIC SYMBOL



## Counter

5493

## LOGIC DIAGRAM



## FUNCTION TABLE

| COUNT | OUTPUTS        |                |                |                |
|-------|----------------|----------------|----------------|----------------|
|       | 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              |

NOTE: Output Q<sub>0</sub> connected to input CP<sub>1</sub>.

## MODE SELECTION

| 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          | Count          | Count          | Count          |
| H               | L               | Count          | Count          | Count          | Count          |
| L               | L               | Count          | Count          | Count          | Count          |

H = High voltage level

L = Low voltage level

X = Don't care

## ABSOLUTE MAXIMUM RATINGS (Over operating free-air temperature range unless otherwise noted.)

| SYMBOL           | PARAMETER                                            | RATING                  | UNIT |
|------------------|------------------------------------------------------|-------------------------|------|
| V <sub>CC</sub>  | Supply voltage                                       | 7.0                     | V    |
| V <sub>I</sub>   | Input voltage range                                  | -0.5 to +5.5            | V    |
| I <sub>I</sub>   | Input current range                                  | -30 to +5               | mA   |
| V <sub>O</sub>   | Voltage applied to output in High output state range | -0.5 to V <sub>CC</sub> | V    |
| T <sub>STG</sub> | Storage temperature range                            | -65 to +150             | °C   |

## RECOMMENDED OPERATING CONDITIONS

| SYMBOL          | PARAMETER                            | LIMITS |     |      | UNIT |
|-----------------|--------------------------------------|--------|-----|------|------|
|                 |                                      | Min    | Nom | Max  |      |
| V <sub>CC</sub> | Supply voltage                       | 4.5    | 5.0 | 5.5  | V    |
| V <sub>IH</sub> | High-level input voltage             | 2.0    |     |      | V    |
| V <sub>IL</sub> | Low-level input voltage              |        |     | +0.8 | V    |
| I <sub>IK</sub> | Input clamp current                  |        |     | -12  | mA   |
| I <sub>OH</sub> | High-level output current            |        |     | -800 | μA   |
| I <sub>OL</sub> | Low-level output current             |        |     | 16   | mA   |
| T <sub>A</sub>  | Operating free-air temperature range | -55    |     | +125 | °C   |

## Counter

5493

**DC ELECTRICAL CHARACTERISTICS** (Over recommended operating free-air temperature range unless otherwise noted.)

| SYMBOL    | PARAMETER                                 | TEST CONDITIONS <sup>1</sup>                                                         | LIMITS                                                  |                  |      | UNIT          |
|-----------|-------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------|------------------|------|---------------|
|           |                                           |                                                                                      | Min                                                     | Typ <sup>2</sup> | Max  |               |
| $V_{OH}$  | High-level output voltage                 | $V_{CC} = \text{Min}, V_{IH} = \text{Min}, V_{IL} = \text{Max}, I_{OH} = \text{Max}$ | 2.4                                                     | 3.4              |      | V             |
| $V_{OL}$  | Low-level output voltage                  | $V_{CC} = \text{Min}, V_{IH} = \text{Min}, V_{IL} = \text{Max}, I_{OL} = \text{Max}$ |                                                         | 0.2              | 0.4  | V             |
| $V_K$     | Input clamp voltage                       | $V_{CC} = \text{Min}, I_I = I_K$                                                     |                                                         |                  | -1.5 | V             |
| $I_{IH2}$ | Input current at maximum input voltage    | $V_{CC} = \text{Max}, V_I = 5.5\text{V}$                                             |                                                         |                  | 1.0  | mA            |
| $I_{IH1}$ | High-level input current                  | $V_{CC} = \text{Max}, V_I = 2.4\text{V}$                                             | MR inputs                                               |                  | 40   | $\mu\text{A}$ |
|           |                                           |                                                                                      | $\overline{\text{CP}}_0, \overline{\text{CP}}_1$ inputs |                  | 80   | $\mu\text{A}$ |
|           |                                           | $V_{CC} = \text{Max}, V_I = 0.4\text{V}$                                             | MR inputs                                               |                  | -1.6 | mA            |
|           |                                           |                                                                                      | $\overline{\text{CP}}_0$ input                          |                  | -3.2 | mA            |
| $I_{IL}$  | Low-level input current                   |                                                                                      | $\overline{\text{CP}}_1$ input                          |                  | -3.2 | mA            |
| $I_{OS}$  | Short-circuit output current <sup>3</sup> | $V_{CC} = \text{Max}$                                                                | -18                                                     |                  | -55  | mA            |
| $I_{CC}$  | Supply current <sup>4</sup> (total)       | $V_{CC} = \text{Max}$                                                                |                                                         | 28               | 46   | mA            |

**AC ELECTRICAL CHARACTERISTICS**  $T_A = 25^\circ\text{C}, V_{CC} = 5.0\text{V}^5$ 

| SYMBOL           | PARAMETER                                      | TEST CONDITIONS | LIMITS                |     | UNIT |
|------------------|------------------------------------------------|-----------------|-----------------------|-----|------|
|                  |                                                |                 | C <sub>L</sub> = 15pF |     |      |
|                  |                                                |                 | Min                   | Max |      |
| f <sub>MAX</sub> | CP <sub>0</sub> input count frequency          | Waveform 1      | 10                    |     | MHz  |
| f <sub>MAX</sub> | CP <sub>1</sub> input count frequency          |                 | 10                    |     | MHz  |
| t <sub>PLH</sub> | Propagation delay                              | Waveform 1      |                       | 33  | ns   |
| t <sub>PHL</sub> | CP <sub>0</sub> input to Q <sub>0</sub> output |                 |                       | 33  | ns   |
| t <sub>PLH</sub> | Propagation delay                              | Waveform 1      |                       | 33  | ns   |
| t <sub>PHL</sub> | CP <sub>1</sub> input to Q <sub>1</sub> output |                 |                       | 33  | ns   |
| t <sub>PLH</sub> | Propagation delay                              | Waveform 1      |                       | 67  | ns   |
| t <sub>PHL</sub> | CP <sub>1</sub> input to Q <sub>2</sub> output |                 |                       | 67  | ns   |
| t <sub>PLH</sub> | Propagation delay                              | Waveform 1      |                       | 102 | ns   |
| t <sub>PHL</sub> | CP <sub>1</sub> input to Q <sub>3</sub> output |                 |                       | 102 | ns   |
| t <sub>PLH</sub> | Propagation delay                              | Waveform 1      |                       | 135 | ns   |
| t <sub>PHL</sub> | CP <sub>0</sub> input to Q <sub>3</sub> output |                 |                       | 135 | ns   |

**AC SETUP REQUIREMENTS**  $T_A = 25^\circ\text{C}, V_{CC} = 5.0\text{V}$ 

| SYMBOL | PARAMETER                            | TEST CONDITIONS | LIMIT |     | UNIT |
|--------|--------------------------------------|-----------------|-------|-----|------|
|        |                                      |                 | Min   | Max |      |
| $t_w$  | $\overline{\text{CP}}_0$ pulse width | Waveform 1      | 50    |     | ns   |
| $t_w$  | $\overline{\text{CP}}_1$ pulse width | Waveform 1      | 50    |     | ns   |
| $t_w$  | MR pulse width                       | Waveform 2      | 50    |     | ns   |

## Counter

5493

AC ELECTRICAL CHARACTERISTICS  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5.0\text{V}$ 

| AC ELECTRICAL CHARACTERISTICS $V_A = 2.5\text{ V}$ , $V_{CC} = 5.0\text{ V}$ |                                                                            |                 |                      |            |            |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----------------|----------------------|------------|------------|
| SYMBOL                                                                       | PARAMETER                                                                  | TEST CONDITIONS | LIMITS               |            | UNIT       |
|                                                                              |                                                                            |                 | $C_L = 50\text{ pF}$ |            |            |
|                                                                              |                                                                            |                 | Min                  | Max        |            |
| $f_{\text{MAX}}$<br>$f_{\text{MAX}}$                                         | $\text{CP}_0$ input count frequency<br>$\text{CP}_1$ input count frequency | Waveform 1      | 10<br>10             |            | MHz<br>MHz |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                         | Propagation delay<br>$\text{CP}_0$ input to $Q_0$ output                   | Waveform 1      |                      | 37<br>37   | ns<br>ns   |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                         | Propagation delay<br>$\text{CP}_1$ input to $Q_1$ output                   | Waveform 1      |                      | 37<br>37   | ns<br>ns   |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                         | Propagation delay<br>$\text{CP}_1$ input to $Q_2$ output                   | Waveform 1      |                      | 71<br>71   | ns<br>ns   |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                         | Propagation delay<br>$\text{CP}_1$ input to $Q_3$ output                   | Waveform 1      |                      | 106<br>106 | ns<br>ns   |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                         | Propagation delay<br>$\text{CP}_0$ input to $Q_3$ output                   | Waveform 1      |                      | 143<br>143 | ns<br>ns   |

AC ELECTRICAL CHARACTERISTICS  $T_A = -55^\circ\text{C}$  and  $+125^\circ\text{C}$ ,  $V_{CC} = 5.0\text{V}^5$ 

| AC ELECTRICAL CHARACTERISTICS $V_A = -55\text{ V}$ and $+125\text{ V}$ , $V_{CC} = 5.0\text{ V}$ |                                                                            |                 |                      |            |            |
|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----------------|----------------------|------------|------------|
| SYMBOL                                                                                           | PARAMETER                                                                  | TEST CONDITIONS | LIMITS               |            | UNIT       |
|                                                                                                  |                                                                            |                 | $C_L = 50\text{ pF}$ |            |            |
|                                                                                                  |                                                                            |                 | Min                  | Max        |            |
| $f_{\text{MAX}}$<br>$f_{\text{MAX}}$                                                             | $\text{CP}_0$ input count frequency<br>$\text{CP}_1$ input count frequency | Waveform 1      | 10<br>10             |            | MHz<br>MHz |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                                             | Propagation delay<br>$\text{CP}_0$ input to $Q_0$ output                   | Waveform 1      |                      | 48<br>48   | ns<br>ns   |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                                             | Propagation delay<br>$\text{CP}_1$ input to $Q_1$ output                   | Waveform 1      |                      | 48<br>48   | ns<br>ns   |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                                             | Propagation delay<br>$\text{CP}_1$ input to $Q_2$ output                   | Waveform 1      |                      | 87<br>87   | ns<br>ns   |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                                             | Propagation delay<br>$\text{CP}_1$ input to $Q_3$ output                   | Waveform 1      |                      | 138<br>138 | ns<br>ns   |
| $t_{\text{PLH}}$<br>$t_{\text{PHL}}$                                                             | Propagation delay<br>$\text{CP}_0$ input to $Q_3$ output                   | Waveform 1      |                      | 186<br>186 | ns<br>ns   |

AC SETUP REQUIREMENTS  $T_A = -55^\circ\text{C}$  and  $+125^\circ\text{C}$ ,  $V_{CC} = 5.0\text{V}^5$ 

| SYMBOL | PARAMETER                 | TEST CONDITIONS | LIMIT |     | UNIT |
|--------|---------------------------|-----------------|-------|-----|------|
|        |                           |                 | Min   | Max |      |
| $t_W$  | $\text{CP}_0$ pulse width | Waveform 1      | 50    |     | ns   |
| $t_W$  | $\text{CP}_1$ pulse width | Waveform 1      | 50    |     | ns   |
| $t_W$  | MR pulse width            | Waveform 2      | 50    |     | ns   |

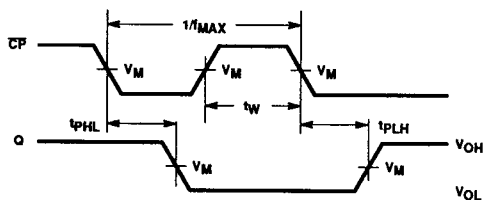
## NOTES:

1. For conditions shown as Min or Max, use the appropriate value specified under recommended operating conditions for the applicable type and function table operating mode.
2. All typical values are at  $V_{CC} = 5\text{V}$ ,  $T_A = 25^\circ\text{C}$ .
3. Not more than one output should be shorted at a time and duration of the short circuit should not exceed one second.
4.  $I_{CC}$  is measured with all outputs open, both MR inputs grounded following momentary connection  $\geq 4.0\text{V}$ , and all other inputs grounded.
5. These parameters are guaranteed, but not tested.

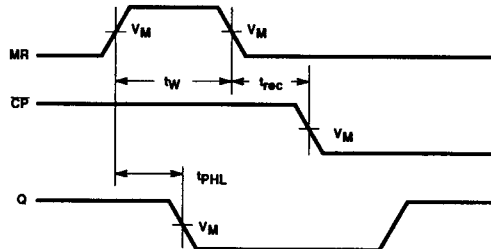
## Counter

5493

## AC WAVEFORMS



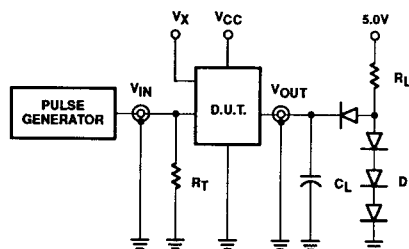
Waveform 1.



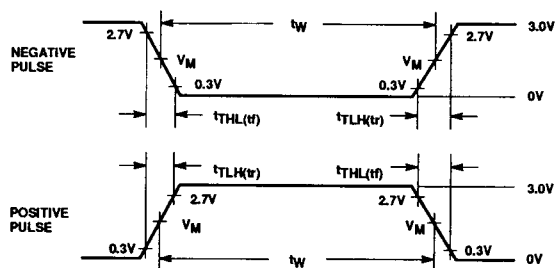
Waveform 2.

NOTE:  $V_M = 1.5V$ The number of Clock Pulses required between the  $t_{PLH}$  and  $t_{PHL}$  measurements can be determined from the appropriate Truth Table.

## TEST CIRCUIT AND WAVEFORM



Test Circuit for 54 Totem-Pole Outputs



Input Pulse Definition

| FAMILY | INPUT PULSE CHARACTERISTICS |       |           |       |            |            |
|--------|-----------------------------|-------|-----------|-------|------------|------------|
|        | $R_L$                       | $V_M$ | Rep. Rate | $T_W$ | $T_{TLH}$  | $T_{THL}$  |
| 54XXX  | 400 $\Omega$                | 1.5V  | 1MHz      | 500ns | $\leq 7ns$ | $\leq 7ns$ |

## DEFINITIONS:

 $C_L$  = Load capacitance includes jig and probe capacitance; see AC Characteristics for value. $R_T$  = Termination resistance should be equal to  $Z_{OUT}$  of Pulse Generators.

D = Diodes are 1N916, 1N3064, or equivalent.

 $V_X$  = Unlocked pins must be held at  $\leq 0.8V$ ,  $\geq 2.7V$  or open per Function Table.