

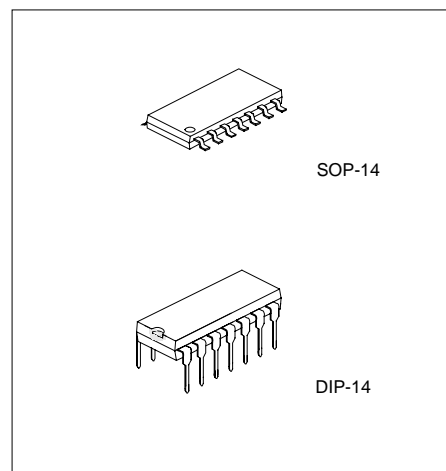
PROGRAMMABLE TIMER

DESCRIPTION

The UTC **CD4541** programmable timer comprise a 16-stage binary counter, an integrated oscillator for use with an external capacitor and two resistors, output control logic, and a special power-on reset circuit. The counter divides the oscillator frequency by any of 4 digitally controlled division ratios.

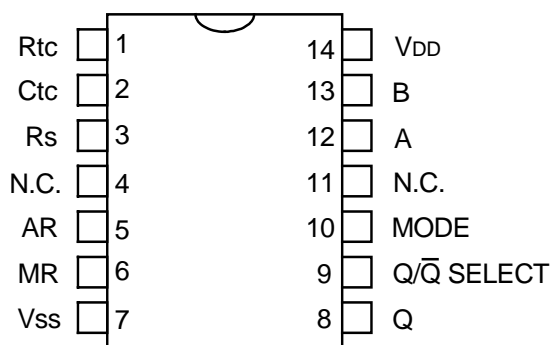
FEATURES

- \*Operates at  $2^n$  frequency divider or as single transition timer
- \*Increments on positive edge clock transitions
- \*Wide supply voltage range: 3.0V ~ 15V
- \*Built-in low power RC oscillator
- \*Oscillator frequency range ~ DC to 100 kHz
- \*External clock applied to Pin 3 can be used instead of oscillator
- \*Available division ratios  $2^8$ ,  $2^{10}$ ,  $2^{13}$ , or  $2^{16}$
- \*High noise immunity: 0.45 V<sub>DD</sub> (typ.)
- \*Master reset totally independent of automatic reset operation
- \*Automatic reset initializes all counters when power turns on
- \* $Q/\bar{Q}$  select provides output logic level flexibility
- \*High output drive min. one TTL load
- \*Maximum input leakage 1  $\mu$  A at 15V over full temperature range



\*Pb-free plating product number: CD4541L

PIN CONFIGURATION



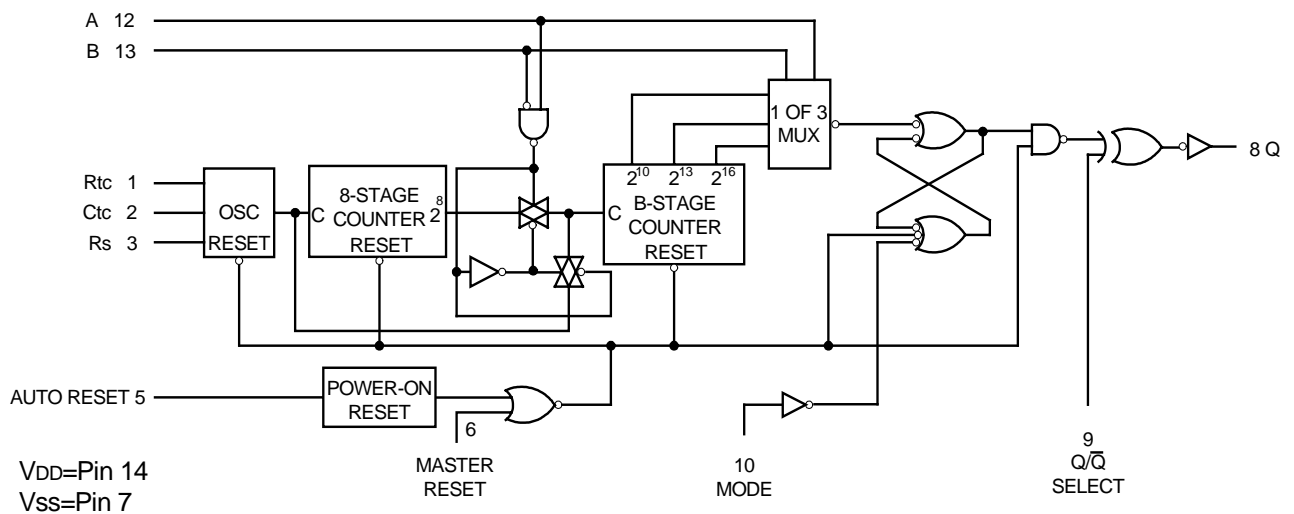
**TRUTH TABLE**

| PIN | STATE                            |                                   |
|-----|----------------------------------|-----------------------------------|
|     | 0                                | 1                                 |
| 5   | Auto Reset Operating             | Auto Reset Disabled               |
| 6   | Timer Operational                | Master Reset On                   |
| 9   | Output Initially Low after Reset | Output Initially High after Reset |
| 10  | Single Cycle Mode                | Recycle Mode                      |

**DIVISION RATIO TABLE**

| A | B | Number of Counter Stages<br>n | Count<br>$2^n$ |
|---|---|-------------------------------|----------------|
| 0 | 0 | 13                            | 8192           |
| 0 | 1 | 10                            | 1024           |
| 1 | 0 | 8                             | 256            |
| 1 | 1 | 16                            | 65536          |

**BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS**

(Note 1, 2)

| PARAMETER                                | SYMBOL    | RATINGS             | UNIT |
|--|-----------|---------------------|------|
| Supply Voltage                           | $V_{DD}$  | -0.5 ~ +18          | V    |
| Input Voltage                            | $V_{IN}$  | -0.5 ~ $V_{DD}+0.5$ | V    |
| Power Dissipation                        | DIP-14    | 700                 | mW   |
|  | SOP-14    | 500                 |      |
| Lead Temperature (soldering, 10 seconds) | $T_L$     | 260                 |      |
| Storage Temperature Range                | $T_{stg}$ | -65 ~ +150          |      |

**RECOMMENDED OPERATING CONDITIONS**

(Note 2)

| PARAMETER                   | SYMBOL    | RATINGS      | UNIT |
|-----------------------------|-----------|--------------|------|
| Supply Voltage              | $V_{DD}$  | 3 ~ 15       | V    |
| Input Voltage               | $V_{IN}$  | 0 ~ $V_{DD}$ | V    |
| Operating Temperature Range | $T_{opr}$ | -40 ~ +85    |      |

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

**Note 2:**  $V_{SS}=0V$  unless otherwise specified.

**DC ELECTRICAL CHARACTERISTICS**(Note 2,  $T_a=25$  , unless otherwise noted.)

| PARAMETER                          | SYMBOL   | TEST CONDITIONS                         | MIN   | TYP        | MAX  | UNIT    |
|------------------------------------|----------|---|-------|------------|------|---------|
| Quiescent Device Current           | $I_{DD}$ | $V_{DD}=5V, V_{IN}=V_{DD}$ or $V_{SS}$  |       | 0.005      | 20   | $\mu A$ |
|                                    |          | $V_{DD}=10V, V_{IN}=V_{DD}$ or $V_{SS}$ |       | 0.010      | 40   |         |
|                                    |          | $V_{DD}=15V, V_{IN}=V_{DD}$ or $V_{SS}$ |       | 0.015      | 80   |         |
| LOW Level Output Voltage           | $V_{OL}$ | $V_{DD}=5V$                             |       | 0          | 0.05 | V       |
|                                    |          | $V_{DD}=10V, I_{Io} < 1 \mu A$          |       | 0          | 0.05 |         |
|                                    |          | $V_{DD}=15V$                            |       | 0          | 0.05 |         |
| HIGH Level Output Voltage          | $V_{OH}$ | $V_{DD}=5V$                             | 4.95  | 5          |      | V       |
|                                    |          | $V_{DD}=10V, I_{Io} < 1 \mu A$          | 9.95  | 10         |      |         |
|                                    |          | $V_{DD}=15V$                            | 14.95 | 15         |      |         |
| LOW Level Input Voltage            | $V_{IL}$ | $V_{DD}=5V, V_o=0.5V$ or $4.5V$         |       | 2          | 1.5  | V       |
|                                    |          | $V_{DD}=10V, V_o=1.0V$ or $9.0V$        |       | 4          | 3.0  |         |
|                                    |          | $V_{DD}=15V, V_o=1.5V$ or $13.5V$       |       | 6          | 4.0  |         |
| HIGH Level Input Voltage           | $V_{IH}$ | $V_{DD}=5V, V_o=0.5V$ or $4.5V$         | 3.5   | 3          |      | V       |
|                                    |          | $V_{DD}=10V, V_o=1.0V$ or $9.0V$        | 7.0   | 6          |      |         |
|                                    |          | $V_{DD}=15V, V_o=1.5V$ or $13.5V$       | 11.0  | 9          |      |         |
| LOW Level Output Current (Note 3)  | $I_{OL}$ | $V_{DD}=5V, V_o=0.4V$                   | 1.96  | 3.6        |      | mA      |
|                                    |          | $V_{DD}=10V, V_o=0.5V$                  | 2.66  | 9.0        |      |         |
|                                    |          | $V_{DD}=15V, V_o=1.5V$                  | 10.4  | 34.0       |      |         |
| HIGH Level Output Current (Note 3) | $I_{OH}$ | $V_{DD}=5V, V_o=2.5V$                   | 4.27  | 130        |      | mA      |
|                                    |          | $V_{DD}=10V, V_o=9.5V$                  | 2.25  | 8.0        |      |         |
|                                    |          | $V_{DD}=15V, V_o=13.5V$                 | 8.8   | 30.0       |      |         |
| Input Current                      | $I_{IN}$ | $V_{DD}=15V, V_{IN}=0V$                 |       | $-10^{-5}$ | -0.3 | $\mu A$ |
|                                    |          | $V_{DD}=15V, V_{IN}=15V$                |       | $10^{-5}$  | 0.3  |         |

**Note 3:**  $I_{OH}$  and  $I_{OL}$  are tested one output at a time.

**AC ELECTRICAL CHARACTERISTICS**(Note 4,  $T_a=25$  ,  $C_L=50\text{pF}$  (refer to test circuits))

| PARAMETER   | SYMBOL                | TEST CONDITIONS  | MIN               | TYP               | MAX               | UNIT          |
|---|-----------------------|--|-------------------|-------------------|-------------------|---------------|
| Output Rise Time  | $t_{TLH}$             | $V_{DD}=5\text{V}$<br>$V_{DD}=10\text{V}$<br>$V_{DD}=15\text{V}$ |                   | 50<br>30<br>25    | 200<br>100<br>80  | ns            |
| Output Fall Time  | $t_{THL}$             | $V_{DD}=5\text{V}$<br>$V_{DD}=10\text{V}$<br>$V_{DD}=15\text{V}$ |                   | 50<br>30<br>25    | 200<br>100<br>80  | ns            |
| Turn-Off, Turn-On Propagation Delay,<br>Clock to Q ( $2^8$ Output)    | $t_{PLH}$ , $t_{PHL}$ | $V_{DD}=5\text{V}$<br>$V_{DD}=10\text{V}$<br>$V_{DD}=15\text{V}$ |                   | 1.8<br>0.6<br>0.4 | 4.0<br>1.5<br>1.0 | $\mu\text{s}$ |
| Turn-On, Turn-Off Propagation Delay,<br>Clock to Q ( $2^{16}$ Output) | $t_{PHL}$ , $t_{PLH}$ | $V_{DD}=5\text{V}$<br>$V_{DD}=10\text{V}$<br>$V_{DD}=15\text{V}$ |                   | 3.2<br>1.5<br>1.0 | 8.0<br>3.0<br>2.0 | $\mu\text{s}$ |
| Clock Pulse Width   | $t_{WH(CL)}$          | $V_{DD}=5\text{V}$<br>$V_{DD}=10\text{V}$<br>$V_{DD}=15\text{V}$ | 400<br>200<br>150 | 200<br>100<br>70  |                   | ns            |
| Clock Pulse Frequency   | $f_{CL}$              | $V_{DD}=5\text{V}$<br>$V_{DD}=10\text{V}$<br>$V_{DD}=15\text{V}$ |                   | 2.5<br>6.0<br>8.5 | 1.0<br>3.0<br>4.0 | MHz           |
| MR Pulse Width  | $t_{WH(R)}$           | $V_{DD}=5\text{V}$<br>$V_{DD}=10\text{V}$<br>$V_{DD}=15\text{V}$ | 400<br>200<br>150 | 170<br>75<br>50   |                   | ns            |
| Average Input Capacitance   | $C_i$                 | Any Input  |                   | 5.0               | 7.5               | pF            |
| Power Dissipation Capacitance<br>(Note 5)                             | $C_{PD}$              |  |                   | 100               |                   | pF            |

**Note 4:** AC Parameters are guaranteed by DC correlated testing.**Note 5:**  $C_{PD}$  determines the no load AC power consumption of any CMOS device.

**OPERATING CHARACTERISTICS**

With Auto Reset pin set to a “0” the counter circuit is initialized by turning on power. Or with power already on, the counter circuit is reset when the Master Reset pin is set to a “1”. Both types of reset will result in synchronously resetting all counter stages independent of counter state.

The RC oscillator frequency is determined by the external RC network, i.e.:

$$f = \frac{1}{2.3 R_{TC} C_{TC}} \text{ if } (1 \text{ kHz} < f < 100\text{kHz})$$

and  $R_S \sim 2 R_{TC}$  where  $R_S = 10 \text{ k}$

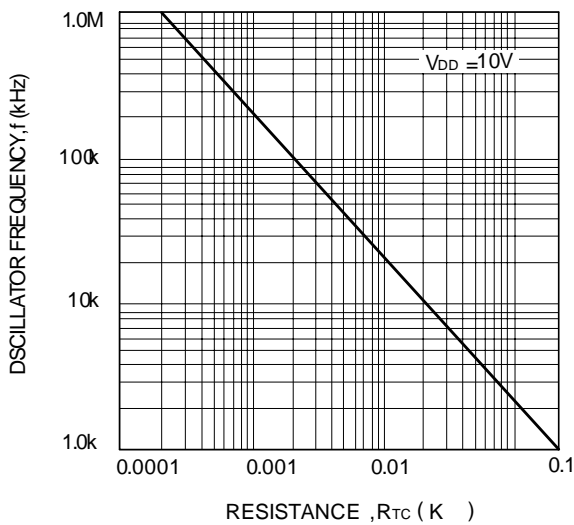
The time select inputs (A and B) provide a two-bit address to output any one of four counter stages ( $2^8$ ,  $2^{10}$ ,  $2^{13}$ , and  $2^{16}$ ). The  $2^n$  counts as shown in the Division Ratio Table represent the Q output of the Nth stage of the counter. When A is “1”,  $2^{16}$  is selected for both states of B.

However, when B is “0”, normal counting is interrupted and the 9th counter stage receives its clock directly from the oscillator (i.e., effectively outputting  $2^8$ ).

The  $\overline{Q/Q}$  select output control pin provides for a choice of output level. When the counter is in a reset condition and  $\overline{Q/Q}$  select pin is set to a “0” the Q output is a “0”. Correspondingly, when  $\overline{Q/Q}$  select pin is set to a “1” the Q output is a “1”.

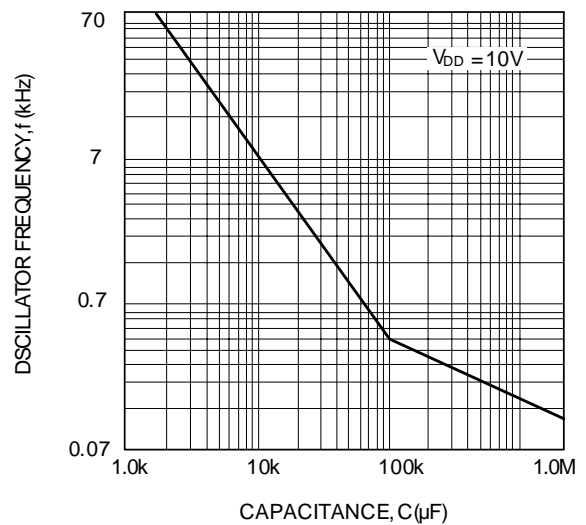
When the mode control pin is set to a “1”, the selected count is continually transmitted to the output. But, with mode pin “0” and after a reset condition the RS flip-flop resets (see Logic Diagram), counting commences and after  $2^{n-1}$  counts the RS flip-flop sets which causes the output to change state. Hence, after another  $2^{n-1}$  counts the output will not change. Thus, a Master Reset pulse must be applied or a change in the mode pin level is required to reset the single cycle operation.

RC Oscillator Frequency as a Function of  $R_{TC}$  and C

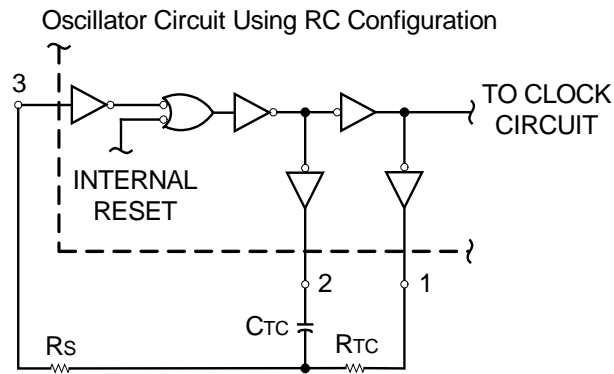


f as a function of C and ( $R_{TC} = 56 \text{ K}$ ,  $R_S = 120 \text{ k}$ )

RC Oscillator Frequency as a Function of  $R_{TC}$  and C

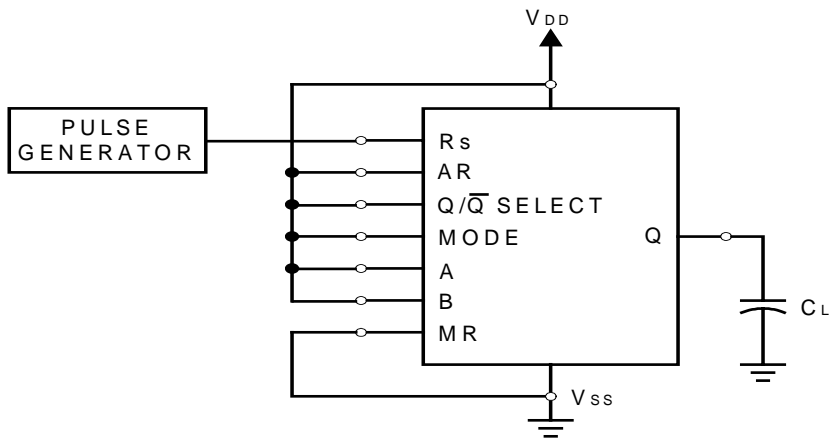


f as a function of  $R_{TC}$  and ( $C = 100 \text{ pF}$ ,  $R_S = 2R_{TC}$ )

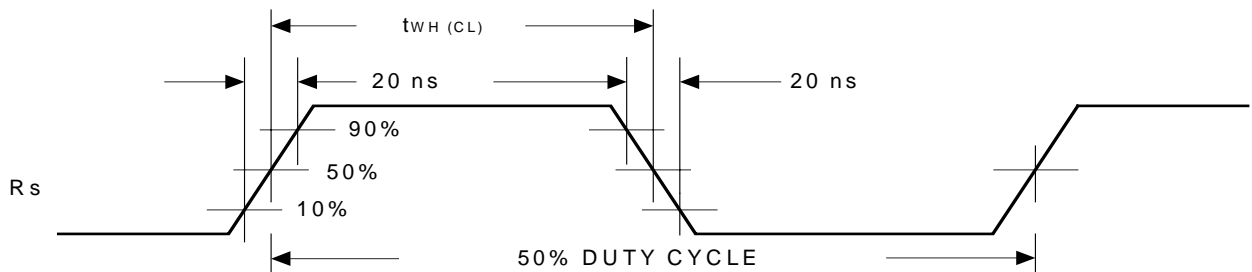


TEST CIRCUIT AND WAVEFORMS

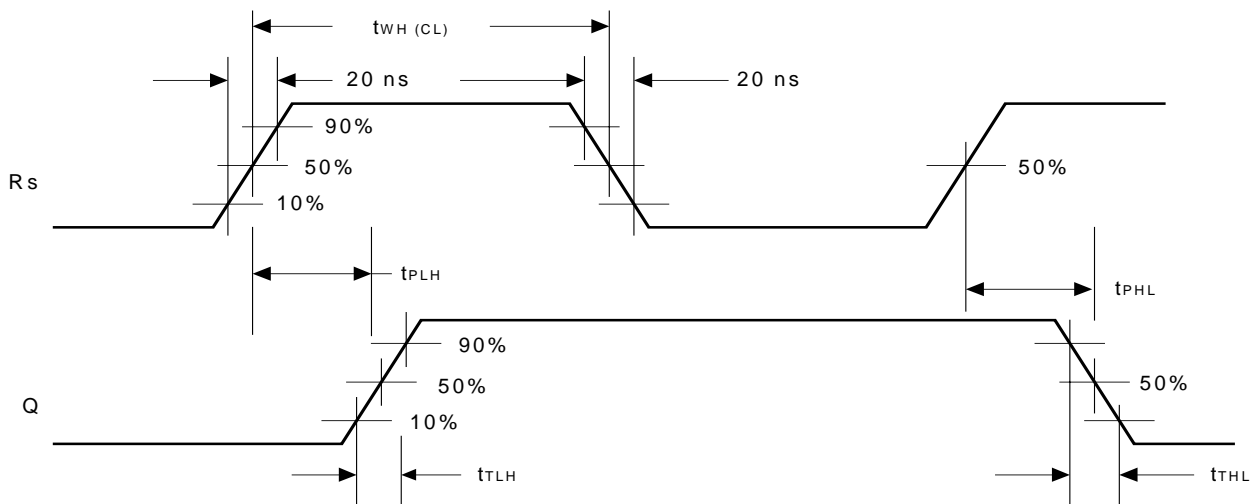
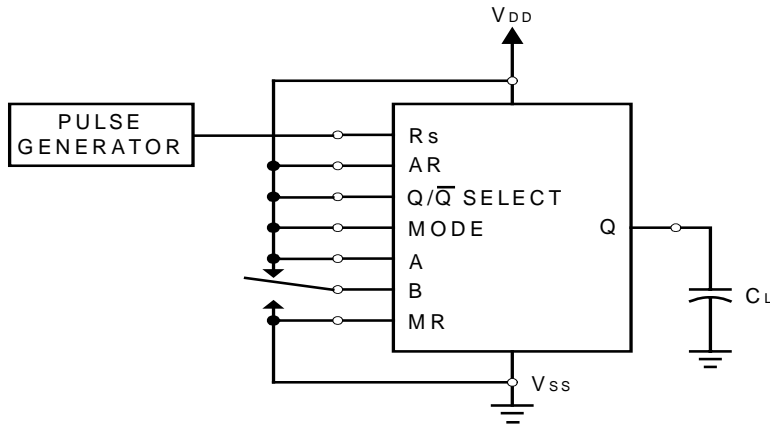
Power Dissipation Test Circuit and Waveforms



(R<sub>TC</sub> and C<sub>TC</sub> outputs are left open)



Switching Time Test Circuit and Waveforms



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