



CD4541

CMOS IC

PROGRAMMABLE TIMER

DESCRIPTION

The **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_{DD} (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 μ A at 15V over full temperature range

ORDERING INFORMATION

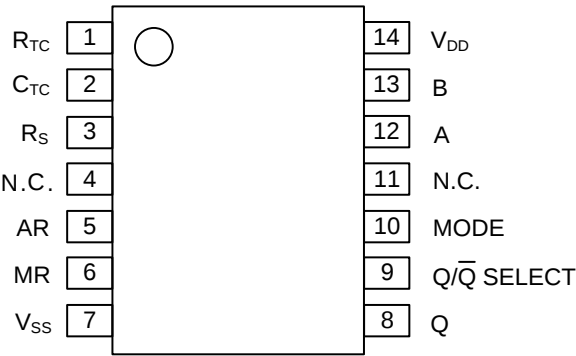
Ordering Number		Package	Packing
Lead Free	Halogen Free		
CD4541L-D14-T	CD4541G-D14-T	DIP-14	Tube
CD4541L-S14-R	CD4541G-S14-R	SOP-14	Tape Reel
CD4541L-P14-R	CD4541G-P14-R	TSSOP-14	Tape Reel

CD4541G-D14-T (1) Packing Type (2) Package Type (3) Green Package	(1) T: Tube, R: Tape Reel (2) D14: DIP-14, S14: SOP-14, P14: TSSOP-14 (3) G: Halogen Free and Lead Free, L: Lead Free
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MARKING

DIP-14	SOP-14 / TSSOP-14
14 13 12 11 10 9 8 UTC □□□□ CD4541 □ □ □ 1 2 3 4 5 6 7 → Date Code → L: Lead Free → G: Halogen Free → Lot Code	14 13 12 11 10 9 8 UTC □□□□ CD4051 □ □ □ 1 2 3 4 5 6 7 → Date Code → L: Lead Free → G: Halogen Free → Lot Code

PIN CONFIGURATION



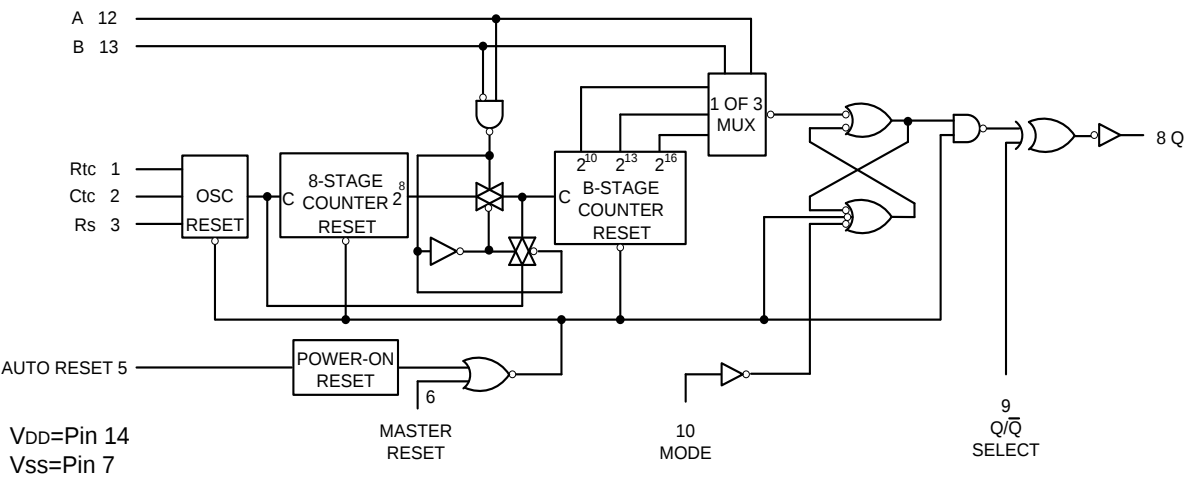
TRUTH TABLE

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 n	Count 2 ⁿ
0	0	13	8192
0	1	10	1024
1	0	8	256
1	1	16	65536

BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATING

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	P _D	700	mW
	SOP-14		500	
	TSSOP-14			
Junction Temperature		T _J	125	°C
Operating Temperature		T _{OPR}	-20 ~ +85	°C
Storage Temperature		T _{STG}	-40 ~ +150	°C

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	3 ~ 15	V
Input Voltage	V_{IN}	0 ~ V_{DD}	V
Operating Temperature	T_{OPR}	-40 ~ +85	°C

■ DC ELECTRICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$, unless otherwise specified)

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

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

■ **AC ELECTRICAL CHARACTERISTICS** (Note 1, $T_A=25^{\circ}\text{C}$, $C_L=50\text{pF}$ (refer to test circuits))

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

Notes: 1. AC Parameters are guaranteed by DC correlated testing.

2. 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.:

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

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

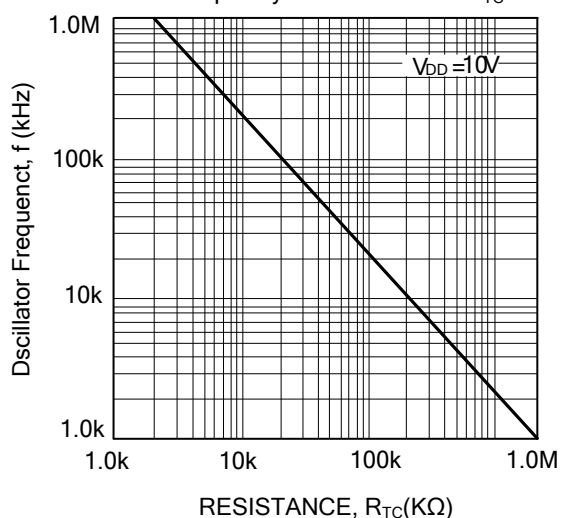
The time select inputs (A and B) provide a two-bit address to output any one of four counter stages (2^8 , 2^{10} , 2^{13} , and 2^{16}). The 2^n counts as shown in the Division Ratio Table represent the Q output of the Nth stage of the counter. When A is "1", 2^{16} is selected for both states of B.

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

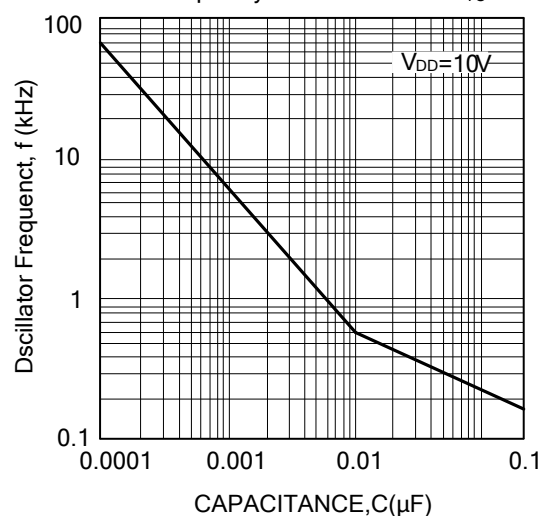
When the mode control pin is set to a "1", the selected count is continually transmitted to the output. But, with mode pin "0" and after a reset condition the RS flip-flop resets (see Logic Diagram), counting commences and after 2^{n-1} counts the RS flip-flop sets which causes the output to change state. 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



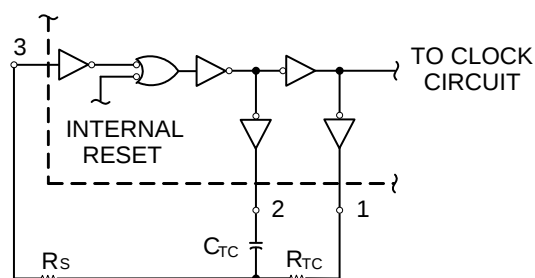
f as a function of R_{TC} and ($C = 100 \text{ pF}$, $R_S = 2R_{TC}$)

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



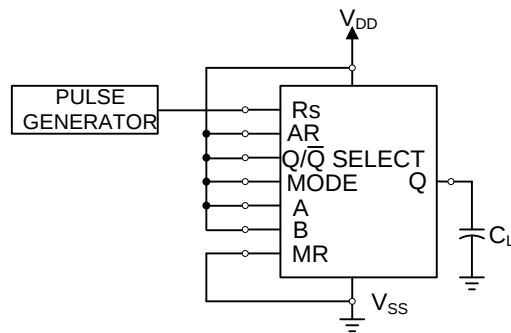
f as a function of C and ($R_{TC} = 56 \text{ K}\Omega$, $R_S = 120 \text{ k}\Omega$)

Oscillator Circuit Using RC Configuration

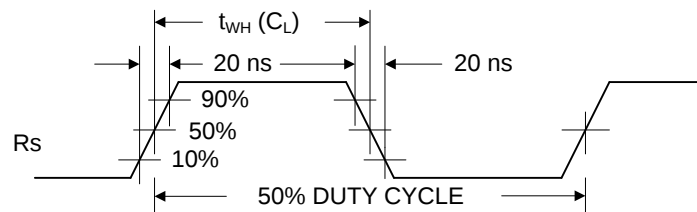


■ TEST CIRCUIT AND WAVEFORMS

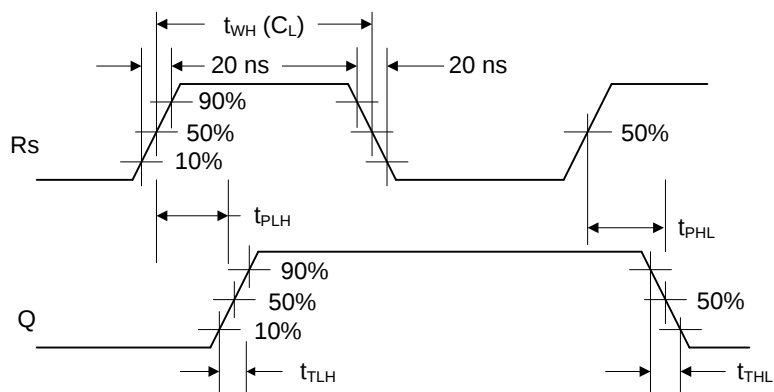
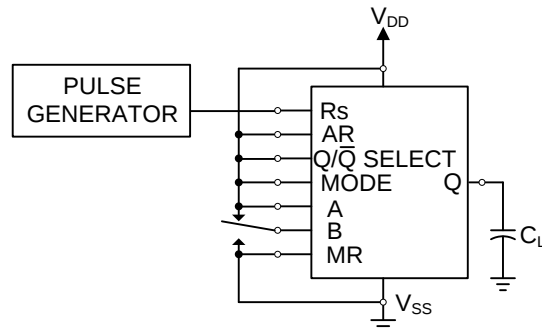
Power Dissipation Test Circuit and Waveforms



(Rtc and Ctc outputs are left open)



Switching Time Test Circuit and Waveforms



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