

## CMOS 14-Stage Ripple-Carry Binary Counter/Divider and Oscillator

High-Voltage Types (20-Volt Rating)

■ CD4060B consists of an oscillator section and 14 ripple-carry binary counter stages. The oscillator configuration allows design of either RC or crystal oscillator circuits. A RESET input is provided which resets the counter to the all-0's state and disables the oscillator. A high level on the RESET line accomplishes the reset function. All counter stages are master-slave flip-flops. The state of the counter is advanced one step in binary order on the negative transition of  $\phi I$  (and  $\phi O$ ). All inputs and outputs are fully buffered. Schmitt trigger action on the input-pulse line permits unlimited input-pulse rise and fall times.

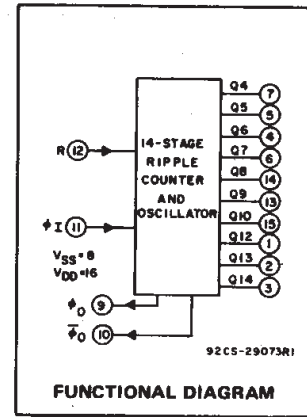
The CD4060B-series types are supplied in 16-lead hermetic dual-in-line ceramic packages (D and F suffixes), 16-lead dual-in-line plastic packages (E suffix), and in chip form (H suffix).

### Features:

- 12 MHz clock rate at 15 V
- Common reset
- Fully static operation
- Buffered inputs and outputs
- Schmitt trigger input-pulse line
- 100% tested for quiescent current at 20 V
- Standardized, symmetrical output characteristics
- 5-V, 10-V, and 15-V parametric ratings
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for description of "B" Series CMOS Devices"

### Oscillator Features:

- All active components on chip
- RC or crystal oscillator configuration
- RC oscillator frequency of 690 kHz min. at 15 V



### Applications

- Control counters
- Timers
- Frequency dividers
- Time-delay circuits

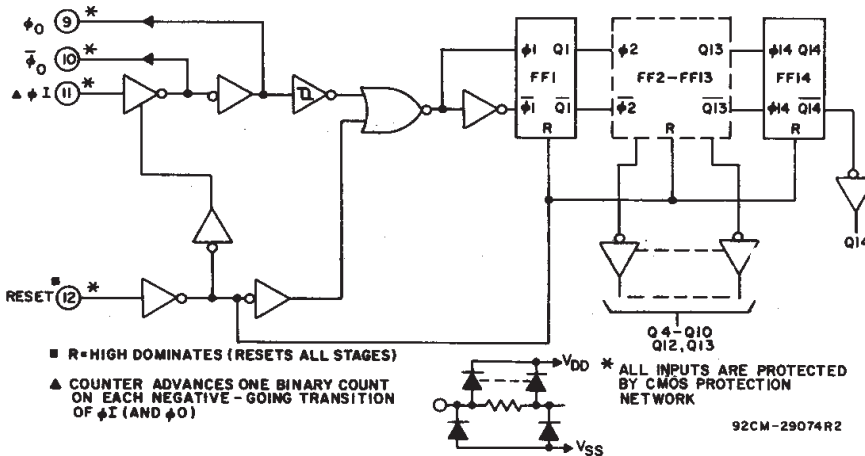


Fig. 1 - Logic diagram.

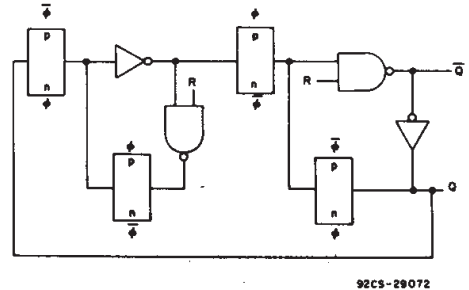


Fig. 2 - Detail of typical flip-flop stage.

### MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, ( $V_{DD}$ )	.....	-0.5V to +20V
Voltages referenced to $V_{SS}$ Terminal)	.....	
INPUT VOLTAGE RANGE, ALL INPUTS	.....	-0.5V to $V_{DD} + 0.5V$
DC INPUT CURRENT, ANY ONE INPUT	.....	$\pm 10mA$
POWER DISSIPATION PER PACKAGE ( $P_D$ ):		
For $T_A = -55^\circ C$ to $+100^\circ C$	.....	500mW
For $T_A = +100^\circ C$ to $+125^\circ C$	.....	Derate Linearly at 12mW/ $^\circ C$ to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR		
FOR $T_A =$ FULL PACKAGE-TEMPERATURE RANGE (All Package Types)	.....	100mW
OPERATING-TEMPERATURE RANGE ( $T_A$ )	.....	$-55^\circ C$ to $+125^\circ C$
STORAGE TEMPERATURE RANGE ( $T_{stg}$ )	.....	$-65^\circ C$ to $+150^\circ C$
LEAD TEMPERATURE (DURING SOLDERING):		
At distance $1/16 \pm 1/32$ inch ( $1.59 \pm 0.79mm$ ) from case for 10s max	.....	$+265^\circ C$

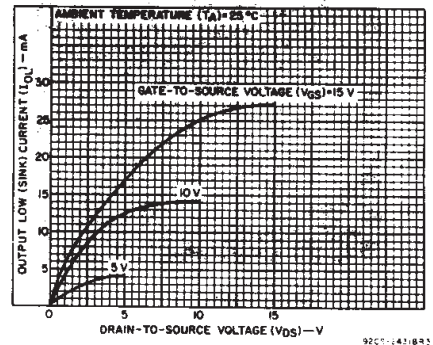


Fig. 3 - Typical n-channel output low (sink) current characteristics.

# CD4060B Types

## STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)	-55	-40	+85	+125	+25			
								Min.	Typ.	Max.	
Quiescent Device Current, I <sub>DD</sub> Max.	—	0,5	5	5	5	150	150	—	0,04	5	μA
	—	0,10	10	10	10	300	300	—	0,04	10	
	—	0,15	15	20	20	600	600	—	0,04	20	
	—	0,20	20	100	100	3000	3000	—	0,08	100	
Output Low (Sink) Current*, I <sub>OL</sub> Min.	0,4	0,5	5	0,64	0,61	0,42	0,36	0,51	1	—	mA
	0,5	0,10	10	1,6	1,5	1,1	0,9	1,3	2,6	—	
	1,5	0,15	15	4,2	4	2,8	2,4	3,4	6,8	—	
Output High (Source) Current*, I <sub>OH</sub> Min.	4,6	0,5	5	-0,64	-0,61	-0,42	-0,36	-0,51	-1	—	mA
	2,5	0,5	5	-2	-1,8	-1,3	-1,15	-1,6	-3,2	—	
	9,5	0,10	10	-1,6	-1,5	-1,1	-0,9	-1,3	-2,6	—	
	13,5	0,15	15	-4,2	-4	-2,8	-2,4	-3,4	-6,8	—	
Output Voltage: Low-Level, V <sub>OL</sub> Max.	—	0,5	5	0,05				—	0	0,05	V
	—	0,10	10	0,05				—	0	0,05	
	—	0,15	15	0,05				—	0	0,05	
Output Voltage: High-Level, V <sub>OH</sub> Min.	—	0,5	5	4,95				4,95	5	—	V
	—	0,10	10	9,95				9,95	10	—	
	—	0,15	15	14,95				14,95	15	—	
Input Low Voltage V <sub>IL</sub> Max.	0,5,4,5	—	5	1,5				—	—	1,5	V
	1,9	—	10	3				—	—	3	
	1,5,13,5	—	15	4				—	—	4	
Input High Voltage, V <sub>IH</sub> Min.	0,5,4,5	—	5	3,5				3,5	—	—	V
	1,9	—	10	7				7	—	—	
	1,5,13,5	—	15	11				11	—	—	
Input Current I <sub>IN</sub> Max.	—	0,18	18	±0,1	±0,1	±1	±1	—	±10 <sup>-5</sup>	±0,1	μA

\* Data not applicable to terminal 9 or 10.

## RECOMMENDED OPERATING CONDITIONS

For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges

CHARACTERISTIC	V <sub>DD</sub>	LIMITS		UNITS
		MIN.	MAX.	
Supply-Voltage Range (For T <sub>A</sub> = Full Package Temperature Range)	—	3	18	V
Input-Pulse Width, t <sub>W</sub> (f = 100 kHz)	5	100	—	ns
	10	40	—	
	15	30	—	
Input-Pulse Rise Time and Fall Time, t <sub>rφ</sub> , t <sub>fφ</sub>	5	Unlimited		
	10			
	15			
Input-Pulse Frequency, f <sub>φI</sub> (External pulse source)	5	—	3,5	MHz
	10	—	8	
	15	—	12	
Reset Pulse Width, t <sub>W</sub>	5	120	—	ns
	10	60	—	
	15	40	—	

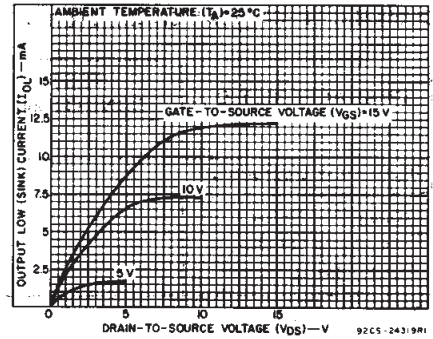


Fig. 4 - Minimum n-channel output low (sink) current characteristics.

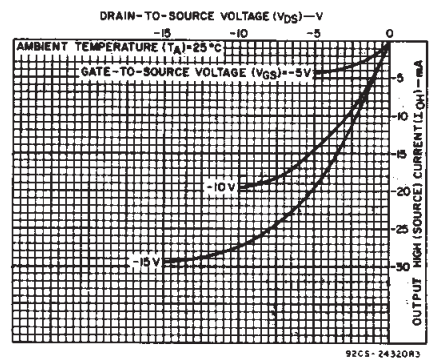


Fig. 5 - Typical p-channel output high (source) current characteristics.

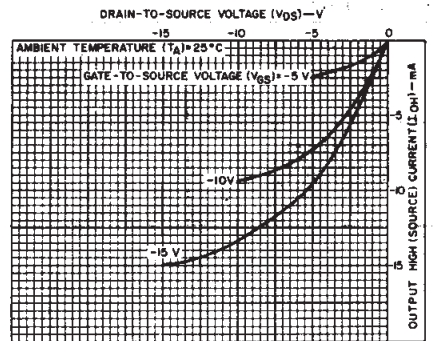


Fig. 6 - Minimum p-channel output high (source) current characteristics.

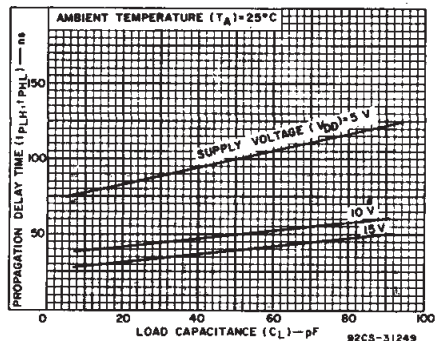


Fig. 7 - Typical propagation delay time (Q<sub>n</sub> to Q<sub>n+1</sub>) as a function of load capacitance.

3  
COMMERCIAL CMOS  
HIGH VOLTAGE ICs

# CD4060B Types

DYNAMIC ELECTRICAL CHARACTERISTICS at  $T_A = 25^\circ\text{C}$ , Input  $t_r, t_f = 20\text{ ns}$ ,  
 $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ k}\Omega$

CHARACTERISTIC	TEST CONDITIONS	LIMITS			UNITS	
		V <sub>DD</sub> (V)	MIN.	TYP.		MAX.
<b>Input-Pulse Operation</b>						
Propagation Delay Time, $\phi_I$ to Q4 Out; $t_{PHL}, t_{PLH}$		5	—	370	740	ns
		10	—	150	300	
		15	—	100	200	
Propagation Delay Time, $Q_n$ to $Q_{n+1}$ ; $t_{PHL}, t_{PLH}$		5	—	100	200	
		10	—	50	100	
		15	—	40	80	
Transition Time, $t_{THL}, t_{TLH}$		5	—	100	200	
		10	—	50	100	
		15	—	40	80	
Min. Input-Pulse Width, $t_W$	f = 100 kHz	5	—	50	100	
		10	—	20	40	
		15	—	15	30	
Input-Pulse Rise & Fall Time, $t_{r\phi}, t_{f\phi}$		5	Unlimited			
		10				
		15				
Max. Input-Pulse Frequency, $f_{\phi_I}$ (External pulse source)		5	3.5	7	—	MHz
		10	8	16	—	
		15	12	24	—	
Input Capacitance, $C_I$	Any Input		—	5	7.5	pF
<b>Reset Operation</b>						
Propagation Delay Time, $t_{PHL}$		5	—	180	360	ns
		10	—	80	160	
		15	—	50	100	
Minimum Reset Pulse Width, $t_W$		5	—	60	120	
		10	—	30	60	
		15	—	20	40	

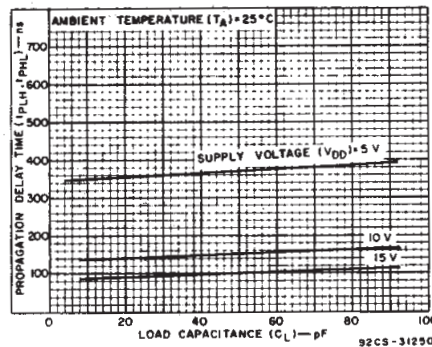


Fig. 8 - Typical propagation delay time ( $\phi_I$  to Q<sub>4</sub> Output) as a function of load capacitance.

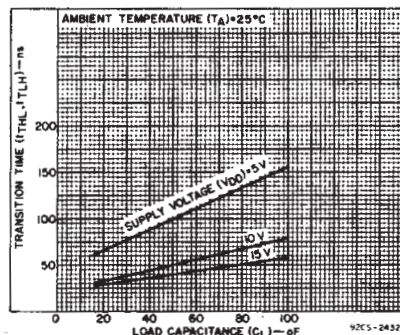


Fig. 9 - Typical transition time as a function of load capacitance.

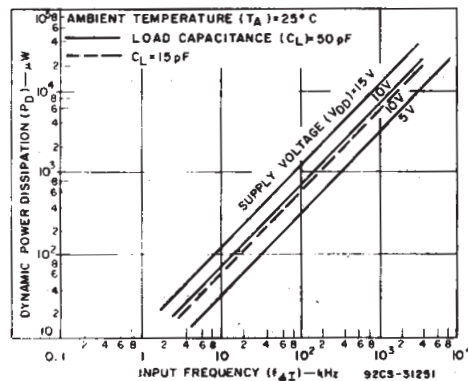


Fig. 10 - Typical dynamic power dissipation as a function of input frequency.

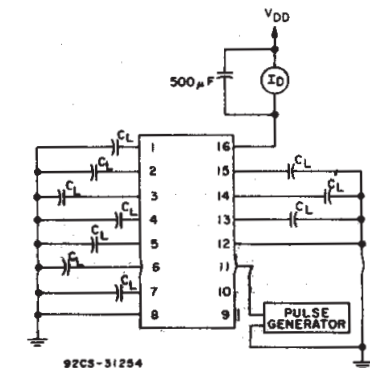


Fig. 11 - Dynamic power dissipation test circuit.

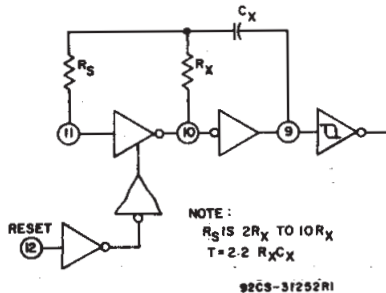


Fig. 12 - Typical RC circuit.

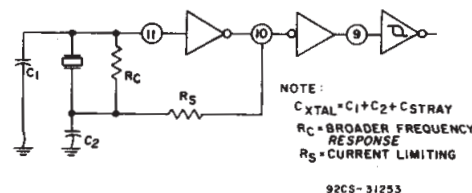


Fig. 13 - Typical crystal circuit.

# CD4060B Types

DYNAMIC ELECTRICAL CHARACTERISTICS at  $T_A = 25^\circ\text{C}$ , Input  $t_r, t_f = 20 \text{ ns}$ ,  $C_L = 50 \text{ pF}$ ,  $R_L = 200 \text{ k}\Omega$  [cont'd]

CHARACTERISTIC	TEST CONDITIONS	VDD (V)	LIMITS			UNITS	
			Min.	Typ.	Max.		
<b>RC Operation</b>							
Variation of Frequency (Unit-to-Unit)	$C_X = 200 \text{ pF}$ , $R_S = 560 \text{ k}\Omega$ , $R_X = 50 \text{ k}\Omega$	5	—	$23 \pm 10\%$	—	kHz	
		10	—	$24 \pm 10\%$	—		
		15	—	$25 \pm 10\%$	—		
Variation of Frequency with voltage change (Same Unit)	$C_X = 200 \text{ pF}$ , $R_S = 560 \text{ k}\Omega$ , $R_X = 50 \text{ k}\Omega$	5V to 10 V	—	1.5	—	kHz	
		10V to 15V	—	0.5	—		
$R_X$ max.	$C_X = 10 \mu\text{F}$ $= 50 \mu\text{F}$ $= 10 \mu\text{F}$	5	—	—	20	M $\Omega$	
		10	—	—	20		
		15	—	—	10		
$C_X$ max.	$R_X = 500 \text{ k}\Omega$ $= 300 \text{ k}\Omega$ $= 300 \text{ k}\Omega$	5	—	—	1000	$\mu\text{F}$	
		10	—	—	50		
		15	—	—	50		
Maximum Oscillator Frequency*	$R_X = 5 \text{ k}\Omega$ $R_S = 30 \text{ k}\Omega$ $C_X = 15 \text{ pF}$	10	530	650	810	kHz	
		15	690	800	940		
Drive Current at Pin 9 (For Oscillator Design)	$I_{OL}$	$V_O = 0.4 \text{ V}$	5	0.16	0.35	—	mA
		$= 0.5 \text{ V}$	10	0.42	0.8	—	
		$= 1.5 \text{ V}$	15	1	2	—	
	$I_{OH}$	$V_O = 4.6 \text{ V}$	5	-0.16	-0.35	—	
		$= 9.5 \text{ V}$	10	-0.42	-0.8	—	
		$= 13.5 \text{ V}$	15	-1	-2	—	

\*RC oscillator applications are not recommended at supply voltages below 7 V for  $R_X < 50 \text{ k}\Omega$ .

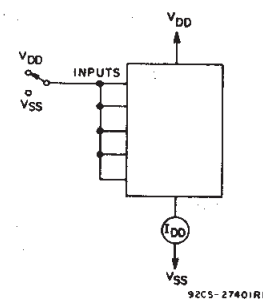


Fig. 14 – Quiescent device current.

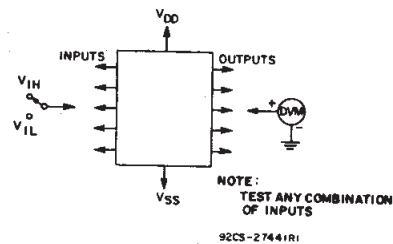


Fig. 15 – Input voltage.

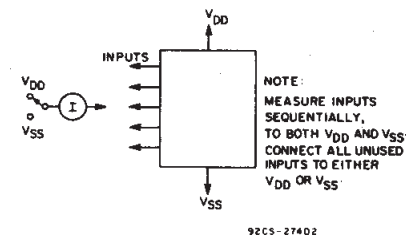
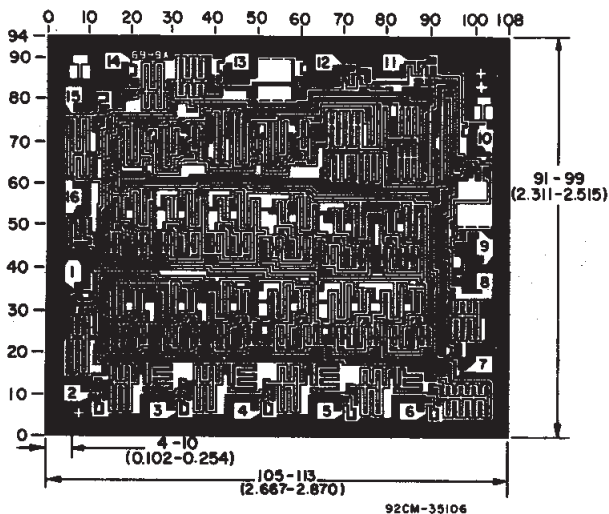
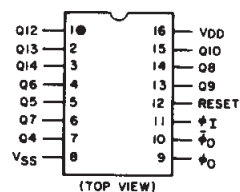


Fig. 16 – Input current.



Chip dimensions and pad layout for CD4060B

## TERMINAL DIAGRAM



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils ( $10^{-3}$  inch).

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