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## CD4093BC

### Quad 2-Input NAND Schmitt Trigger

#### General Description

The CD4093B consists of four Schmitt-trigger circuits. Each circuit functions as a 2-input NAND gate with Schmitt-trigger action on both inputs. The gate switches at different points for positive and negative-going signals. The difference between the positive ( $V_T^+$ ) and the negative voltage ( $V_T^-$ ) is defined as hysteresis voltage ( $V_H$ ).

All outputs have equal source and sink currents and conform to standard B-series output drive (see Static Electrical Characteristics).

#### Features

- Wide supply voltage range: 3.0V to 15V
- Schmitt-trigger on each input with no external components
- Noise immunity greater than 50%
- Equal source and sink currents
- No limit on input rise and fall time
- Standard B-series output drive
- Hysteresis voltage (any input)  $T_A = 25^\circ\text{C}$

Typical       $V_{DD} = 5.0\text{V}$     $V_H = 1.5\text{V}$   
 $V_{DD} = 10\text{V}$     $V_H = 2.2\text{V}$   
 $V_{DD} = 15\text{V}$     $V_H = 2.7\text{V}$

Guaranteed       $V_H = 0.1 V_{DD}$

#### Applications

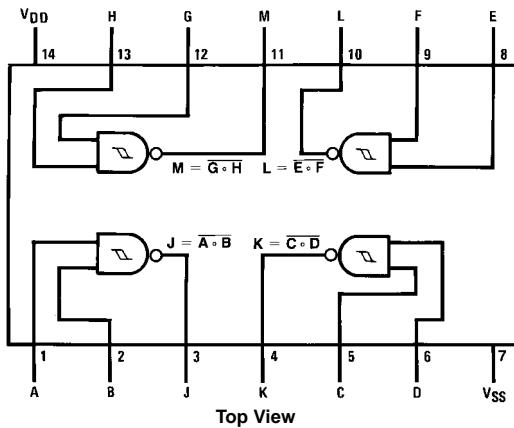
- Wave and pulse shapers
- High-noise-environment systems
- Monostable multivibrators
- Astable multivibrators
- NAND logic

#### Ordering Code:

Order Number	Package Number	Package Description
CD4093BCM	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
CD4093BCN	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

#### Connection Diagram



**Absolute Maximum Ratings**(Note 1)

(Note 2)

DC Supply Voltage ( $V_{DD}$ )	-0.5 to +18 $V_{DC}$
Input Voltage ( $V_{IN}$ )	-0.5 to $V_{DD}$ +0.5 $V_{DC}$
Storage Temperature Range ( $T_S$ )	-65°C to +150°C
Power Dissipation ( $P_D$ )	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature ( $T_L$ )	
(Soldering, 10 seconds)	260°C

**Recommended Operating Conditions** (Note 2)

DC Supply Voltage ( $V_{DD}$ )	3 to 15 $V_{DC}$
Input Voltage ( $V_{IN}$ )	0 to $V_{DD}$ $V_{DC}$
Operating Temperature Range ( $T_A$ )	-55°C to +125°C

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

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

**DC Electrical Characteristics** (Note 2)

Symbol	Parameter	Conditions	-55°C		+25°C			+125°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
$I_{DD}$	Quiescent Device Current	$V_{DD} = 5V$		0.25			0.25		7.5	μA
		$V_{DD} = 10V$		0.5			0.5		15.0	
		$V_{DD} = 15V$		1.0			1.0		30.0	
$V_{OL}$	LOW Level Output Voltage	$V_{IN} = V_{DD}$ , $ I_{O1}  < 1 \mu A$			0.05		0	0.05		V
		$V_{DD} = 5V$			0.05		0	0.05		
		$V_{DD} = 10V$			0.05		0	0.05		
		$V_{DD} = 15V$			0.05		0	0.05		
$V_{OH}$	HIGH Level Output Voltage	$V_{IN} = V_{SS}$ , $ I_{O1}  < 1 \mu A$			4.95		4.95	5		V
		$V_{DD} = 5V$			9.95		9.95	10		
		$V_{DD} = 10V$			14.95		14.95	15		
		$V_{DD} = 15V$						4.95		
$V_{T-}$	Negative-Going Threshold Voltage (Any Input)	$ I_{O1}  < 1 \mu A$			1.3	2.25	1.5	1.8	2.25	V
		$V_{DD} = 5V$ , $V_O = 4.5V$			2.85	4.5	3.0	4.1	4.5	
		$V_{DD} = 10V$ , $V_O = 9V$			4.35	6.75	4.5	6.3	6.75	
		$V_{DD} = 15V$ , $V_O = 13.5V$						4.5	4.5	
$V_{T+}$	Positive-Going Threshold Voltage (Any Input)	$ I_{O1}  < 1 \mu A$			2.75	3.6	2.75	3.3	3.5	V
		$V_{DD} = 5V$ , $V_O = 0.5V$			5.5	7.15	5.5	6.2	7.0	
		$V_{DD} = 10V$ , $V_O = 1V$			8.25	10.65	8.25	9.0	10.5	
		$V_{DD} = 15V$ , $V_O = 1.5V$						8.1	10.5	
$V_H$	Hysteresis ( $V_{T+} - V_{T-}$ ) (Any Input)	$V_{DD} = 5V$	0.5	2.35	0.5	1.5	2.0	0.35	2.0	V
		$V_{DD} = 10V$	1.0	4.3	1.0	2.2	4.0	0.70	4.0	
		$V_{DD} = 15V$	1.5	6.3	1.5	2.7	6.0	1.20	6.0	
$I_{OL}$	LOW Level Output Current (Note 3)	$V_{IN} = V_{DD}$			0.64		0.51	0.88		mA
		$V_{DD} = 5V$ , $V_O = 0.4V$			1.6		1.3	2.25		
		$V_{DD} = 10V$ , $V_O = 0.5V$			4.2		3.4	8.8		
		$V_{DD} = 15V$ , $V_O = 1.5V$						0.9	2.4	
$I_{OH}$	HIGH Level Output Current (Note 3)	$V_{IN} = V_{SS}$			-0.64		0.51	-0.88		mA
		$V_{DD} = 5V$ , $V_O = 4.6V$			-1.6		-1.3	-2.25		
		$V_{DD} = 10V$ , $V_O = 9.5V$			-4.2		-3.4	-8.8		
		$V_{DD} = 15V$ , $V_O = 13.5V$						-0.9	-2.4	
$I_{IN}$	Input Current	$V_{DD} = 15V$ , $V_{IN} = 0V$			-0.1		-10 <sup>-5</sup>	-0.1		μA
		$V_{DD} = 15V$ , $V_{IN} = 15V$			0.1		10 <sup>-5</sup>	0.1		

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

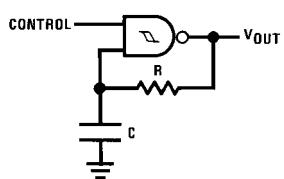
**AC Electrical Characteristics** (Note 4) $T_A = 25^\circ\text{C}$ ,  $C_L = 50 \text{ pF}$ ,  $R_L = 200\text{k}$ , Input  $t_r, t_f = 20 \text{ ns}$ , unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{PHL}, t_{PLH}$	Propagation Delay Time	$V_{DD} = 5\text{V}$		300	450	ns
		$V_{DD} = 10\text{V}$		120	210	
		$V_{DD} = 15\text{V}$		80	160	
$t_{THL}, t_{TLH}$	Transition Time	$V_{DD} = 5\text{V}$		90	145	ns
		$V_{DD} = 10\text{V}$		50	75	
		$V_{DD} = 15\text{V}$		40	60	
$C_{IN}$	Input Capacitance	(Any Input)		5.0	7.5	pF
$C_{PD}$	Power Dissipation Capacitance	(Per Gate)		24		pF

Note 4: AC Parameters are guaranteed by DC correlated testing.

## Typical Applications

### Gated Oscillator



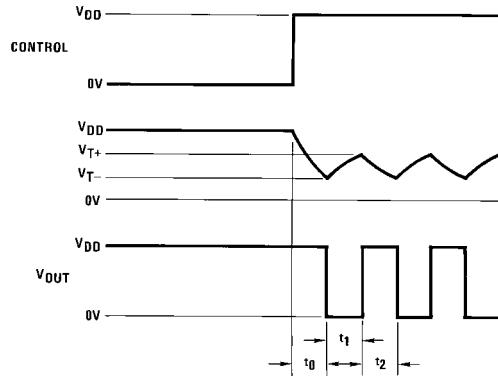
Assume  $t_1 + t_2 \gg t_{PPLH} + t_{PLH}$  then:

$$t_0 = RC \ln [V_{DD}/V_{T-}]$$

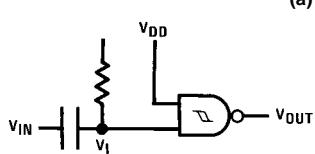
$$t_1 = RC \ln [(V_{DD} - V_{T+})/(V_{DD} - V_{T-})]$$

$$t_2 = RC \ln [V_{T+}/V_{T-}]$$

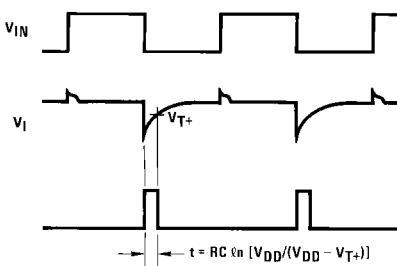
$$f = \frac{1}{t_1 + t_2} = \frac{1}{RC \ln \frac{(V_{T+})(V_{DD} - V_{T-})}{(V_{T-})(V_{DD} - V_{T+})}}$$



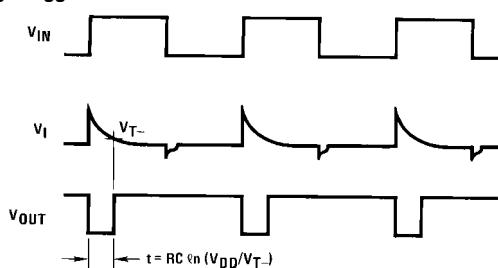
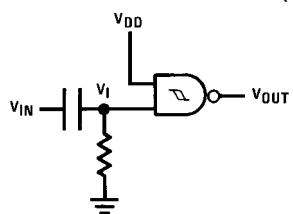
### Gated One-Shot



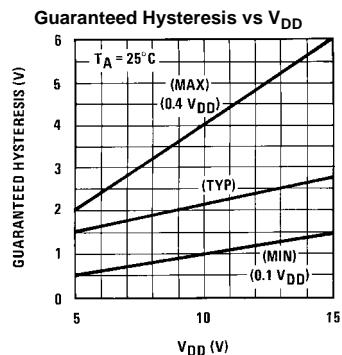
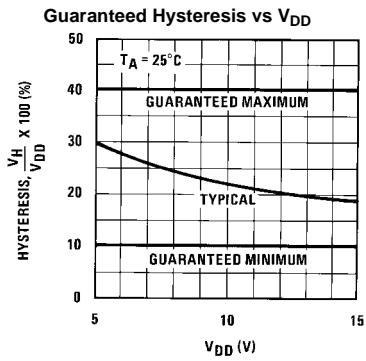
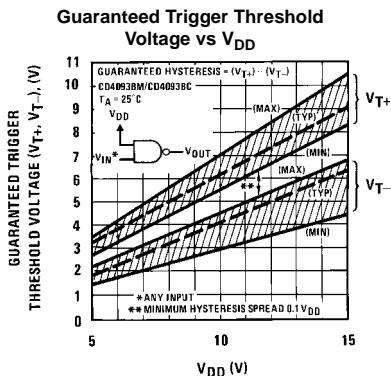
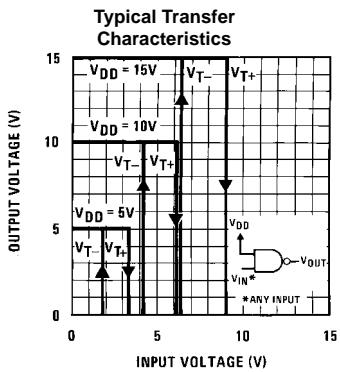
(a) Negative-Edge Triggered



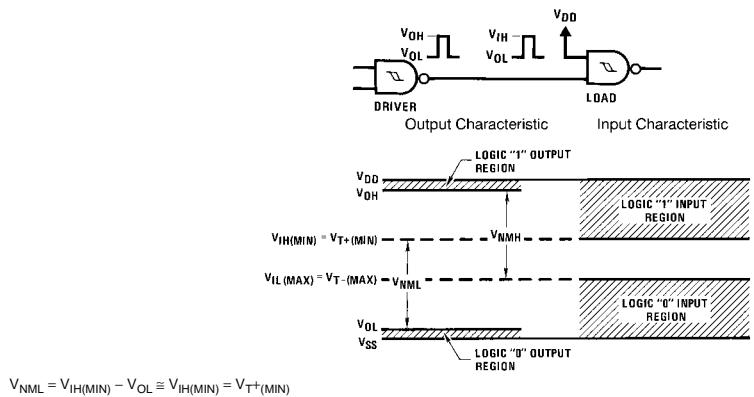
(b) Positive-Edge Triggered



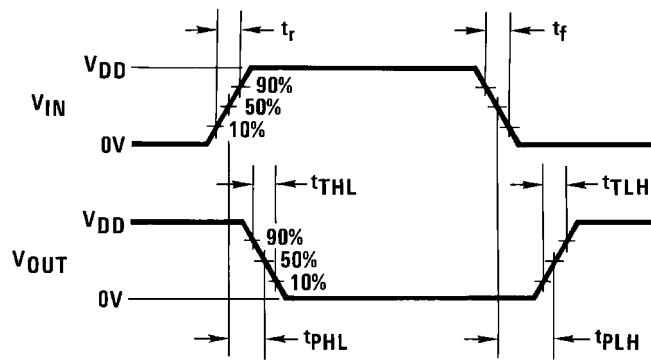
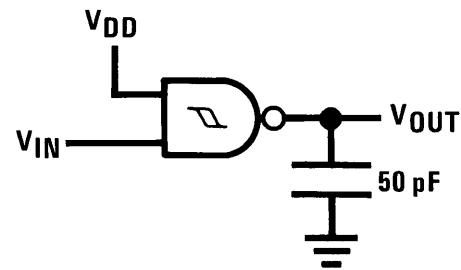
## Typical Performance Characteristics

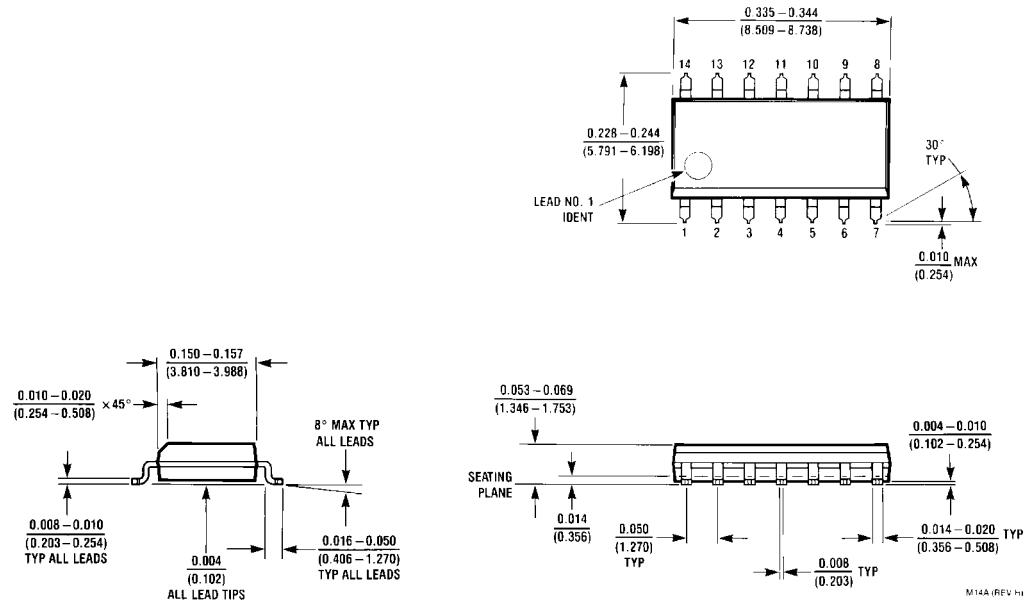


## Input and Output Characteristics



## AC Test Circuits and Switching Time Waveforms

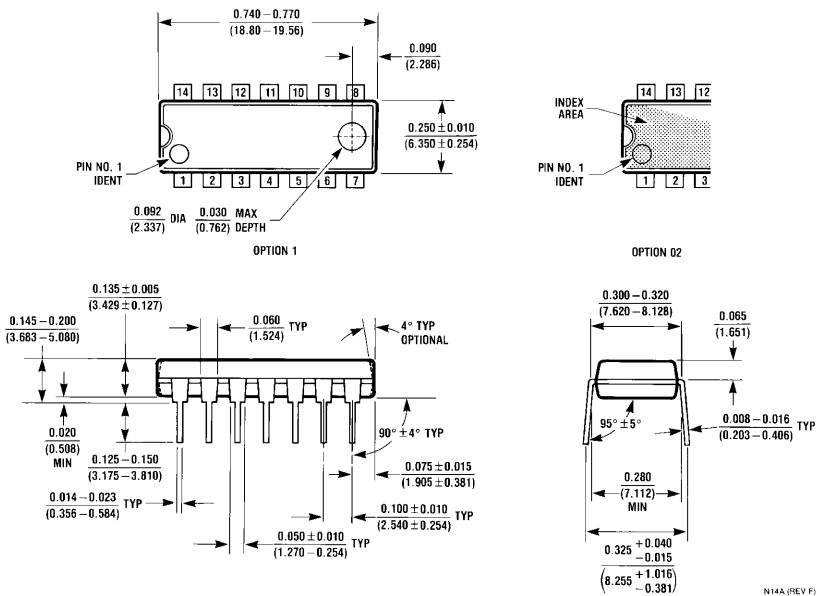


**Physical Dimensions** inches (millimeters) unless otherwise noted

14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow  
Package Number M14A

## Physical Dimensions

inches (millimeters) unless otherwise noted (Continued)



14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide  
Package Number N14A

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