

## 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

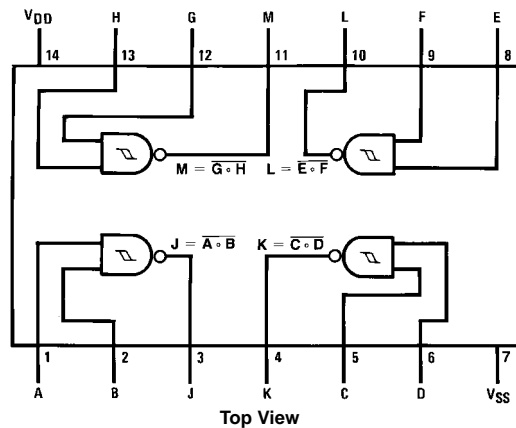
- Wave and pulse shapers
- High-noise-environment systems
- Monostable multivibrators
- Astable multivibrators
- NAND logic

### 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	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		0.25 0.5 1.0				0.25 0.5 1.0	7.5 15.0 30.0	$\mu A$
$V_{OL}$	LOW Level Output Voltage	$V_{IN} = V_{DD}$ , $I_{O1} < 1 \mu A$ $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		0.05 0.05 0.05		0 0 0		0.05 0.05 0.05	0.05 0.05 0.05	V
$V_{OH}$	HIGH Level Output Voltage	$V_{IN} = V_{SS}$ , $I_{O1} < 1 \mu A$ $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	4.95 9.95 14.95		4.95 9.95 14.95	5 10 15		4.95 9.95 14.95		V
$V_{T-}$	Negative-Going Threshold Voltage (Any Input)	$I_{O1} < 1 \mu A$ $V_{DD} = 5V$ , $V_O = 4.5V$ $V_{DD} = 10V$ , $V_O = 9V$ $V_{DD} = 15V$ , $V_O = 13.5V$	1.3 2.85 4.35	2.25 4.5 6.75	1.5 3.0 4.5	1.8 4.1 6.3	2.25 4.5 6.75	1.5 3.0 4.5	2.3 4.65 6.9	V
$V_{T+}$	Positive-Going Threshold Voltage (Any Input)	$I_{O1} < 1 \mu A$ $V_{DD} = 5V$ , $V_O = 0.5V$ $V_{DD} = 10V$ , $V_O = 1V$ $V_{DD} = 15V$ , $V_O = 1.5V$	2.75 5.5 8.25	3.6 7.15 10.65	2.75 5.5 8.25	3.3 6.2 9.0	3.5 7.0 10.5	2.65 5.35 8.1	3.5 7.0 10.5	V
$V_H$	Hysteresis ( $V_{T+} - V_{T-}$ ) (Any Input)	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	0.5 1.0 1.5	2.35 4.3 6.3	0.5 1.0 1.5	1.5 2.2 2.7	2.0 4.0 6.0	0.35 0.70 1.20	2.0 4.0 6.0	V
$I_{OL}$	LOW Level Output Current (Note 3)	$V_{IN} = V_{DD}$ $V_{DD} = 5V$ , $V_O = 0.4V$ $V_{DD} = 10V$ , $V_O = 0.5V$ $V_{DD} = 15V$ , $V_O = 1.5V$	0.64 1.6 4.2		0.51 1.3 3.4	0.88 2.25 8.8		0.36 0.9 2.4		mA
$I_{OH}$	HIGH Level Output Current (Note 3)	$V_{IN} = V_{SS}$ $V_{DD} = 5V$ , $V_O = 4.6V$ $V_{DD} = 10V$ , $V_O = 9.5V$ $V_{DD} = 15V$ , $V_O = 13.5V$	-0.64 -1.6 -4.2		0.51 -1.3 -3.4	-0.88 -2.25 -8.8		-0.36 -0.9 -2.4		mA
$I_{IN}$	Input Current	$V_{DD} = 15V$ , $V_{IN} = 0V$ $V_{DD} = 15V$ , $V_{IN} = 15V$		-0.1 0.1		$-10^{-5}$ $10^{-5}$	-0.1 0.1		-1.0 1.0	$\mu A$

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

**AC Electrical Characteristics** (Note 4)

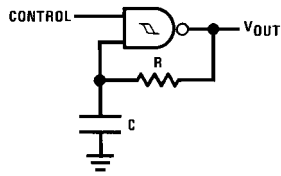
$T_A = 25^\circ\text{C}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ k}$ , Input  $t_r$ ,  $t_f = 20\text{ ns}$ , unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{PHL}$ , $t_{PLH}$	Propagation Delay Time	$V_{DD} = 5\text{V}$ $V_{DD} = 10\text{V}$ $V_{DD} = 15\text{V}$		300 120 80	450 210 160	ns
$t_{THL}$ , $t_{TLH}$	Transition Time	$V_{DD} = 5\text{V}$ $V_{DD} = 10\text{V}$ $V_{DD} = 15\text{V}$		90 50 40	145 75 60	ns
$C_{IN}$	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



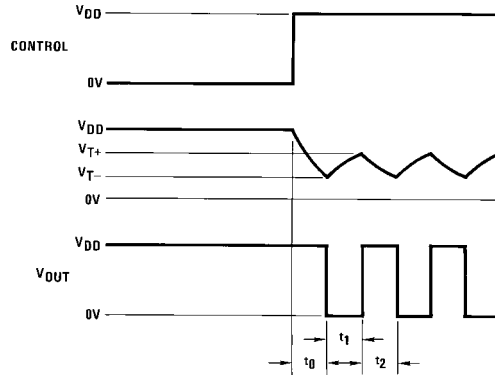
Assume  $t_1 + t_2 \gg t_{PHL} + t_{PLH}$  then:

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

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

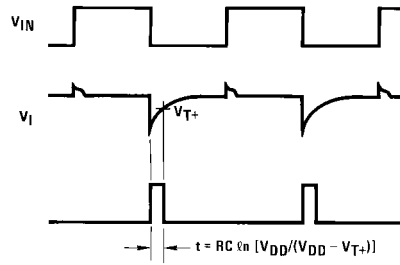
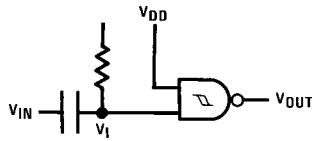
$$t_2 = RC \ln [V_T^+/V_T^-]$$

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

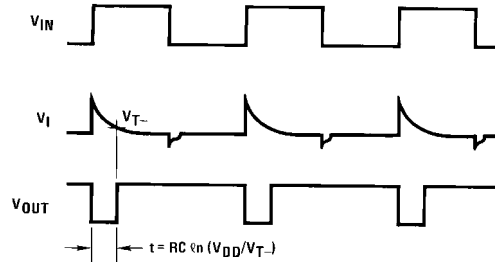
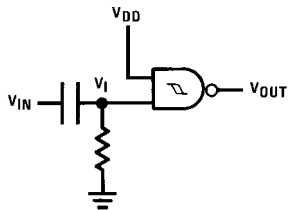


### Gated One-Shot

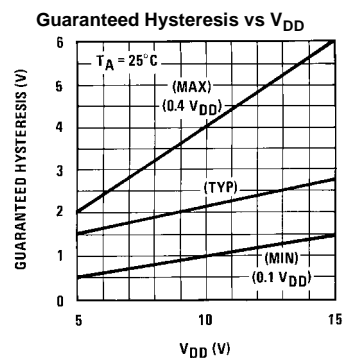
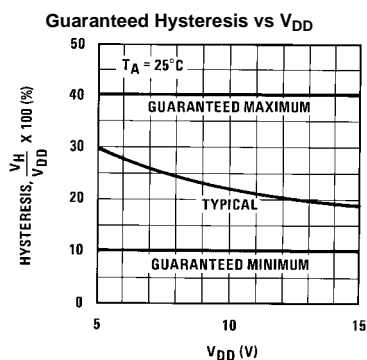
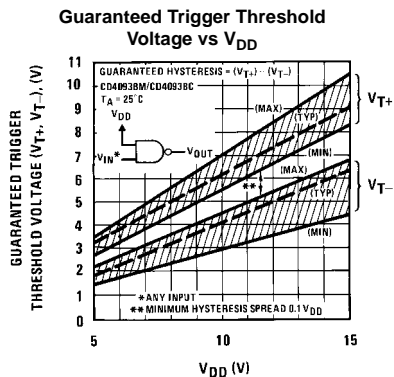
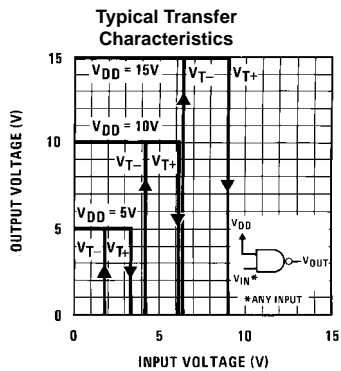
(a) Negative-Edge Triggered



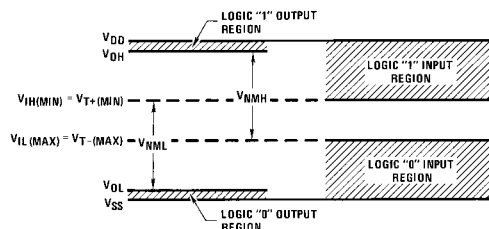
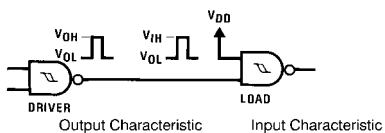
(b) Positive-Edge Triggered



## Typical Performance Characteristics



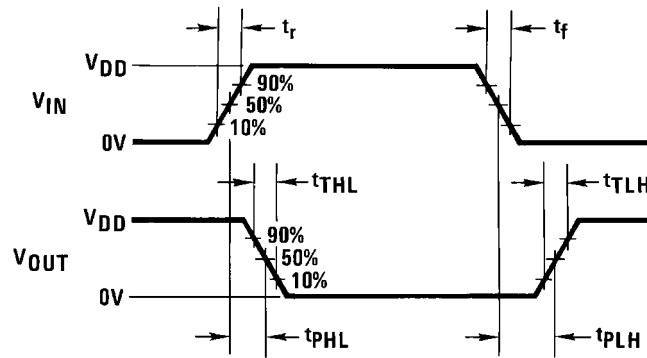
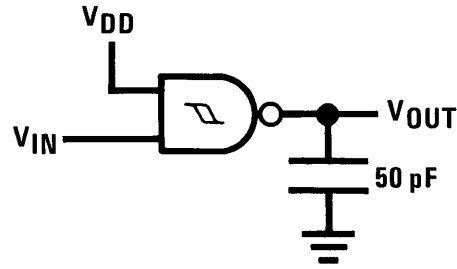
## Input and Output Characteristics



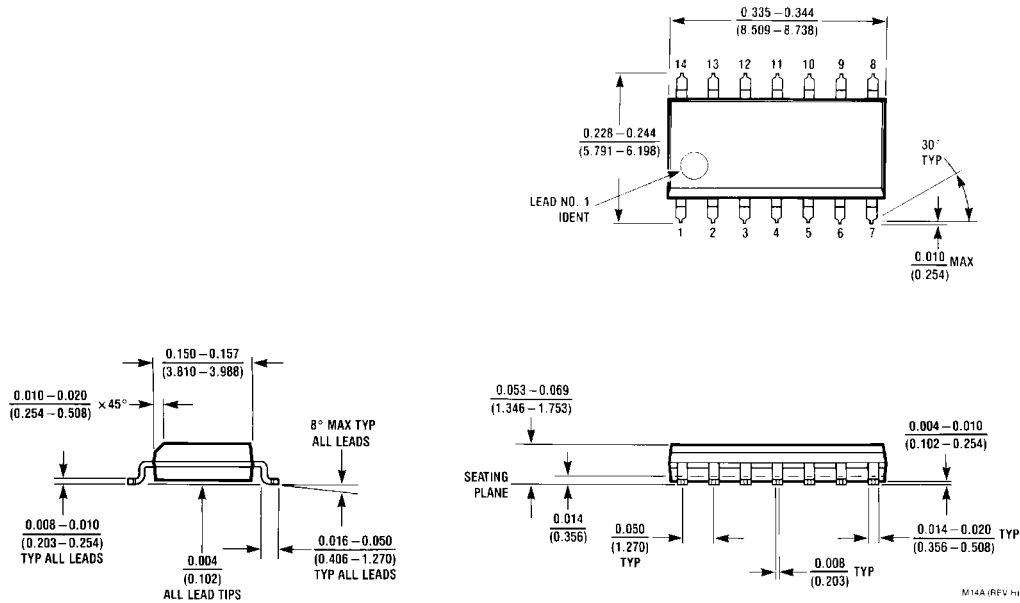
$$V_{NML} = V_{IH(MIN)} - V_{OL} \cong V_{IH(MIN)} = V_{T+(MIN)}$$

$$V_{NMH} = V_{OH} - V_{IL(MAX)} \cong V_{DD} - V_{IL(MAX)} = V_{DD} - V_{T-(MAX)}$$

### AC Test Circuits and Switching Time Waveforms



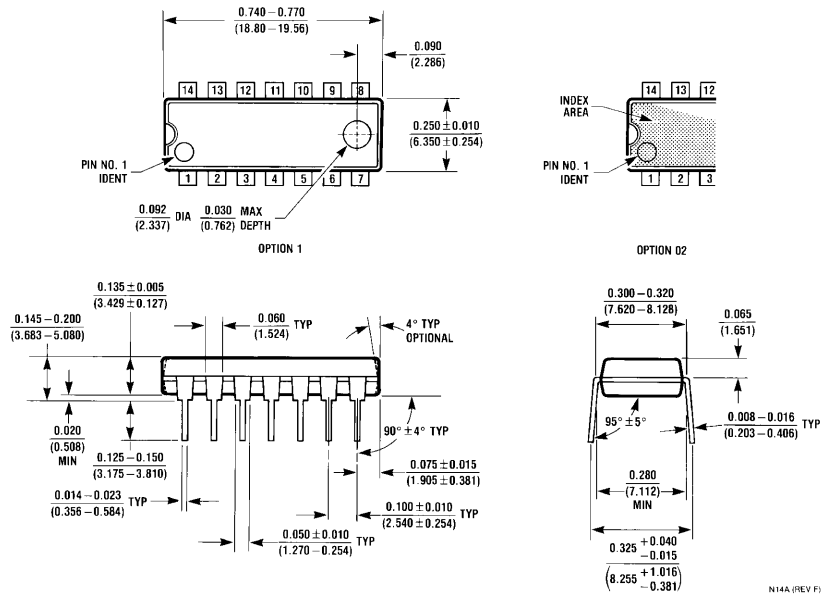
**Physical Dimensions** inches (millimeters) unless otherwise noted



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

M14A (REV. H)

**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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