

## 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

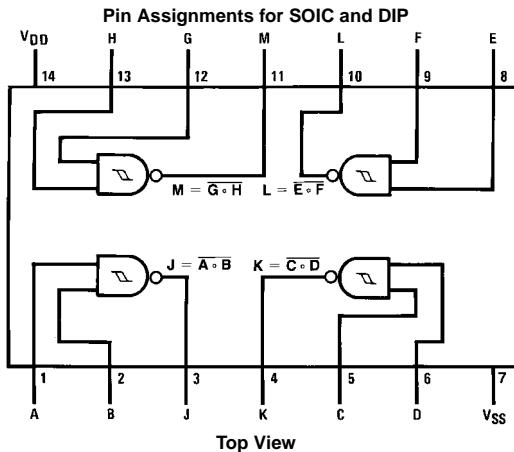
- Wave and pulse shapers
- High-noise-environment systems
- Monostable multivibrators
- Astable multivibrators
- NAND logic

#### Ordering Code:

Order Number	Package Number	Package Description
CD4093BCM	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow Body
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**<sup>(Note 1)</sup>

(Note 2)

DC Supply Voltage ( $V_{DD}$ )	-0.5 to +18 V <sub>DC</sub>
Input Voltage ( $V_{IN}$ )	-0.5 to $V_{DD}$ +0.5 V <sub>DC</sub>
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**<sup>(Note 2)</sup>

DC Supply Voltage ( $V_{DD}$ )	3 to 15 V <sub>DC</sub>
Input Voltage ( $V_{IN}$ )	0 to $V_{DD}$ V <sub>DC</sub>
Operating Temperature Range ( $T_A$ )	-40°C to +85°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**<sup>(Note 2)</sup>

Symbol	Parameter	Conditions	-40°C		+25°C			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
$I_{DD}$	Quiescent Device Current	$V_{DD} = 5V$		1.0			1.0		7.5	µA
		$V_{DD} = 10V$		2.0			2.0		15.0	µA
		$V_{DD} = 15V$		4.0			4.0		30.0	µA
$V_{OL}$	LOW Level Output Voltage	$V_{IN} = V_{DD},  I_O  < 1 \mu A$			0.05		0	0.05		V
		$V_{DD} = 5V$			0.05		0	0.05		V
		$V_{DD} = 10V$			0.05		0	0.05		V
		$V_{DD} = 15V$			0.05		0	0.05		V
$V_{OH}$	HIGH Level Output Voltage	$V_{IN} = V_{SS},  I_O  < 1 \mu A$			4.95		4.95	5		V
		$V_{DD} = 5V$			9.95		9.95	10		V
		$V_{DD} = 10V$			14.95		14.95	15		V
		$V_{DD} = 15V$			14.95		14.95	14.95		V
$V_{T^-}$	Negative-Going Threshold Voltage (Any Input)	$ I_O  < 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
		$V_{DD} = 10V, V_O = 9V$			4.35	6.75	4.5	6.3	6.75	V
		$V_{DD} = 15V, V_O = 13.5V$								V
$V_{T^+}$	Positive-Going Threshold Voltage (Any Input)	$ I_O  < 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
		$V_{DD} = 10V, V_O = 1V$			8.25	10.65	8.25	9.0	10.5	V
		$V_{DD} = 15V, V_O = 1.5V$								V
$V_H$	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
		$V_{DD} = 15V$	1.5	6.3	1.5	2.7	6.0	1.20	6.0	V
$I_{OL}$	LOW Level Output Current (Note 3)	$V_{IN} = V_{DD}$			0.52		0.44	0.88		mA
		$V_{DD} = 5V, V_O = 0.4V$			1.3		1.1	2.25		mA
		$V_{DD} = 10V, V_O = 0.5V$			3.6		3.0	8.8		mA
		$V_{DD} = 15V, V_O = 1.5V$								mA
$I_{OH}$	HIGH Level Output Current (Note 3)	$V_{IN} = V_{SS}$			-0.52		0.44	-0.88		mA
		$V_{DD} = 5V, V_O = 4.6V$			-1.3		-1.1	-2.25		mA
		$V_{DD} = 10V, V_O = 9.5V$			-3.6		-3.0	-8.8		mA
		$V_{DD} = 15V, V_O = 13.5V$								mA
$I_{IN}$	Input Current	$V_{DD} = 15V, V_{IN} = 0V$			-0.3		-10 <sup>-5</sup>	-0.3		µA
		$V_{DD} = 15V, V_{IN} = 15V$			0.3		10 <sup>-5</sup>	0.3		µA

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

### AC Electrical Characteristics (Note 4)

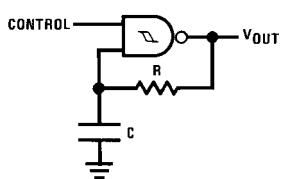
$T_A = 25^\circ\text{C}$ ,  $C_L = 50 \text{ pF}$ ,  $R_L = 200\text{k}$ , Input  $t_r, t_f = 20 \text{ ns}$ , unless otherwise specified

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 ns 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 ns 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



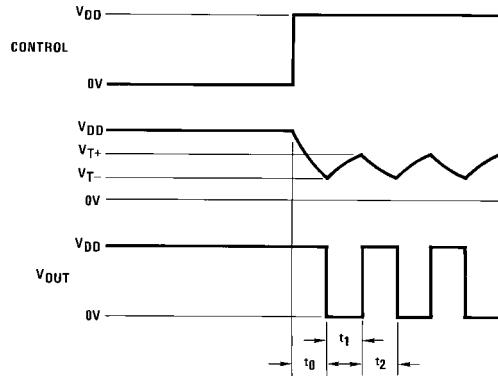
Assume  $t_1 + t_2 \gg t_{PHL} + t_{PLH}$  then:

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

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

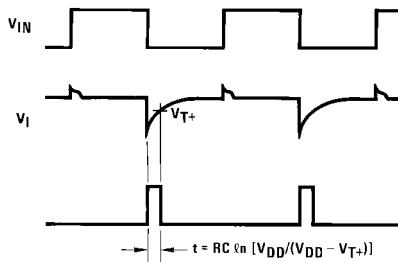
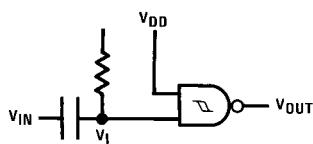
$$t_2 = RC / n [V_{T+}/V_{T-}]$$

$$f = \frac{1}{t_1 + t_2} = \frac{1}{RC / n \left( \frac{(V_{T+})(V_{DD} - V_{T-})}{(V_{T-})(V_{DD} - V_{T+})} \right)}$$

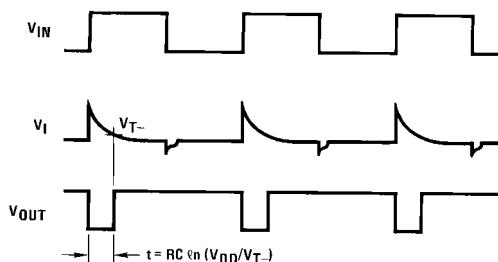
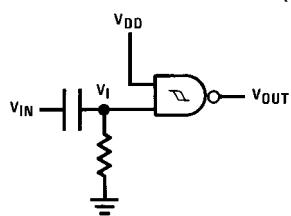


### Gated One-Shot

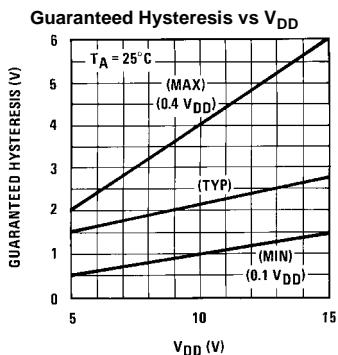
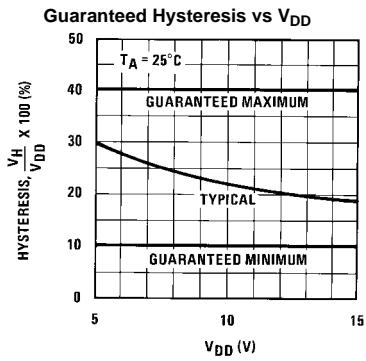
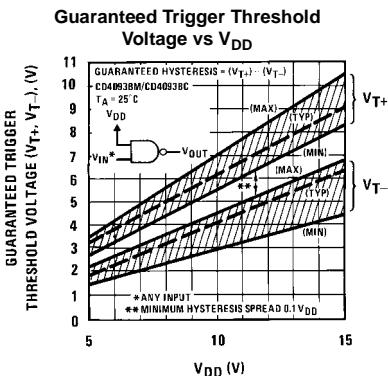
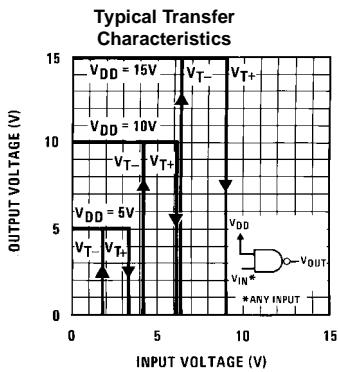
#### (a) Negative-Edge Triggered



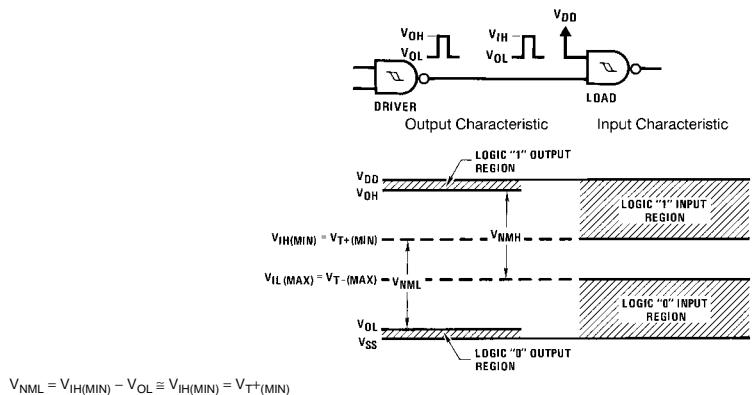
#### (b) Positive-Edge Triggered

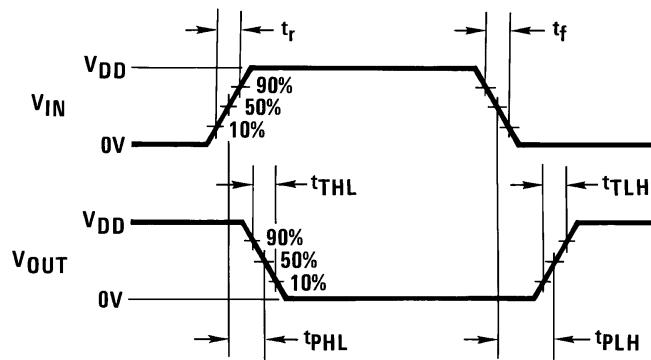
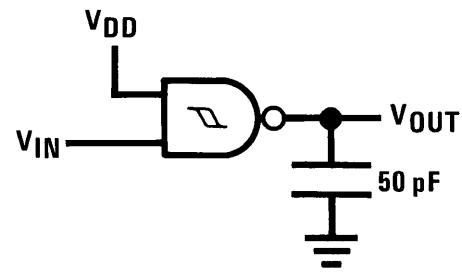


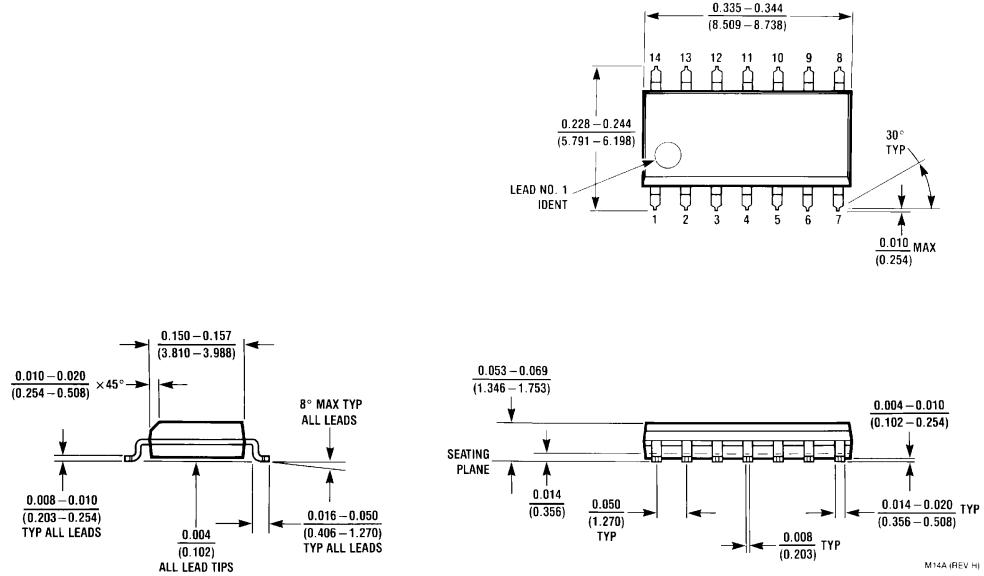
## Typical Performance Characteristics



## Input and Output Characteristics

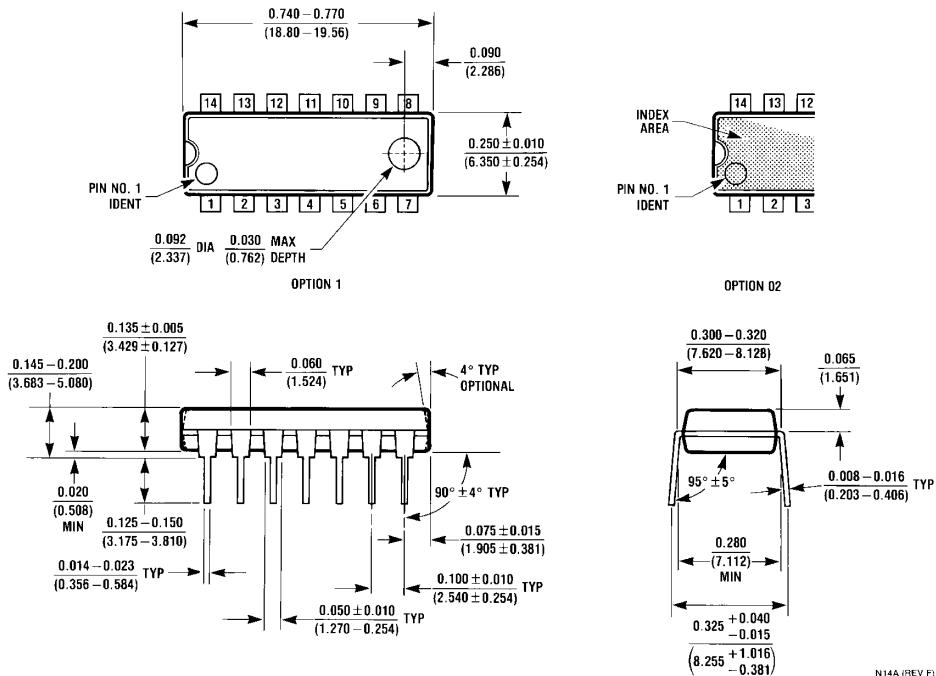


**AC Test Circuits and Switching Time Waveforms**

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

14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow Body  
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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