



October 1987
 Revised January 1999

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

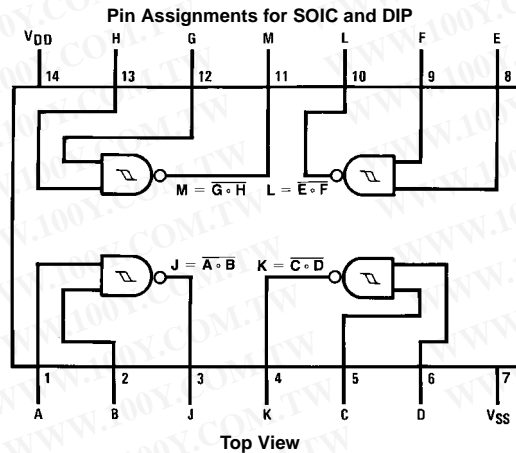
- Wave and pulse shapers
- High-noise-environment systems
- Monostable multivibrators
- Astable multivibrators
- NAND logic

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



CD4093BC Quad 2-Input NAND Schmitt Trigger

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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)	-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 (Note 2)

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	$V_{IN} = V_{DD}, I_{O} < 1 \mu A$								
		$V_{DD} = 5V$		0.05		0	0.05		0.05	V
		$V_{DD} = 10V$		0.05		0	0.05		0.05	V
V_{OH}	HIGH Level Output Voltage	$V_{IN} = V_{SS}, I_{O} < 1 \mu A$								
		$V_{DD} = 5V$	4.95		4.95	5		4.95		V
		$V_{DD} = 10V$	9.95		9.95	10		9.95		V
V_{T-}	Negative-Going Threshold Voltage (Any Input)	$V_{DD} = 5V, V_O = 4.5V$	1.3	2.25	1.5	1.8	2.25	1.5	2.3	V
		$V_{DD} = 10V, V_O = 9V$	2.85	4.5	3.0	4.1	4.5	3.0	4.65	V
		$V_{DD} = 15V, V_O = 13.5V$	4.35	6.75	4.5	6.3	6.75	4.5	6.9	V
V_{T+}	Positive-Going Threshold Voltage (Any Input)	$V_{DD} = 5V, V_O = 0.5V$	2.75	3.6	2.75	3.3	3.5	2.65	3.5	V
		$V_{DD} = 10V, V_O = 1V$	5.5	7.15	5.5	6.2	7.0	5.35	7.0	V
		$V_{DD} = 15V, V_O = 1.5V$	8.25	10.65	8.25	9.0	10.5	8.1	10.5	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)	$V_{IN} = V_{DD}$								
		$V_{DD} = 5V, V_O = 0.4V$	0.52		0.44	0.88		0.36		mA
		$V_{DD} = 10V, V_O = 0.5V$	1.3		1.1	2.25		0.9		mA
I_{OH}	HIGH Level Output Current (Note 3)	$V_{IN} = V_{SS}$								
		$V_{DD} = 5V, V_O = 4.6V$	-0.52		0.44	-0.88		-0.36		mA
		$V_{DD} = 10V, V_O = 9.5V$	-1.3		-1.1	-2.25		-0.9		mA
I_{IN}	Input Current	$V_{DD} = 15V, V_{IN} = 0V$		-0.3		-10^{-5}	-0.3		-1.0	μA
		$V_{DD} = 15V, V_{IN} = 15V$		0.3		10^{-5}	0.3		1.0	μA

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

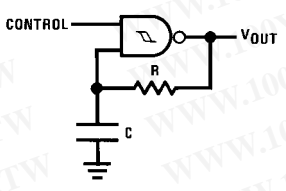
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AC Electrical Characteristics (Note 4)						
T _A = 25°C, C _L = 50 pF, R _L = 200k, Input t _r , t _f = 20 ns, unless otherwise specified						
Symbol	Parameter	Conditions	Min	Typ	Max	Units
t _{PHL} , t _{PLH}	Propagation Delay Time	V _{DD} = 5V		300	450	ns
		V _{DD} = 10V		120	210	ns
		V _{DD} = 15V		80	160	ns
t _{THL} , t _{TLH}	Transition Time	V _{DD} = 5V		90	145	ns
		V _{DD} = 10V		50	75	ns
		V _{DD} = 15V		40	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.						

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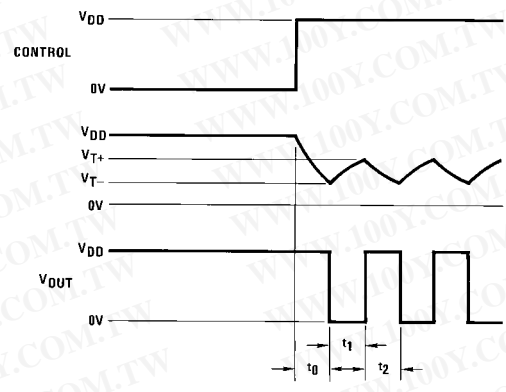
Typical Applications

Gated Oscillator



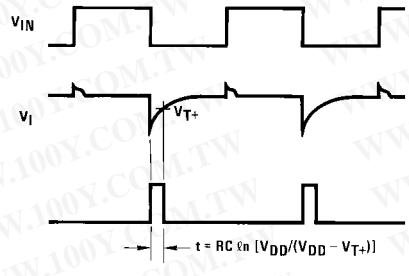
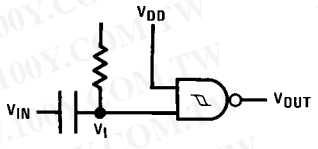
Assume $t_1 + t_2 \gg t_{PHL} + t_{PLH}$ then:
 $t_0 = RC \ln [V_{DD}/V_{T-}]$
 $t_1 = RC \ln [(V_{DD} - V_{T-})/(V_{DD} - V_{T+})]$
 $t_2 = RC \ln [V_{T+}/V_{T-}]$

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

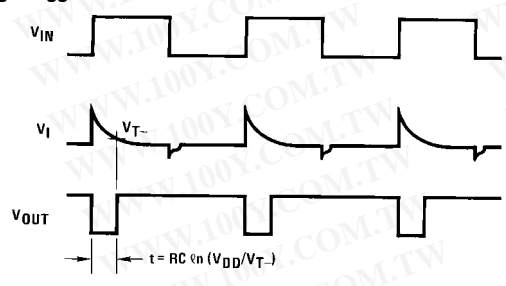
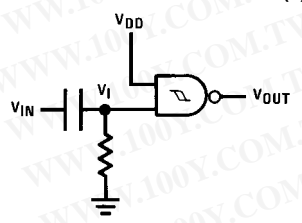


Gated One-Shot

(a) Negative-Edge Triggered

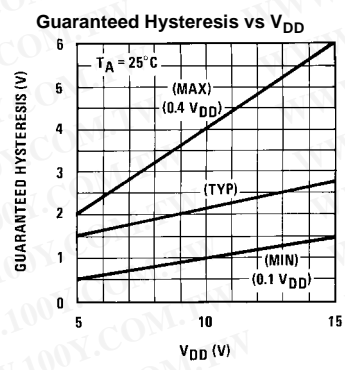
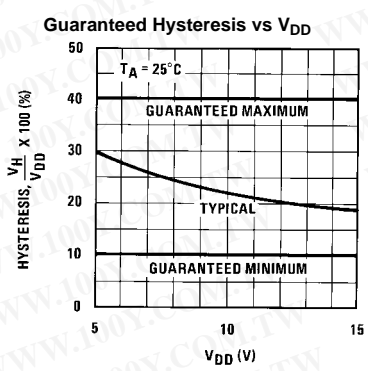
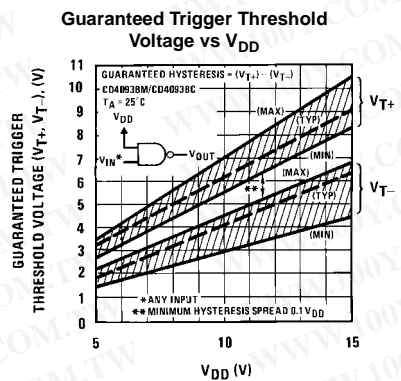
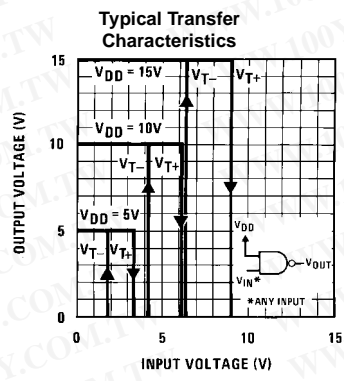


(b) Positive-Edge Triggered

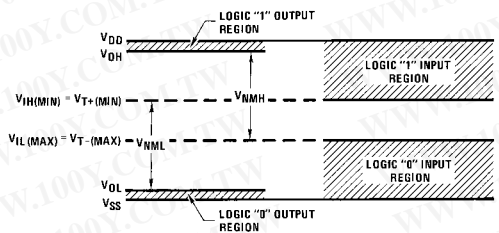
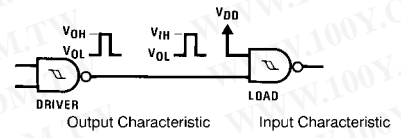


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Typical Performance Characteristics



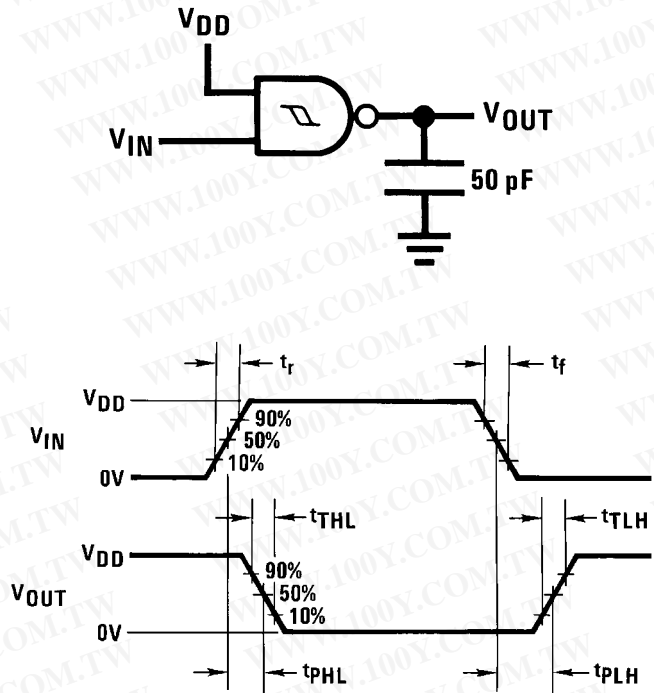
Input and Output Characteristics



$V_{NML} = V_{IH(MIN)} - V_{OL} \cong V_{IH(MIN)} - V_{T+(MIN)}$
 $V_{NMH} = V_{OH} - V_{IL(MAX)} \cong V_{DD} - V_{IL(MAX)} = V_{DD} - V_{T-(MAX)}$

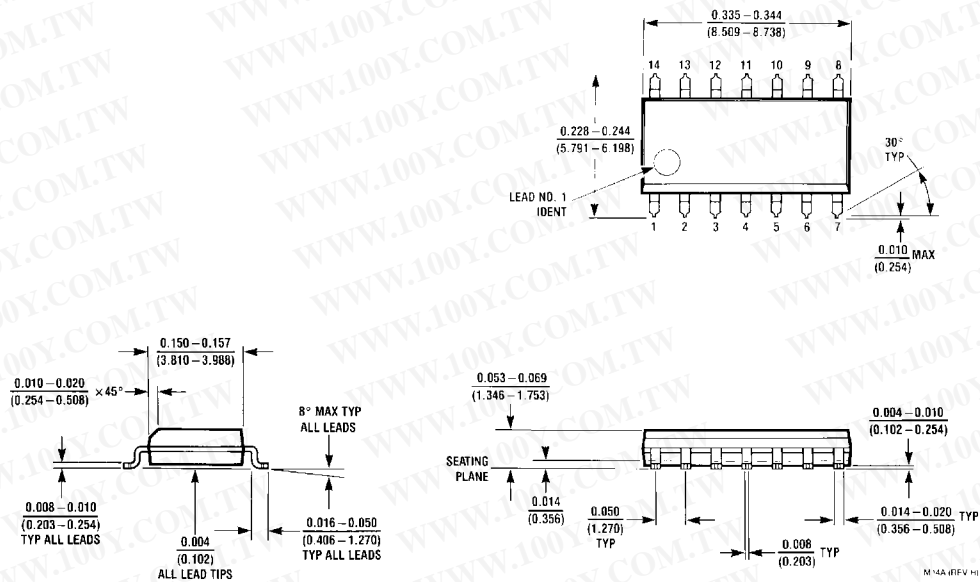
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AC Test Circuits and Switching Time Waveforms



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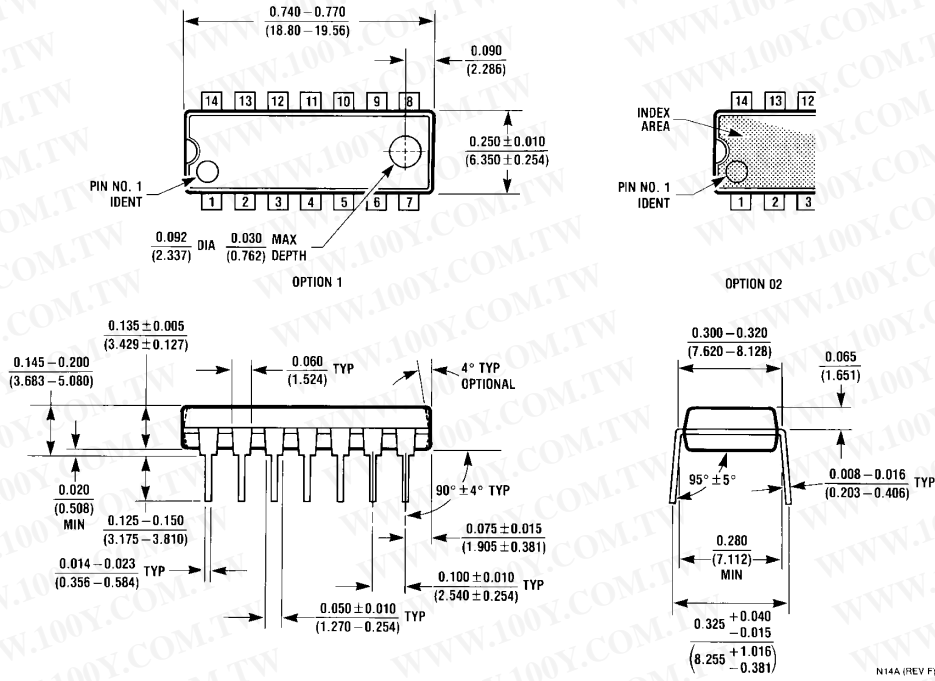
Physical Dimensions inches (millimeters) unless otherwise noted



14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow Body Package Number M14A

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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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