

CMOS Quad 2-Input NAND Schmitt Triggers

High-Voltage Types (20 Volt Rating)

■ CD4093B consists of four Schmitt-trigger circuits. Each circuit functions as a two-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 voltage (V_P) and the negative voltage (V_N) is defined as hysteresis voltage (V_H) (see Fig. 2).

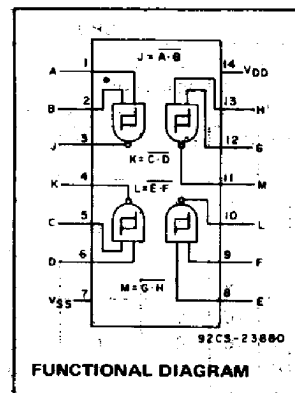
The CD4093B types are supplied in 14-lead hermetic dual-in-line ceramic packages (D and F suffixes), 14-lead dual-in-line plastic package (E suffix), and in chip form (H suffix).

Features:

- Schmitt-trigger action on each input with no external components
- Hysteresis voltage typically 0.9 V at $V_{DD} = 5$ V and 2.3 V at $V_{DD} = 10$ V
- Noise immunity greater than 50%
- No limit on input rise and fall times
- Standardized, symmetrical output characteristics
- 100% tested for quiescent current at 20 V
- Maximum input current of $1 \mu A$ at 18 V over full package-temperature range, 100 nA at 18 V and 25°C
- 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"

Applications:

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



RECOMMENDED OPERATING CONDITIONS

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

CHARACTERISTIC	MIN.	MAX.	UNITS
Supply-Voltage Range (T_A = Full Package-Temp. Range)	3	18	V

MAXIMUM RATINGS: Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE (V_{DD})

Voltages referenced to V_{SS} Terminal)

INPUT VOLTAGE RANGE, ALL INPUTS -0.5V to $V_{DD} + 0.5$ V

DC INPUT CURRENT, ANY ONE INPUT ± 10 mA

POWER DISSIPATION PER PACKAGE (P_D):

For $T_A = -55^\circ\text{C}$ to $+100^\circ\text{C}$ 500 mW

For $T_A = +100^\circ\text{C}$ to $+125^\circ\text{C}$ Derate Linearly at 12 mW/ $^\circ\text{C}$ to 200 mW

DEVICE DISSIPATION PER OUTPUT TRANSISTOR

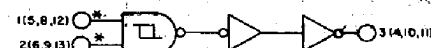
For T_A = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) 100 mW

OPERATING-TEMPERATURE RANGE (T_A) -55°C to $+125^\circ\text{C}$

STORAGE TEMPERATURE RANGE (T_{stg}) -65°C to $+150^\circ\text{C}$

LEAD TEMPERATURE (DURING SOLDERING):

At distance $1/16 \pm 1/32$ inch (1.59 ± 0.79 mm) from case for 10 s max $+265^\circ\text{C}$



* ALL INPUTS PROTECTED BY CMOS PROTECTION NETWORK.

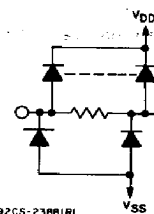


Fig. 1 - Logic diagram—1 of 4 Schmitt triggers.

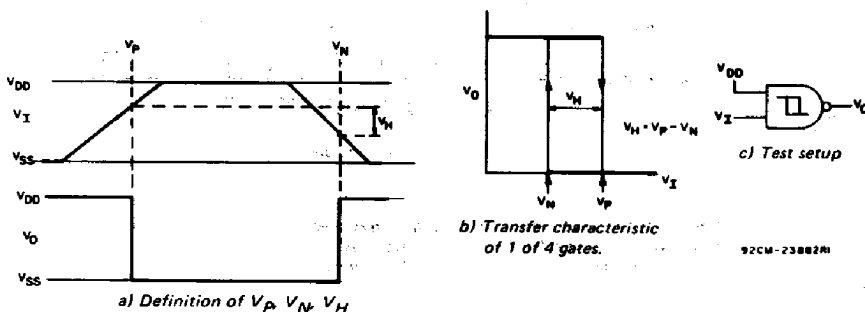


Fig. 2 - Hysteresis definition, characteristic, and test setup.

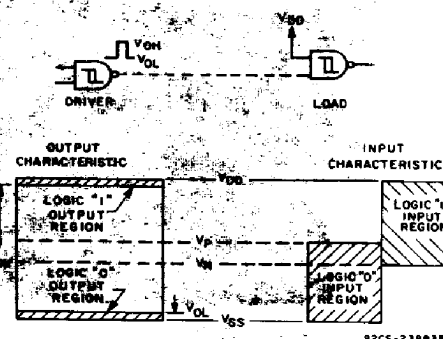


Fig. 3 - Input and output characteristics.

CD4093B Types

STATIC ELECTRICAL CHARACTERISTICS

CHARACTER- ISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V _O (V)	V _{IN} (V)	V _{DD} (V)	-55	-40	+85	+125	+25			
								MIN.	TYP.	MAX.	
Quiescent Device Current, I _{DD} Max.	—	0.5	5	1	1	30	30	—	0.02	1	μA
	—	0.10	10	2	2	60	60	—	0.02	2	
	—	0.15	15	4	4	120	120	—	0.02	4	
	—	0.20	20	20	20	600	600	—	0.04	20	
Positive Trigger Threshold Voltage V _p Min.	—	a	5	2.2	2.2	2.2	2.2	2.2	2.9	—	V
	—	a	10	4.6	4.6	4.6	4.6	4.6	5.9	—	
	—	a	15	6.8	6.8	6.8	6.8	6.8	8.8	—	
	—	b	5	2.6	2.6	2.6	2.6	2.6	3.3	—	
	—	b	10	5.6	5.6	5.6	5.6	5.6	7	—	
	—	b	15	6.3	6.3	6.3	6.3	6.3	9.4	—	
V _p Max.	—	a	5	3.6	3.6	3.6	3.6	—	2.9	3.6	V
	—	a	10	7.1	7.1	7.1	7.1	—	5.9	7.1	
	—	a	15	10.8	10.8	10.8	10.8	—	8.8	10.8	
	—	b	5	4	4	4	4	—	3.3	4	
	—	b	10	8.2	8.2	8.2	8.2	—	7	8.2	
	—	b	15	12.7	12.7	12.7	12.7	—	9.4	12.7	
Negative Trigger Threshold Voltage V _N Min.	—	a	5	0.9	0.9	0.9	0.9	0.9	1.9	—	V
	—	a	10	2.5	2.5	2.5	2.5	2.5	3.9	—	
	—	a	15	4	4	4	4	4	5.8	—	
	—	b	5	1.4	1.4	1.4	1.4	1.4	2.3	—	
	—	b	10	3.4	3.4	3.4	3.4	3.4	5.1	—	
	—	b	15	4.8	4.8	4.8	4.8	4.8	7.3	—	
V _N Max.	—	a	5	2.8	2.8	2.8	2.8	—	1.9	2.8	V
	—	a	10	5.2	5.2	5.2	5.2	—	3.9	5.2	
	—	a	15	7.4	7.4	7.4	7.4	—	5.8	7.4	
	—	b	5	3.2	3.2	3.2	3.2	—	2.3	3.2	
	—	b	10	6.6	6.6	6.6	6.6	—	5.1	6.6	
	—	b	15	9.6	9.6	9.6	9.6	—	7.3	9.6	
Hysteresis Voltage V _H Min.	—	a	5	0.3	0.3	0.3	0.3	0.3	0.9	—	V
	—	a	10	1.2	1.2	1.2	1.2	1.2	2.3	—	
	—	a	15	1.6	1.6	1.6	1.6	1.6	3.5	—	
	—	b	5	0.3	0.3	0.3	0.3	0.3	0.9	—	
	—	b	10	1.2	1.2	1.2	1.2	1.2	2.3	—	
	—	b	15	1.6	1.6	1.6	1.6	1.6	3.5	—	
V _H Max.	—	a	5	1.6	1.6	1.6	1.6	—	0.9	1.6	V
	—	a	10	3.4	3.4	3.4	3.4	—	2.3	3.4	
	—	a	15	5	5	5	5	—	3.5	5	
	—	b	5	1.6	1.6	1.6	1.6	—	0.9	1.6	
	—	b	10	3.4	3.4	3.4	3.4	—	2.3	3.4	
	—	b	15	5	5	5	5	—	3.5	5	

* Input on terminals 1, 5, 8, 12 or 2, 6, 9, 13; other inputs to V_{DD} .

b Input on terminals 1 and 2, 5 and 6, 8 and 9, or 12 and 13; other inputs to V_{DD} .

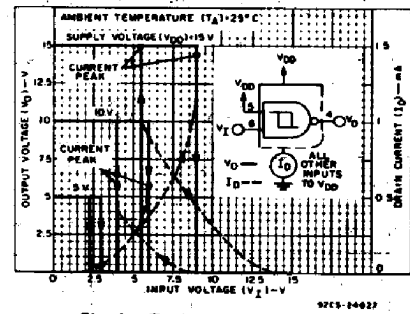


Fig. 4 - Typical current and voltage transfer characteristics.

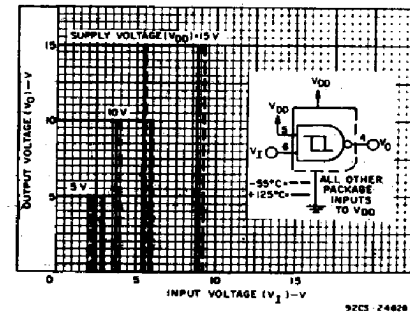


Fig. 5 - Typical voltage transfer characteristics as a function of temperature.

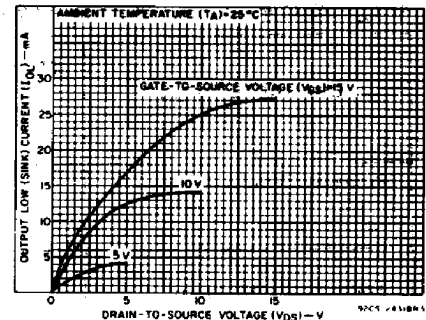


Fig. 6 - Typical output low (sink) current characteristics.

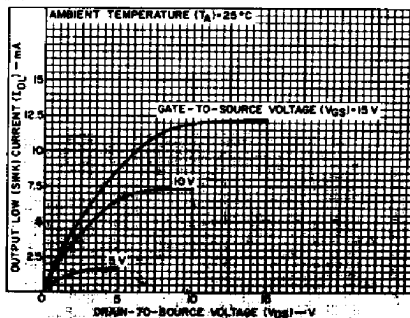


Fig. 7 - Minimum output low (sink) current characteristics.

CD4093B Types

STATIC ELECTRICAL CHARACTERISTICS (CONT'D)

CHARACTER- ISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V _O (V)	V _{IN} (V)	V _{DD} (V)	-55	-40	+85	+125	+25			
								MIN.	TYP.	MAX.	
Output Low (Sink) Current, I _{OL} 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 _{OH} 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 _{OL} 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 _{OH} 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	—	—	
Input Current, I _{IN} Max.	—	0.18	18	±0.1	±0.1	±1	±1	—	±10 ⁻⁵	±0.1	μA

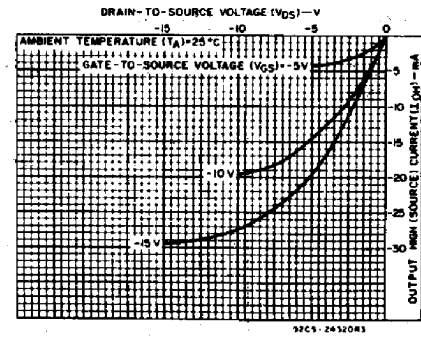


Fig. 8 - Typical output high (source) current characteristics.

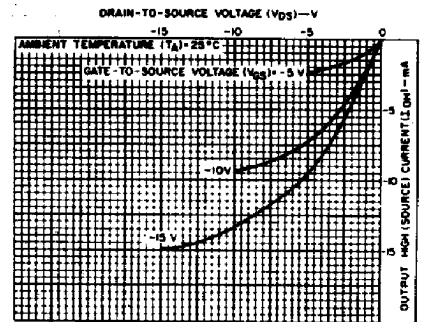


Fig. 9 - Minimum output high (source) current characteristics.

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 _{DD} VOLTS	TYP.	MAX.	
Propagation Delay Time: t _{PHL} , t _{PLH}		5	190	380	ns
		10	90	180	
		15	65	130	
Transition Time, t _{THL} , t _{TLH}		5	100	200	ns
		10	50	100	
		15	40	80	
Input Capacitance, C _{IN}	Any Input		5	7.5	pF

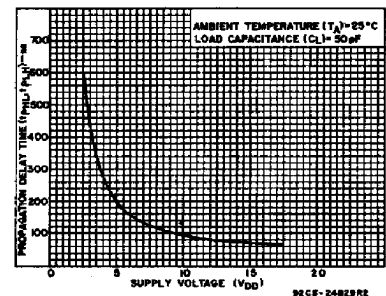


Fig. 10 - Typical propagation delay time vs. supply voltage.

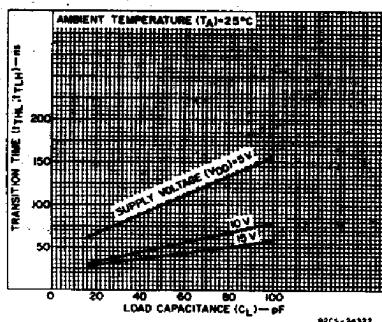


Fig. 11 - Typical transition time vs. load capacitance.

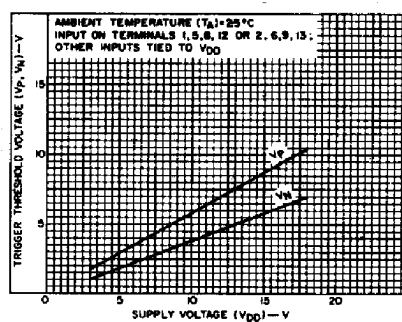


Fig. 12 - Typical trigger threshold voltage vs. V_{DD} .

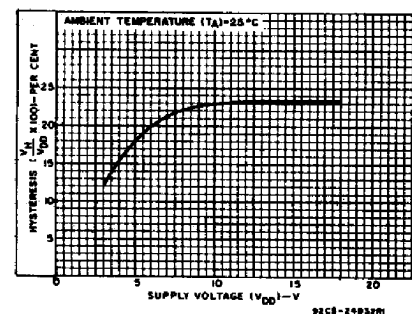


Fig. 13 - Typical per cent hysteresis vs. supply voltage.

CD4093B Types

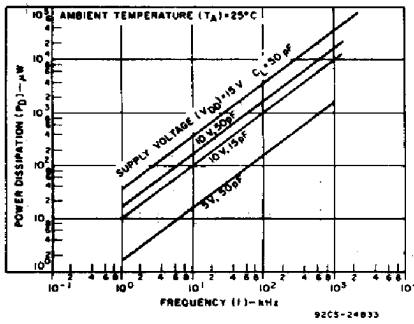


Fig. 14 - Typical power dissipation vs. frequency characteristics.

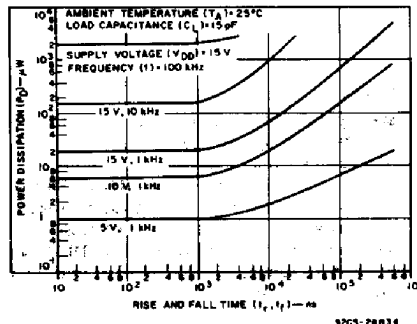


Fig. 15 - Typical power dissipation vs. rise and fall times.

APPLICATIONS

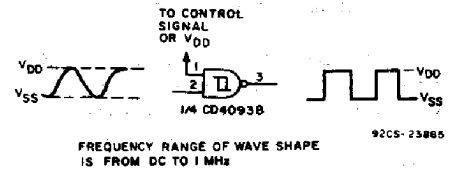


Fig. 16 - Wave shaper.

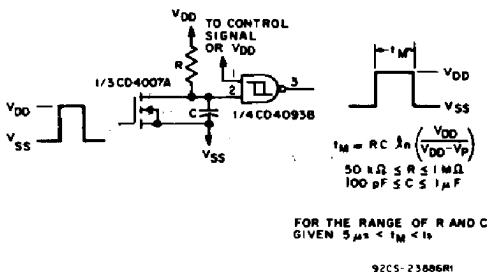


Fig. 17 - Monostable multivibrator.

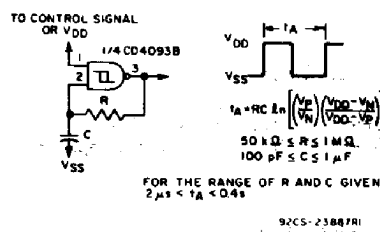


Fig. 18 - Astable multivibrator.

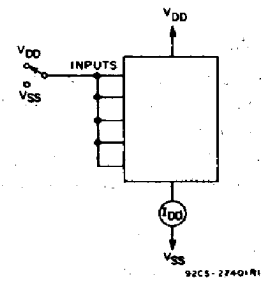


Fig. 19 - Quiescent device current test circuit.

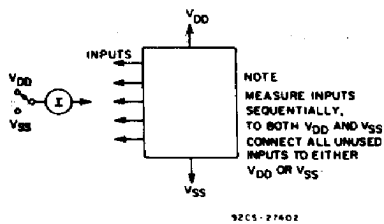


Fig. 20 - Input current test circuit.

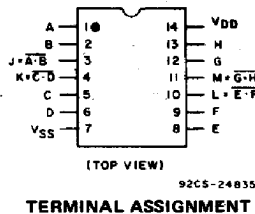
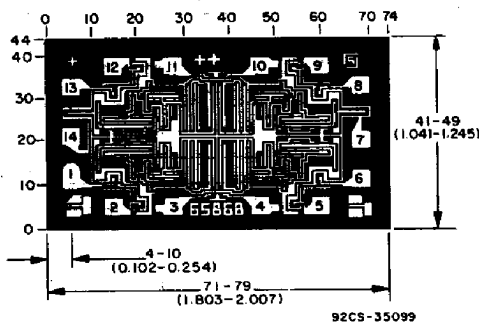


Fig. 21 - Contact Debouncer



Dimensions and Pad Layout for CD4093BH

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