QUAD 2-INPUT NAND SCHMITT TRIGGERS

GENERAL DESCRIPTION

The MMC 4093 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 going and negative going signals. The difference between the positive voltage (V_P) and negative voltage (V_N) is defined as hysteresis voltage (V_H). The MMC 4093 types are supplied in 14-lead hermetic dual-in-line ceramic or plastic packages.

FEATURES

- Schmitt-triger 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
- No limit on input rise and fall times

APLICATIONS

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

ABSOLUTE MAXIMUM RATINGS

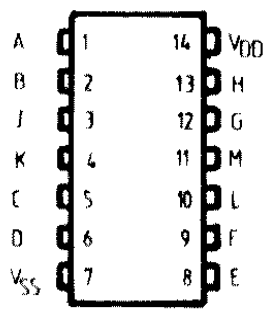
V_{DD}*	Supply voltage: G and H types	-0.5 to	20	V
	E and F types	-0.5 to	18	V
V_i	Input voltage	-0.5 to	V_{DD}+0.5	V
I_I	DC input current (any one input)		±10	mA
P_{tot}	Total power dissipation (per package)		200	mW
	Dissipation per output transistor for T_A = full package-temperature range		100	mW
T_A	Operating temperature : G and H types	-55 to	125	°C
	E and F types	-40 to	85	°C
T_{stg}	Storage temperature	-65 to	150	°C

* All voltage values are referred to V_{SS} pin voltage

RECOMMENDED OPERATING CONDITIONS

V_{DD}*	Supply voltage: G and H types	3 to	18	V
	E and F types	3 to	15	V
V_i	Input voltage	0 to	V_{DD}	V
T_A	Operating temperature G and H types	-55 to	125	°C
	E and F types	-40 to	85	C

CONNECTION DIAGRAM



J · $\overline{A \cdot B}$

K · $\overline{C \cdot D}$

L $\overline{E \cdot F}$

M $\overline{G \cdot H}$

FUNCTIONAL DIAGRAM

STATIC ELECTRICAL CHARACTERISTICS

(over recommended operating conditions)

PARAMETER			TEST CONDITIONS				VALUES							UNIT
			V_I (V)	V_O (V)	$\|I_O\|$ (μA)	V_{DD} (V)	T^*_{LOW}		25°C			T^*_{HIGH}		
							min.	max.	min.	typ	max.	min.	max.	
I_L	Quiescent current	G, H types	0/ 5			5		1		0.02	1		30	μA
			0/10			10		2		0.02	2		60	
			0/15			15		4		0.02	4		120	
			0/20			20		20		0.04	20		600	
		E, F types	0/ 5			5		4		0.02	4		30	
			0/10			10		8		0.02	8		60	
			0/15			15		16		0.02	16		120	
V_P	Positive trigger threshold voltage		a			5	2.2	3.6	2.2	2.9	3.6	2.2	3.6	V
			a			10	4.6	7.1	4.6	5.9	7.1	4.6	7.1	
			a			15	6.8	10.8	6.8	8.8	10.8	6.8	10.8	
			b			5	2.6	4	2.6	3.3	4	2.6	4	
			b			10	5.6	8.2	5.6	7	8.2	5.6	8.2	
			b			15	6.3	12.7	6.3	9.4	12.7	6.3	12.7	
V_N	Negative trigger threshold voltage		a			5	0.9	2.8	0.9	1.9	2.8	0.9	2.8	V
			a			10	2.5	5.2	2.5	3.9	5.2	2.5	5.2	
			a			15	4	7.4	4	5.8	7.4	4	7.4	
			b			5	1.4	3.2	1.4	2.3	3.2	1.4	3.2	
			b			10	3.4	6.6	3.4	5.1	6.6	3.4	6.6	
			b			15	4.8	9.6	4.8	7.3	9.6	4.8	9.6	
V_H	Hysteresis voltage		a			5	0.3	1.6	0.3	0.9	1.6	0.3	1.6	V
			a			10	1.2	3.4	1.2	2.3	3.4	1.2	3.4	
			a			15	1.6	5	1.6	3.5	5	1.6	5	
			b			5	0.3	1.6	0.3	0.9	1.6	0.3	1.6	
			b			10	1.2	3.4	1.2	2.3	3.4	1.2	3.4	
			b			15	1.6	5	1.6	3.5	5	1.6	5	
I_{OH}	Output drive current	G, H types	0/ 5	2.5		5	−2		−1.6	−3.2		−1.15		mA
			0/ 5	4.6		5	−0.64		−0.51	−1		−0.36		
			0/10	9.5		10	−1.6		−1.3	−2.6		−0.9		
			0/15	13.5		15	−4.2		−3.4	−6.8		−2.4		
		E, F types	0/ 5	2.5		5	−1.53		−1.36	−3.2		−1.1		
			0/ 5	4.6		5	−0.52		−0.44	−1		−0.36		
			0/10	9.5		10	−1.3		−1.1	−2.6		−0.9		
			0/15	13.5		15	−3.6		−3.0	−6.8		−2.4		
V_{OH}	Output high voltage		0/ 5		< 1	5	4.95		4.95			4.95		V
			0/10		< 1	10	9.95		9.95			9.95		
			0/15		< 1	15	14.95		14.95			14.95		

a: 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}.

PARAMETER			TEST CONDITIONS				VALUES							UNIT
			V_I (V)	V_O (V)	$\|I_O\|$ (μA)	V_{DD} (V)	T^*_{LOW}		25°C			T^*_{HIGH}		
							min.	max.	min.	typ	max.	min.	max.	
V_{OL}	Output low voltage		5 /0 10/0 15/0		< 1 < 1 < 1	5 10 15		0.05 0.05 0.05			0.05 0.05 0.05		0.05 0.05 0.05	V
I_{OL}	Output sink current	G, H types	0/ 5 0/10 0/15	0.4 0.5 1.5		5 10 15	0.64 1.6 4.2		0.51 1.3 3.4	1 2.6 6.8		0.36 0.9 2.4		mA
		E, F types	0/ 5 0/10 0/15	0.4 0.5 1.5		5 10 15	0.52 1.3 3.6		0.44 1.1 3.0	1 2.6 6.8		0.36 0.9 2.4		
I_{IH}, I_{IL}	Input leakage current	G, H types	0/18	Any input		18		±0.1		$±10^{-5}$	±0.1		±1	μA
		E, F types	0/15			15		±0.3		$±10^{-5}$	±0.3		±1	
C_I	Input capacitance			Any input						5	7.5			pF

- T_{LOW} = −55°C for G, H devices; −40°C for E, F devices.
- T_{HIGH} = +125°C for G, H devices; +85°C for E, F devices.

The Noise Margin for both "1" and "0" level is:

1 V min. with V_{DD} = 5 V
2 V min. with V_{DD} = 10 V
2.5 V min. with V_{DD} = 15 V

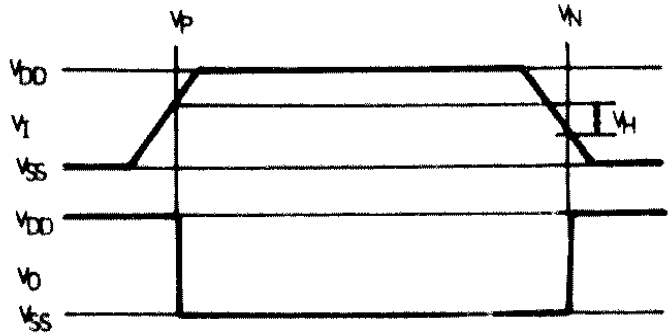
DYNAMIC ELECTRICAL CHARACTERISTICS

(T_A = 25°C; input t_r, t_f = 20 ns, C_L = 50 pF, R_L = 200 kohm)

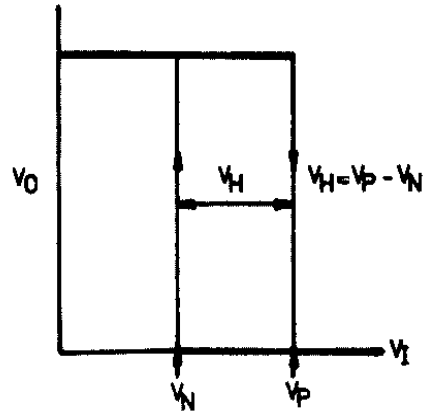
PARAMETER		TEST CONDITIONS	VALUES			UNIT
		V_{DD} (V)	min.	typ.	max.	
t_{PHL}, t_{PLH}	Propagation delay time	5 10 15		190 90 65	380 180 90	ns
t_{THL}, t_{TLH}	Transition time	5 10 15		100 50 40	200 100 80	ns

Fig. 1 Hysteresis definition, characteristic and test setup

(a) Definition of V_P, V_N and V_H



(b) Transfer characteristic of 1 of 4 gates



(c) Test setup

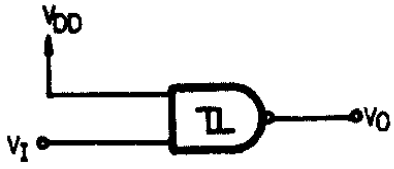
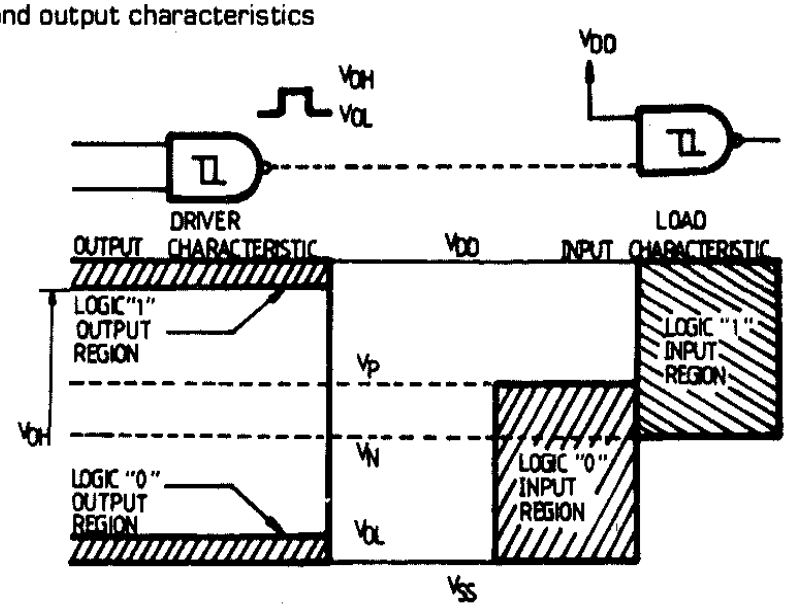
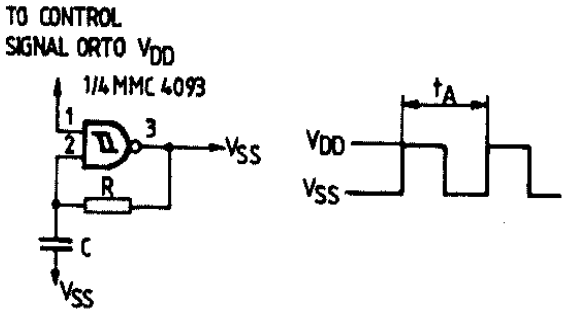


Fig. 2 Input and output characteristics



APPLICATION

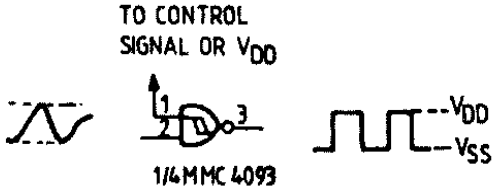
Astable multivibrator



$$t_A = 2RC\ln\left[\left(\frac{V_P}{V_N}\right)\left(\frac{V_{DD}-V_N}{V_{DD}-V_P}\right)\right]$$

$50k \leq R \leq 1M\Omega$
$100pF \leq C \leq 1\mu F$
For the range of R and C given $2\mu s < t_A < 0.4s$

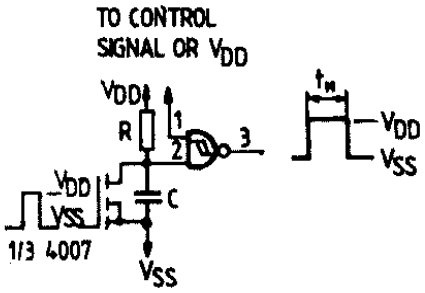
Wave shaper
Frequency range of wave shaperis from DC to 1MHz



Monostable multivibrator

$$t_M = RC\ln\frac{V_{DD}}{V_{DD}-V_P}$$

$50k \leq R \leq 1M\Omega$
$100pF \leq C \leq 1\mu F$



For the range of R and C given $5\mu s \leq t_M \leq 1s$