CD4093BMS

CMOS Quad 2-Input NAND Schmitt Triggers

December 1992

Features

- **High Voltage Types (20V Rating)**
- **Schmitt Trigger Action on Each Input With No External Components**
- **Hysteresis Voltage Typically 0.9V at VDD = 5V and 2.3V at VDD = 10V**
- **Noise Immunity Greater than 50%**
- **No Limit on Input Rise and Fall Times**
- **Standardized, Symmetrical Output Characteristics**
- **100% Tested for Quiescent Current at 20V**
- **Maximum Input Current of 1μA at 18V Over Full Package Temperature Range, 100nA at 18V and +25°C**
- **5V, 10V and 15V 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**

Description

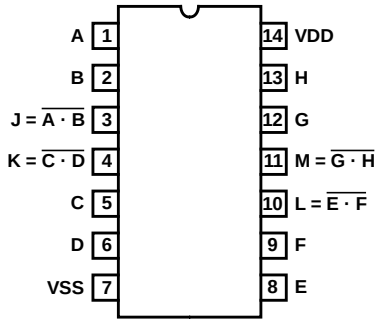
CD4093BMS consists of four Schmitt trigger circuits. Each circuit functions as a two input NAND gate with Schmitt trigger action on both inputs. The gate switches at different points for positive and negative going signals. The difference between the positive voltage (VP) and the negative voltage (VN) is defined as hysteresis voltage (VH) (see Figure 1).

The CD4093BMS is supplied in these 14 lead outline packages:

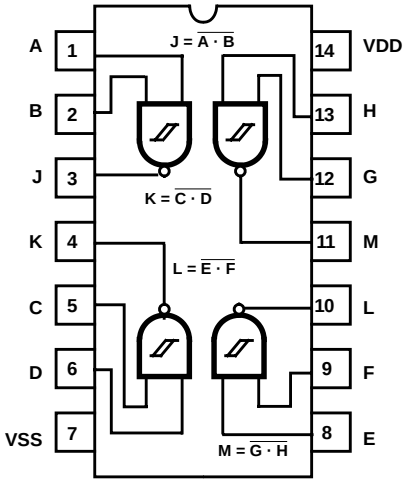
Braze Seal DIP	H4H
Frit Seal DIP	H1B
Ceramic Flatpack	H3W

Pinout

CD4093BMSMS
TOP VIEW



Functional Diagram



Absolute Maximum Ratings

DC Supply Voltage Range, (VDD) . . . . . -0.5V to +20V
(Voltage Referenced to VSS Terminals)
Input Voltage Range, All Inputs . . . . . -0.5V to VDD +0.5V
DC Input Current, Any One Input . . . . . ±10mA
Operating Temperature Range . . . . . -55°C to +125°C
Package Types D, F, K, H
Storage Temperature Range (TSTG) . . . . . -65°C to +150°C
Lead Temperature (During Soldering) . . . . . +265°C
At Distance 1/16 ± 1/32 Inch (1.59mm ± 0.79mm) from case for 10s Maximum

Reliability Information

Thermal Resistance	θ_{ja}	θ_{jc}
Ceramic DIP and FRIT Package	80°C/W	20°C/W
Flatpack Package	70°C/W	20°C/W

Maximum Package Power Dissipation (PD) at +125°C
For TA = -55°C to +100°C (Package Type D, F, K) 500mW
For TA = +100°C to +125°C (Package Type D, F, K) . . . . . Derate Linearity at 12mW/°C to 200mW
Device Dissipation per Output Transistor 100mW
For TA = Full Package Temperature Range (All Package Types)
Junction Temperature . . . . . +175°C

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS (NOTE 1)		GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Supply Current	IDD	VDD = 20V, VIN = VDD or GND		1	+25°C	-	2	µA
				2	+125°C	-	200	µA
		VDD = 18V, VIN = VDD or GND		3	-55°C	-	2	µA
Input Leakage Current	IIL	VIN = VDD or GND	VDD = 20	1	+25°C	-100	-	nA
				2	+125°C	-1000	-	nA
			VDD = 18V	3	-55°C	-100	-	nA
Input Leakage Current	IIH	VIN = VDD or GND	VDD = 20	1	+25°C	-	100	nA
				2	+125°C	-	1000	nA
			VDD = 18V	3	-55°C	-	100	nA
Output Voltage	VOL15	VDD = 15V, No Load		1, 2, 3	+25°C, +125°C, -55°C	-	50	mV
Output Voltage	VOH15	VDD = 15V, No Load (Note 5)		1, 2, 3	+25°C, +125°C, -55°C	14.95	-	V
Output Current (Sink)	IOL5	VDD = 5V, VOUT = 0.4V		1	+25°C	0.53	-	mA
Output Current (Sink)	IOL10	VDD = 10V, VOUT = 0.5V		1	+25°C	1.4	-	mA
Output Current (Sink)	IOL15	VDD = 15V, VOUT = 1.5V		1	+25°C	3.5	-	mA
Output Current (Source)	IOH5A	VDD = 5V, VOUT = 4.6V		1	+25°C	-	-0.53	mA
Output Current (Source)	IOH5B	VDD = 5V, VOUT = 2.5V		1	+25°C	-	-1.8	mA
Output Current (Source)	IOH10	VDD = 10V, VOUT = 9.5V		1	+25°C	-	-1.4	mA
Output Current (Source)	IOH15	VDD = 15V, VOUT = 13.5V		1	+25°C	-	-3.5	mA
N Threshold Voltage	VNTH	VDD = 10V, ISS = -10µA		1	+25°C	-2.8	-0.7	V
P Threshold Voltage	VPTH	VSS = 0V, IDD = 10µA		1	+25°C	0.7	2.8	V
Functional	F	VDD = 2.8V, VIN = VDD or GND		7	+25°C	VOH > VDD/2	VOL < VDD/2	V
		VDD = 20V, VIN = VDD or GND		7	+25°C			
		VDD = 18V, VIN = VDD or GND		8A	+125°C			
		VDD = 3V, VIN = VDD or GND		8B	-55°C			
Positive Trigger Threshold Voltage	VP5V	VDD = 5V (Note 2)		1, 2, 3	+25°C, +125°C, -55°C	2.2	3.6	V
	VP15V	VDD = 15V (Note 3)		1, 2, 3	+25°C, +125°C, -55°C	6.8	10.8	V
Positive Trigger Threshold Voltage	VP5V	VDD = 5V (Note 4)		1, 2, 3	+25°C, +125°C, -55°C	2.6	4.0	V
Negative Trigger Threshold Voltage	VN5V	VDD = 5V (Note 2)		1, 2, 3	+25°C, +125°C, -55°C	0.9	2.8	V
	VN15V	VDD = 15V (Note 3)		1, 2, 3	+25°C, +125°C, -55°C	4.0	7.4	V
Negative Trigger Threshold Voltage	VN5V	VDD = 5V (Note 4)		1, 2, 3	+25°C, +125°C, -55°C	1.4	3.2	V
Hysteresis Voltage	VH5V	VDD = 5V (Note 2)		1, 2, 3	+25°C, +125°C, -55°C	0.3	1.6	V
	VH15V	VDD = 15V (Note 3)		1, 2, 3	+25°C, +125°C, -55°C	1.6	5.0	V
Hysteresis Voltage	VH5V	VDD = 5V (Note 4)		1, 2, 3	+25°C, +125°C, -55°C	0.3	1.6	V

NOTES:
1. All voltages referenced to device GND, 100% testing being implemented.
2. Inputs on terminals 1, 5, 8, 12
3. Input on Terminal 1
4. Input on terminals 1 and 2, 5 and 6, 8 and 9, or 12 and 13
5. For accuracy, voltage is measured differentially to VDD. Limit is 0.050V max.

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS (NOTES 1, 2)	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Propagation Delay	TPHL TPLH	VDD = 5V, VIN = VDD or GND	9	+25°C	-	380	ns
			10, 11	+125°C, -55°C	-	513	ns
Transition Time	TTHL TTLH	VDD = 5V, VIN = VDD or GND	9	+25°C	-	200	ns
			10, 11	+125°C, -55°C	-	270	ns

NOTES:

1. CL = 50pF, RL = 200K, Input TR, TF < 20ns.
2. -55°C and +125°C limits guaranteed, 100% testing being implemented.

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Supply Current	IDD	VDD = 5V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	1	µA
				+125°C	-	30	µA
		VDD = 10V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	2	µA
				+125°C	-	60	µA
		VDD = 15V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	2	µA
				+125°C	-	120	µA
Output Voltage	VOL	VDD = 5V, No Load	1, 2	+25°C, +125°C, -55°C	-	50	mV
Output Voltage	VOL	VDD = 10V, No Load	1, 2	+25°C, +125°C, -55°C	-	50	mV
Output Voltage	VOH	VDD = 5V, No Load	1, 2	+25°C, +125°C, -55°C	4.95	-	V
Output Voltage	VOH	VDD = 10V, No Load	1, 2	+25°C, +125°C, -55°C	9.95	-	V
Output Current (Sink)	IOL5	VDD = 5V, VOUT = 0.4V	1, 2	+125°C	0.36	-	mA
				-55°C	0.64	-	mA
Output Current (Sink)	IOL10	VDD = 10V, VOUT = 0.5V	1, 2	+125°C	0.9	-	mA
				-55°C	1.6	-	mA
Output Current (Sink)	IOL15	VDD = 15V, VOUT = 1.5V	1, 2	+125°C	2.4	-	mA
				-55°C	4.2	-	mA
Output Current (Source)	IOH5A	VDD = 5V, VOUT = 4.6V	1, 2	+125°C	-	-0.36	mA
				-55°C	-	-0.64	mA
Output Current (Source)	IOH5B	VDD = 5V, VOUT = 2.5V	1, 2	+125°C	-	-1.15	mA
				-55°C	-	-2.0	mA
Output Current (Source)	IOH10	VDD = 10V, VOUT = 9.5V	1, 2	+125°C	-	-0.9	mA
				-55°C	-	-1.6	mA
Output Current (Source)	IOH15	VDD =15V, VOUT = 13.5V	1, 2	+125°C	-	-2.4	mA
				-55°C	-	-4.2	mA
Propagation Delay	TPHL TPLH	VDD = 10V	1, 2, 3	+25°C	-	180	ns
		VDD = 15V	1, 2, 3	+25°C	-	130	ns
Transition Time	TTHL TTLH	VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	80	ns

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Positive Trigger Threshold Voltage	VP10V	VDD = 10V	1, 2, 4	+25°C, +125°C, -55°C	4.6	7.1	V
	VP10V	VDD = 10V	1, 2, 5	+25°C, +125°C, -55°C	5.6	8.2	V
	VP15V	VDD = 15V	1, 2, 5	+25°C, +125°C, -55°C	6.3	12.7	V
Negative Trigger Threshold Voltage	VN10V	VDD = 10V	1, 2, 4	+25°C, +125°C, -55°C	2.5	5.2	V
	VN10V	VDD = 10V	1, 2, 5	+25°C, +125°C, -55°C	3.4	6.6	V
	VN15V	VDD = 15V	1, 2, 5	+25°C, +125°C, -55°C	4.8	9.6	V
Hysteresis Voltage	VH10V	VDD = 10V	1, 2, 4	+25°C, +125°C, -55°C	1.2	3.4	V
	VH10V	VDD = 10V	1, 2, 5	+25°C, +125°C, -55°C	1.2	3.4	V
	VH15V	VDD = 15V	1, 2, 5	+25°C, +125°C, -55°C	1.6	5.0	V
Input Capacitance	CIN	Any Input	1, 2	+25°C	-	7.5	pF

NOTES:

1. All voltages referenced to device GND.
2. The parameters listed on Table 3 are controlled via design or process and are not directly tested. These parameters are characterized on initial design release and upon design changes which would affect these characteristics.
3. CL = 50pF, RL = 200K, Input TR, TF < 20ns.
4. Input on terminals 1, 5, 8, 12
5. Input on terminals 1 and 2, 5 and 6, 8 and 9, or 12 and 13

TABLE 4. POST IRRADIATION ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Supply Current	IDD	VDD = 20V, VIN = VDD or GND	1, 4	+25°C	-	7.5	µA
N Threshold Voltage	VNTH	VDD = 10V, ISS = -10µA	1, 4	+25°C	-2.8	-0.2	V
N Threshold Voltage Delta	ΔVTN	VDD = 10V, ISS = -10µA	1, 4	+25°C	-	±1	V
P Threshold Voltage	VTP	VSS = 0V, IDD = 10µA	1, 4	+25°C	0.2	2.8	V
P Threshold Voltage Delta	ΔVTP	VSS = 0V, IDD = 10µA	1, 4	+25°C	-	±1	V
Functional	F	VDD = 18V, VIN = VDD or GND	1	+25°C	VOH > VDD/2	VOL < VDD/2	V
		VDD = 3V, VIN = VDD or GND					
Propagation Delay Time	TPHL TPLH	VDD = 5V	1, 2, 3, 4	+25°C	-	1.35 x +25°C Limit	ns

NOTES: 1. All voltages referenced to device GND.
2. CL = 50pF, RL = 200K, Input TR, TF < 20ns.
3. See Table 2 for +25°C limit.
4. Read and Record

TABLE 5. BURN-IN AND LIFE TEST DELTA PARAMETERS +25°C

PARAMETER	SYMBOL	DELTA LIMIT
Supply Current - MSI-1	IDD	± 0.2µA
Output Current (Sink)	IOL5	± 20% x Pre-Test Reading
Output Current (Source)	IOH5A	± 20% x Pre-Test Reading

TABLE 6. APPLICABLE SUBGROUPS

CONFORMANCE GROUP		MIL-STD-883 METHOD	GROUP A SUBGROUPS	READ AND RECORD
Initial Test (Pre Burn-In)		100% 5004	1, 7, 9	IDD, IOL5, IOH5A
Interim Test 1 (Post Burn-In)		100% 5004	1, 7, 9	IDD, IOL5, IOH5A
Interim Test 2 (Post Burn-In)		100% 5004	1, 7, 9	IDD, IOL5, IOH5A
PDA (Note 1)		100% 5004	1, 7, 9, Deltas	
Interim Test 3 (Post Burn-In)		100% 5004	1, 7, 9	IDD, IOL5, IOH5A
PDA (Note 1)		100% 5004	1, 7, 9, Deltas	
Final Test		100% 5004	2, 3, 8A, 8B, 10, 11	
Group A		Sample 5005	1, 2, 3, 7, 8A, 8B, 9, 10, 11	
Group B	Subgroup B-5	Sample 5005	1, 2, 3, 7, 8A, 8B, 9, 10, 11, Deltas	Subgroups 1, 2, 3, 9, 10, 11
	Subgroup B-6	Sample 5005	1, 7, 9	
Group D		Sample 5005	1, 2, 3, 8A, 8B, 9	Subgroups 1, 2 3

NOTE: 1. 5% Parameteric, 3% Functional; Cumulative for Static 1 and 2.

TABLE 7. TOTAL DOSE IRRADIATION

CONFORMANCE GROUPS	MIL-STD-883 METHOD	TEST		READ AND RECORD	
		PRE-IRRAD	POST-IRRAD	PRE-IRRAD	POST-IRRAD
Group E Subgroup 2	5005	1, 7, 9	Table 4	1, 9	Table 4

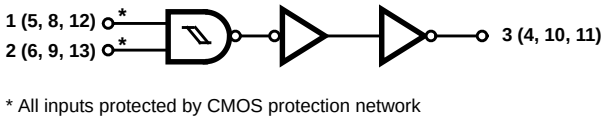
TABLE 8. BURN-IN AND IRRADIATION TEST CONNECTIONS

FUNCTION	OPEN	GROUND	VDD	9V ± -0.5V	OSCILLATOR	
					50kHz	25kHz
Static Burn-In 1 Note 1	3, 4, 10, 11	1, 2, 5-9, 12, 13	14			
Static Burn-In 2 Note 1	3, 4, 10, 11	7	1, 2, 5, 6, 8, 9, 12-14			
Dynamic Burn-In Note 1	-	7	14	3, 4, 10, 11	1, 2, 5, 6, 8, 9, 12, 13	-
Irradiation Note 2	3, 4, 10, 11	7	1, 2, 5, 6, 8, 9, 12-14			

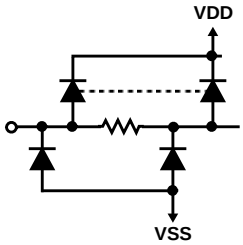
NOTES:

1. Each pin except VDD and GND will have a series resistor of 10K ± 5%, VDD = 18V ± 0.5V
2. Each pin except VDD and GND will have a series resistor of 47K ± 5%; Group E, Subgroup 2, sample size is 4 dice/wafer, 0 failures, VDD = 10V ± 0.5V

Logic Diagram



* All inputs protected by CMOS protection network



1 OF 4 SCHMITT TRIGGERS

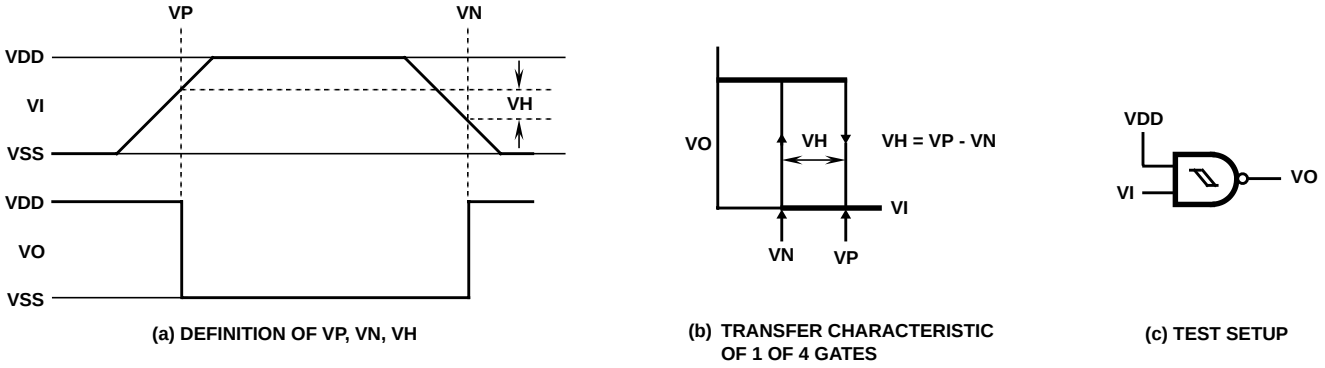


FIGURE 1. HYSTERESIS DEFINITION, CHARACTERISTIC, AND TEST SETUP

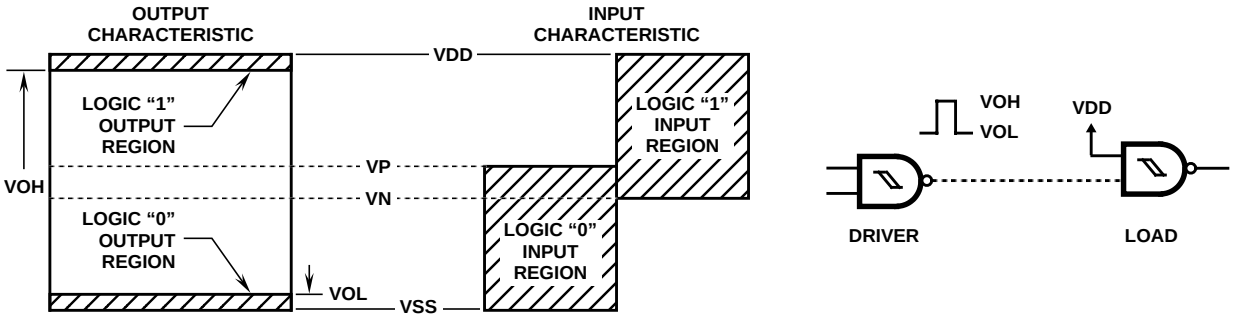


FIGURE 2. INPUT AND OUTPUT CHARACTERISTICS

Typical Performance Curves

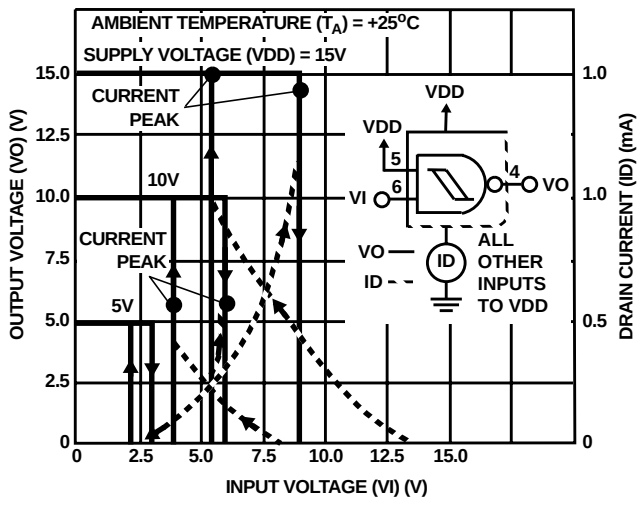


FIGURE 3. TYPICAL CURRENT AND VOLTAGE TRANSFER CHARACTERISTICS

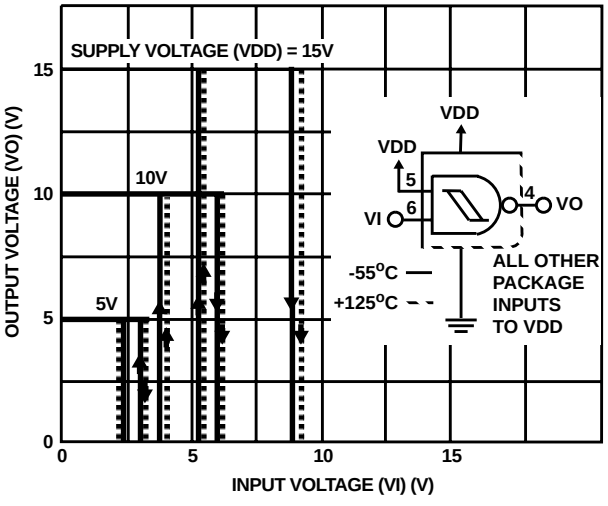


FIGURE 4. TYPICAL VOLTAGE TRANSFER CHARACTERISTICS AS A FUNCTION OF TEMPERATURE

Typical Performance Curves (Continued)

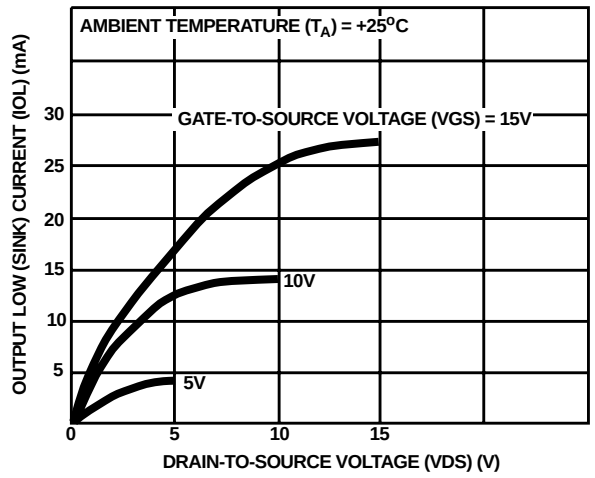


FIGURE 5. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

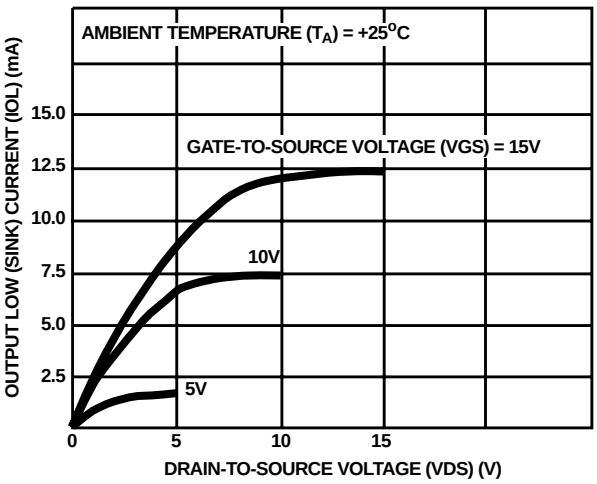


FIGURE 6. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

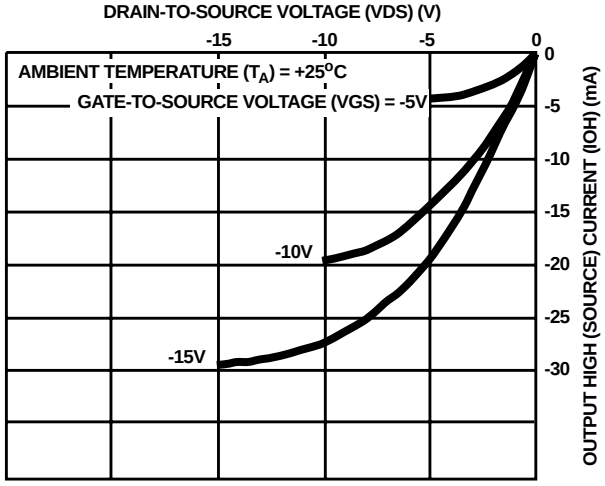


FIGURE 7. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

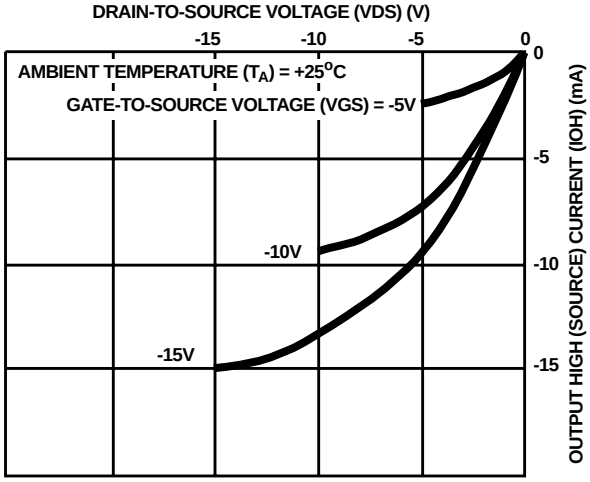


FIGURE 8. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

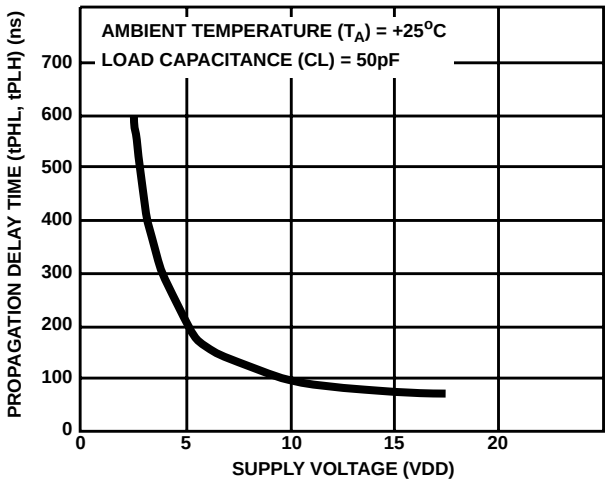


FIGURE 9. TYPICAL PROPAGATION DELAY TIME vs. SUPPLY VOLTAGE

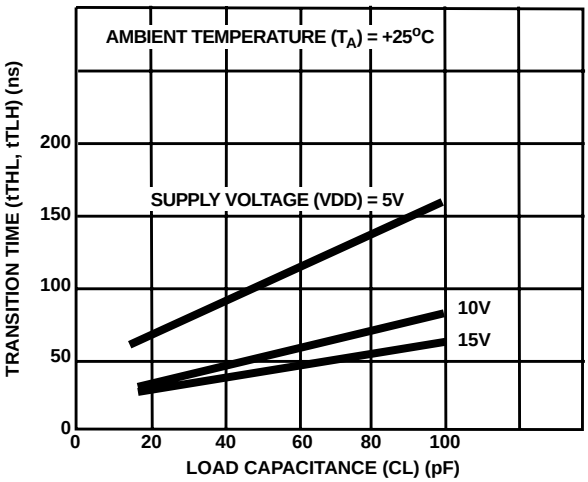


FIGURE 10. TYPICAL TRANSITION TIME vs. LOAD CAPACITANCE

Typical Performance Curves (Continued)

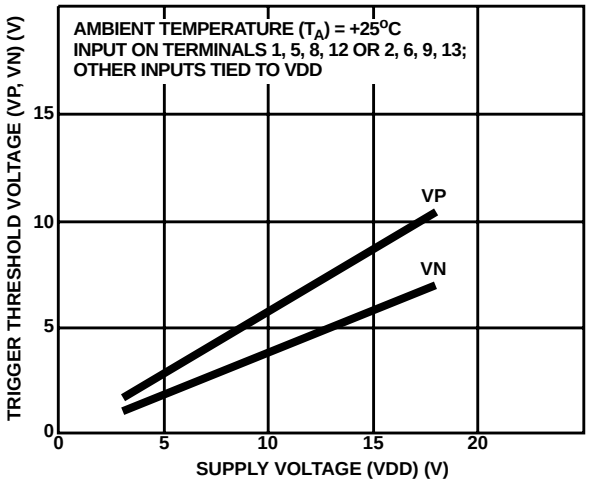


FIGURE 11. TYPICAL TRIGGER THRESHOLD VOLTAGE vs. VDD

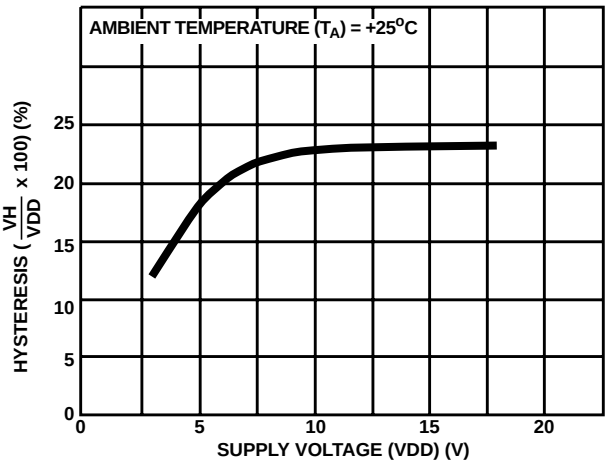


FIGURE 12. TYPICAL PERCENT HYSTERESIS vs. SUPPLY VOLTAGE

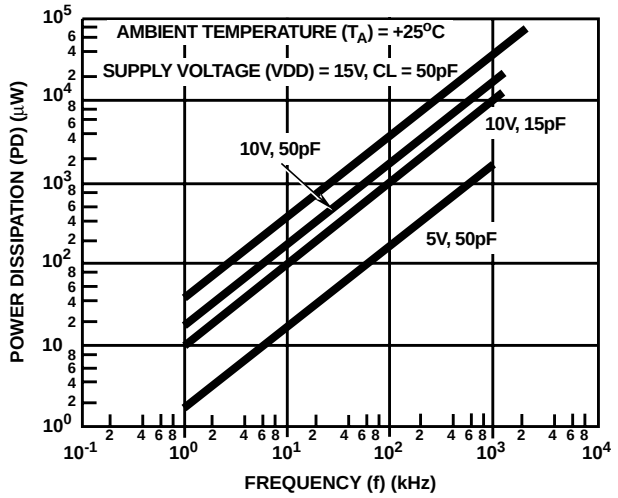


FIGURE 13. TYPICAL POWER DISSIPATION vs. FREQUENCY CHARACTERISTICS

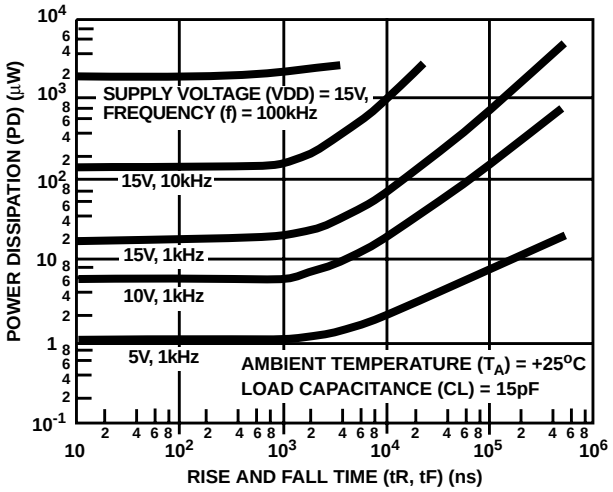
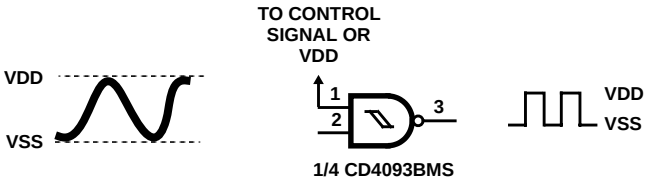


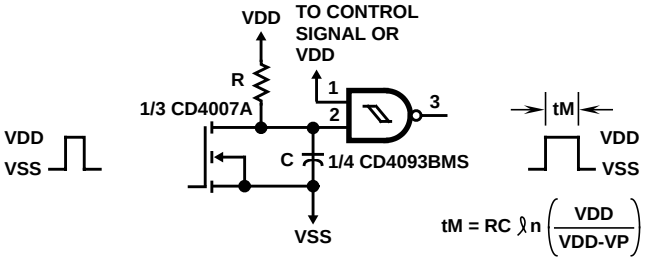
FIGURE 14. TYPICAL POWER DISSIPATION vs. RISE AND FALL TIMES

Applications



FREQUENCY RANGE OF WAVE SHAPE IS FROM DC TO 1MHz

FIGURE 15. WAVE SHAPER



FOR THE RANGE OF R AND C GIVEN 5μs < tM < 1s

FIGURE 16. MONOSTABLE MULTIVIBRATOR

Applications (Continued)

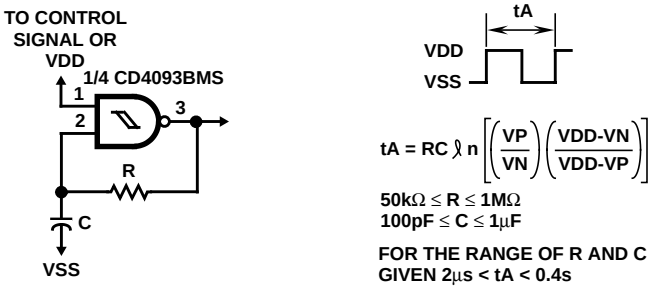
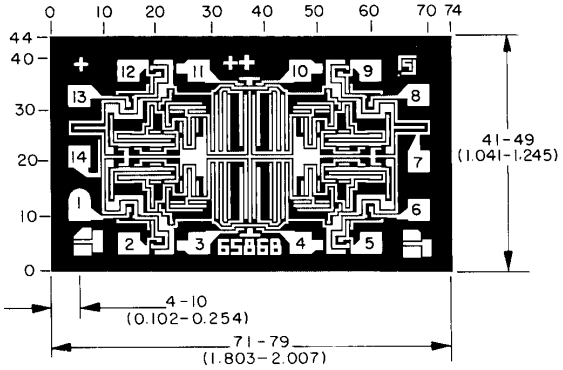


FIGURE 17. ASTABLE MULTIVIBRATOR

Chip Dimensions and Pad Layout



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

METALLIZATION: Thickness: 11kÅ – 14kÅ, AL.

PASSIVATION: 10.4kÅ - 15.6kÅ, Silane

BOND PADS: 0.004 inches X 0.004 inches MIN

DIE THICKNESS: 0.0198 inches - 0.0218 inches

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