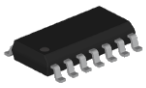
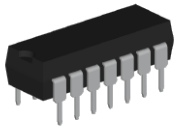
CD4093

CMOS IC

CMOS Quad 2-Input NAND Schmitt Triggers



SOP-14



DIP-14

TSSOP-14

■ DESCRIPTION

CD4093 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).

■ FEATURES

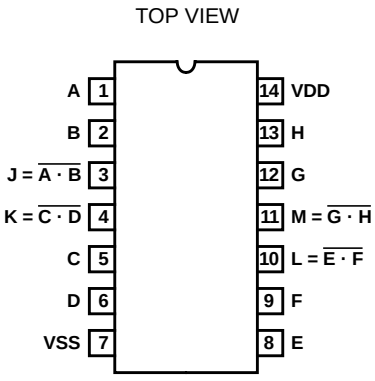
* Schmitt Trigger Action on Each Input With No External Components
* Hysteresis Voltage Typically 0.9V at VDD = 5V and 2.3V at VDD = 10V
* Noise Immunity Greater than 50%
* No Limit on Input Rise and Fall Times
* Standardized, Symmetrical Output Characteristics
* 100% Tested for Quiescent Current at 20V
* Maximum Input Current of 1μA at 18V Over Full Pack-age Temperature Range, 100nA at 18V and +25oC
* 5V, 10V and 15V Parametric Ratings
* Meets All Requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

ORDERING INFORMATION

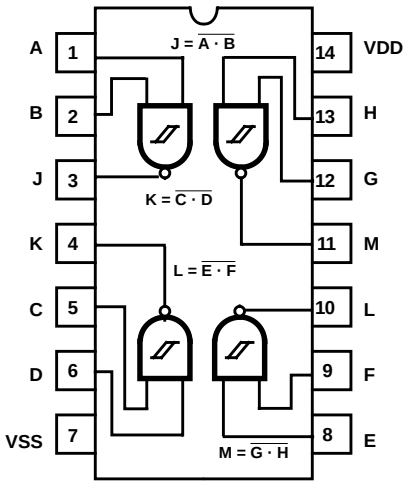
Device	Package
CD4093BE	DIP-14
CD4093BM	SOP-14
CD4093BPW	TSSOP-14

■ PIN CONFIGURATION

TOP VIEW



■ Functional Diagram



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■ ABSOLUTE MAXIMUM RATING

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

Storage Temperature Range (TSTG) . . . . . -65°C to +150°C
Lead Temperature (During Soldering) . . . . . +265°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.

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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

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TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
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		UNITS
					MIN	MAX	
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

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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

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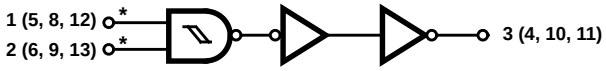
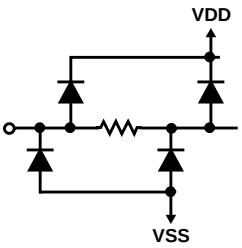
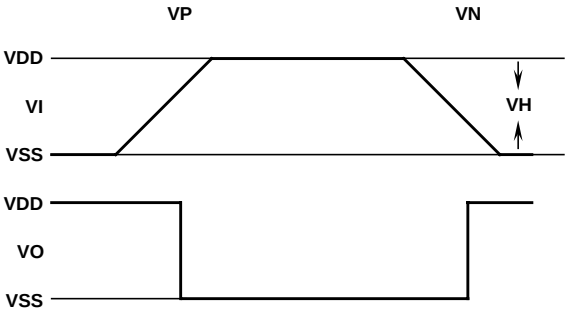
Logic Diagram



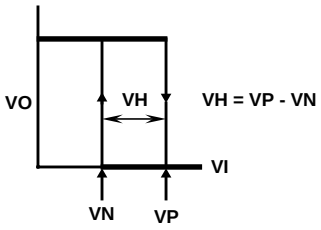
* All inputs protected by CMOS protection network



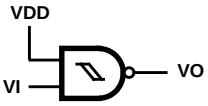
1 OF 4 SCHMITT TRIGGERS



(a) DEFINITION OF VP, VN, VH



(b) TRANSFER CHARACTERISTIC OF 1 OF 4 GATES



(c) TEST SETUP

FIGURE 1. HYSTERESIS DEFINITION, CHARACTERISTIC, AND TEST SETUP

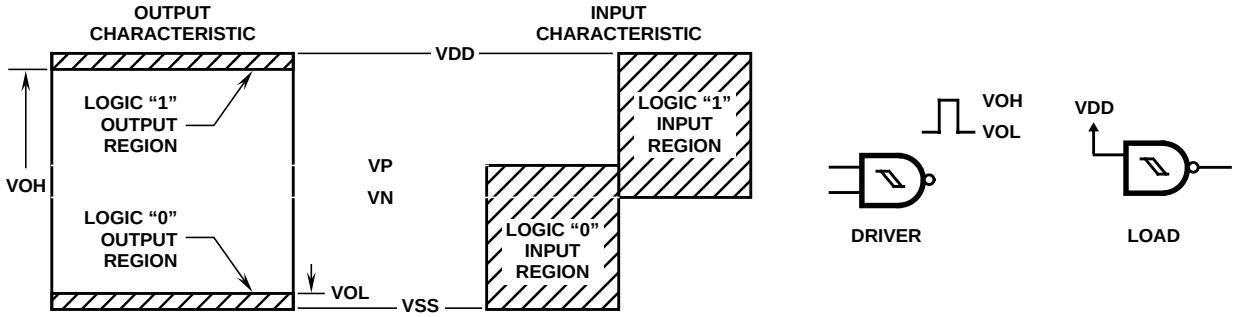


FIGURE 2. INPUT AND OUTPUT CHARACTERISTICS

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Typical Performance Curves

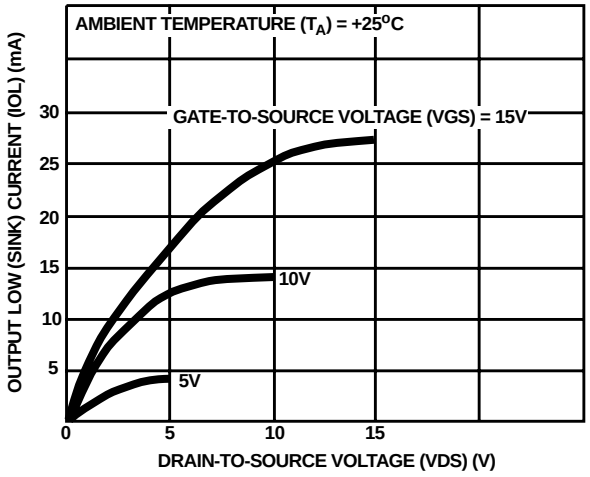

FIGURE 1. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

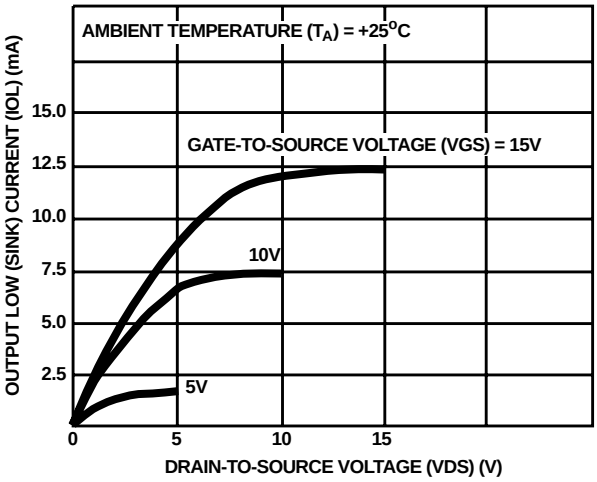

FIGURE 2. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

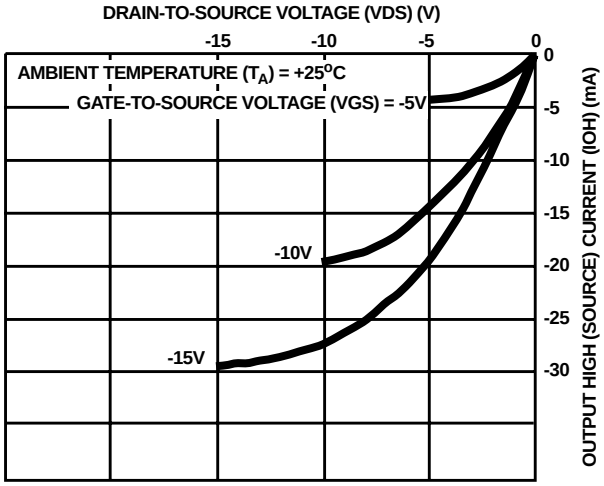

FIGURE 3. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

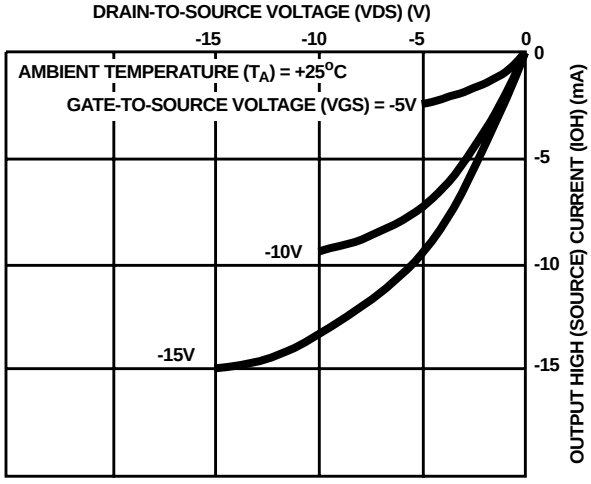

FIGURE 4. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

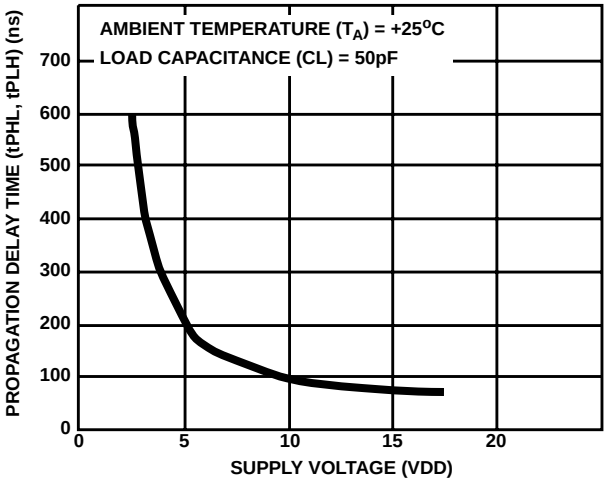

FIGURE 5. TYPICAL PROPAGATION DELAY TIME vs. SUPPLY VOLTAGE

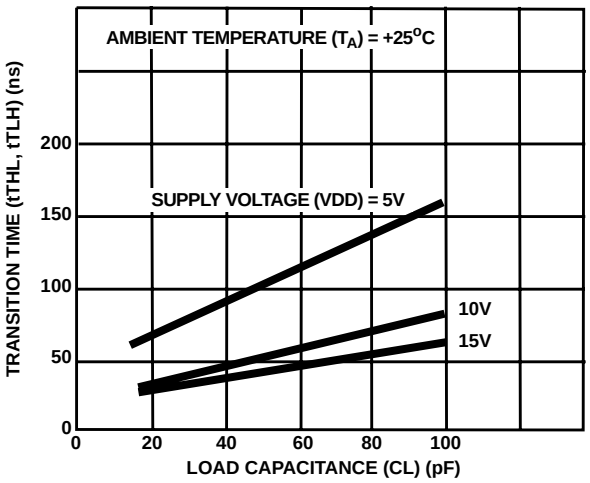

FIGURE 6. TYPICAL TRANSITION TIME vs. LOAD CAPACITANCE

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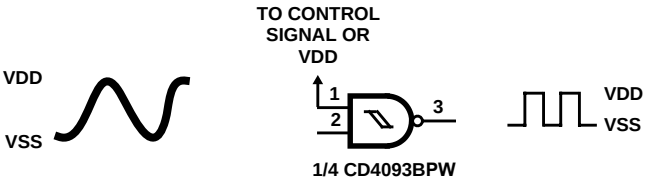
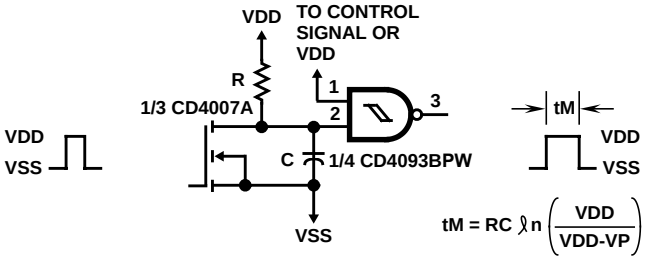
Applications



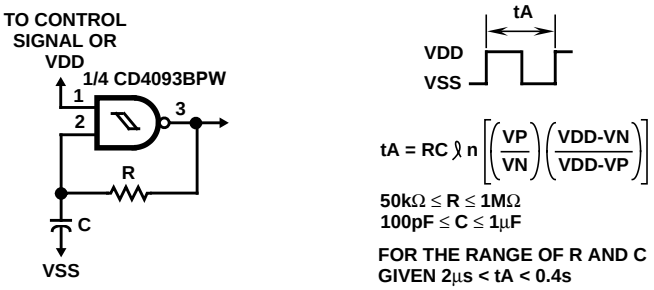
FREQUENCY RANGE OF WAVE SHAPE
IS FROM DC TO 1MHz

FIGURE 7. WAVE SHAPER



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

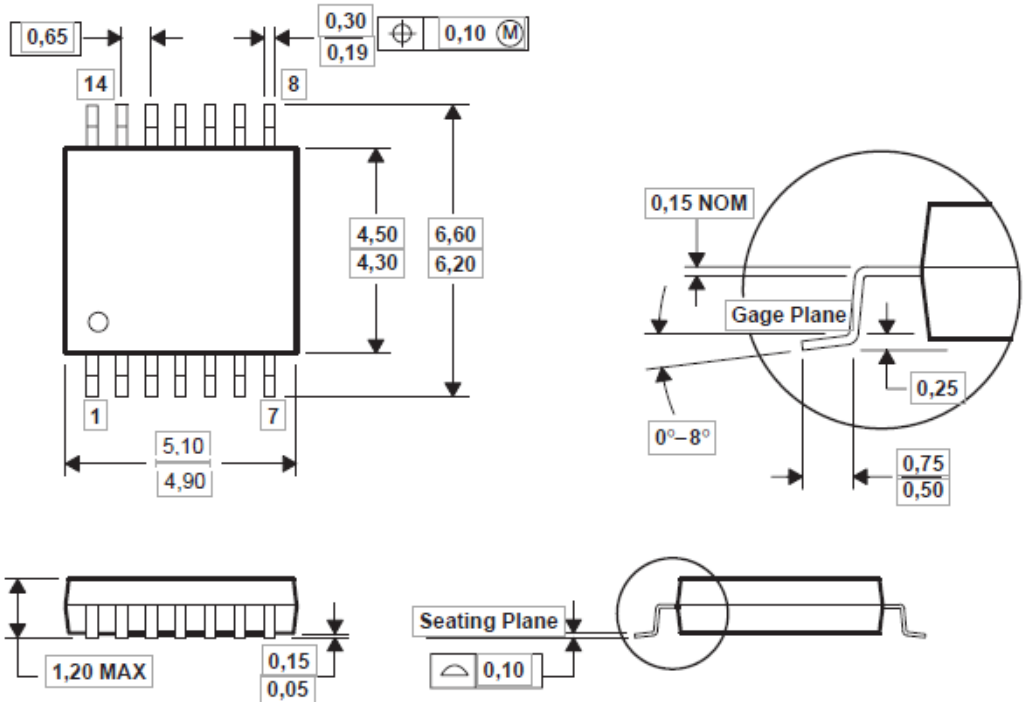
FIGURE 8. MONOSTABLE MULTIVIBRATOR



FOR THE RANGE OF R AND C
GIVEN 2μs < tA < 0.4s

FIGURE 9. ASTABLE MULTIVIBRATOR

TSSOP-14: PACKAGE OUTLINE DIMENSIONS



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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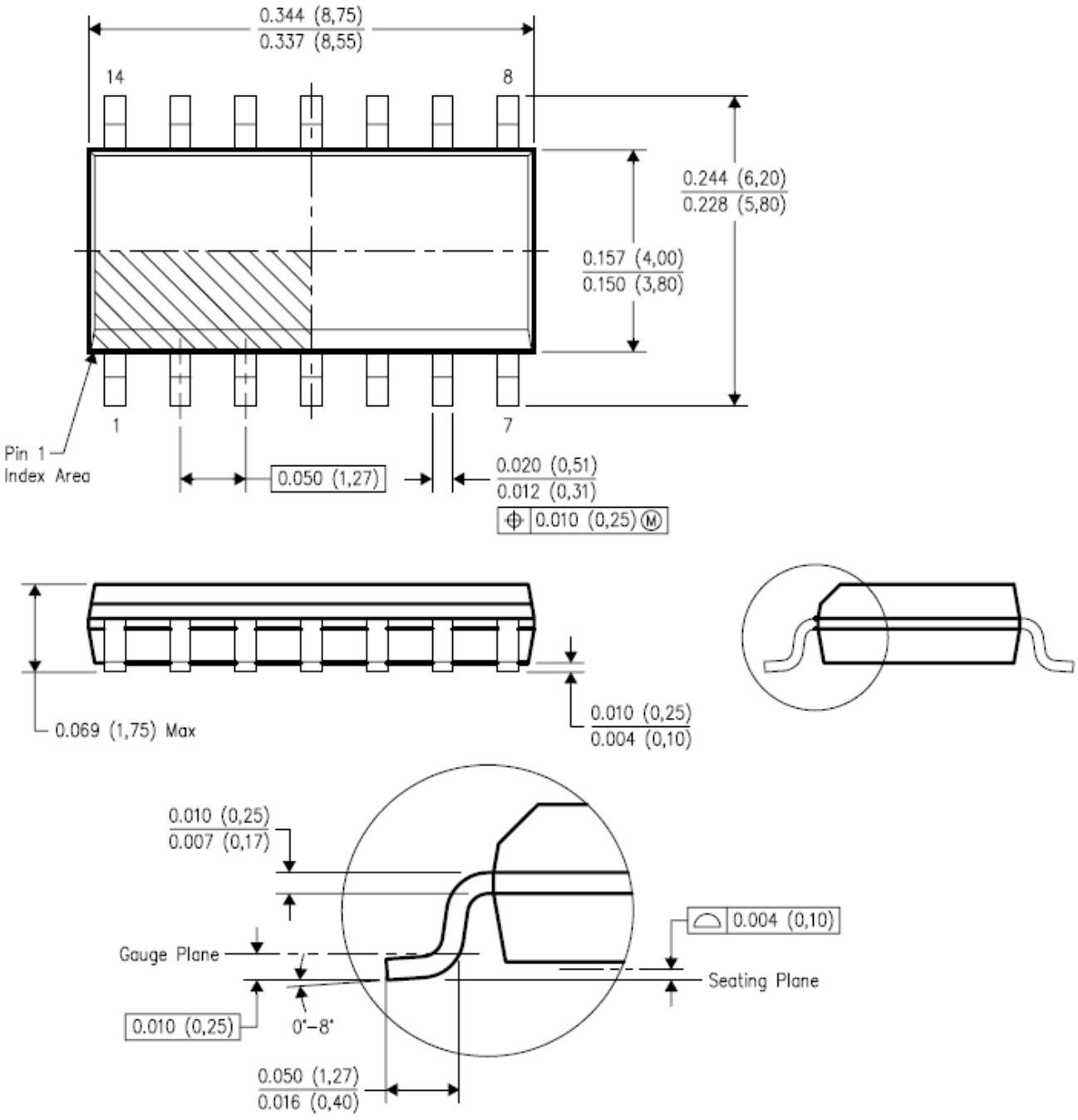
SOP-14: PACKAGE OUTLINE DIMENSIONS



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AB.

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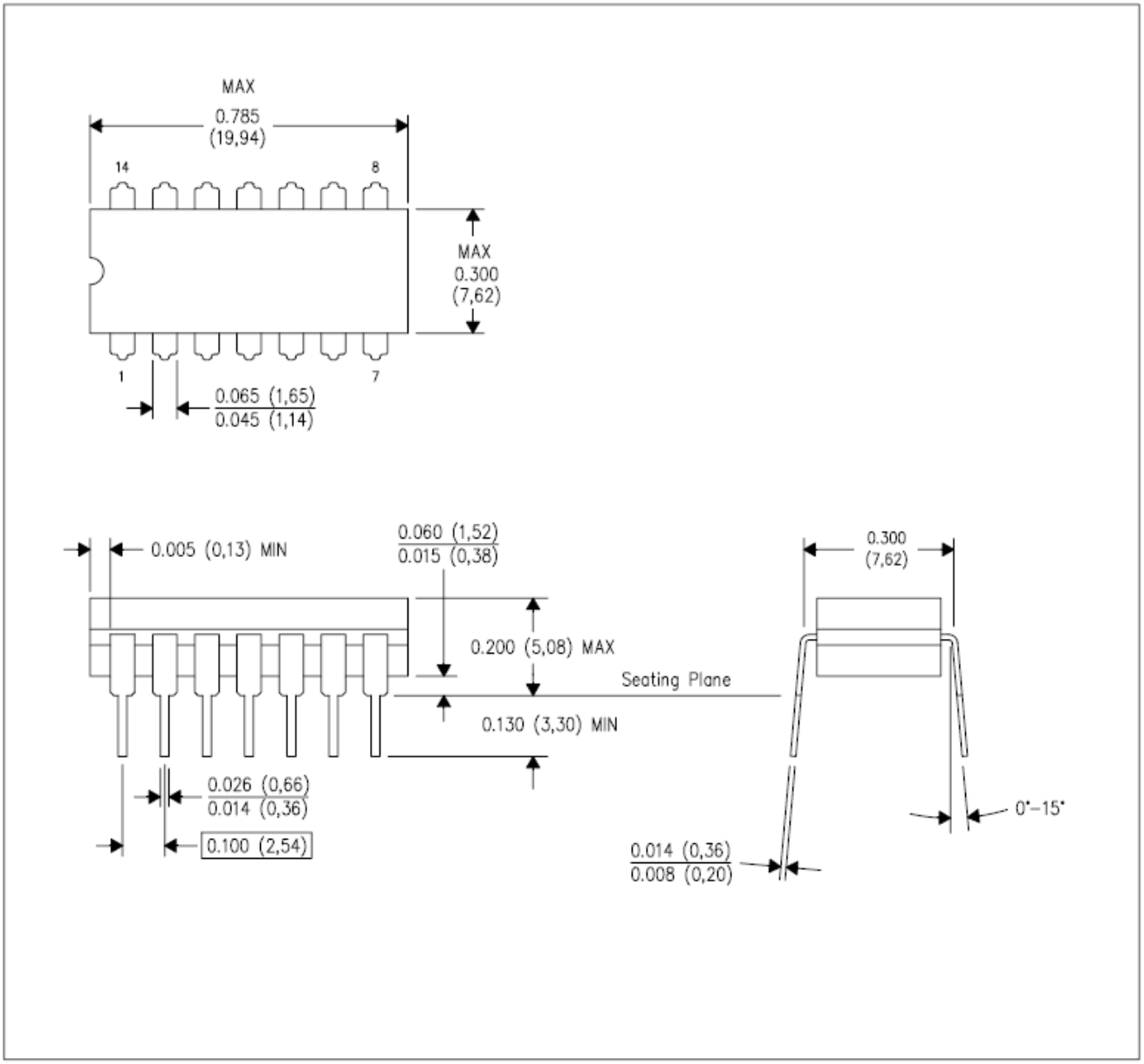
DIP-14: PACKAGE OUTLINE DIMENSIONS



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls within MIL STD 1835 GDIP1–T14, GDIP1–T16, GDIP1–T18 and GDIP1–T20.

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