# CD4093BMS

CMOS Quad 2-Input NAND Schmitt Triggers

FN3330
Rev 0.00
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

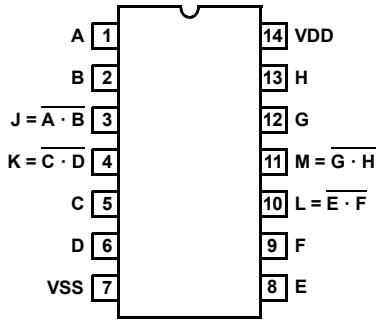
CD4093BMS consists of four Schmitt trigger circuits. Each circuit functions as a two input NAND gate with Schmitt trigger action on both inputs. The gate switches at different points for positive and negative going signals. The difference between the positive voltage (VP) and the negative voltage (VN)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

The CD4093BMS is supplied in these 14 lead outline packages:

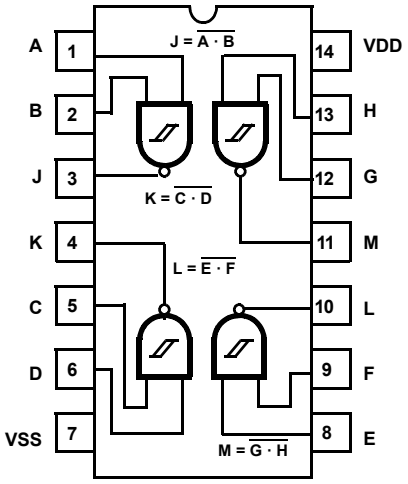
| | |
|---|---|
| Braze Seal DIP | H4H |
| Frit Seal DIP | H1B |
| Ceramic Flatpack | H3W |

## 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 | $\theta_{ja}$ | $\theta_{jc}$ |
|---|---|---|
| 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 Packages)
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 |

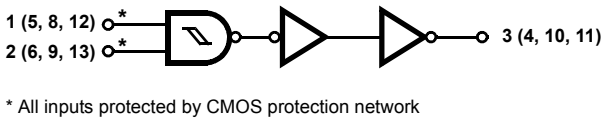
**TABLE 8. BURN-IN AND IRRADIATION TEST CONNECTIONS**

| 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 | | | |

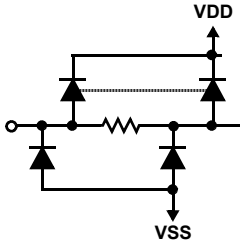
NOTES:

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**

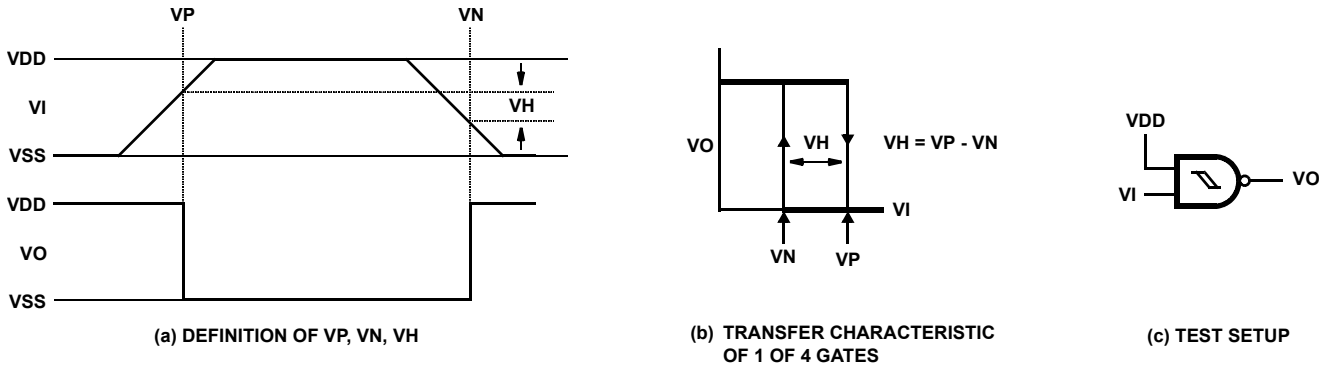



**FIGURE 1. HYSTERESIS DEFINITION, CHARACTERISTIC, AND TEST SETUP**

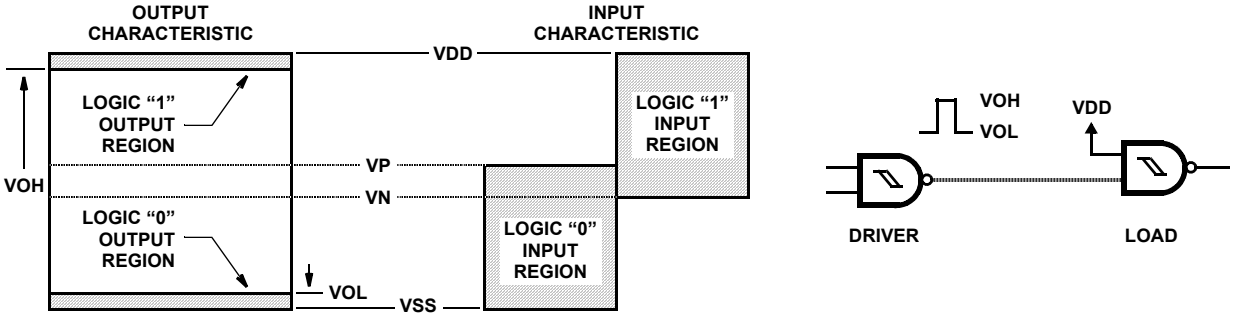



**FIGURE 2. INPUT AND OUTPUT CHARACTERISTICS**

## *Typical Performance Curves*

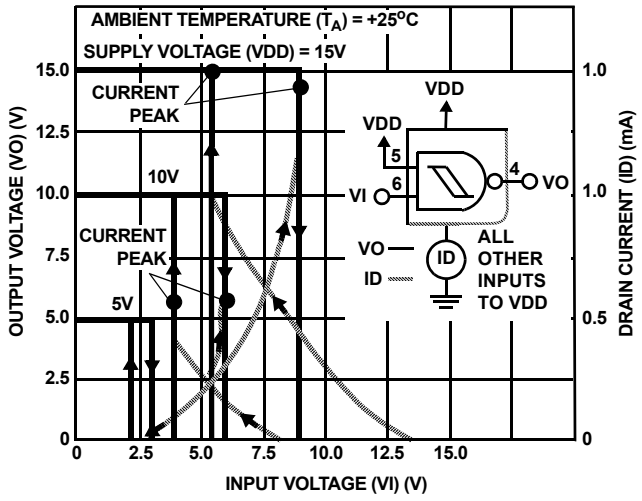



**FIGURE 3. TYPICAL CURRENT AND VOLTAGE TRANSFER CHARACTERISTICS**

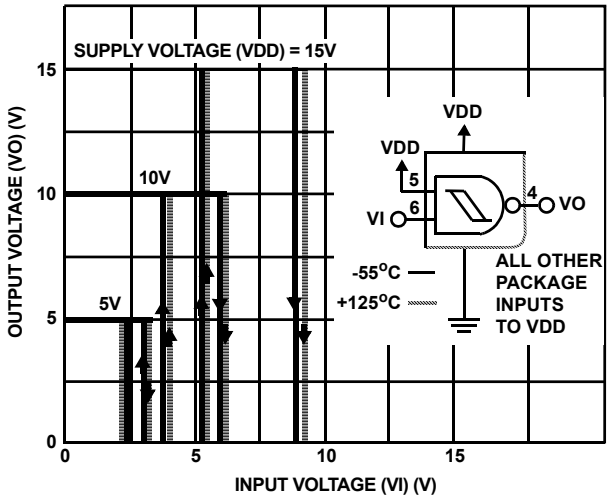



**FIGURE 4. TYPICAL VOLTAGE TRANSFER CHARACTERISTICS AS A FUNCTION OF TEMPERATURE**

## *Typical Performance Curves* (Continued)

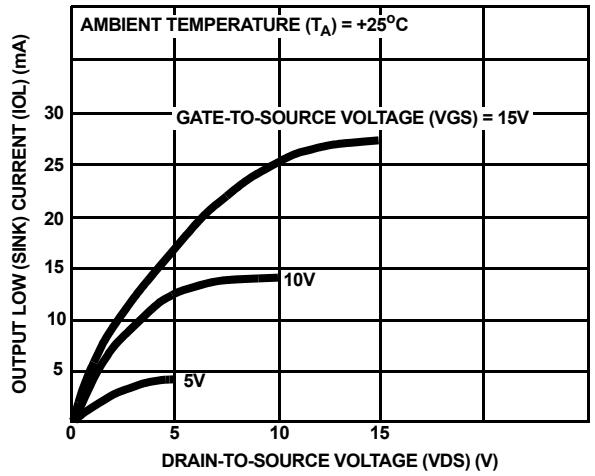



FIGURE 5. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

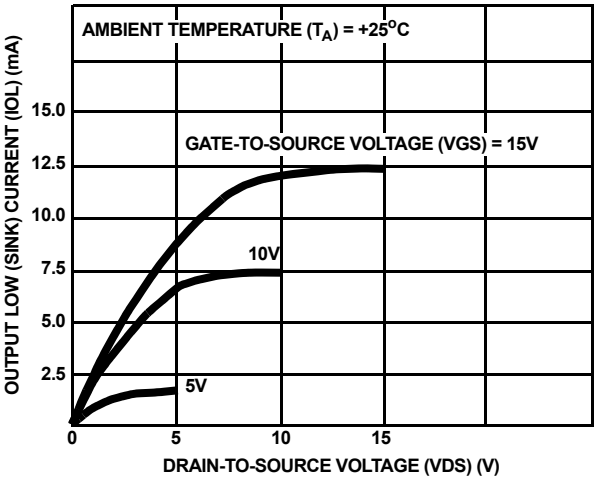



FIGURE 6. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

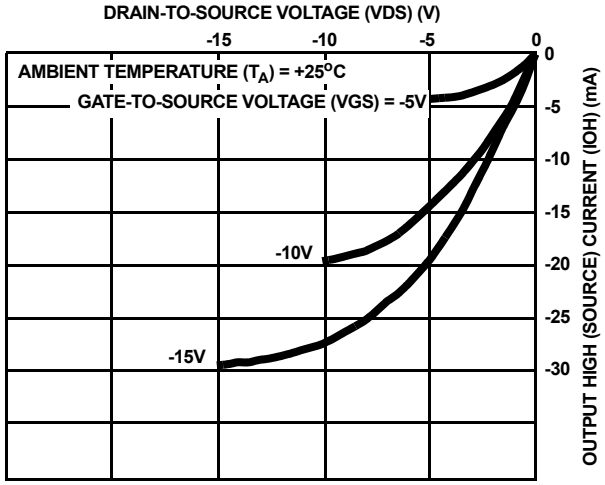



FIGURE 7. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

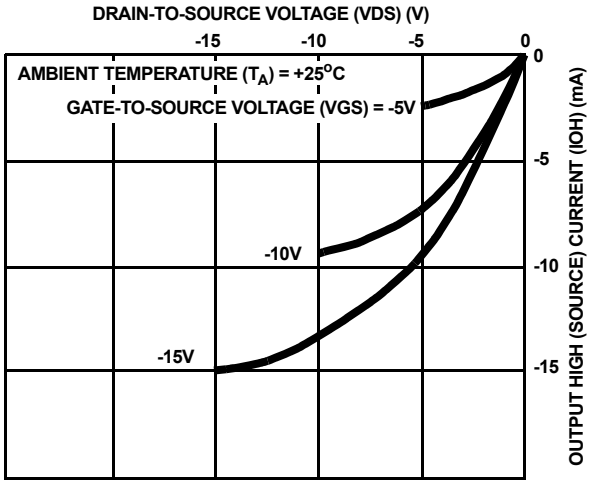



FIGURE 8. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

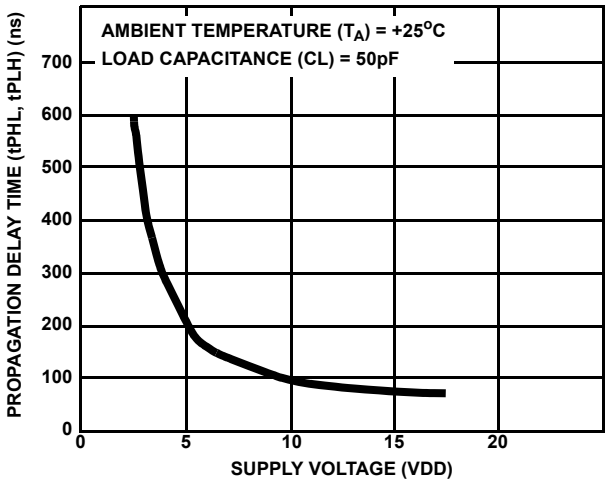



FIGURE 9. TYPICAL PROPAGATION DELAY TIME vs. SUPPLY VOLTAGE

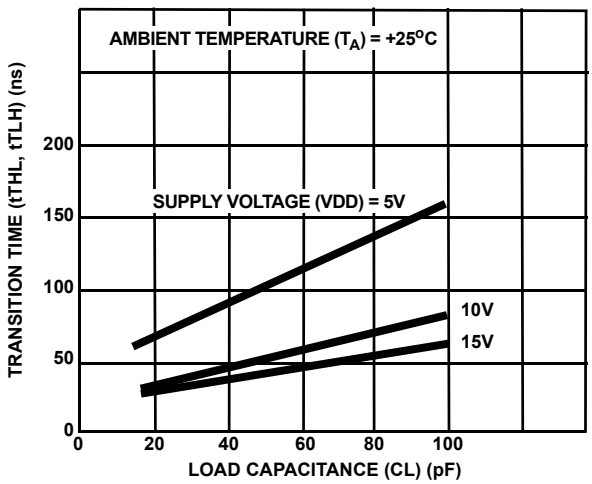



FIGURE 10. TYPICAL TRANSITION TIME vs. LOAD CAPACITANCE

## *Typical Performance Curves* (Continued)

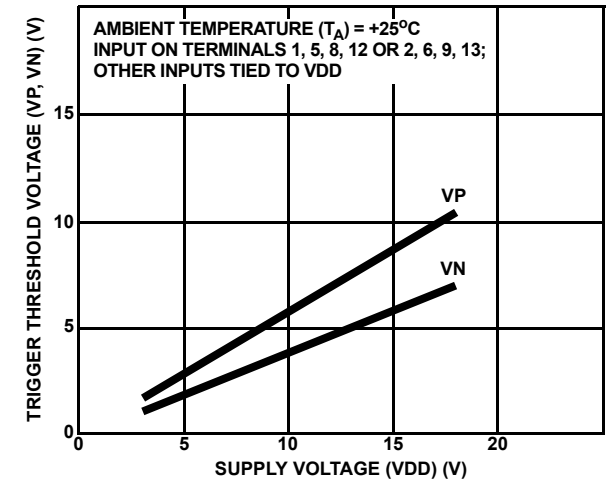



FIGURE 11. TYPICAL TRIGGER THRESHOLD VOLTAGE vs. VDD

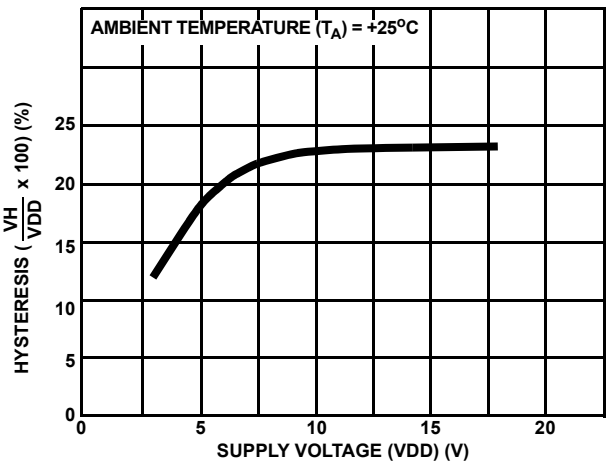



FIGURE 12. TYPICAL PERCENT HYSTERESIS vs. SUPPLY VOLTAGE

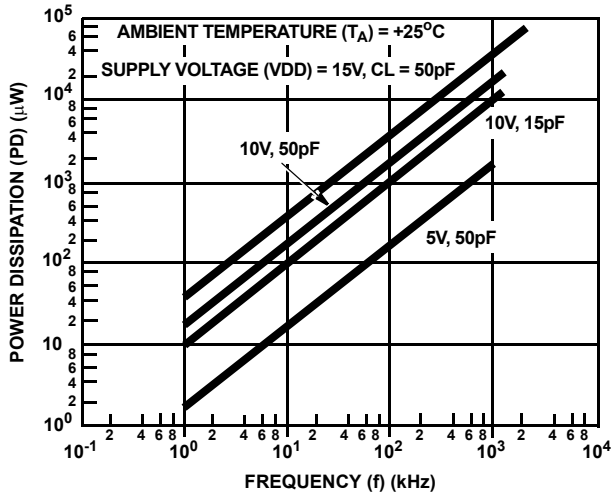



FIGURE 13. TYPICAL POWER DISSIPATION vs. FREQUENCY CHARACTERISTICS

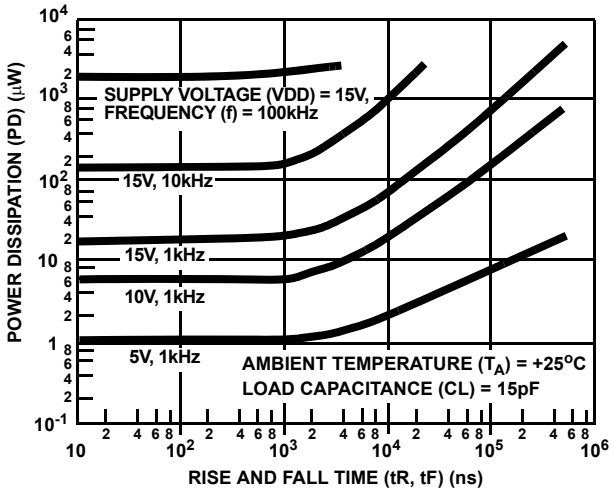
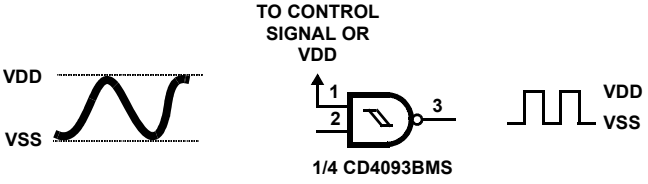


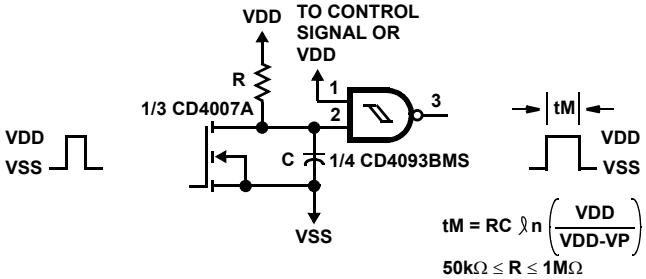

FIGURE 14. TYPICAL POWER DISSIPATION vs. RISE AND FALL TIMES

## *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)

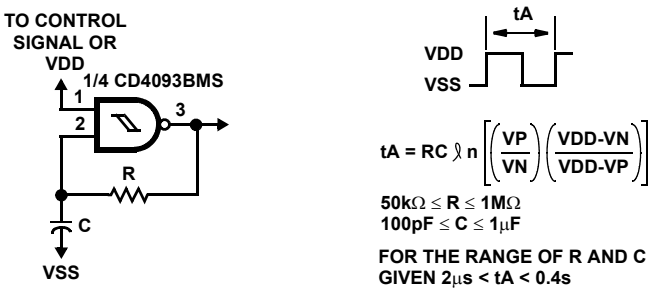
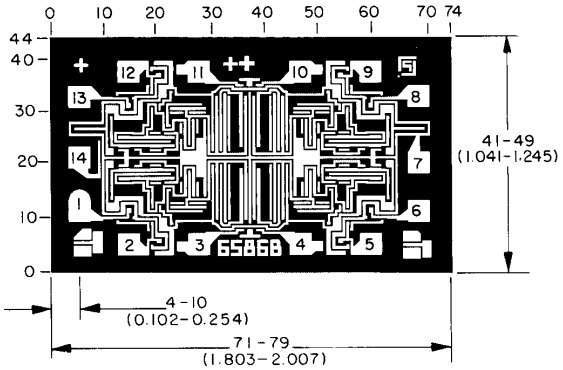



**FIGURE 17. ASTABLE MULTIVIBRATOR**

## *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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