

December 1992

CMOS Hex Schmitt Triggers

Features

- High Voltage Type (20V Rating)
- Schmitt Trigger Action with No External Components
- Hysteresis Voltage (Typ.)
 - 0.9V at VDD = 5V
 - 2.3V at VDD = 10V
 - 3.5V at VDD = 15V
- Noise Immunity Greater than 50%
- No Limit on Input Rise and Fall Times
- Low VDD to VSS Current During Slow Input Ramp
- 100% Tested for Quiescent Current at 20V
- 5V, 10V and 15V Parametric Ratings
- Maximum Input Current of 1µA at 18V Over Full Package Temperature Range; 100nA at 18V and +25°C
- Standardized Symmetrical Output Characteristics
- 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

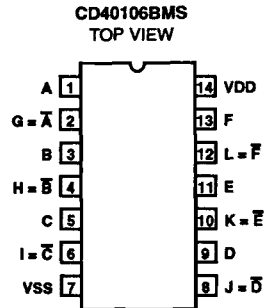
Description

CD40106BMS consists of six Schmitt trigger circuits. Each circuit functions as an inverter with Schmitt trigger action on the input. The trigger switches at different points for positive and negative going signals. The difference between the positive going voltage (VP) and the negative going voltage (VN) is defined as hysteresis voltage (VH) (see Figure 17).

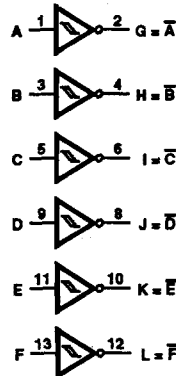
The CD40106BMS is supplied in these 14 lead outline packages:

| | |
|------------------|-----|
| Braze Seal DIP | H4Q |
| Frit Seal DIP | H1B |
| Ceramic Flatpack | H3W |

Pinout



Functional Diagram



Logic Diagram

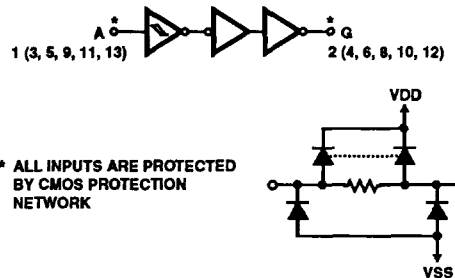


FIGURE 1. 1 OF 6 SCHMITT TRIGGERS

7
LOGIC

Specifications CD40106BMS

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 $T_A = -55^\circ\text{C}$ to +100°C (Package Type D, F, K) | 500mW | |
| For $T_A = +100^\circ\text{C}$ to +125°C (Package Type D, F, K) | Derate Linearity at 12mW/°C to 200mW | |
| Device Dissipation per Output Transistor | 100mW | |
| For $T_A =$ 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 | | UNITS |
|--|--------|------------------------------|----------|----------------------|----------------------|----------------|----------------|-------|
| | | | | | | MIN | MAX | |
| 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 |
| | | | | 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 |
| | | | | 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 2) | | 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 (See Figure 17) | VP5 | VDD = 5V | | 1, 2, 3 | +25°C, +125°C, -55°C | 2.2 | 3.6 | V |
| | VP10 | VDD = 10V | | 1, 2, 3 | +25°C, +125°C, -55°C | 4.6 | 7.1 | V |
| | VP15 | VDD = 15V | | 1, 2, 3 | +25°C, +125°C, -55°C | 6.8 | 10.8 | V |
| Negative Trigger Threshold Voltage (See Figure 17) | VN5 | VDD = 5V | | 1, 2, 3 | +25°C, +125°C, -55°C | 0.9 | 2.8 | V |
| | VN10 | VDD = 10V | | 1, 2, 3 | +25°C, +125°C, -55°C | 2.5 | 5.2 | V |
| | VN15 | VDD = 15V | | 1, 2, 3 | +25°C, +125°C, -55°C | 4 | 7.4 | V |
| Hysteresis Voltage (See Figure 17) | VH5 | VDD = 5V | | 1, 2, 3 | +25°C, +125°C, -55°C | 0.3 | 1.6 | V |
| | VH10 | VDD = 10V | | 1, 2, 3 | +25°C, +125°C, -55°C | 1.2 | 3.4 | V |
| | VH15 | VDD = 15V | | 1, 2, 3 | +25°C, +125°C, -55°C | 1.6 | 5.0 | V |

- NOTES: 1. All voltages referenced to device GND, 100% testing being implemented.
 2. Go/No Go test with limits applied to inputs.
 3. 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 (NOTE 1, 2) | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|-------------------|--------------|----------------------------|-------------------|---------------|--------|-----|-------|
| | | | | | MIN | MAX | |
| Propagation Delay | TPHL TPLH | VDD = 5V, VIN = VDD or GND | 9 | +25°C | - | 280 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 378 | 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 | | UNITS |
|-------------------------|--------------|-----------------------------|---------|----------------------|--------|-------|-------|
| | | | | | MIN | MAX | |
| 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 | - | 140 | ns |
| | | VDD = 15V | 1, 2, 3 | +25°C | - | 120 | ns |

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TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

| PARAMETER | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|-------------------|--------|------------|---------|-------------|--------|-----|-------|
| | | | | | MIN | MAX | |
| Transition Time | TTHL | VDD = 10V | 1, 2, 3 | +25°C | - | 100 | ns |
| | TTLH | VDD = 15V | 1, 2, 3 | +25°C | - | 80 | ns |
| 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

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. 3. See Table 2 for +25°C limit.
 2. CL = 50pF, RL = 200K, Input TR, TF < 20ns. 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 | |

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TABLE 6. APPLICABLE SUBGROUPS

| CONFORMANCE GROUP | | MIL-STD-883 METHOD | GROUP A SUBGROUPS | READ AND RECORD |
|-------------------|--------------|--------------------|---------------------------------------|------------------------------|
| 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% Parametric, 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 | 2, 4, 6, 8, 10, 12 | 1, 3, 5, 7, 9, 11, 13 | 14 | | | |
| Static Burn-In 2 Note 1 | 2, 4, 6, 8, 10, 12 | 7 | 1, 3, 5, 9, 11, 13, 14 | | | |
| Dynamic Burn-In Note 1 | - | 7 | 14 | 2, 4, 6, 8, 10, 12 | 1, 3, 5, 9, 11, 13 | |
| Irradiation Note 2 | 2, 4, 6, 8, 10, 12 | 7 | 1, 3, 5, 9, 11, 13, 14 | | | |

NOTES:

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

Typical Performance Characteristics

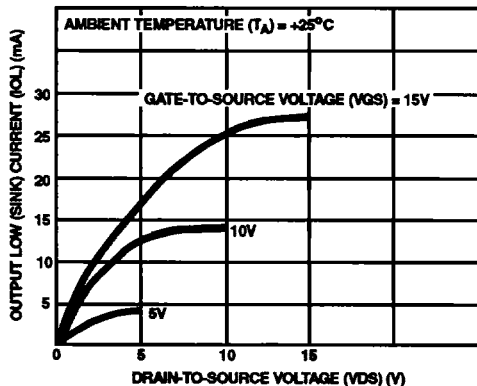


FIGURE 2. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

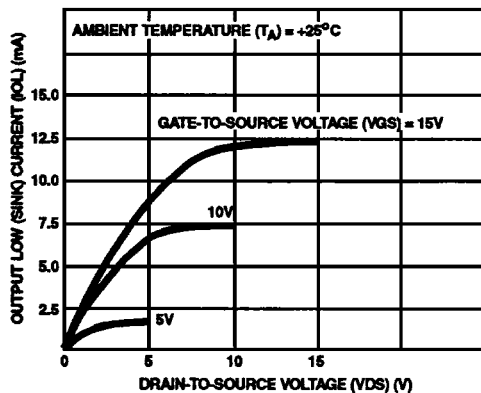


FIGURE 3. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

Typical Performance Characteristics (Continued)

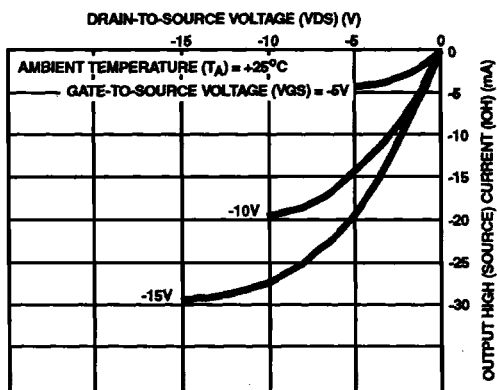


FIGURE 4. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

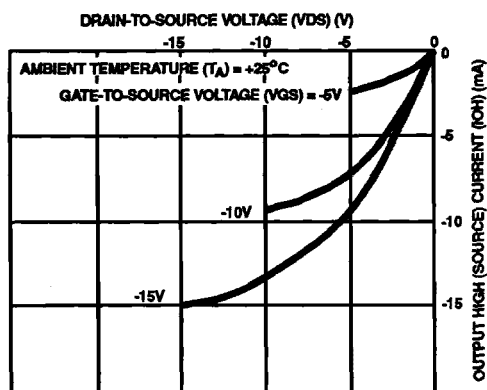


FIGURE 5. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

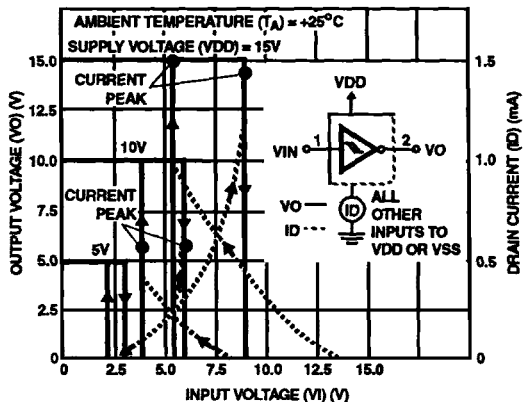


FIGURE 6. TYPICAL CURRENT AND VOLTAGE TRANSFER CHARACTERISTICS

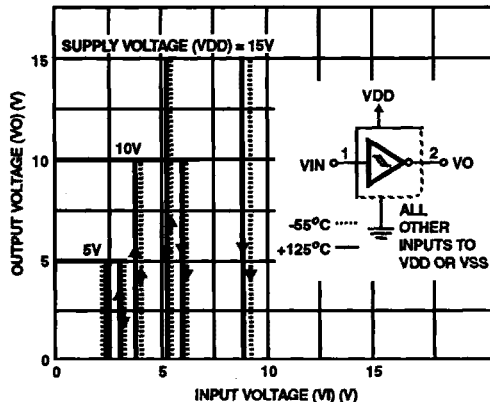


FIGURE 7. TYPICAL VOLTAGE TRANSFER CHARACTERISTICS AS A FUNCTION OF TEMPERATURE

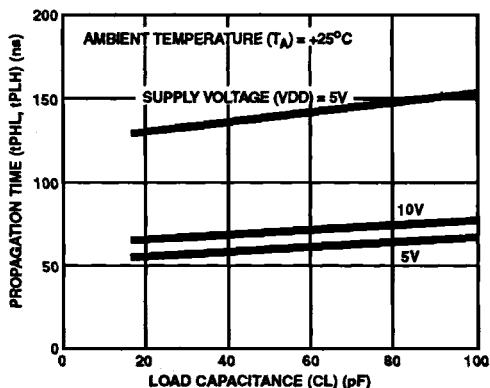


FIGURE 8. TYPICAL PROPAGATION DELAY TIME AS A FUNCTION OF LOAD CAPACITANCE

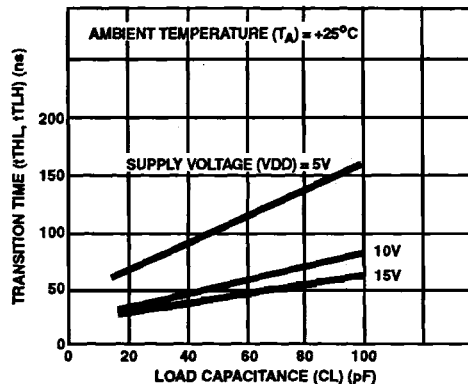


FIGURE 9. TYPICAL TRANSITION TIME AS A FUNCTION OF LOAD CAPACITANCE

Typical Performance Characteristics (Continued)

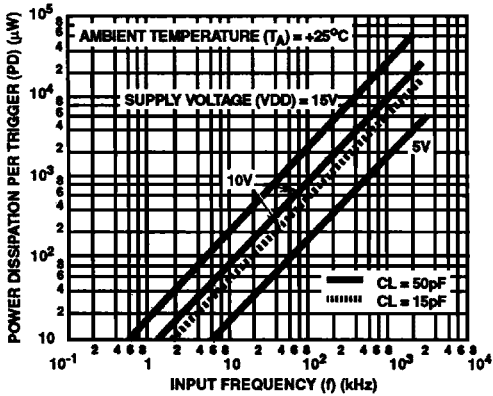


FIGURE 10. TYPICAL POWER DISSIPATION PER TRIGGER AS A FUNCTION OF INPUT FREQUENCY

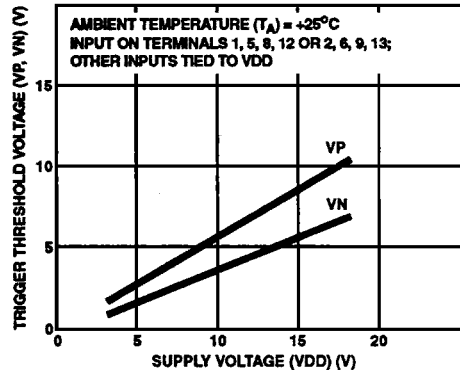


FIGURE 11. TYPICAL TRIGGER THRESHOLD VOLTAGE AS A FUNCTION OF SUPPLY VOLTAGE

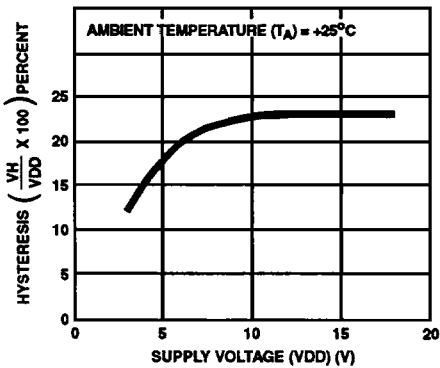


FIGURE 12. TYPICAL PERCENT HYSTERESIS AS A FUNCTION OF SUPPLY VOLTAGE

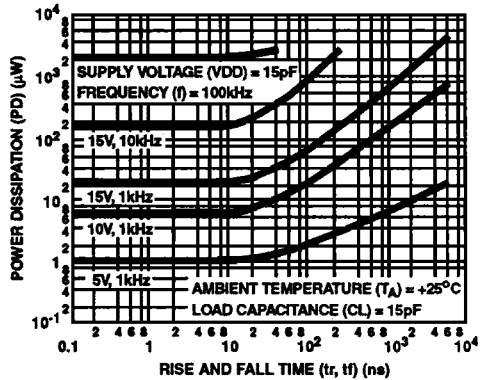
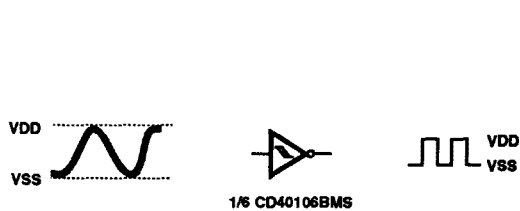


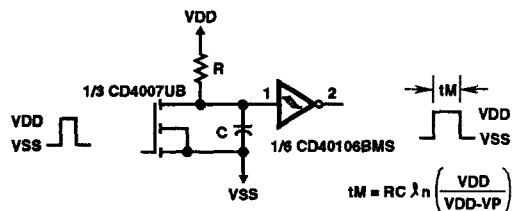
FIGURE 13. TYPICAL POWER DISSIPATION AS A FUNCTION OF RISE AND FALL TIMES

Applications



FREQUENCY RANGE OF WAVE SHAPE IS FROM DC TO 1MHz

FIGURE 14. WAVE SHAPER

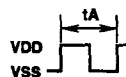
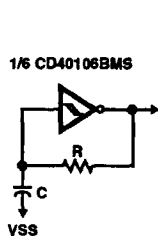


$$1M = RC \lambda_n \left(\frac{VDD}{VDD-VP} \right)$$

50kΩ ≤ R ≤ 1MΩ
100pF ≤ C ≤ 1μF

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

FIGURE 15. MONOSTABLE MULTIVIBRATOR

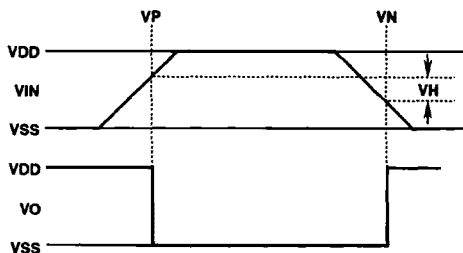


$$1A = RC \lambda_n \left[\left(\frac{VP}{VN} \right) \left(\frac{VDD-VN}{VDD-VP} \right) \right]$$

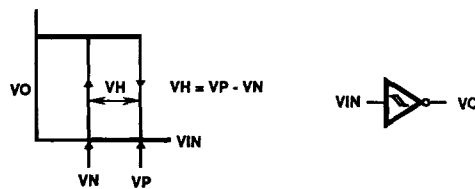
50kΩ ≤ R ≤ 1MΩ
100pF ≤ C ≤ 1μF

FOR THE RANGE OF R AND C
GIVEN 2μs < 1A < 0.4s

FIGURE 16. ASTABLE MULTIVIBRATOR



(a) DEFINITION OF VP, VN, VH



(b) TRANSFER CHARACTERISTIC OF 1 OF 6 GATES

FIGURE 17. HYSTERESIS DEFINITION, CHARACTERISTICS, AND TEST SETUP

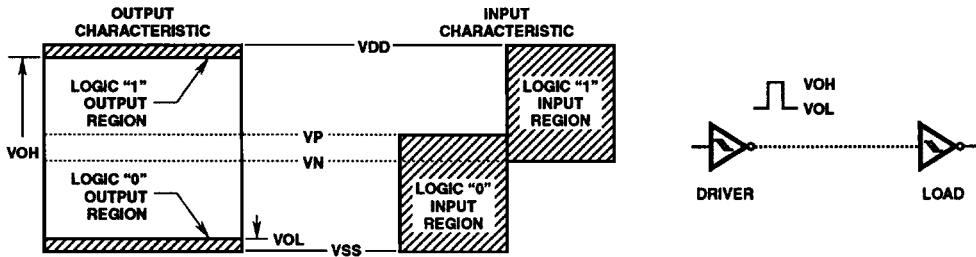
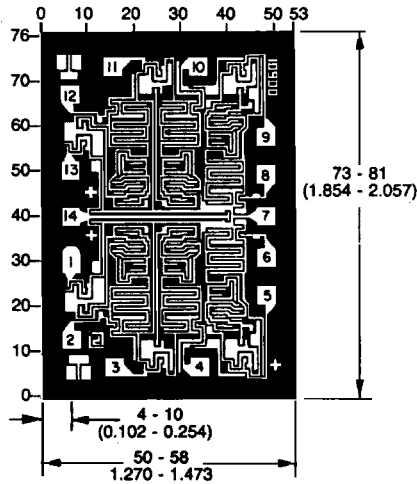


FIGURE 18. INPUT AND OUTPUT CHARACTERISTICS

Chip Dimensions and Pad Layout



Dimensions 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: $11\text{k}\text{\AA} - 14\text{k}\text{\AA}$, AL.
- PASSIVATION:** $10.4\text{k}\text{\AA} - 15.6\text{k}\text{\AA}$, Silane
- BOND PADS:** 0.004 inches X 0.004 inches MIN
- DIE THICKNESS:** 0.0198 inches - 0.0218 inches