

CMOS Dual 'D'-Type Flip-Flop

Features

- High-Voltage Type (20V Rating)
- Set-Reset Capability
- Static Flip-Flop Operation - Retains State Indefinitely With Clock Level Either "High" Or "Low"
- Medium-Speed Operation - 16 MHz (typ.) Clock Toggle Rate at 10V
- Standardized Symmetrical Output Characteristics
- 100% Tested for Quiescent Current at 20V
- Maximum Input Current of 1 μ A at 18V Over Full Package Temperature Range; 100nA at 18V and +25°C
- Noise Margin (Over Full Package Temperature Range):
 - 1V at VDD = 5V
 - 2V at VDD = 10V
 - 2.5V at VDD = 15V
- 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

- Registers
- Counters
- Control Circuits

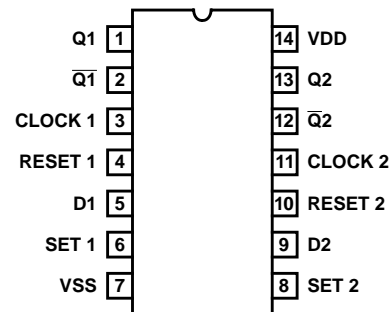
Description

CD4013BMS consists of two identical, independent data type flip-flops. Each flip-flop has independent data, set, reset, and clock inputs and Q and \bar{Q} outputs. These devices can be used for shift register applications, and, by connecting \bar{Q} output to the data input, for counter and toggle applications. The logic level present at the D input is transferred to the Q output during the positive going transition of the clock pulse. Setting or resetting is independent of the clock and is accomplished by a high level on the set or reset line, respectively.

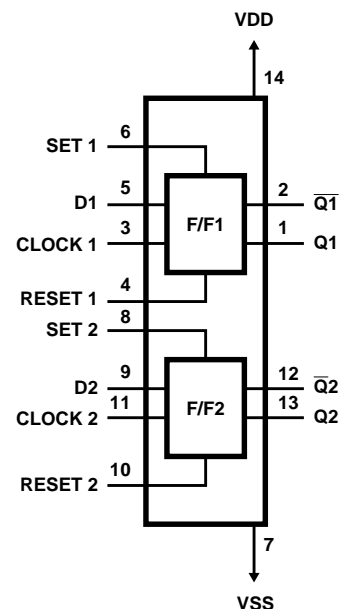
The CD4013BMS is supplied in these 14 lead outline packages:

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

Pinout



Functional Diagram



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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 | | 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 |
| | | | VDD = 18V | 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 |
| | | | VDD = 18V | 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 3) | | 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 | | | |
| Input Voltage Low (Note 2) | VIL | VDD = 5V, VOH > 4.5V, VOL < 0.5V | | 1, 2, 3 | +25°C, +125°C, -55°C | - | 1.5 | V |
| Input Voltage High (Note 2) | VIH | VDD = 5V, VOH > 4.5V, VOL < 0.5V | | 1, 2, 3 | +25°C, +125°C, -55°C | 3.5 | - | V |
| Input Voltage Low (Note 2) | VIL | VDD = 15V, VOH > 13.5V, VOL < 1.5V | | 1, 2, 3 | +25°C, +125°C, -55°C | - | 4 | V |
| Input Voltage High (Note 2) | VIH | VDD = 15V, VOH > 13.5V, VOL < 1.5V | | 1, 2, 3 | +25°C, +125°C, -55°C | 11 | - | V |

NOTES: 1. All voltages referenced to device GND, 100% testing being implemented. 3. For accuracy, voltage is measured differentially to VDD. Limit is 0.050V max.
 2. Go/No Go test with limits applied to inputs

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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 Clock to Q, \bar{Q} | TPHL1 TPLH1 | VDD = 5V, VIN = VDD or GND | 9 | +25°C | - | 300 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 405 | ns |
| Propagation Delay Set to \bar{Q} , Reset to Q | TPHL2 | VDD = 5V, VIN = VDD or GND | 9 | +25°C | - | 400 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 540 | ns |
| Propagation Delay Set to Q, Reset to \bar{Q} | TPLH2 | VDD = 5V, VIN = VDD or GND | 9 | +25°C | - | 300 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 405 | ns |
| Transition Time Clock to Q, \bar{Q} | TTHL TTLH | VDD = 5V, VIN = VDD or GND | 9 | +25°C | - | 200 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 270 | ns |
| Maximum Clock Input Frequency | FCL | VDD = 5V, VIN = VDD or GND | 9 | +25°C | 3.5 | - | MHz |
| | | | 10, 11 | +125°C, -55°C | 3.5/1.35 | - | MHz |

NOTES:

1. VDD = 5V, CL = 50pF, RL = 200K
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 | - | 1.0 | μA |
| | | | | +125°C | - | 30 | μA |
| | | VDD = 10V, VIN = VDD or GND | 1, 2 | -55°C, +25°C | - | 2.0 | μA |
| | | | | +125°C | - | 60 | μA |
| | | VDD = 15V, VIN = VDD or GND | 1, 2 | -55°C, +25°C | - | 2.0 | 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 | - | -1.6 | mA |
| Output Current (Source) | IOH10 | VDD = 10V, VOUT = 9.5V | 1, 2 | +125°C | - | -0.9 | mA |
| | | | | -55°C | - | -4.2 | mA |

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TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

| PARAMETER | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|----------------|---|---------|----------------------|--------|------|-------|
| | | | | | MIN | MAX | |
| Output Current (Source) | IOH15 | VDD = 15V, VO _{UT} = 13.5V | 1, 2 | +125°C | - | -2.4 | mA |
| | | | | -55°C | - | -4.2 | mA |
| Input Voltage Low | VIL | VDD = 10V, VO _H > 9V, VO _L < 1V | 1, 2 | +25°C, +125°C, -55°C | - | 3 | V |
| Input Voltage High | VIH | VDD = 10V, VO _H > 9V, VO _L < 1V | 1, 2 | +25°C, +125°C, -55°C | +7 | - | V |
| Propagation Delay Clock to Q, \bar{Q} | TPHL1 TPLH1 | VDD = 10V | 1, 2, 3 | +25°C | - | 130 | ns |
| | | VDD = 15V | 1, 2, 3 | +25°C | - | 90 | ns |
| Propagation Delay Set to \bar{Q} Reset to Q | TPHL2 | VDD = 10V | 1, 2, 3 | +25°C | - | 170 | ns |
| | | VDD = 15V | 1, 2, 3 | +25°C | - | 120 | ns |
| Propagation Delay Set to Q Reset to \bar{Q} | TPLH2 | VDD = 10V | 1, 2, 3 | +25°C | - | 130 | ns |
| | | VDD = 15V | 1, 2, 3 | +25°C | - | 90 | ns |
| Transition Time Clock to Q, \bar{Q} | TTHL TTLH | VDD = 10V | 1, 2, 3 | +25°C | - | 100 | ns |
| | | VDD = 15V | 1, 2, 3 | +25°C | - | 80 | ns |
| Maximum Clock Input Frequency | FCL | VDD = 10V | 1, 2, 3 | +25°C | 8 | - | MHz |
| | | VDD = 15V | 1, 2, 3 | +25°C | 12 | - | MHz |
| Minimum Data Setup Time | TS | VDD = 5V | 1, 2, 3 | +25°C | - | 40 | ns |
| | | VDD = 10V | 1, 2, 3 | +25°C | - | 20 | ns |
| | | VDD = 15V | 1, 2, 3 | +25°C | - | 15 | ns |
| Minimum Clock Pulse Width | TW | VDD = 5V | 1, 2, 3 | +25°C | - | 140 | ns |
| | | VDD = 10V | 1, 2, 3 | +25°C | - | 60 | ns |
| | | VDD = 15V | 1, 2, 3 | +25°C | - | 40 | ns |
| Minimum Set or Reset Pulse Width | TW | VDD = 5V | 2, 3 | +25°C | - | 180 | ns |
| | | VDD = 10V | 2, 3 | +25°C | - | 80 | ns |
| | | VDD = 15V | 2, 3 | +25°C | - | 50 | 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 |

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TABLE 4. POST IRRADIATION ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETER | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---------------------------|------------------|------------------------------|------------|-------------|-------------|--------------------|-------|
| | | | | | MIN | MAX | |
| N Threshold Voltage Delta | ΔV_{NTH} | VDD = 10V, ISS = -10 μ A | 1, 4 | +25°C | - | ± 1 | V |
| P Threshold Voltage | VPTH | VSS = 0V, IDD = 10 μ A | 1, 4 | +25°C | 0.2 | 2.8 | V |
| P Threshold Voltage Delta | ΔV_{PTH} | VSS = 0V, IDD = 10 μ A | 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 | $\pm 0.2\mu$ A |
| Output Current (Sink) | IOL5 | $\pm 20\%$ x Pre-Test Reading |
| Output Current (Source) | IOH5A | $\pm 20\%$ 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 | 1, 2, 3, 7, 8A, 8B, 9, 10, 11, Deltas | Subgroups 1, 2, 3, 9, 10, 11 |
| | Subgroup B-6 | 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 |

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TABLE 8. BURN-IN AND IRRADIATION TEST CONNECTIONS

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

NOTE:

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

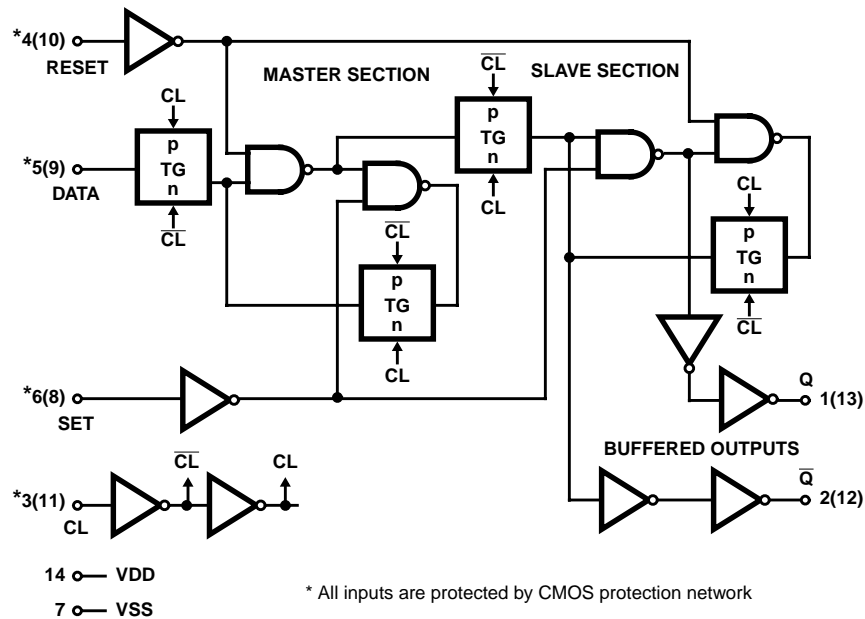


FIGURE 1. ONE OF TWO IDENTICAL FLIP-FLOPS

TRUTH TABLE

| CL* | D | R | S | Q | Q̄ |
|-----|---|---|---|---|----|
| | 0 | 0 | 0 | 0 | 1 |
| | 1 | 0 | 0 | 1 | 0 |
| | X | 0 | 0 | Q | Q̄ |
| X | X | 1 | 0 | 0 | 1 |
| X | X | 0 | 1 | 1 | 0 |
| X | X | 1 | 1 | 1 | 1 |

No Change

Logic 0 = Low * = Level change
 Logic 1 = High X = Don't care
 N(N) = FF1/FF2 terminal assignments

Typical Performance Characteristics

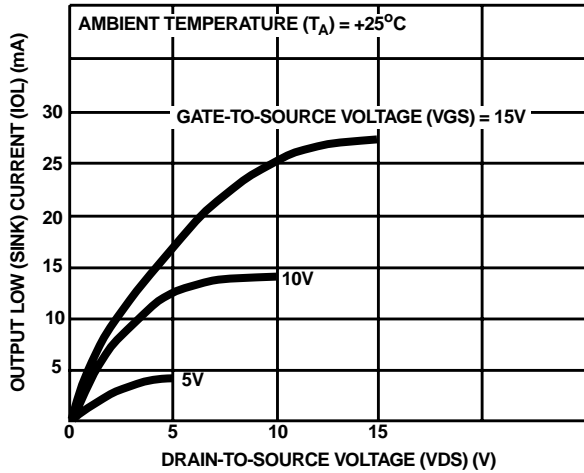


FIGURE 2. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

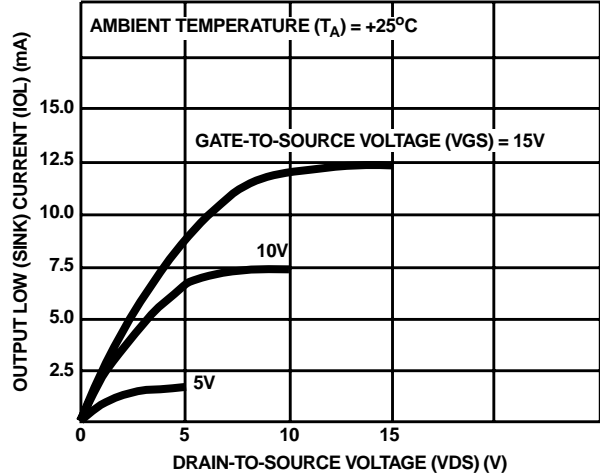


FIGURE 3. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

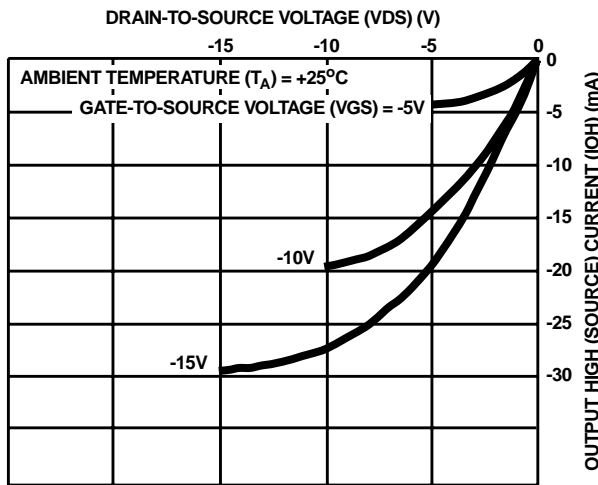


FIGURE 4. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

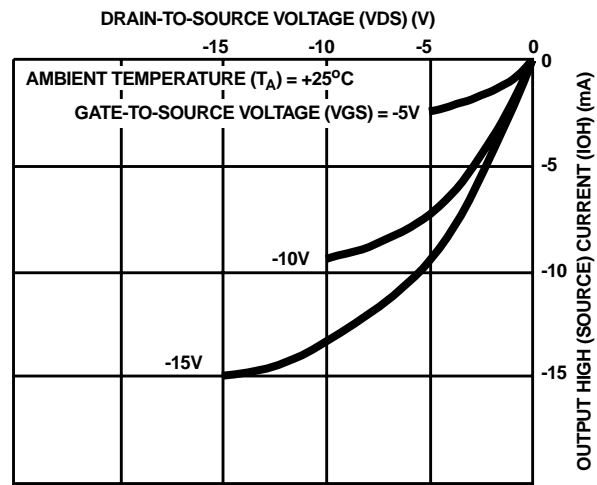


FIGURE 5. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

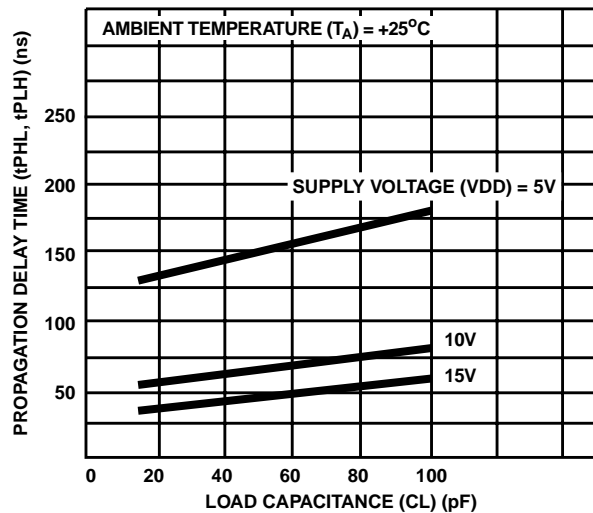


FIGURE 6. TYPICAL PROPAGATION DELAY TIME vs LOAD CAPACITANCE (CLOCK OR SET TO Q, CLOCK OR RESET TO \bar{Q})

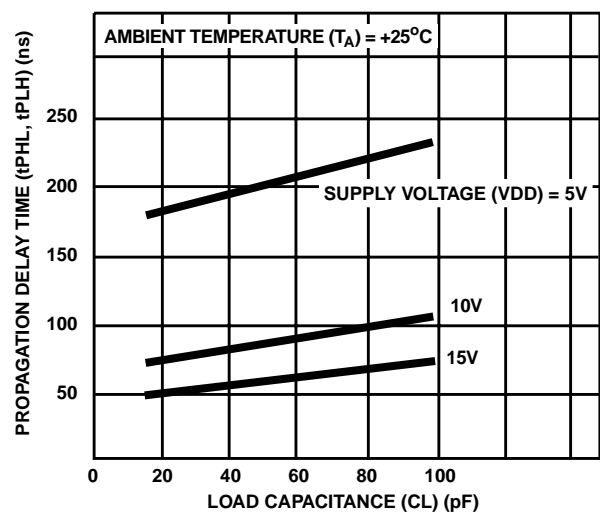


FIGURE 7. TYPICAL PROPAGATION DELAY TIME vs LOAD CAPACITANCE (SET TO \bar{Q} OR RESET TO Q)

Typical Performance Characteristics (Continued)

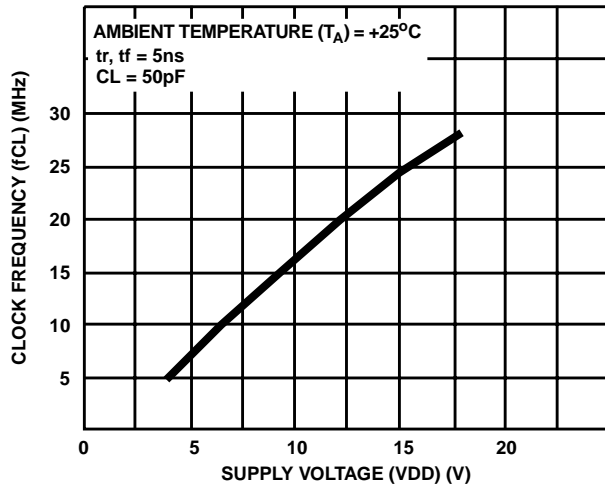


FIGURE 8. TYPICAL MAXIMUM CLOCK FREQUENCY vs SUPPLY VOLTAGE

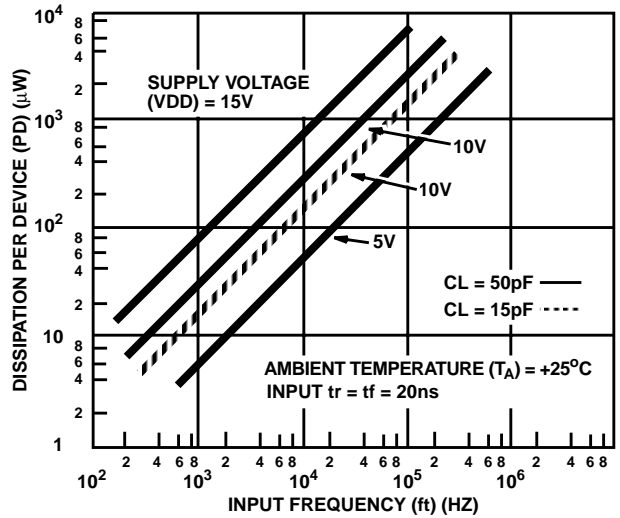
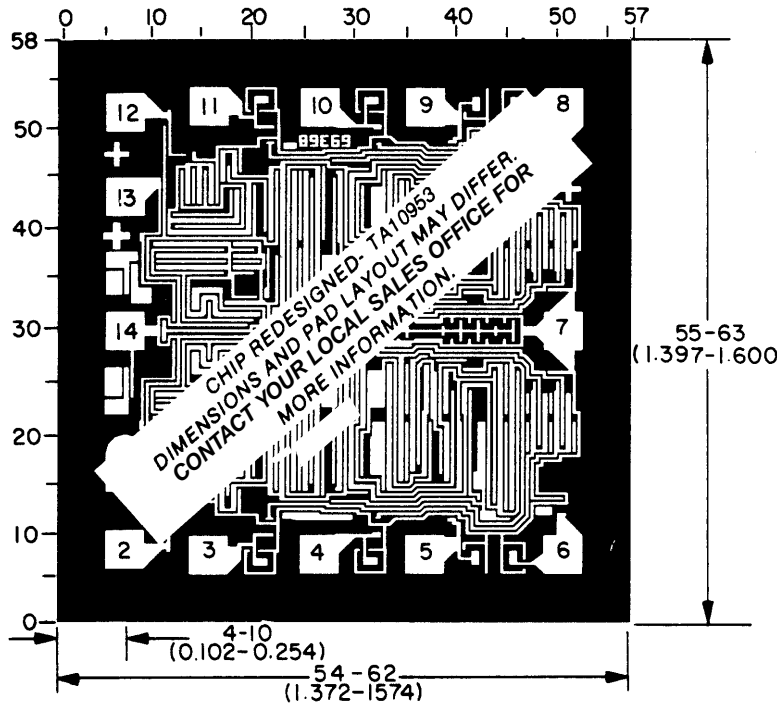


FIGURE 9. TYPICAL POWER DISSIPATION vs FREQUENCY

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: $11\text{k}\text{\AA} - 14\text{k}\text{\AA}$, 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