# intersil

## CMOS Hex Buffer/Converter

The CD4049UBMS is an inverting hex buffer and features logic level conversion using only one supply (voltage (VCC). The input signal high level (VIH) can exceed the VCC supply voltage when this device is used for logic level conversions. This device is intended for use as CMOS to DTL/TTL converters and can drive directly two DTL/TTL loads. (VCC = 5V, VOL ≤ 0.4V, and IOL ≥ 3.3mA.

The CD4049UBMS is designated as replacement for CD4009UB. Because the CD4049UBMS requires only one power supply, it is preferred over the CD4009UB and CD4010B and should be used in place of the CD4009UB in all inverter, current driver, or logic level conversion applications. In these applications the CD4049UBMS is pin compatible with the CD4009UB, and can be substituted for this device in existing as well as in new designs. Terminal No. 16 is not connected internally on the CD4049UBMS, therefore, connection to this terminal is of no consequence to circuit operation. For applications not requiring high sink current or voltage conversion, the CD4069UB Hex Inverter is recommended.

The CD4049UBMS is supplied in these 16 lead outline packages:

| | |
|---|---|
| Braze Seal DIP | H4S |
| Frit Seal DIP | H1E |
| Ceramic Flatpack | H3X |

## Features

- **High Voltage Type (20V Rating)**
- **Inverting Type**
- **High Sink Current for Driving 2 TTL Loads**
- **High-to-Low Level Logic Conversion**
- **100% Tested for Quiescent Current at 20V**
- **Maximum Input Current of 1µA at 18V Over Full Package Temperature Range; 100nA at 18V and +25$^O$C**
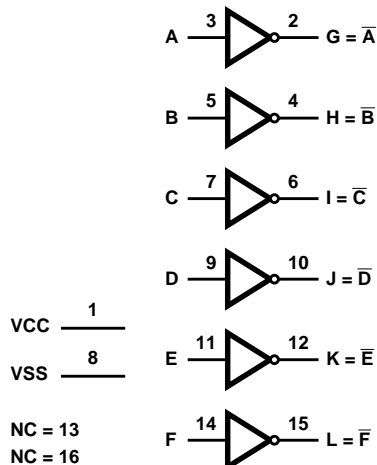- **5V, 10V and 15V Parametric Ratings**

## Applications

- **CMOS to DTL/TTL Hex Converter**
- **CMOS Current "Sink" or "Source" Driver**
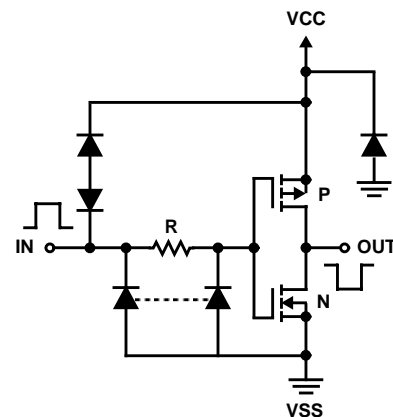- **CMOS High-to-Low Logic Level Converter**

## Pinout

**CD4049UBMS**
TOP VIEW
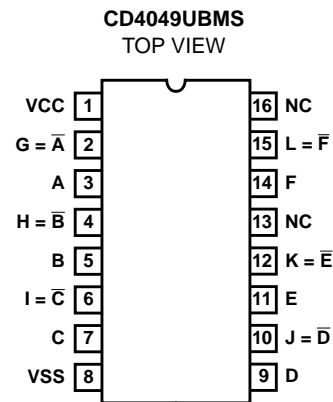


## Functional Diagram



## Schematic



**FIGURE 1. SCHEMATIC DIAGRAM, 1 OF 6 IDENTICAL UNITS**

## 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$^o$C to +125$^o$C
  Package Types D, F, K, H
Storage Temperature Range (TSTG). . . . . . . . . . . -65$^o$C to +150$^o$C
Lead Temperature (During Soldering) . . . . . . . . . . . . . . . . +265$^o$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$^o$C/W   20$^o$C/W
  Flatpack Package. . . . . . . . . . . . . . .  70$^o$C/W   20$^o$C/W
Maximum Package Power Dissipation (PD) at +125$^o$C
  For TA = -55$^o$C to +100$^o$C (Package Type D, F, K) . . . . . .500mW
  For TA = +100$^o$C to +125$^o$C (Package Type D, F, K) . . . . . Derate
                      Linearity at 12mW/$^o$C to 200mW
Device Dissipation per Output Transistor. . . . . . . . . . . . . . . .100mW
  For TA = Full Package Temperature Range (All Package Types)
Junction Temperature . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .+175$^o$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$^o$C | - | 2 | µA |
| | | | | 2 | +125$^o$C | - | 200 | µA |
| | | VDD = 18V, VIN = VDD or GND | | 3 | -55$^o$C | - | 2 | µA |
| Input Leakage Current | IIL | VIN = VDD or GND | VDD = 20 | 1 | +25$^o$C | -100 | - | nA |
| | | | | 2 | +125$^o$C | -1000 | - | nA |
| | | | VDD = 18V | 3 | -55$^o$C | -100 | - | nA |
| Input Leakage Current | IIH | VIN = VDD or GND | VDD = 20 | 1 | +25$^o$C | - | 100 | nA |
| | | | | 2 | +125$^o$C | - | 1000 | nA |
| | | | VDD = 18V | 3 | -55$^o$C | - | 100 | nA |
| Output Voltage | VOL15 | VDD = 15V, No Load | | 1, 2, 3 | +25$^o$C, +125$^o$C, -55$^o$C | - | 50 | mV |
| Output Voltage | VOH15 | VDD = 15V, No Load (Note 3) | | 1, 2, 3 | +25$^o$C, +125$^o$C, -55$^o$C | 14.95 | - | V |
| Output Current (Sink) | IOL4 | VDD = 4.5V, VOUT = 0.4V | | 1 | +25$^o$C | 2.6 | - | mA |
| Output Current (Sink) | IOL5 | VDD = 5V, VOUT = 0.4V | | 1 | +25$^o$C | 3.2 | - | mA |
| Output Current (Sink) | IOL10 | VDD = 10V, VOUT = 0.5V | | 1 | +25$^o$C | 8.0 | - | mA |
| Output Current (Sink) | IOL15 | VDD = 15V, VOUT = 1.5V | | 1 | +25$^o$C | 24 | - | mA |
| Output Current (Source) | IOH5A | VDD = 5V, VOUT = 4.6V | | 1 | +25$^o$C | - | -0.8 | mA |
| Output Current (Source) | IOH5B | VDD = 5V, VOUT = 2.5V | | 1 | +25$^o$C | - | -3.2 | mA |
| Output Current (Source) | IOH10 | VDD = 10V, VOUT = 9.5V | | 1 | +25$^o$C | - | -1.8 | mA |
| Output Current (Source) | IOH15 | VDD = 15V, VOUT = 13.5V | | 1 | +25$^o$C | - | -6.0 | mA |
| N Threshold Voltage | VNTH | VDD = 10V, ISS = -10µA | | 1 | +25$^o$C | -2.8 | -0.7 | V |
| P Threshold Voltage | VPTH | VSS = 0V, IDD = 10µA | | 1 | +25$^o$C | 0.7 | 2.8 | V |
| Functional | F | VDD = 2.8V, VIN = VDD or GND | | 7 | +25$^o$C | VOH > VDD/2 | VOL < VDD/2 | V |
| | | VDD = 20V, VIN = VDD or GND | | 7 | +25$^o$C | | | |
| | | VDD = 18V, VIN = VDD or GND | | 8A | +125$^o$C | | | |
| | | VDD = 3V, VIN = VDD or GND | | 8B | -55$^o$C | | | |
| Input Voltage Low (Note 2) | VIL | VDD = 5V, VOH > 4.5V, VOL < 0.5V | | 1, 2, 3 | +25$^o$C, +125$^o$C, -55$^o$C | - | 1.0 | V |
| Input Voltage High (Note 2) | VIH | VDD = 5V, VOH > 4.5V, VOL < 0.5V | | 1, 2, 3 | +25$^o$C, +125$^o$C, -55$^o$C | 4.0 | - | V |
| Input Voltage Low (Note 2) | VIL | VDD = 15V, VOH > 13.5V, VOL < 1.5V | | 1, 2, 3 | +25$^o$C, +125$^o$C, -55$^o$C | - | 2.5 | V |
| Input Voltage High (Note 2) | VIH | VDD = 15V, VOH > 13.5V, VOL < 1.5V | | 1, 2, 3 | +25$^o$C, +125$^o$C, -55$^o$C | 12.5 | - | V |

NOTES: 1. All voltages referenced to device GND, 100% testing being im-
plemented.
2. Go/No Go test with limits applied to inputs.

3. For accuracy, voltage is measured differentially to VDD. Limit is
0.050V max.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

| PARAMETER | SYMBOL | CONDITIONS (NOTE 1, 2) | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Propagation Delay | TPHL | VDD = 5V, VIN = VDD or GND | 9 | +25$^o$C | - | 65 | ns |
| | | | 10, 11 | +125$^o$C, -55$^o$C | - | 88 | ns |
| Propagation Delay | TPLH | VDD = 5V, VIN = VDD or GND | 9 | +25$^o$C | - | 120 | ns |
| | | | 10, 11 | +125$^o$C, -55$^o$C | - | 162 | ns |
| Transition Time | TTHL | VDD = 5V, VIN = VDD or GND | 9 | +25$^o$C | - | 60 | ns |
| | | | 10, 11 | +125$^o$C, -55$^o$C | - | 81 | ns |
| Transition Time | TTLH | VDD = 5V, VIN = VDD or GND | 9 | +25$^o$C | - | 160 | ns |
| | | | 10, 11 | +125$^o$C, -55$^o$C | - | 216 | ns |

NOTES:

1. CL = 50pF, RL = 200K, Input TR, TF < 20ns.

2. -55$^o$C and +125$^o$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$^o$C, +25$^o$C | - | 1 | µA |
| | | | | +125$^o$C | - | 30 | µA |
| | | VDD = 10V, VIN = VDD or GND | 1, 2 | -55$^o$C, +25$^o$C | - | 2 | µA |
| | | | | +125$^o$C | - | 60 | µA |
| | | VDD = 15V, VIN = VDD or GND | 1, 2 | -55$^o$C, +25$^o$C | - | 2 | µA |
| | | | | +125$^o$C | - | 120 | µA |
| Output Voltage | VOL | VDD = 5V, No Load | 1, 2 | +25$^o$C, +125$^o$C, -55$^o$C | - | 50 | mV |
| Output Voltage | VOL | VDD = 10V, No Load | 1, 2 | +25$^o$C, +125$^o$C, -55$^o$C | - | 50 | mV |
| Output Voltage | VOH | VDD = 5V, No Load | 1, 2 | +25$^o$C, +125$^o$C, -55$^o$C | 4.95 | - | V |
| Output Voltage | VOH | VDD = 10V, No Load | 1, 2 | +25$^o$C, +125$^o$C, -55$^o$C | 9.95 | - | V |
| Output Current (Sink) | IOL4 | VDD = 4.5V, VOUT = 0.4V | 1, 2 | +125$^o$C | 1.8 | - | mA |
| | | | | -55$^o$C | 3.3 | - | mA |
| Output Current (Sink) | IOL5 | VDD = 5V, VOUT = 0.4V | 1, 2 | +125$^o$C | 2.4 | - | mA |
| | | | | -55$^o$C | 4.0 | - | mA |
| Output Current (Sink) | IOL10 | VDD = 10V, VOUT = 0.5V | 1, 2 | +125$^o$C | 5.6 | - | mA |
| | | | | -55$^o$C | 10 | - | mA |
| Output Current (Sink) | IOL15 | VDD = 15V, VOUT = 1.5V | 1, 2 | +125$^o$C | 18 | - | mA |
| | | | | -55$^o$C | 26 | - | mA |
| Output Current (Source) | IOH5A | VDD = 5V, VOUT = 4.6V | 1, 2 | +125$^o$C | - | -0.48 | mA |
| | | | | -55$^o$C | - | -0.81 | mA |
| Output Current (Source) | IOH5B | VDD = 5V, VOUT = 2.5V | 1, 2 | +125$^o$C | - | -1.55 | mA |
| | | | | -55$^o$C | - | -2.6 | mA |
| Output Current (Source) | IOH10 | VDD = 10V, VOUT = 9.5V | 1, 2 | +125$^o$C | - | -1.18 | mA |
| | | | | -55$^o$C | - | -2.0 | mA |
| Output Current (Source) | IOH15 | VDD =15V, VOUT = 13.5V | 1, 2 | +125$^o$C | - | -3.1 | mA |
| | | | | -55$^o$C | - | -5.2 | mA |
| Input Voltage Low | VIL | VDD = 10V, VOH > 9V, VOL < 1V | 1, 2 | +25$^o$C, +125$^o$C, -55$^o$C | - | 2 | V |
| Input Voltage High | VIH | VDD = 10V, VOH > 9V, VOL < 1V | 1, 2 | +25$^o$C, +125$^o$C, -55$^o$C | 8 | - | V |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

| PARAMETER | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Propagation Delay | TPHL | VIN = 10V, VDD = 5V | 1, 2, 3 | +25$^o$C | - | 30 | ns |
| | | VIN = 10V, VDD = 10V | 1, 2, 3 | +25$^o$C | - | 40 | ns |
| Propagation Delay | TPLH | VIN = 10V, VDD = 5V | 1, 2, 3 | +25$^o$C | - | 90 | ns |
| | | VIN = 10V, VDD = 10V | 1, 2, 3 | +25$^o$C | - | 65 | ns |
| Propagation Delay | TPHL | VIN = 15V, VDD = 5V | 1, 2, 3 | +25$^o$C | - | 20 | ns |
| | | VIN = 15V, VDD = 15V | 1, 2, 3 | +25$^o$C | - | 30 | ns |
| Propagation Delay | TPLH | VIN = 15V, VDD = 5V | 1, 2, 3 | +25$^o$C | - | 90 | ns |
| | | VIN = 15V, VDD = 15V | 1, 2, 3 | +25$^o$C | - | 50 | ns |
| Transition Time | TTHL | VDD = 10V, VIN = VDD OR GND | 1, 2, 3 | +25$^o$C | - | 40 | ns |
| | | VDD = 15V, VIN = VDD OR GND | 1, 2, 3 | +25$^o$C | - | 30 | ns |
| Transition Time | TTLH | VDD = 10V, VIN = VDD OR GND | 1, 2, 3 | +25$^o$C | - | 80 | ns |
| | | VDD = 15V, VIN = VDD OR GND | 1, 2, 3 | +25$^o$C | - | 60 | ns |
| Input Capacitance | CIN | Any Input | 1, 2 | +25$^o$C | - | 22.5 | 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 MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Supply Current | IDD | VDD = 20V, VIN = VDD or GND | 1, 4 | +25$^o$C | - | 7.5 | μA |
| N Threshold Voltage | VNTH | VDD = 10V, ISS = -10μA | 1, 4 | +25$^o$C | -2.8 | -0.2 | V |
| N Threshold Voltage Delta | ΔVTND | VDD = 10V, ISS = -10μA | 1, 4 | +25$^o$C | - | ±1 | V |
| P Threshold Voltage | VTP | VSS = 0V, IDD = 10μA | 1, 4 | +25$^o$C | 0.2 | 2.8 | V |
| P Threshold Voltage Delta | ΔVTPD | VSS = 0V, IDD = 10μA | 1, 4 | +25$^o$C | - | ±1 | V |
| Functional | F | VDD = 18V, VIN = VDD or GND | 1 | +25$^o$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$^o$C | - | 1.35 x +25$^o$C Limit | ns |

NOTES:  1. All voltages referenced to device GND.    3. See Table 2 for +25$^o$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$^O$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 |

# CD4049UBMS

### TABLE 6. APPLICABLE SUBGROUPS

| CONFORMANCE GROUP | | MIL-STD-883 METHOD | GROUP A SUBGROUPS | READ AND RECORD |
|---|---|---|---|---|
| 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) | 2, 4, 6, 10, 12, 13, 15 | 3, 5, 7-9, 11-14 | 1, 16 | | | |
| Static Burn-In 2 (Note 1) | 2, 4, 6, 10, 12, 13, 15 | 8 | 1, 3, 5, 7, 9, 11, 14, 16 | | | |
| Dynamic Burn-In (Note 3) | 13 | 8 | 1, 16 | 2, 4, 6, 10, 12, 15 | 3, 5, 7, 9, 11, 14 | |
| Irradiation (Note 2) | 2, 4, 6, 10, 12, 13, 15, 16 | 8 | 1, 3, 5, 7, 9, 11, 14 | | | |

NOTE:

1. Each pin except pin 1, pin 16, and GND will have a series resistor of 10K ± 5%, VDD = 18V ± 0.5V

2. Each pin except pin 1, pin 16, 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

3. Each pin except pin 1, pin 16, and GND will have a series resistor of 4.75K ± 5%, VDD = 18V ± 0.5V

## *Typical Performance Characteristics*
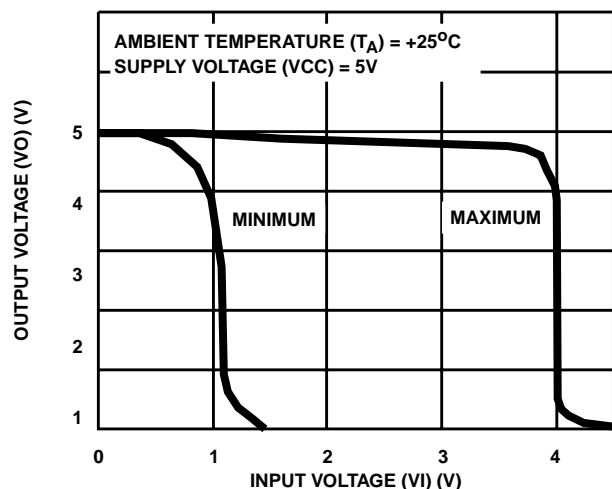


FIGURE 2. MINIMUM AND MAXIMUM VOLTAGE TRANSFER CHARACTERISTICS
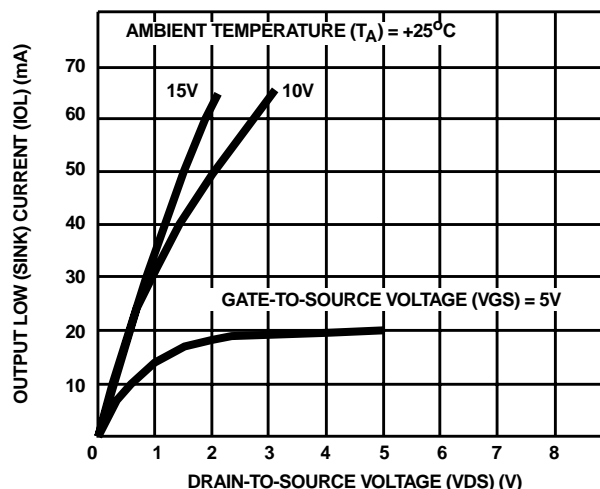


FIGURE 3. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

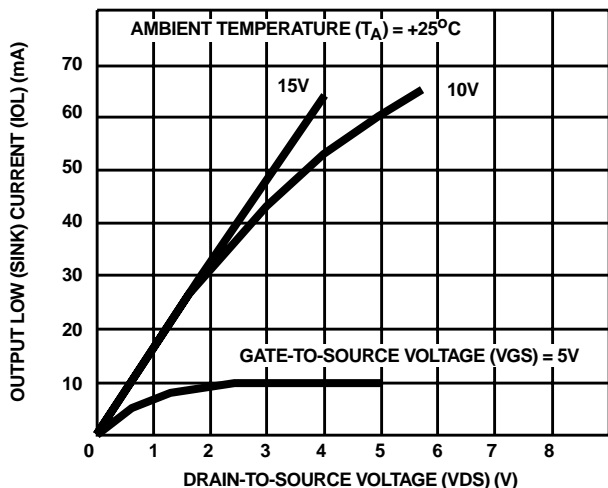## *Typical Performance Characteristics* (Continued)

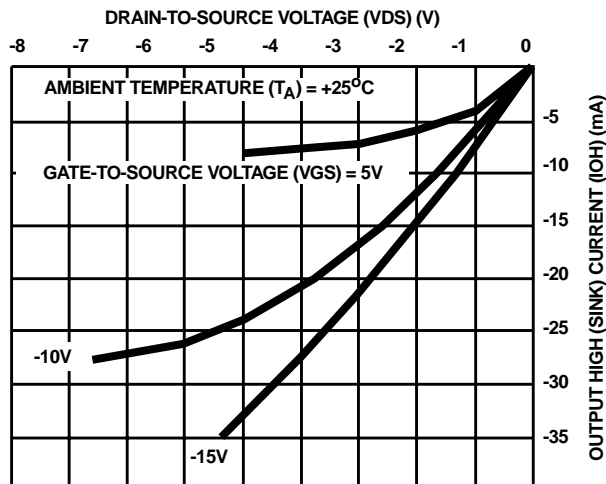**FIGURE 4. MINIMUM OUTPUT LOW (SINK) CURRENT DRAIN CHARACTERISTICS**

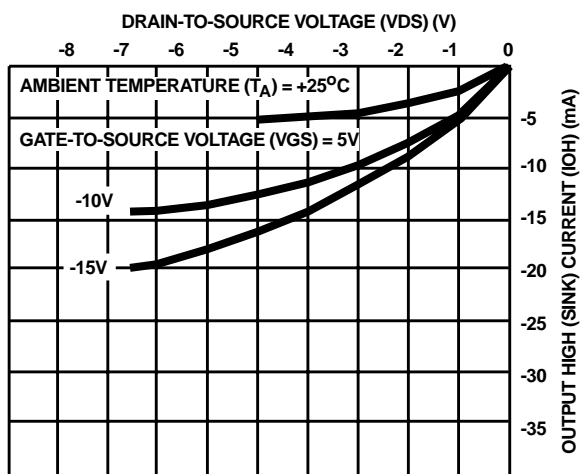**FIGURE 5. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS**
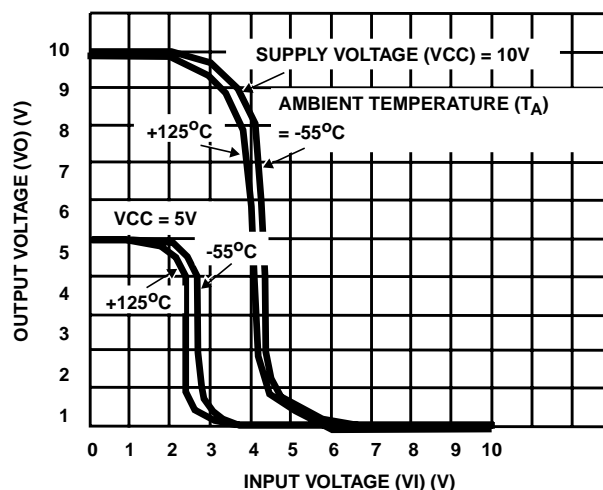
**FIGURE 6. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS**

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

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## *Typical Performance Characteristics* (Continued)
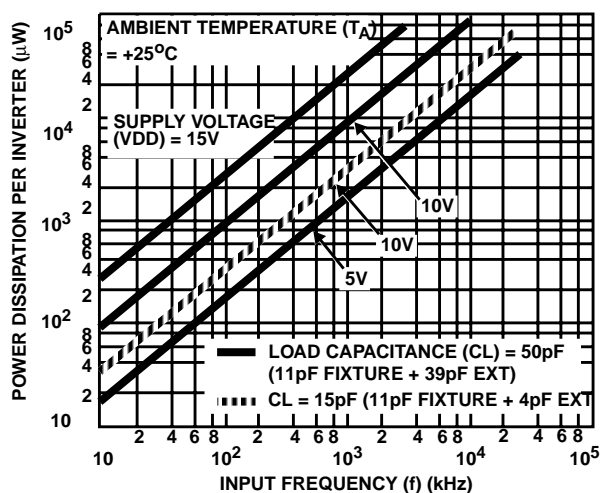


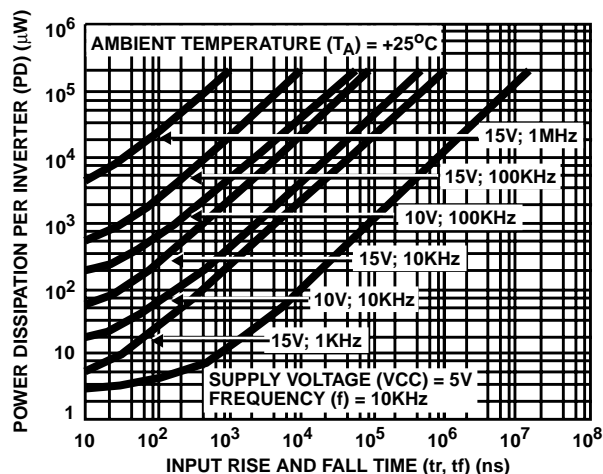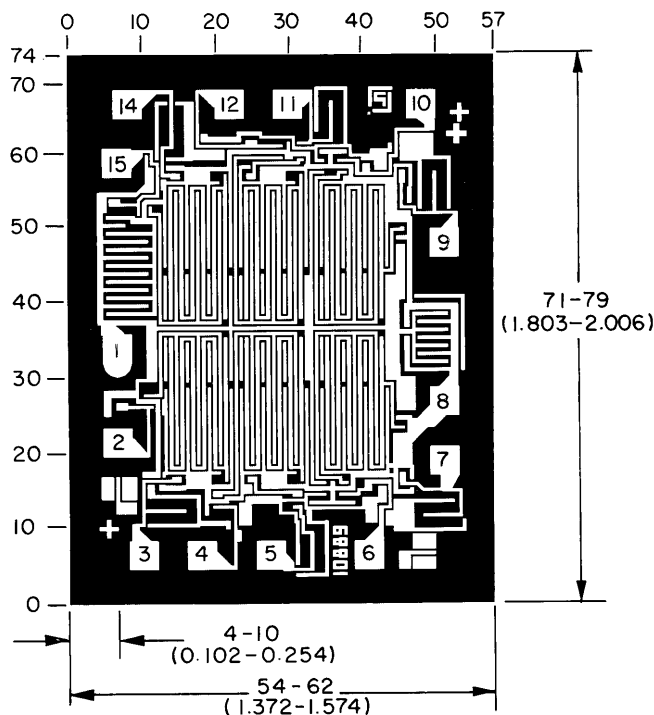**FIGURE 8. TYPICAL POWER DISSIPATION vs FREQUENCY CHARACTERISTICS**



**FIGURE 9. TYPICAL POWER DISSIPATION vs INPUT RISE AND FALL TIMES PER INVERTER**

## *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: 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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