

CMOS Hex Buffer/Converters

The Harris CD4049UB and CD4050B are inverting and non-inverting hex buffers, respectively, and feature logic-level conversion using only one supply voltage (V_{CC}). The input-signal high level (V_{IH}) can exceed the V_{CC} supply voltage when these devices are used for logic-level conversions. These devices are intended for use as CMOS to DTL/TTL converters and can drive directly two DTL/TTL loads. ($V_{CC} = 5V$, $V_{OL} \leq 0.4V$, and $I_{OL} \geq 3.3mA$.)

The CD4049UB and CD4050B are designated as replacements for CD4009UB and CD4010B, respectively. Because the CD4049UB and CD4050B require only one power supply, they are preferred over the CD4009UB and CD4010B and should be used in place of the CD4009UB and CD4010B in all inverter, current driver, or logic-level conversion applications. In these applications the CD4049UB and CD4050B are pin compatible with the CD4009UB and CD4010B respectively, and can be substituted for these devices in existing as well as in new designs. Terminal No. 16 is not connected internally on the CD4049UB or CD4050B, 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.

Features

- CD4049UB Inverting
- CD4050B Non-Inverting
- 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 $1\mu A$ at 18V Over Full Package Temperature Range; 100nA at 18V and 25°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

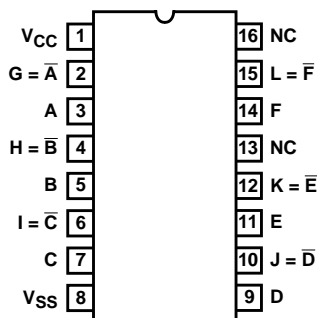
Ordering Information

| PART NUMBER | TEMP. RANGE (°C) | PACKAGE | PKG. NO. |
|-------------|------------------|--------------|----------|
| CD4049UBE | -55 to 125 | 16 Ld PDIP | E16.3 |
| CD4050BE | -55 to 125 | 16 Ld PDIP | E16.3 |
| CD4049UBF | -55 to 125 | 16 Ld Cerdip | F16.3 |
| CD4050BF | -55 to 125 | 16 Ld Cerdip | F16.3 |
| CD4050BM | -55 to 125 | 16 Ld SOIC | M16.3 |

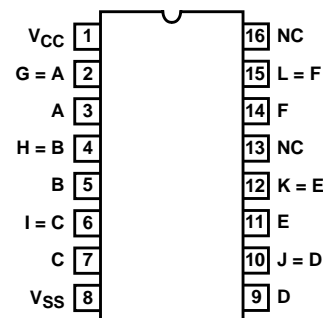
NOTE: Wafer and die for this part number is available which meets all electrical specifications. Please contact your local sales office or Harris customer service for ordering information.

Pinouts

CD4049UB (PDIP, Cerdip)
TOP VIEW

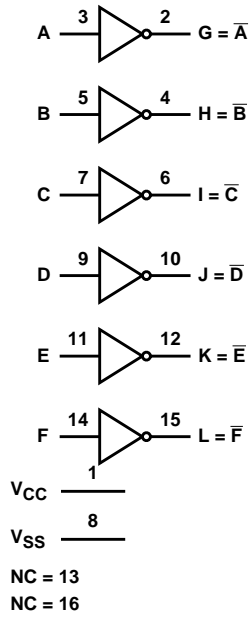


CD4050B (PDIP, Cerdip, SOIC)
TOP VIEW

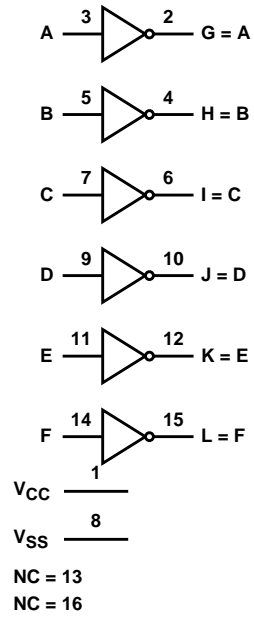


Functional Block Diagrams

CD4049UB



CD4050B



Schematic Diagrams

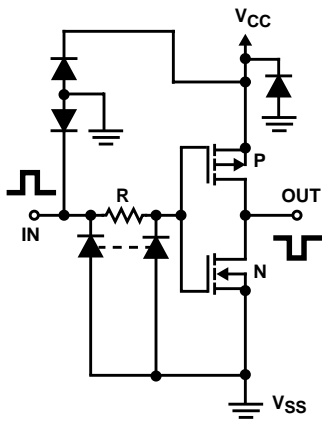


FIGURE 1A. SCHEMATIC DIAGRAM OF CD4049UB, 1 OF 6 IDENTICAL UNITS

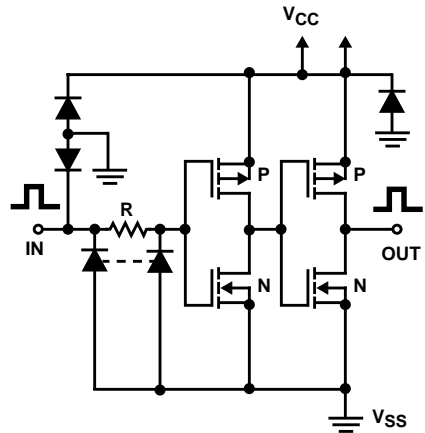


FIGURE 1B. SCHEMATIC DIAGRAM OF CD4050B, 1 OF 6 IDENTICAL UNITS

CD4049UB, CD4050B

Absolute Maximum Ratings

| | |
|--------------------------------------|--------------------------------|
| Supply Voltage (V+ to V-)..... | -0.5V to 20V |
| DC Input Voltage | -0.5V to V _{DD} +0.5V |
| DC Input Current, Any One Input..... | ±10mA |

Operating Conditions

| | |
|-------------------------|----------------|
| Temperature Range | -55°C to 125°C |
|-------------------------|----------------|

Thermal Information

| | | |
|--|----------------------|----------------------|
| Thermal Resistance (Typical, Note 1) | θ_{JA} (°C/W) | θ_{JC} (°C/W) |
| PDIP Package | 90 | N/A |
| CERDIP Package..... | 130 | 55 |
| SOIC Package | 100 | N/A |
| Maximum Junction Temperature (Plastic Package) | 150°C | |
| Maximum Storage Temperature Range..... | -65°C to 150°C | |
| Maximum Lead Temperature (Soldering 10s) | 265°C | |
| (SOIC - Lead Tips Only) | | |

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

1. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

DC Electrical Specifications

| PARAMETER | TEST CONDITIONS | | | LIMITS AT INDICATED TEMPERATURE (°C) | | | | | | | UNITS |
|---|--------------------|---------------------|---------------------|--------------------------------------|-------|-------|-------|-------|------|------|-------|
| | | | | 25 | | | | | | | |
| | V _O (V) | V _{IN} (V) | V _{CC} (V) | -55 | -40 | 85 | 125 | MIN | TYP | MAX | |
| Quiescent Device Current I _{DD} (Max) | - | 0,5 | 5 | 1 | 1 | 30 | 30 | - | 0.02 | 1 | µA |
| | - | 0,10 | 10 | 2 | 2 | 60 | 60 | - | 0.02 | 2 | µA |
| | - | 0,15 | 15 | 4 | 4 | 120 | 120 | - | 0.02 | 4 | µA |
| | - | 0,20 | 20 | 20 | 20 | 600 | 600 | - | 0.04 | 20 | µA |
| Output Low (Sink) Current I _{OL} (Min) | 0.4 | 0,5 | 4.5 | 3.3 | 3.1 | 2.1 | 1.8 | 2.6 | 5.2 | - | mA |
| | 0.4 | 0,5 | 5 | 4 | 3.8 | 2.9 | 2.4 | 3.2 | 6.4 | - | mA |
| | 0.5 | 0,10 | 10 | 10 | 9.6 | 6.6 | 5.6 | 8 | 16 | - | mA |
| | 1.5 | 0,15 | 15 | 26 | 25 | 20 | 18 | 24 | 48 | - | mA |
| Output High (Source) Current I _{OH} (Min) | 4.6 | 0,5 | 5 | -0.81 | -0.73 | -0.58 | -0.48 | -0.65 | -1.2 | - | mA |
| | 2.5 | 0,5 | 5 | -2.6 | -2.4 | -1.9 | -1.55 | -2.1 | -3.9 | - | mA |
| | 9.5 | 0,10 | 10 | -2.0 | -1.8 | -1.35 | -1.18 | -1.65 | -3.0 | - | mA |
| | 13.5 | 0,15 | 15 | -5.2 | -4.8 | -3.5 | -3.1 | -4.3 | -8.0 | - | mA |
| Out Voltage Low Level V _{OL} (Max) | - | 0,5 | 5 | 0.05 | 0.05 | 0.05 | 0.05 | - | 0 | 0.05 | V |
| | - | 0,10 | 10 | 0.05 | 0.05 | 0.05 | 0.05 | - | 0 | 0.05 | V |
| | - | 0,15 | 5 | 0.05 | 0.05 | 0.05 | 0.05 | - | 0 | 0.05 | V |
| Output Voltage High Level V _{OH} (Min) | - | 0,5 | 5 | 4.95 | 4.95 | 4.95 | 4.95 | 4.95 | 5 | - | V |
| | - | 0,10 | 10 | 9.95 | 9.95 | 9.95 | 9.95 | 9.95 | 10 | - | V |
| | - | 0,15 | 15 | 14.95 | 14.95 | 14.95 | 14.95 | 14.95 | 15 | - | V |
| Input Low Voltage, V _{IL} (Max) CD4049UB | 4.5 | - | 5 | 1 | 1 | 1 | 1 | - | - | 1 | V |
| | 9 | - | 10 | 2 | 2 | 2 | 2 | - | - | 2 | V |
| | 13.5 | - | 15 | 2.5 | 2.5 | 2.5 | 2.5 | - | - | 2.5 | V |
| Input Low Voltage, V _{IL} (Max) CD4050B | 0.5 | - | 5 | 1.5 | 1.5 | 1.5 | 1.5 | - | - | 1.5 | V |
| | 1 | - | 10 | 3 | 3 | 3 | 3 | - | - | 3 | V |
| | 1.5 | - | 15 | 4 | 4 | 4 | 4 | - | - | 4 | V |
| Input High Voltage, V _{IH} Min CD4049UB | 0.5 | - | 5 | 4 | 4 | 4 | 4 | 4 | - | - | V |
| | 1 | - | 10 | 8 | 8 | 8 | 8 | 8 | - | - | V |
| | 1.5 | - | 15 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | - | - | V |

CD4049UB, CD4050B

DC Electrical Specifications (Continued)

| PARAMETER | TEST CONDITIONS | | | LIMITS AT INDICATED TEMPERATURE (°C) | | | | | | | UNITS |
|--|--------------------|---------------------|---------------------|--------------------------------------|------|-----|-----|-----|-------------------|------|-------|
| | | | | 25 | | | | | | | |
| | V _O (V) | V _{IN} (V) | V _{CC} (V) | -55 | -40 | 85 | 125 | MIN | TYP | MAX | |
| Input High Voltage, V _{IH} Min CD4050B | 4.5 | - | 5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | - | - | V |
| | 9 | - | 10 | 7 | 7 | 7 | 7 | 7 | - | - | V |
| | 13.5 | - | 15 | 11 | 11 | 11 | 11 | 11 | - | - | V |
| Input Current, I _{IN} Max | - | 0,18 | 18 | ±0.1 | ±0.1 | ±1 | ±1 | - | ±10 ⁻⁵ | ±0.1 | μA |

AC Electrical Specifications T_A = 25°C, Input t_r, t_f = 20ns, C_L = 50pF, R_L = 200kΩ

| PARAMETER | TEST CONDITIONS | | LIMITS (ALL PACKAGES) | | UNITS |
|---|-----------------|-----------------|-----------------------|------|-------|
| | V _{IN} | V _{CC} | TYP | MAX | |
| Propagation Delay Time Low to High, t _{PLH} CD4049UB | 5 | 5 | 60 | 120 | ns |
| | 10 | 10 | 32 | 65 | ns |
| | 10 | 5 | 45 | 90 | ns |
| | 15 | 15 | 25 | 50 | ns |
| | 15 | 5 | 45 | 90 | ns |
| Propagation Delay Time Low to High, t _{PLH} CD4050B | 5 | 5 | 70 | 140 | ns |
| | 10 | 10 | 40 | 80 | ns |
| | 10 | 5 | 45 | 90 | ns |
| | 15 | 15 | 30 | 60 | ns |
| | 15 | 5 | 40 | 80 | ns |
| Propagation Delay Time High to Low, t _{PHL} CD4049UB | 5 | 5 | 32 | 65 | ns |
| | 10 | 10 | 20 | 40 | ns |
| | 10 | 5 | 15 | 30 | ns |
| | 15 | 15 | 15 | 30 | ns |
| | 15 | 5 | 10 | 20 | ns |
| Propagation Delay Time High to Low, t _{PHL} CD4050B | 5 | 5 | 55 | 110 | ns |
| | 10 | 10 | 22 | 55 | ns |
| | 10 | 5 | 50 | 100 | ns |
| | 15 | 15 | 15 | 30 | ns |
| | 15 | 5 | 50 | 100 | ns |
| Transition Time, Low to High, t _{TLH} | 5 | 5 | 80 | 160 | ns |
| | 10 | 10 | 40 | 80 | ns |
| | 15 | 15 | 30 | 60 | ns |
| Transition Time, High to Low, t _{THL} | 5 | 5 | 30 | 60 | ns |
| | 10 | 10 | 20 | 40 | ns |
| | 15 | 15 | 15 | 30 | ns |
| Input Capacitance, C _{IN} CD4049UB | - | - | 15 | 22.5 | pF |
| Input Capacitance, C _{IN} CD4050B | - | - | 5 | 7.5 | pF |

Typical Performance Curves

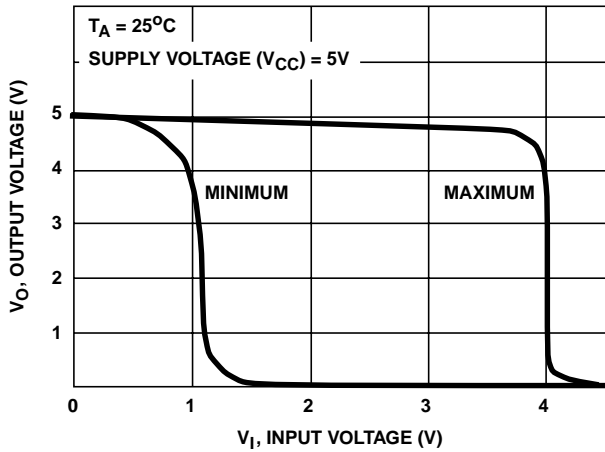


FIGURE 2. MINIMUM AND MAXIMUM VOLTAGE TRANSFER CHARACTERISTICS FOR CD4049UB

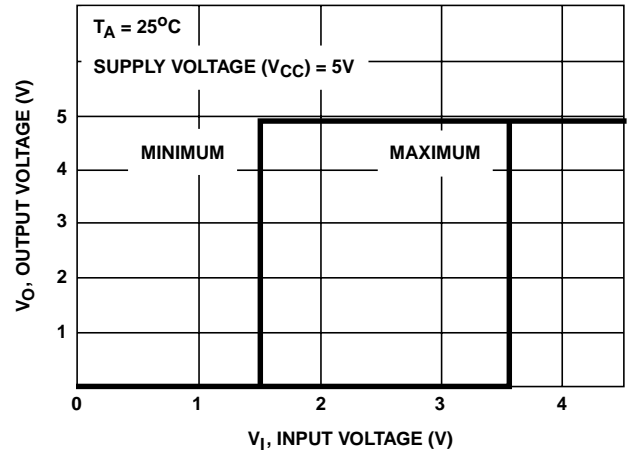


FIGURE 3. MINIMUM AND MAXIMUM VOLTAGE TRANSFER CHARACTERISTICS FOR CD4050B

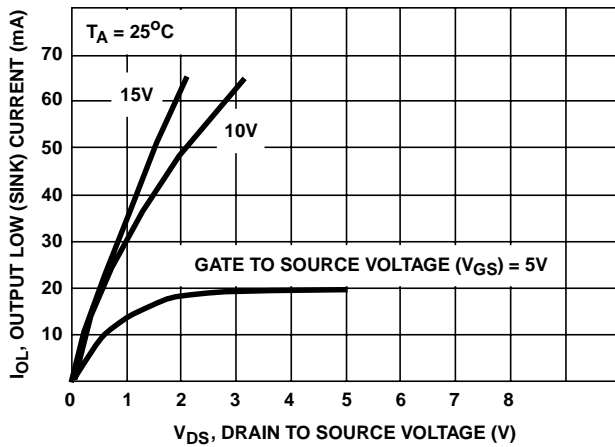


FIGURE 4. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

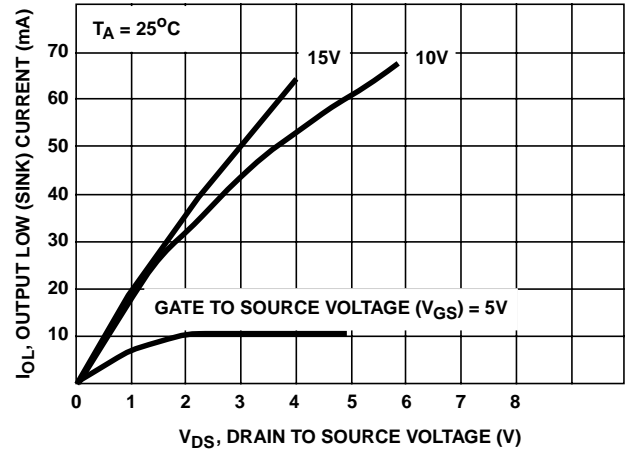


FIGURE 5. MINIMUM OUTPUT LOW (SINK) CURRENT DRAIN CHARACTERISTICS

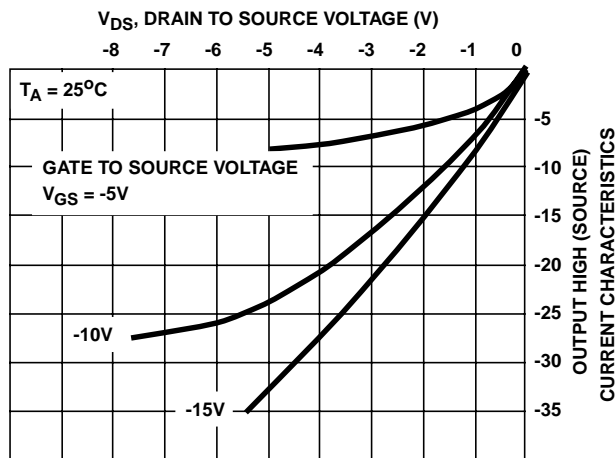


FIGURE 6. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

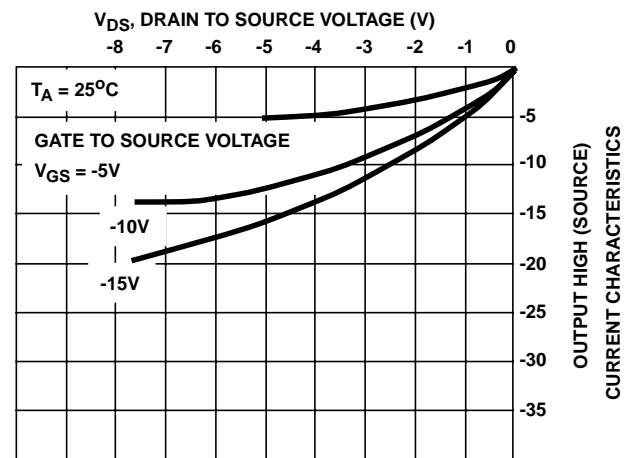


FIGURE 7. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

Typical Performance Curves (Continued)

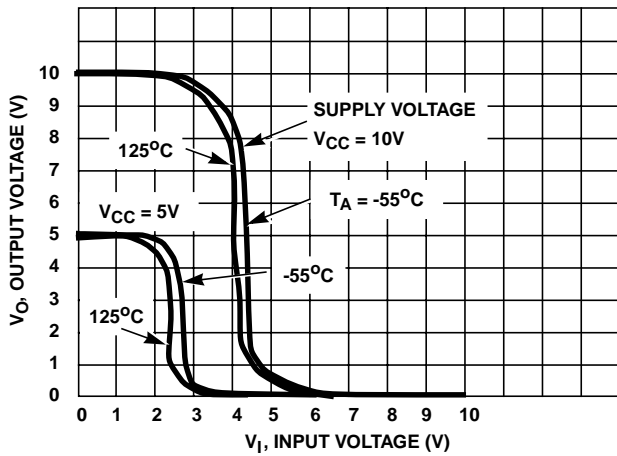


FIGURE 8. TYPICAL VOLTAGE TRANSFER CHARACTERISTICS AS A FUNCTION OF TEMPERATURE FOR CD4049UB

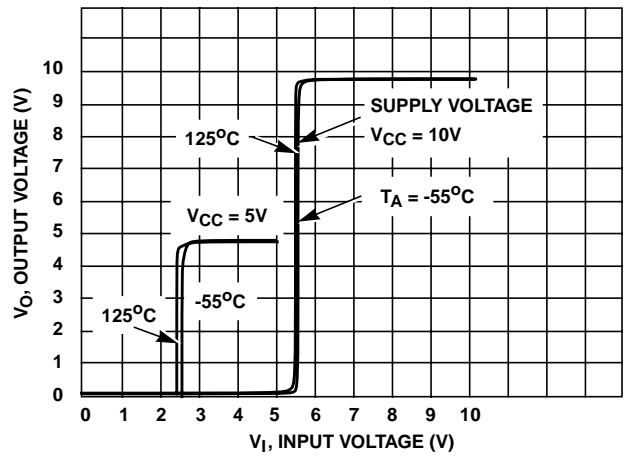


FIGURE 9. TYPICAL VOLTAGE TRANSFER CHARACTERISTICS AS A FUNCTION OF TEMPERATURE FOR CD4050B

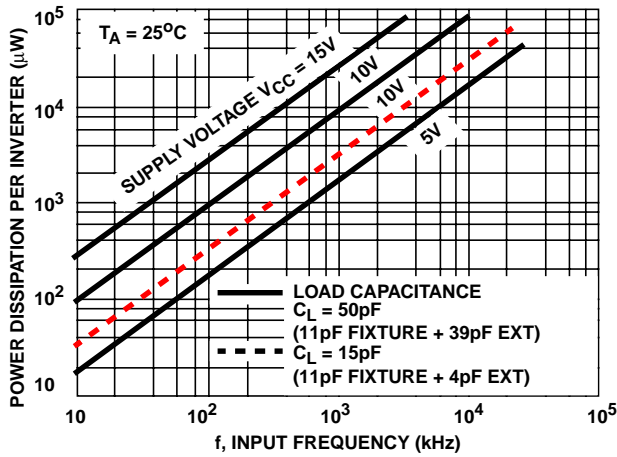


FIGURE 10. TYPICAL POWER DISSIPATION vs FREQUENCY CHARACTERISTICS

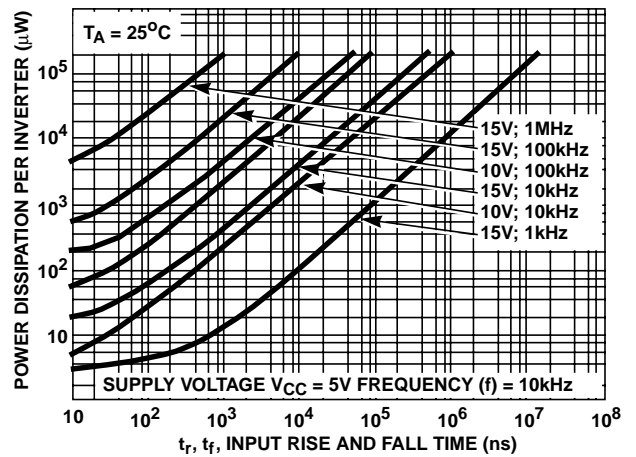


FIGURE 11. TYPICAL POWER DISSIPATION vs INPUT RISE AND FALL TIMES PER INVERTER FOR CD4049UB

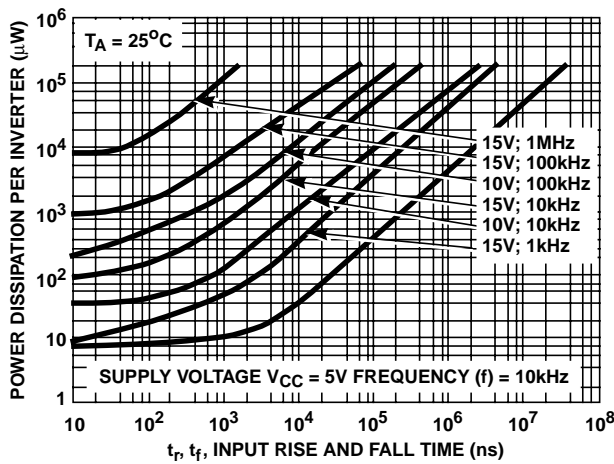


FIGURE 12. TYPICAL POWER DISSIPATION vs INPUT RISE AND FALL TIMES PER INVERTER FOR CD4050B

Test Circuits

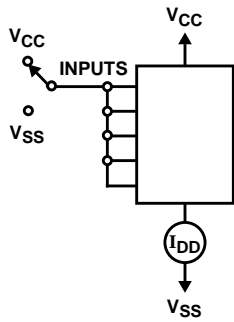
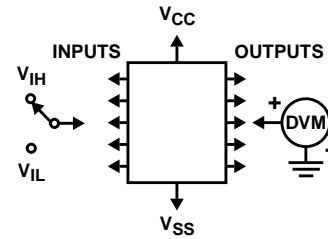
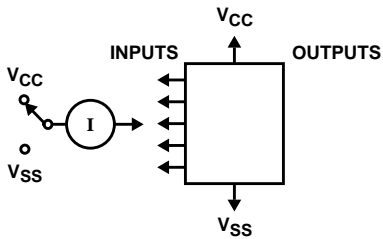


FIGURE 13. QUIESCENT DEVICE CURRENT TEST CIRCUIT

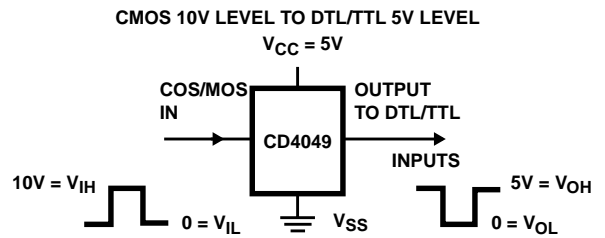


NOTE: Test any one input with other inputs at V_{CC} or V_{SS} .
FIGURE 14. INPUT VOLTAGE TEST CIRCUIT



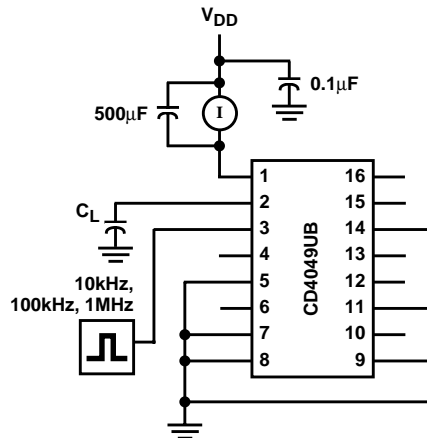
NOTE: Measure inputs sequentially, to both V_{CC} and V_{SS} connect all unused inputs to either V_{CC} or V_{SS} .

FIGURE 15. INPUT CURRENT TEST CIRCUIT



In Terminal - 3, 5, 7, 9, 11, or 14
Out Terminal - 2, 4, 6, 10, 12 or 15
 V_{CC} Terminal - 1
 V_{SS} Terminal - 8

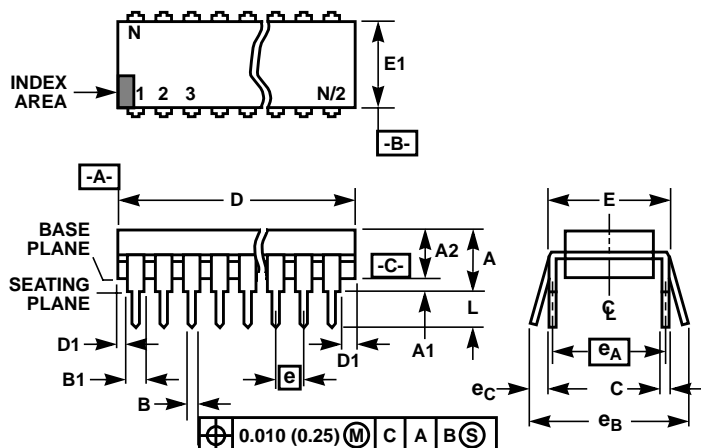
FIGURE 16. LOGIC LEVEL CONVERSION APPLICATION



C_L INCLUDES FIXTURE CAPACITANCE

FIGURE 17. DYNAMIC POWER DISSIPATION TEST CIRCUITS

Dual-In-Line Plastic Packages (PDIP)



NOTES:

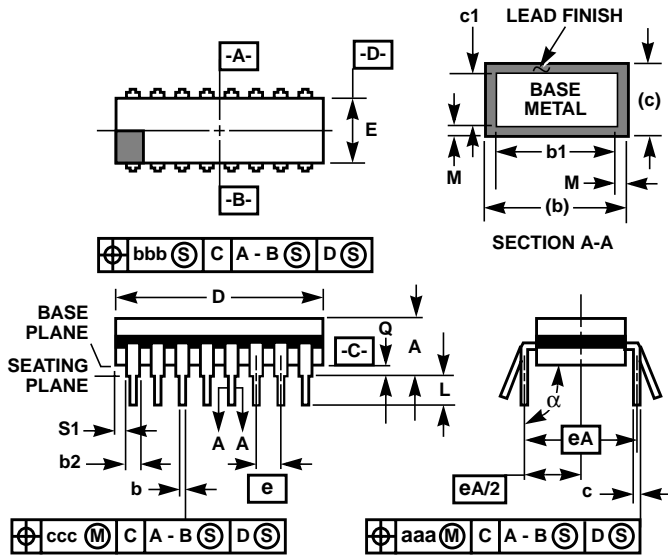
1. Controlling Dimensions: INCH. In case of conflict between English and Metric dimensions, the inch dimensions control.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication No. 95.
4. Dimensions A, A1 and L are measured with the package seated in JEDEC seating plane gauge GS-3.
5. D, D1, and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010 inch (0.25mm).
6. E and e_A are measured with the leads constrained to be perpendicular to datum [-C-].
7. e_B and e_C are measured at the lead tips with the leads unconstrained. e_C must be zero or greater.
8. B1 maximum dimensions do not include dambar protrusions. Dambar protrusions shall not exceed 0.010 inch (0.25mm).
9. N is the maximum number of terminal positions.
10. Corner leads (1, N, N/2 and N/2 + 1) for E8.3, E16.3, E18.3, E28.3, E42.6 will have a B1 dimension of 0.030 - 0.045 inch (0.76 - 1.14mm).

E16.3 (JEDEC MS-001-BB ISSUE D)
16 LEAD DUAL-IN-LINE PLASTIC PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|--------|-----------|-------|-------------|-------|-------|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.210 | - | 5.33 | 4 |
| A1 | 0.015 | - | 0.39 | - | 4 |
| A2 | 0.115 | 0.195 | 2.93 | 4.95 | - |
| B | 0.014 | 0.022 | 0.356 | 0.558 | - |
| B1 | 0.045 | 0.070 | 1.15 | 1.77 | 8, 10 |
| C | 0.008 | 0.014 | 0.204 | 0.355 | - |
| D | 0.735 | 0.775 | 18.66 | 19.68 | 5 |
| D1 | 0.005 | - | 0.13 | - | 5 |
| E | 0.300 | 0.325 | 7.62 | 8.25 | 6 |
| E1 | 0.240 | 0.280 | 6.10 | 7.11 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| e_A | 0.300 BSC | | 7.62 BSC | | 6 |
| e_B | - | 0.430 | - | 10.92 | 7 |
| L | 0.115 | 0.150 | 2.93 | 3.81 | 4 |
| N | 16 | | 16 | | 9 |

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Ceramic Dual-In-Line Frit Seal Packages (CERDIP)



NOTES:

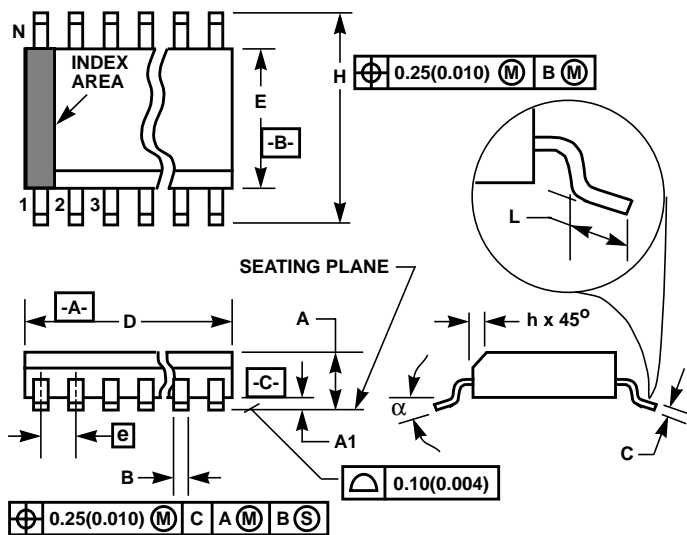
1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.

F16.3 MIL-STD-1835 GDIP1-T16 (D-2, CONFIGURATION A)
16 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|----------|-----------|--------|-------------|-------|-------|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.200 | - | 5.08 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 0.840 | - | 21.34 | 5 |
| E | 0.220 | 0.310 | 5.59 | 7.87 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.300 BSC | | 7.62 BSC | | - |
| eA/2 | 0.150 BSC | | 3.81 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.060 | 0.38 | 1.52 | 6 |
| S1 | 0.005 | - | 0.13 | - | 7 |
| α | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2, 3 |
| N | 16 | | 16 | | 8 |

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Small Outline Plastic Packages (SOIC)



M16.3 (JEDEC MS-013-AA ISSUE C)
16 LEAD WIDE BODY SMALL OUTLINE PLASTIC PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|--------|-----------|--------|-------------|-------|-------|
| | MIN | MAX | MIN | MAX | |
| A | 0.0926 | 0.1043 | 2.35 | 2.65 | - |
| A1 | 0.0040 | 0.0118 | 0.10 | 0.30 | - |
| B | 0.013 | 0.0200 | 0.33 | 0.51 | 9 |
| C | 0.0091 | 0.0125 | 0.23 | 0.32 | - |
| D | 0.3977 | 0.4133 | 10.10 | 10.50 | 3 |
| E | 0.2914 | 0.2992 | 7.40 | 7.60 | 4 |
| e | 0.050 BSC | | 1.27 BSC | | - |
| H | 0.394 | 0.419 | 10.00 | 10.65 | - |
| h | 0.010 | 0.029 | 0.25 | 0.75 | 5 |
| L | 0.016 | 0.050 | 0.40 | 1.27 | 6 |
| N | 16 | | 16 | | 7 |
| alpha | 0° | 8° | 0° | 8° | - |

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch)
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

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