

# CMOS Hex Buffers/Converters

High-Voltage Types (20-Volt Rating)

Inverting Type: CD4009UB

Non-Inverting Type: CD4010B

■ CD4009UB and CD4010B Hex Buffer/Converters may be used as CMOS to TTL or DTL logic-level converters or CMOS high-sink-current drivers.

The CD4049UB and CD4050B are preferred hex buffer replacements for the CD4009UB and CD4010B, respectively, in all applications except multiplexers. For applications not requiring high sink current or voltage conversion, the CD4069UB Hex Inverter is recommended.

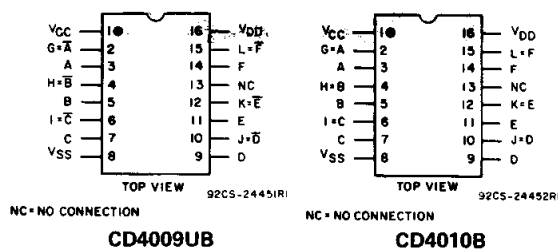
The CD4009UB and CD4010B types are supplied in 16-lead hermetic dual-in-line ceramic packages (D and F suffixes), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline package (NSR suffix), and in chip form (H suffix).

## Features:

- 100% tested for quiescent current at 20 V
- Maximum input current of 1  $\mu$ A at 18 V over full package-temperature range; 100 nA at 18 V and 25°C
- 5-V, 10-V, and 15-V parametric ratings

## Applications:

- CMOS to DTL/TTL hex converter
- CMOS current "sink" or "source" driver
- CMOS high-to-low logic-level converter
- Multiplexer — 1 to 6 or 6 to 1



## TERMINAL ASSIGNMENTS

## MAXIMUM RATINGS, Absolute-Maximum Values:

### DC SUPPLY-VOLTAGE RANGE, ( $V_{DD}$ )

Voltages referenced to  $V_{SS}$  Terminal) ..... -0.5V to +20V

INPUT VOLTAGE RANGE, ALL INPUTS ..... -0.5V to  $V_{DD}$  +0.5V

DC INPUT CURRENT, ANY ONE INPUT .....  $\pm 10$ mA

### POWER DISSIPATION PER PACKAGE ( $P_D$ ):

For  $T_A = -55^\circ\text{C}$  to  $+100^\circ\text{C}$  ..... 500mW

For  $T_A = +100^\circ\text{C}$  to  $+125^\circ\text{C}$  ..... Derate Linearly at 12mW/ $^\circ\text{C}$  to 200mW

### DEVICE DISSIPATION PER OUTPUT TRANSISTOR

FOR  $T_A = \text{FULL PACKAGE-TEMPERATURE RANGE (All Package Types)}$  ..... 100mW

OPERATING-TEMPERATURE RANGE ( $T_A$ ) .....  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$

STORAGE TEMPERATURE RANGE ( $T_{stg}$ ) .....  $-65^\circ\text{C}$  to  $+150^\circ\text{C}$

### LEAD TEMPERATURE (DURING SOLDERING):

At distance 1/16  $\pm$  1/32 inch (1.59  $\pm$  0.79mm) from case for 10s max .....  $+265^\circ\text{C}$

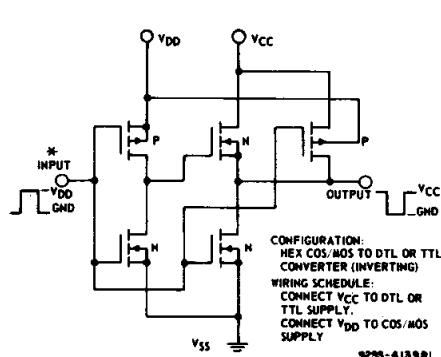


Fig. 1 – Schematic diagram of CD4009UB—  
1 of 6 identical stages.

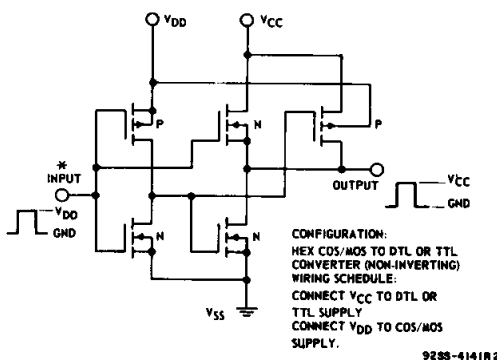
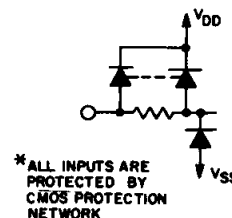
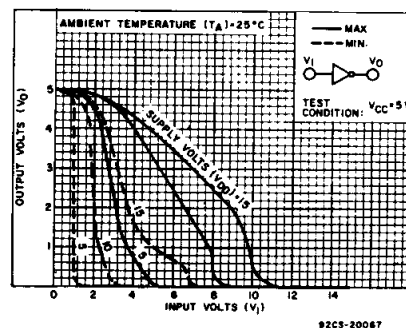
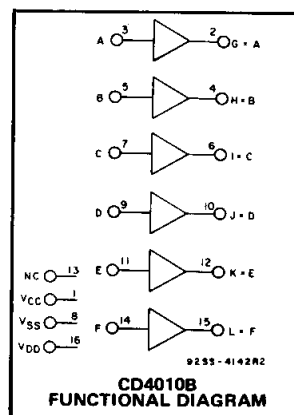
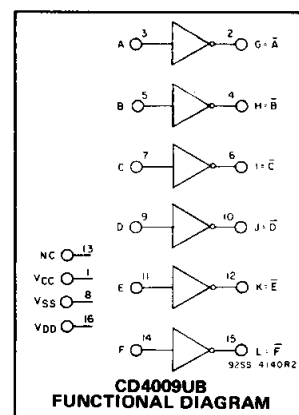


Fig. 2 – Schematic diagram of CD4010B—  
1 of 6 identical stages.



## CD4009UB, CD4010B Types

### RECOMMENDED OPERATING CONDITIONS

For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

| CHARACTERISTIC                                                              | LIMITS     |          | UNITS |
|-----------------------------------------------------------------------------|------------|----------|-------|
|                                                                             | MIN.       | MAX.     |       |
| Supply-Voltage Range (For $T_A$ = Full Package Temperature Range), $V_{DD}$ | 3          | 18       | V     |
| $V_{CC}^*$                                                                  | 3          | $V_{DD}$ | V     |
| Input Voltage Range ( $V_I$ )                                               | $V_{CC}^*$ | $V_{DD}$ | V     |

\*The CD4009UB and CD4010B have high-to-low level voltage conversion capability but not low-to-high level, therefore it is recommended that  $V_{DD} > V_I > V_{CC}$ .

### STATIC ELECTRICAL CHARACTERISTICS

| CHARAC-<br>TERISTIC                                        | CONDITIONS            |                        |                        | LIMITS AT INDICATED TEMPERATURES (°C) |       |       |       |       |                   |      | UNITS |
|------------------------------------------------------------|-----------------------|------------------------|------------------------|---------------------------------------|-------|-------|-------|-------|-------------------|------|-------|
|                                                            | V <sub>O</sub><br>(V) | V <sub>IN</sub><br>(V) | V <sub>DD</sub><br>(V) | -55                                   | -40   | +85   | +125  | +25   |                   |      |       |
|                                                            |                       |                        |                        |                                       |       |       |       | Min.  | Typ.              | Max. |       |
| Quiescent<br>Device<br>Current, I <sub>DD</sub><br>Max.    | —                     | 0,5                    | 5                      | 1                                     | 1     | 30    | 30    | —     | 0.02              | 1    | μA    |
|                                                            | —                     | 0,10                   | 10                     | 2                                     | 2     | 60    | 60    | —     | 0.02              | 2    |       |
|                                                            | —                     | 0,15                   | 15                     | 4                                     | 4     | 120   | 120   | —     | 0.02              | 4    |       |
|                                                            | —                     | 0,20                   | 20                     | 20                                    | 20    | 600   | 600   | —     | 0.04              | 20   |       |
| Output Low<br>(Sink)<br>Current<br>I <sub>OL</sub> Min.    | 0.4                   | 0,5                    | 4.5                    | 3.2                                   | 3.1   | 2.1   | 1.8   | 2.6   | 3.4               | —    | mA    |
|                                                            | 0.4                   | 0,5                    | 5                      | 3.75                                  | 3.6   | 2.4   | 2.1   | 3     | 4                 | —    |       |
|                                                            | 0.5                   | 0,10                   | 10                     | 10                                    | 9.6   | 6.4   | 5.6   | 8     | 10                | —    |       |
|                                                            | 1.5                   | 0,15                   | 15                     | 30                                    | 40    | 19    | 16    | 24    | 36                | —    |       |
| Output High<br>(Source)<br>Current<br>I <sub>OH</sub> Min. | 4.6                   | 0,5                    | 5                      | -0.25                                 | -0.23 | -0.18 | -0.15 | -0.2  | -0.4              | —    |       |
|                                                            | 2.5                   | 0,5                    | 5                      | -1                                    | -0.9  | -0.65 | -0.58 | -0.8  | -1.6              | —    |       |
|                                                            | 9.5                   | 0,10                   | 10                     | -0.55                                 | -0.5  | -0.38 | -0.33 | -0.45 | -0.9              | —    |       |
|                                                            | 13.5                  | 0,15                   | 15                     | -1.65                                 | -1.6  | -1.25 | -1.1  | -1.5  | -3                | —    |       |
| Output Voltage:<br>Low-Level,<br>V <sub>OL</sub> Max.      | —                     | 0,5                    | 5                      | 0.05                                  |       |       |       | —     | 0                 | 0.05 | V     |
|                                                            | —                     | 0,10                   | 10                     | 0.05                                  |       |       |       | —     | 0                 | 0.05 |       |
|                                                            | —                     | 0,15                   | 15                     | 0.05                                  |       |       |       | —     | 0                 | 0.05 |       |
| Output Voltage:<br>High-Level,<br>V <sub>OH</sub> Min.     | —                     | 0,5                    | 5                      | 4.95                                  |       |       |       | 4.95  | 5                 | —    |       |
|                                                            | —                     | 0,10                   | 10                     | 9.95                                  |       |       |       | 9.95  | 10                | —    |       |
|                                                            | —                     | 0,15                   | 15                     | 14.95                                 |       |       |       | 14.95 | 15                | —    |       |
| Input Low<br>Voltage:<br>V <sub>IL</sub> Max.<br>CD4009UB  | 4.5                   | —                      | 5                      | 1                                     |       |       |       | —     | —                 | 1    | V     |
|                                                            | 9                     | —                      | 10                     | 2                                     |       |       |       | —     | —                 | 2    |       |
|                                                            | 13.5                  | —                      | 15                     | 2.5                                   |       |       |       | —     | —                 | 2.5  |       |
| Input Low<br>Voltage:<br>V <sub>IL</sub> Max.<br>CD4010B   | 0.5                   | —                      | 5                      | 1.5                                   |       |       |       | —     | —                 | 1.5  |       |
|                                                            | 1                     | —                      | 10                     | 3                                     |       |       |       | —     | —                 | 3    |       |
|                                                            | 1.5                   | —                      | 15                     | 4                                     |       |       |       | —     | —                 | 4    |       |
| Input High<br>Voltage:<br>V <sub>IH</sub> Min.<br>CD4009UB | 0.5                   | —                      | 5                      | 4                                     |       |       |       | 4     | —                 | —    | V     |
|                                                            | 1                     | —                      | 10                     | 8                                     |       |       |       | 8     | —                 | —    |       |
|                                                            | 1.5                   | —                      | 15                     | 12.5                                  |       |       |       | 12.5  | —                 | —    |       |
| Input High<br>Voltage:<br>V <sub>IH</sub> Min.<br>CD4010B  | 4.5                   | —                      | 5                      | 3.5                                   |       |       |       | 3.5   | —                 | —    |       |
|                                                            | 9                     | —                      | 10                     | 7                                     |       |       |       | 7     | —                 | —    |       |
|                                                            | 13.5                  | —                      | 15                     | 11                                    |       |       |       | 11    | —                 | —    |       |
| Input Current,<br>I <sub>IN</sub> Max.                     | —                     | 0,18                   | 18                     | ±0.1                                  | ±0.1  | ±1    | ±1    | —     | ±10 <sup>-5</sup> | ±0.1 | μA    |

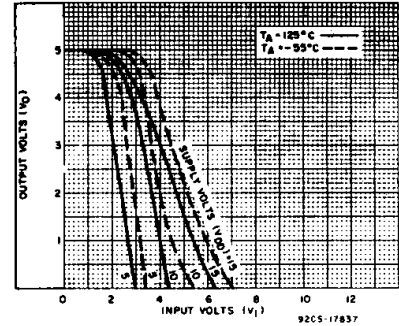


Fig. 4 — Typical voltage transfer characteristics as function of temp.—CD4009UB.

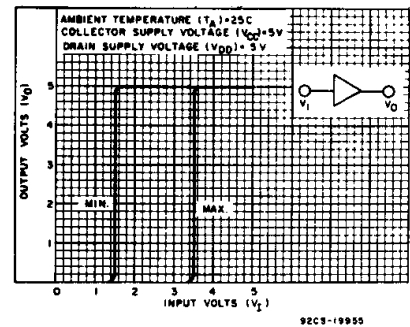


Fig. 5 — Minimum and maximum voltage transfer characteristics ( $V_{DD}=5$ )—CD4010B.

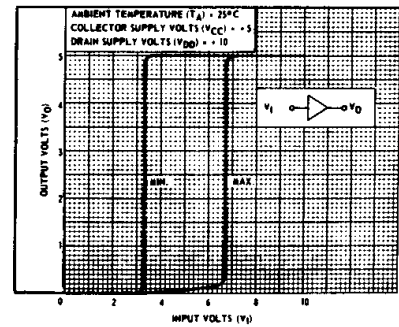


Fig. 6 — Minimum and maximum voltage transfer characteristics ( $V_{DD}=10$ )—CD4010B.

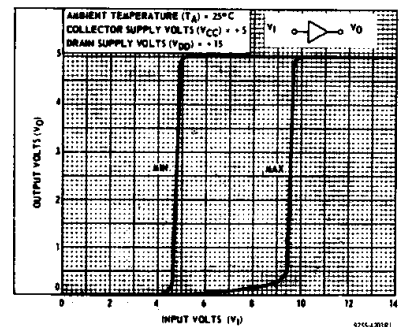


Fig. 7 — Minimum and maximum voltage transfer characteristics ( $V_{DD}=15$ )—CD4010B.

# CD4009UB, CD4010B Types

**DYNAMIC ELECTRICAL CHARACTERISTICS** at  $T_A=25^\circ\text{C}$ ; Input  $t_r, t_f=20\text{ ns}$ ,  
 $C_L=50\text{ pF}$ ,  $R_L=200\text{ K}\Omega$

| CHARACTERISTIC                                           | CONDITIONS             |                       |                        | LIMITS<br>ALL PKGS |      | UNIT |
|----------------------------------------------------------|------------------------|-----------------------|------------------------|--------------------|------|------|
|                                                          | V <sub>DD</sub><br>(V) | V <sub>I</sub><br>(V) | V <sub>CC</sub><br>(V) | TYP.               | MAX. |      |
| Propagation Delay Time:<br>Low-to-High, t <sub>PLH</sub> | 5                      | 5                     | 5                      | 70                 | 140  | ns   |
|                                                          | 10                     | 10                    | 10                     | 40                 | 80   |      |
|                                                          | 10                     | 10                    | 5                      | 35                 | 70   |      |
|                                                          | 15                     | 15                    | 15                     | 30                 | 60   |      |
|                                                          | 15                     | 15                    | 5                      | 30                 | 60   |      |
| CD4010B                                                  | 5                      | 5                     | 5                      | 100                | 200  | ns   |
|                                                          | 10                     | 10                    | 10                     | 50                 | 100  |      |
|                                                          | 10                     | 10                    | 5                      | 50                 | 100  |      |
|                                                          | 15                     | 15                    | 15                     | 35                 | 70   |      |
|                                                          | 15                     | 15                    | 5                      | 35                 | 70   |      |
| High-to-Low, t <sub>PHL</sub>                            | 5                      | 5                     | 5                      | 30                 | 60   | ns   |
|                                                          | 10                     | 10                    | 10                     | 20                 | 40   |      |
|                                                          | 10                     | 10                    | 5                      | 15                 | 30   |      |
|                                                          | 15                     | 15                    | 15                     | 15                 | 30   |      |
|                                                          | 15                     | 15                    | 5                      | 10                 | 20   |      |
| CD4010B                                                  | 5                      | 5                     | 5                      | 65                 | 130  | ns   |
|                                                          | 10                     | 10                    | 10                     | 35                 | 70   |      |
|                                                          | 10                     | 10                    | 5                      | 30                 | 70   |      |
|                                                          | 15                     | 15                    | 15                     | 25                 | 50   |      |
|                                                          | 15                     | 15                    | 5                      | 20                 | 40   |      |
| Transition Time:<br>Low-to-High, t <sub>TLH</sub>        | 5                      | 5                     | 5                      | 150                | 350  | ns   |
|                                                          | 10                     | 10                    | 10                     | 75                 | 150  |      |
|                                                          | 15                     | 15                    | 15                     | 55                 | 110  |      |
| High-to-Low, t <sub>THL</sub>                            | 5                      | 5                     | 5                      | 35                 | 70   | ns   |
|                                                          | 10                     | 10                    | 10                     | 20                 | 40   |      |
|                                                          | 15                     | 15                    | 15                     | 15                 | 30   |      |
| Input Capacitance, C <sub>IN</sub>                       |                        |                       |                        |                    |      | pF   |
|                                                          |                        |                       |                        |                    |      |      |
| CD4009UB                                                 | —                      | —                     | —                      | 15                 | 22.5 |      |
| CD4010B                                                  | —                      | —                     | —                      | 5                  | 7.5  |      |

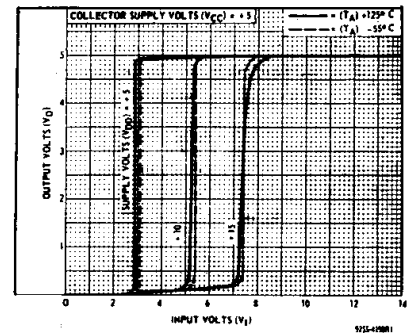


Fig. 8 - Typical voltage transfer characteristics as a function of temperature-CD4010B.

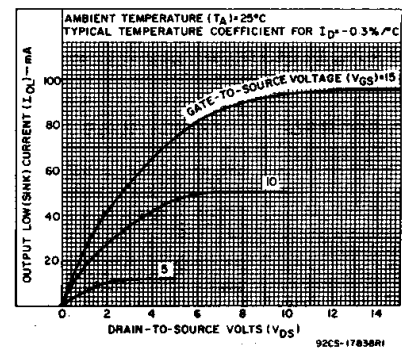


Fig. 9 - Typical output low (sink) current characteristics.

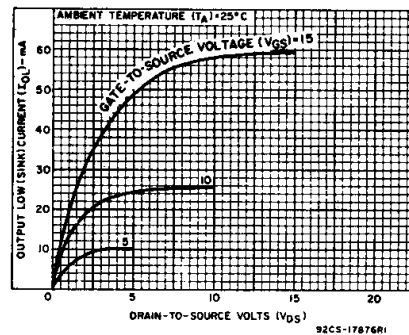


Fig. 10 - Minimum output low (sink) current characteristics.

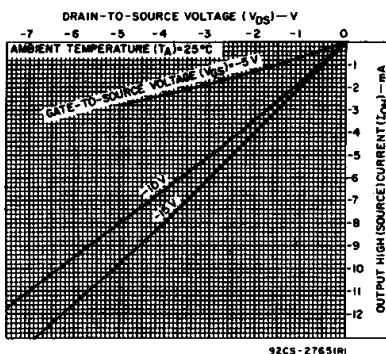


Fig. 11 - Typical output high (source) current characteristics.

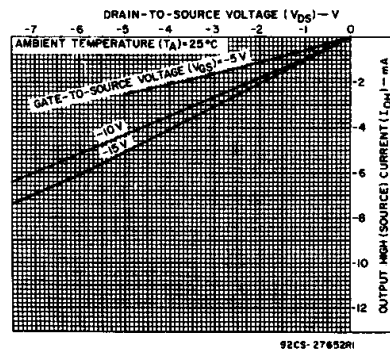


Fig. 12 - Minimum output high (source) current characteristics.

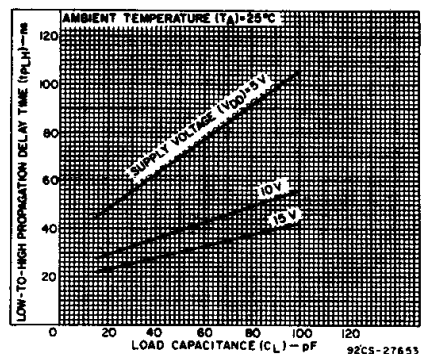


Fig. 13 - Typical low-to-high propagation delay time vs. load capacitance (CD4009UB).

# CD4009UB, CD4010B Types

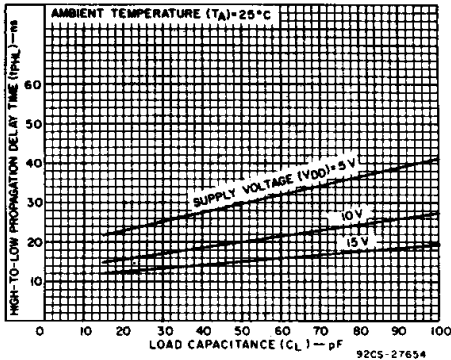


Fig. 14 - Typical high-to-low propagation delay time vs. load capacitance (CD4009UB).

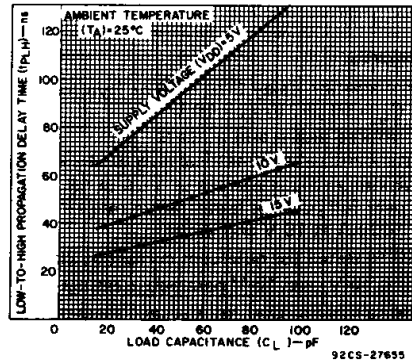


Fig. 15 - Typical low-to-high propagation delay time vs. load capacitance (CD4010B).

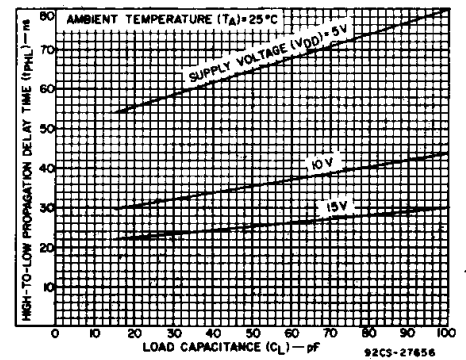


Fig. 16 - Typical high-to-low propagation delay time vs. load capacitance (CD4010B).

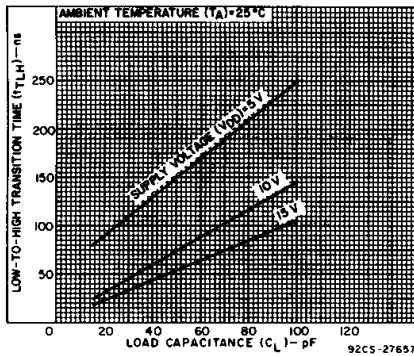


Fig. 17 - Typical low-to-high transition time vs. load capacitance.

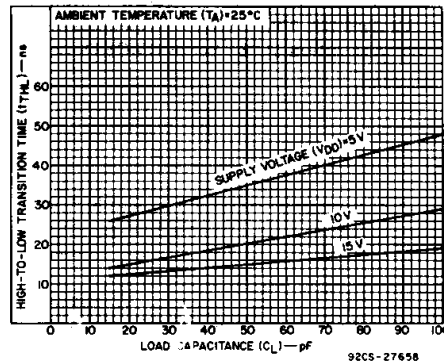


Fig. 18 - Typical high-to-low transition time vs. load capacitance.

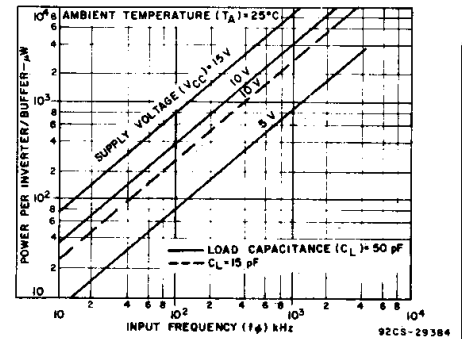


Fig. 19 - Typical dissipation characteristics.

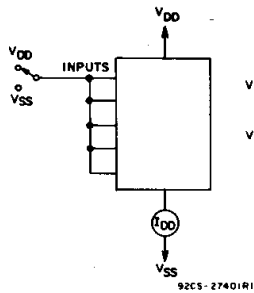


Fig. 20 - Quiescent device current test circuit.

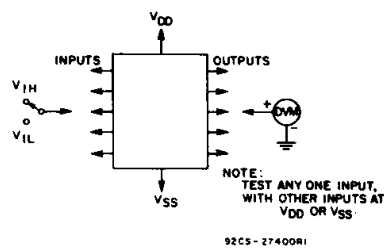


Fig. 21 - Noise immunity test circuit.

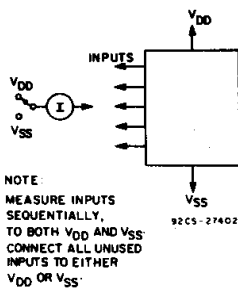
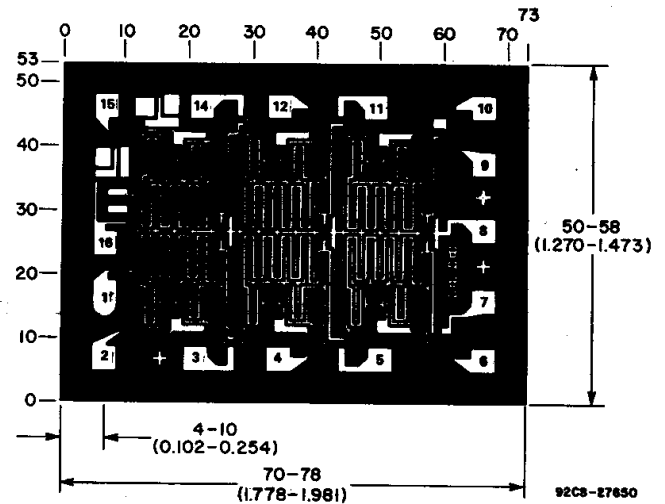


Fig. 22 - Input current test circuit.



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid Graduations Are In Mils (10<sup>-3</sup> Inch)

Photograph of chip for CD4009UB. Dimensions and pad layout for CD4010B are identical.

3  
COMMERCIAL CMOS  
HIGH VOLTAGE ICs

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