

# CD4067B, CD4097B Types

## CMOS Analog Multiplexers/Demultiplexers

High-Voltage Types (20-Volt Rating)

CD4067B – Single 16-Channel Multiplexer/Demultiplexer

CD4097B – Differential 8-Channel Multiplexer/Demultiplexer

■ CD4067B and CD4097B CMOS analog multiplexers/demultiplexers\* are digitally controlled analog switches having low ON impedance, low OFF leakage current, and internal address decoding. In addition, the ON resistance is relatively constant over the full input-signal range.

The CD4067B is a 16-channel multiplexer with four binary control inputs, A, B, C, D, and an inhibit input, arranged so that any combination of the inputs selects one switch.

The CD4097B is a differential 8-channel multiplexer having three binary control inputs A, B, C, and an inhibit input. The inputs permit selection of one of eight pairs of switches.

A logic "1" present at the inhibit input turns all channels off.

The CD4067 and CD4097 are supplied in 24-lead dual-in-line welded-seal ceramic packages (D suffix), 24-lead dual-in-line frit-seal ceramic packages (F suffix), 24-lead dual-in-line plastic packages (E suffix), 24-lead small-outline package (NSR suffix), and in chip form (H suffix).

\*When these devices are used as demultiplexers, the channel in/out terminals are the outputs and the common out/in terminals are the inputs.

### Recommended Operating Conditions at $T_A = 25^\circ\text{C}$ (Unless Otherwise Specified)

For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges. Values shown apply to all types except as noted.

| Characteristic  | Min. | Max. | Units    |
|---|------|------|----------|
| Supply-Voltage Range ( $T_A$ =Full Package-Temp. Range) | 3    | 18   | V        |
| Multiplexer Switch Input Current Capability             | –    | 25   | mA       |
| Output Load Resistance                                  | 100  | –    | $\Omega$ |

### NOTE:

In certain applications, the external load-resistor current may include both  $V_{DD}$  and signal-line components. To avoid drawing  $V_{DD}$  current when switch current flows into the transmission gate inputs, the voltage drop across the bidirectional switch must not exceed 0.8 volt (calculated from  $R_{ON}$  values shown in ELECTRICAL CHARACTERISTICS CHART). No  $V_{DD}$  current will flow through  $R_L$  if the switch current flows into terminal 1 on the CD4067; terminals 1 and 17 on the CD4097.

### Features:

- Low ON resistance:  $125 \Omega$  (typ.) over 15  $V_{pp}$  signal-input range for  $V_{DD}-V_{SS}=15 \text{ V}$
- High OFF resistance: channel leakage of  $\pm 10 \text{ pA}$  (typ.) @  $V_{DD}-V_{SS}=10 \text{ V}$
- Matched switch characteristics:  $R_{ON}=5 \Omega$  (typ.) for  $V_{DD}-V_{SS}=15 \text{ V}$
- Very low quiescent power dissipation under all digital-control input and supply conditions:  $0.2 \mu\text{W}$  (typ.) @  $V_{DD}-V_{SS}=10 \text{ V}$
- Binary address decoding on chip
- 5-V, 10-V, and 15-V parametric ratings
- 100% tested for quiescent current at 20 V
- Standardized symmetrical output characteristics
- Maximum input current of  $1 \mu\text{A}$  at 18 V over full package temperature range;  $100 \text{ nA}$  at 18 V and  $25^\circ\text{C}$
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

### Applications:

- Analog and digital multiplexing and demultiplexing
- A/D and D/A conversion
- Signal gating

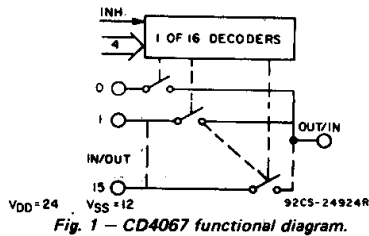
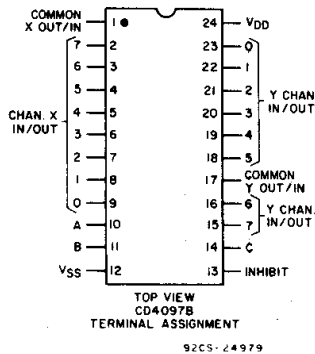
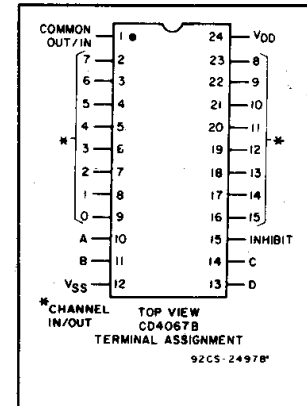


Fig. 1 – CD4067 functional diagram.

CD4067 TRUTH TABLE

| A | B | C | D | Inh | Selected Channel |
|---|---|---|---|-----|------------------|
| X | X | X | X | 1   | None             |
| 0 | 0 | 0 | 0 | 0   | 0                |
| 1 | 0 | 0 | 0 | 0   | 1                |
| 0 | 1 | 0 | 0 | 0   | 2                |
| 1 | 1 | 0 | 0 | 0   | 3                |
| 0 | 0 | 1 | 0 | 0   | 4                |
| 1 | 0 | 1 | 0 | 0   | 5                |
| 0 | 1 | 1 | 0 | 0   | 6                |
| 1 | 1 | 1 | 0 | 0   | 7                |
| 0 | 0 | 0 | 1 | 0   | 8                |
| 1 | 0 | 0 | 1 | 0   | 9                |
| 0 | 1 | 0 | 1 | 0   | 10               |
| 1 | 1 | 0 | 1 | 0   | 11               |
| 0 | 0 | 1 | 1 | 0   | 12               |
| 1 | 0 | 1 | 1 | 0   | 13               |
| 0 | 1 | 1 | 1 | 0   | 14               |
| 1 | 1 | 1 | 1 | 0   | 15               |

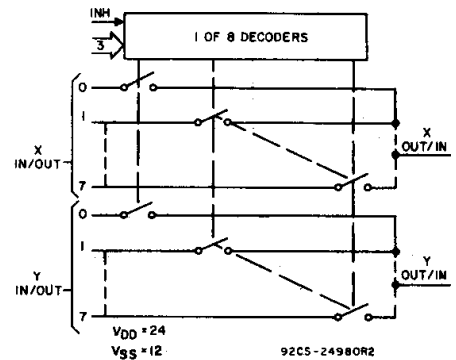


Fig. 2 – CD4097 functional diagram.

CD4097 TRUTH TABLE

| A | B | C | Inh | Selected Channel |
|---|---|---|-----|------------------|
| X | X | X | 1   | None             |
| 0 | 0 | 0 | 0   | 0X, 0Y           |
| 1 | 0 | 0 | 0   | 1X, 1Y           |
| 0 | 1 | 0 | 0   | 2X, 2Y           |
| 1 | 1 | 0 | 0   | 3X, 3Y           |
| 0 | 0 | 1 | 0   | 4X, 4Y           |
| 1 | 0 | 1 | 0   | 5X, 5Y           |
| 0 | 1 | 1 | 0   | 6X, 6Y           |
| 1 | 1 | 1 | 0   | 7X, 7Y           |

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## ELECTRICAL CHARACTERISTICS

| CHARACTERISTIC   | CONDITIONS                 |   |                 | LIMITS AT INDICATED TEMPERATURES (°C) |     |              |      |      |           | Units       |          |
|--|----------------------------|---|-----------------|---------------------------------------|-----|--------------|------|------|-----------|-------------|----------|
|  | $V_{is}$<br>(V)            | $V_{SS}$<br>(V)   | $V_{DD}$<br>(V) | -55                                   | -40 | +85          | +125 | +25  |           |             |          |
|  |                            |   |                 |                                       |     |              |      | Min. | Typ.      |             | Max.     |
| <b>SIGNAL INPUTS (<math>V_{is}</math>) AND OUTPUTS (<math>V_{OS}</math>)</b>               |                            |   |                 |                                       |     |              |      |      |           |             |          |
| Quiescent Device Current, $I_{DD}$ Max.  |                            |   | 5               | 5                                     | 5   | 150          | 150  | —    | 0.04      | 5           | $\mu A$  |
|  |                            |   | 10              | 10                                    | 10  | 300          | 300  | —    | 0.04      | 10          |          |
|  |                            |   | 15              | 20                                    | 20  | 600          | 600  | —    | 0.04      | 20          |          |
|  |                            |   | 20              | 100                                   | 100 | 3000         | 3000 | —    | 0.08      | 100         |          |
| ON-state Resistance<br>$V_{SS} \leq V_{is} \leq V_{DD}$<br>$r_{on}$ Max.                   |                            | 0   | 5               | 800                                   | 850 | 1200         | 1300 | —    | 470       | 1050        | $\Omega$ |
|  |                            | 0   | 10              | 310                                   | 330 | 520          | 550  | —    | 180       | 400         |          |
|  |                            | 0   | 15              | 200                                   | 210 | 300          | 320  | —    | 125       | 240         |          |
| Change in on-state Resistance (Between Any Two Channels)<br>$\Delta r_{on}$                |                            | 0   | 5               | —                                     | —   | —            | —    | —    | 15        | —           | $\Omega$ |
|  |                            | 0   | 10              | —                                     | —   | —            | —    | —    | 10        | —           |          |
|  |                            | 0   | 15              | —                                     | —   | —            | —    | —    | 5         | —           |          |
| OFF Channel Leakage Current: Any Channel OFF Max. or All Channels OFF (Common OUT/IN) Max. |                            | 0   | 18              | $\pm 100^*$                           |     | $\pm 1000^*$ |      |      | $\pm 0.1$ | $\pm 100^*$ | nA       |
| Capacitance: Input, $C_{is}$   |                            |   |                 | —                                     | —   | —            | —    | —    | 5         | —           | pF       |
| Output, $C_{os}$   |                            |   |                 | —                                     | —   | —            | —    | —    | 55        | —           |          |
| CD4067   |                            |   |                 | —                                     | —   | —            | —    | —    | 35        | —           |          |
| CD4097   |                            | -5  | 5               | —                                     | —   | —            | —    | —    | 0.2       | —           |          |
| Feed-through, $C_{ios}$  |                            |   |                 | —                                     | —   | —            | —    | —    | —         | —           |          |
|  |                            |   |                 | —                                     | —   | —            | —    | —    | —         | —           |          |
|  |                            |   |                 | —                                     | —   | —            | —    | —    | —         | —           |          |
| Propagation Delay Time (Signal Input to Output)  | $V_{DD}$                   | $R_L = 200 K\Omega$<br>$C_L = 50 pF$<br>$t_r, t_f = 20 ns$              | 5               | —                                     | —   | —            | —    | —    | 30        | 60          | ns       |
|  |                            |   | 10              | —                                     | —   | —            | —    | —    | 15        | 30          |          |
|  |                            |   | 15              | —                                     | —   | —            | —    | —    | 10        | 20          |          |
| <b>CONTROL (ADDRESS or INHIBIT) <math>V_C</math></b>                                       |                            |   |                 |                                       |     |              |      |      |           |             |          |
| Input Low Voltage, $V_{IL}$ Max.   | $=V_{DD}$ thru $1 K\Omega$ | $R_L = 1 K\Omega$ to $V_{SS}$<br>$I_{IS} < 2 \mu A$ on all OFF Channels | 5               | 1.5                                   | —   | —            | —    | —    | —         | 1.5         | V        |
|  |                            |   | 10              | 3                                     | —   | —            | —    | —    | 3         |             |          |
|  |                            |   | 15              | 4                                     | —   | —            | —    | —    | 4         |             |          |
| Input High Voltage, $V_{IH}$ Min.  | $1 K\Omega$                | $R_L = 1 K\Omega$ to $V_{SS}$<br>$I_{IS} < 2 \mu A$ on all OFF Channels | 5               | 3.5                                   | 3.5 | —            | —    | —    | —         | —           |          |
|  |                            |   | 10              | 7                                     | 7   | —            | —    | —    | —         |             |          |
|  |                            |   | 15              | 11                                    | 11  | —            | —    | —    | —         |             |          |

\* Determined by minimum feasible leakage measurement for automatic testing.

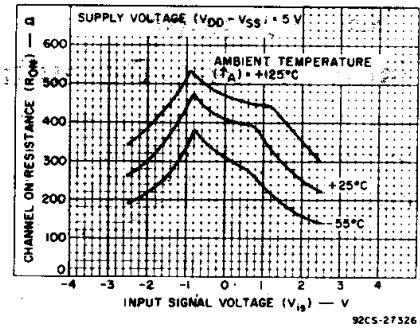


Fig. 3—Typical ON resistance vs. input signal voltage (all types).

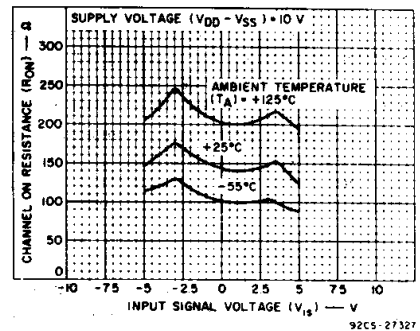


Fig. 4—Typical ON resistance vs. input signal voltage (all types).

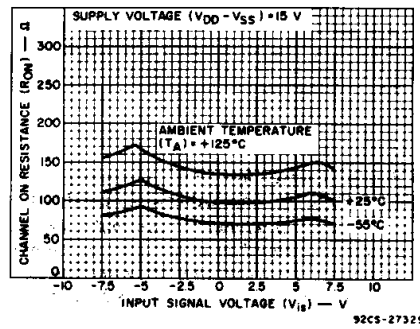


Fig. 5—Typical ON resistance vs. input signal voltage (all types).

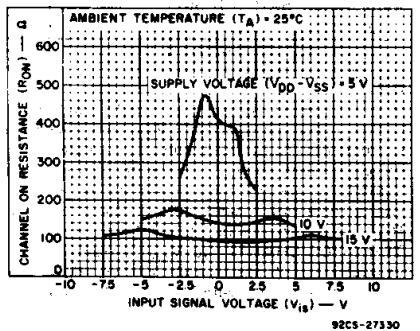


Fig. 6—Typical ON resistance vs. input signal voltage (all types).

# CD4067B, CD4097B Types

## ELECTRICAL CHARACTERISTICS (Cont'd)

| CHARACTERISTIC  | CONDITIONS  |                        |                        | LIMITS AT INDICATED TEMPERATURES (°C) |      |     |      |      |                   |      | Units |
|---|---|------------------------|------------------------|---------------------------------------|------|-----|------|------|-------------------|------|-------|
|   | V <sub>is</sub><br>(V)  | V <sub>SS</sub><br>(V) | V <sub>DD</sub><br>(V) | -55                                   | -40  | +85 | +125 | +25  |                   |      |       |
|   |   |                        |                        |                                       |      |     |      | Min. | Typ.              | Max. |       |
| Input Current, I <sub>IN</sub> Max.   | V <sub>IN</sub> = 0, 18 V   |                        |                        | ±0.1                                  | ±0.1 | ±1  | ±1   | —    | ±10 <sup>-5</sup> | ±0.1 | μA    |
| Propagation Delay Time: Address or Inhibit-to-Signal OUT (Channel turning ON) | R <sub>L</sub> = 10 KΩ, C <sub>L</sub> = 50 pF, t <sub>r</sub> , t <sub>f</sub> = 20 ns |                        |                        |                                       |      |     |      |      |                   |      | ns    |
|   |   | 0                      | 5                      | —                                     | —    | —   | —    | —    | 325               | 650  |       |
|   |   | 0                      | 10                     | —                                     | —    | —   | —    | —    | 135               | 270  |       |
| Address or Inhibit-to-Signal OUT (Channel turning OFF)                        | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 50 pF, t <sub>r</sub> , t <sub>f</sub> = 20 ns |                        |                        |                                       |      |     |      |      |                   |      | ns    |
|   |   | 0                      | 5                      | —                                     | —    | —   | —    | —    | 220               | 440  |       |
|   |   | 0                      | 10                     | —                                     | —    | —   | —    | —    | 90                | 180  |       |
| Input Capacitance, C <sub>IN</sub>  | Any Address or Inhibit Input  |                        |                        |                                       |      |     |      |      |                   |      | pF    |
|   |   | 0                      | 5                      | —                                     | —    | —   | —    | —    | 5                 | 7.5  |       |
|   |   | 0                      | 15                     | —                                     | —    | —   | —    | —    | —                 | —    |       |

## TEST CIRCUITS

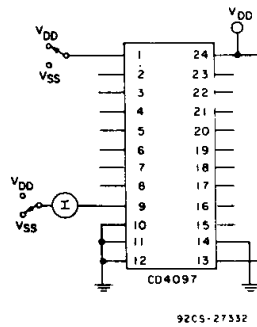
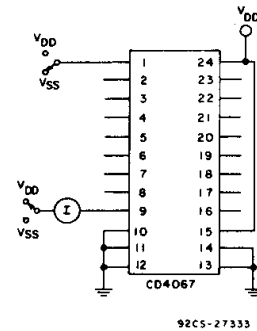


Fig. 7—OFF channel leakage current—any channel OFF.

## MAXIMUM RATINGS, Absolute-Maximum Values:

- DC SUPPLY-VOLTAGE RANGE, (V<sub>DD</sub>)  
Voltages referenced to V<sub>SS</sub> Terminal) ..... -0.5V to +20V
- INPUT VOLTAGE RANGE, ALL INPUTS ..... -0.5V to V<sub>DD</sub> +0.5V
- DC INPUT CURRENT, ANY ONE INPUT ..... ±10mA
- POWER DISSIPATION PER PACKAGE (P<sub>D</sub>):  
For T<sub>A</sub> = -55°C to +100°C ..... 500mW  
For T<sub>A</sub> = +100°C to +125°C ..... Derate Linearly at 12mW/°C to 200mW
- DEVICE DISSIPATION PER OUTPUT TRANSISTOR  
FOR T<sub>A</sub> = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) ..... 100mW
- OPERATING-TEMPERATURE RANGE (T<sub>A</sub>) ..... -55°C to +125°C
- STORAGE TEMPERATURE RANGE (T<sub>stg</sub>) ..... -65°C to +150°C
- LEAD TEMPERATURE (DURING SOLDERING):  
At distance 1/16 ± 1/32 inch (1.59 ± 0.79mm) from case for 10s max ..... +265°C

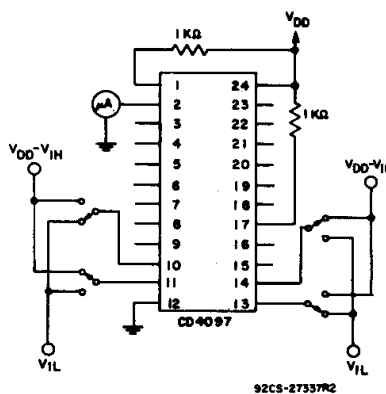
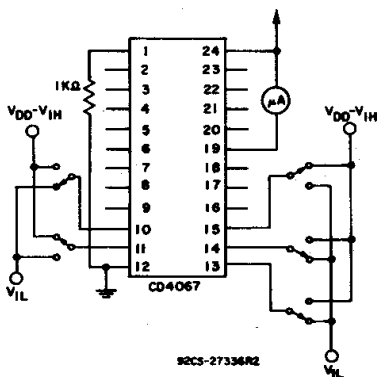


Fig. 8—Input voltage—measure < 2 μA on all OFF channels (e.g., channel 12).

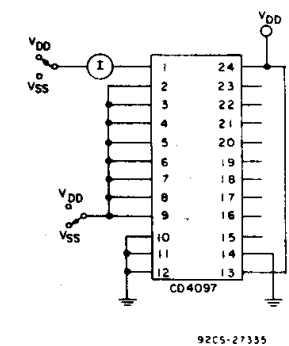
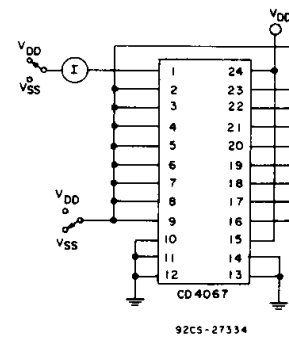


Fig. 9—OFF channel leakage current—all channels OFF.

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## ELECTRICAL CHARACTERISTICS (Cont'd)

| CHARACTERISTIC  | TEST CONDITIONS                         |                     |                     | TYPICAL VALUES   | UNITS   |           |
|---|---|---------------------|---------------------|--|---|-----------|
|   | V <sub>is</sub> (V)                     | V <sub>DD</sub> (V) | R <sub>L</sub> (KΩ) |  |   |           |
| Cutoff (-3 dB) Frequency Channel ON (Sine Wave Input) | 5 <sup>●</sup>                          | 10                  | 1                   | V <sub>OS</sub> at Common OUT/IN   | CD4067: 14<br>CD4097: 20                              | MHz       |
|   | 20 log $\frac{V_{OS}}{V_{is}} = -3$ dB  |                     |                     | V <sub>OS</sub> at Any Channel   | 60  |           |
| Total Harmonic Distortion, THD                        | 2 <sup>●</sup>                          | 5                   | 10                  | f <sub>is</sub> = 1 kHz sine wave  | 0.3   | %         |
|   | 3 <sup>●</sup>                          | 10                  |                     |  | 0.2   |           |
|   | 5 <sup>●</sup>                          | 15                  |                     |  | 0.12  |           |
|   |   |                     |                     |  |   |           |
| -40 dB Feedthrough Frequency (All Channels OFF)       | 5 <sup>●</sup>                          | 10                  | 1                   | V <sub>OS</sub> at Common OUT/IN   | CD4067: 20<br>CD4097: 12                              | MHz       |
|   | 20 log $\frac{V_{OS}}{V_{is}} = -40$ dB |                     |                     | V <sub>OS</sub> at Any Channel   | 8   |           |
| Signal Crosstalk (Frequency at -40 dB)                | 5 <sup>●</sup>                          | 10                  | 1                   | Between Any 2 Channels <sup>▲</sup>  | 1   | MHz       |
|   | 20 log $\frac{V_{OS}}{V_{is}} = -40$ dB |                     |                     | Between Sections CD4097 Only   | Measured on Common: 10<br>Measured on Any Channel: 18 |           |
|   |   |                     |                     |  |   |           |
| Address-or-Inhibit-to-Signal Crosstalk                | -                                       | 10                  | 10 <sup>*</sup>     | V <sub>SS</sub> =0, t <sub>r</sub> , t <sub>f</sub> =20 ns, V <sub>C</sub> =V <sub>DD</sub> -V <sub>SS</sub> (Square Wave) | 75  | mV (Peak) |

● Peak-to-peak voltage symmetrical about  $\frac{V_{DD}-V_{SS}}{2}$ .

▲ Worst case.

\* Both ends of channel.

## TEST CIRCUITS (Cont'd)

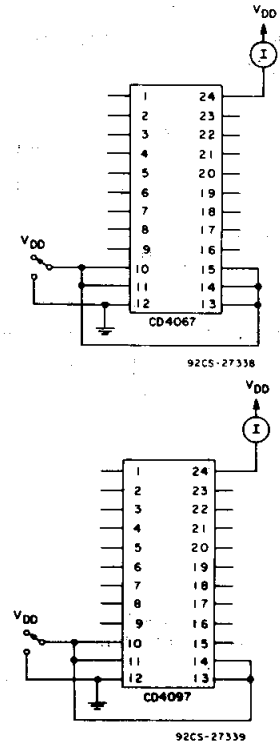


Fig. 10—Quiescent device current.

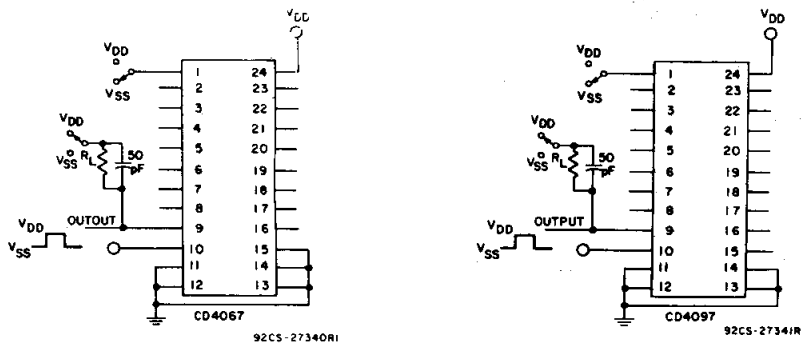


Fig. 11—Turn-on and turn-off propagation delay—address select input to signal output (e.g. measured on channel 0).

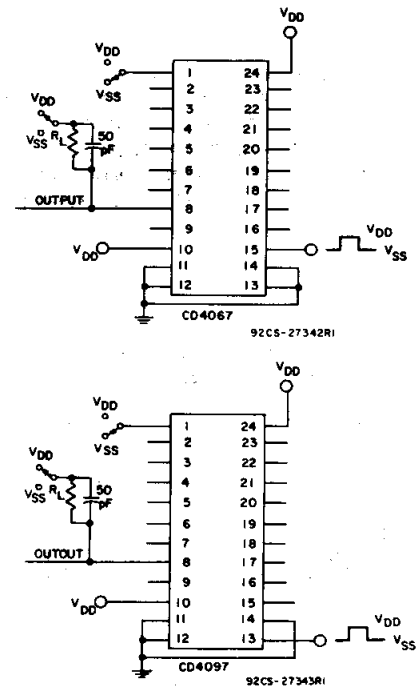


Fig. 12—Turn-on and turn-off propagation delay—  
inhibit input to signal output (e.g. measured on channel 1).

# CD4067B, CD4097B Types

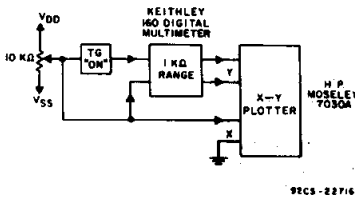


Fig. 13- Channel ON resistance measurement circuit.

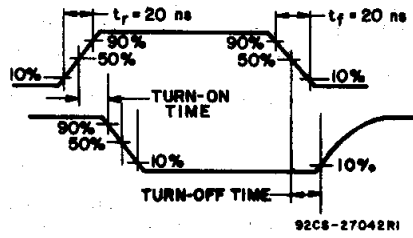


Fig. 14- Propagation delay waveform channel being turned ON ( $R_L = 10\text{ K}\Omega$ ,  $C_L = 50\text{ pF}$ ).

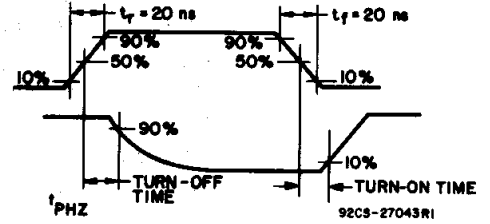


Fig. 15- Propagation delay waveform, channel being turned OFF ( $R_L = 300\Omega$ ,  $C_L = 50\text{ pF}$ ).

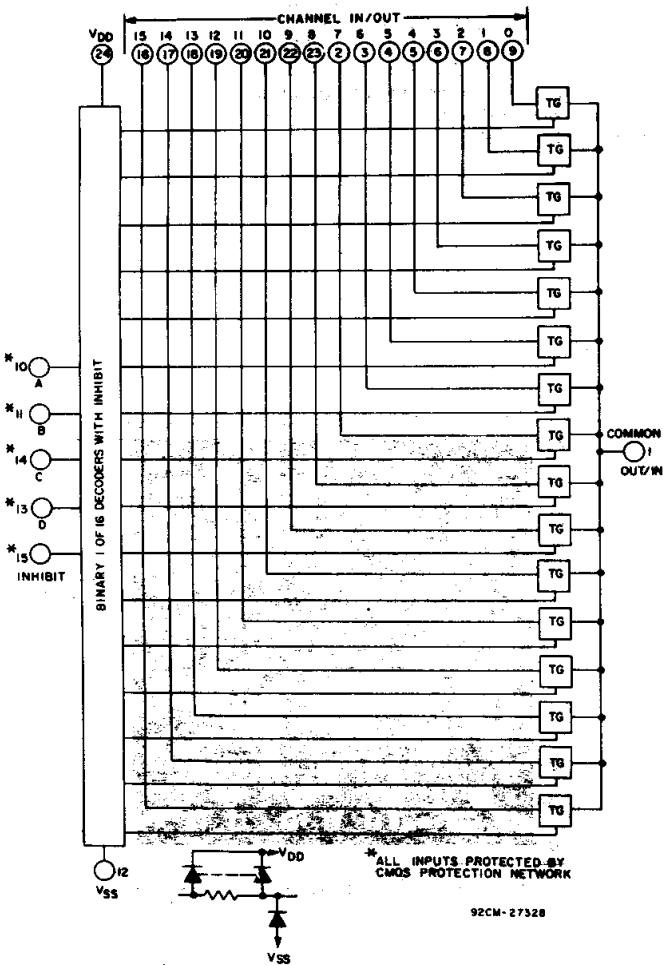


Fig. 16- CD4067 logic diagram.

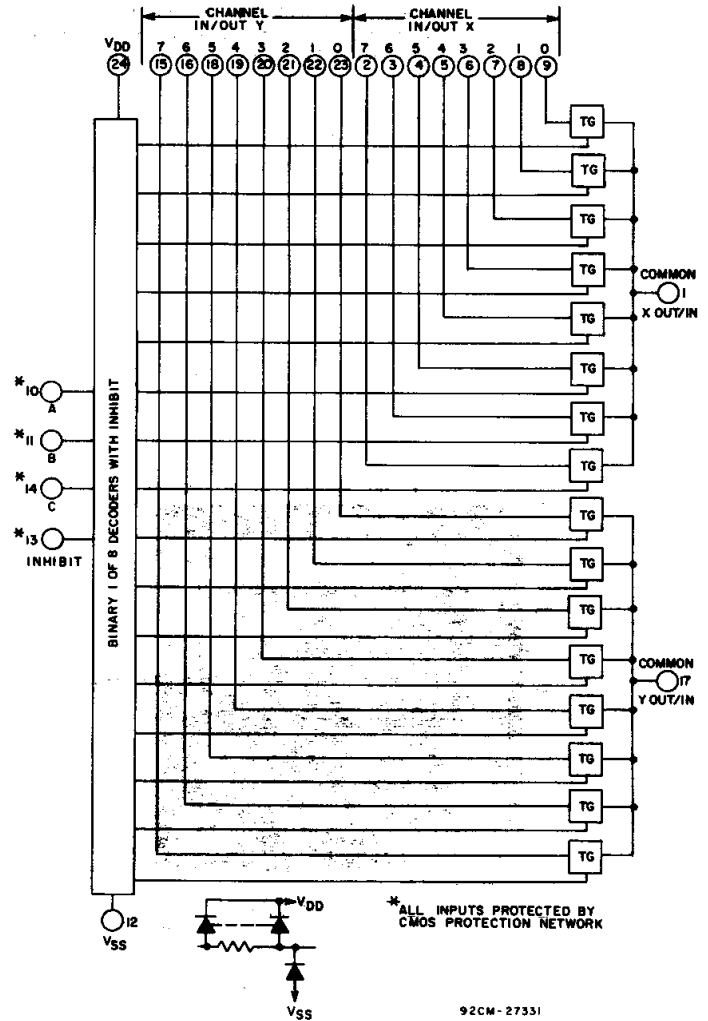


Fig. 17- CD4097 logic diagram.

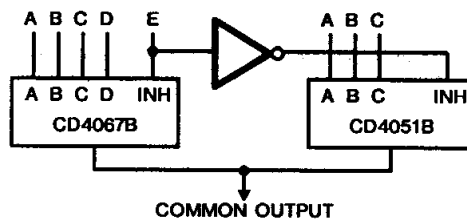


Fig. 18-24-to-1 MUX Addressing

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### SPECIAL CONSIDERATIONS

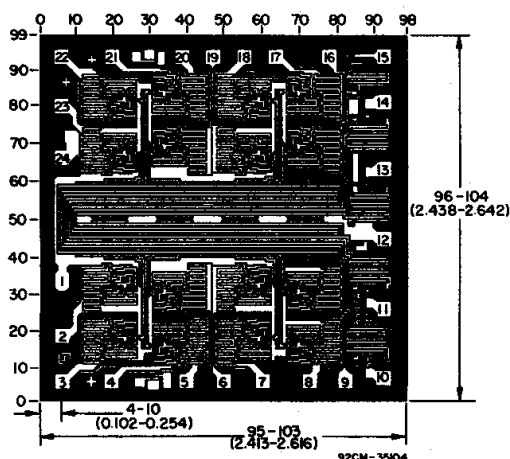
In applications where separate power sources are used to drive  $V_{DD}$  and the signal inputs, the  $V_{DD}$  current capability should exceed  $V_{DD}/R_L$  ( $R_L$ =effective external load). This provision avoids permanent current flow or clamp action on the  $V_{DD}$  supply when power is applied or removed from the CD4067B or CD4097B.

When switching from one address to another, some of the ON periods of the channels of the multiplexers will overlap momentarily, which may be objectionable in certain applications. Also when a channel is turned on or off by an address input, there is a momentary conductive path from the channel to  $V_{SS}$ , which will dump some charge from any capacitor connected to the input or output of the channel. The inhibit input turning on a channel will similarly dump some charge to  $V_{SS}$ .

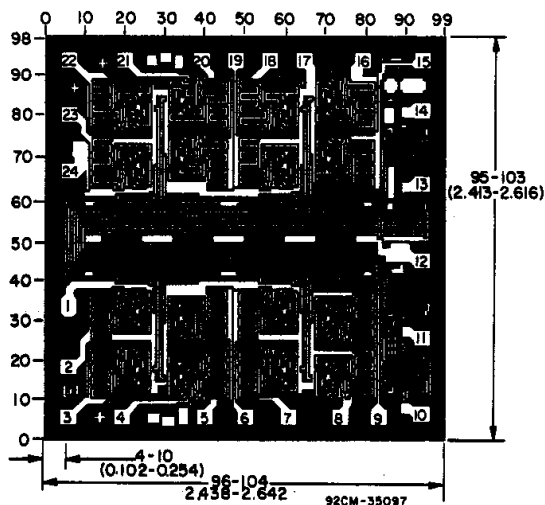
The amount of charge dumped is mostly a function of the signal level above  $V_{SS}$ . Typically, at  $V_{DD}-V_{SS}=10$  V, a 100-pF

capacitor connected to the input or output of the channel will lose 3-4% of its voltage at the moment the channel turns on or off. This loss of voltage is essentially independent of the address or inhibit signal transition time, if the transition time is less than 1-2  $\mu$ s. When the inhibit signal turns a channel off, there is no charge dumping to  $V_{SS}$ . Rather, there is a slight rise in the channel voltage level (65 mV typ.) due to capacitive coupling from inhibit input to channel input or output. Address inputs also couple some voltage steps onto the channel signal levels.

In certain applications, the external load-resistor current may include both  $V_{DD}$  and signal-line components. To avoid drawing  $V_{DD}$  current when switch current flows into the transmission gate inputs, the voltage drop across the bidirectional switch must not exceed 0.8 volt (calculated from  $R_{ON}$  values shown in ELECTRICAL CHARACTERISTICS CHART). No  $V_{DD}$  current will flow through  $R_L$  if the switch current flows into terminal 1 on the CD4067B, terminals 1 and 17 on the CD4097B.



Dimensions and pad layout for CD4067BH.



Dimensions and pad layout for CD4097BH.

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils ( $10^{-3}$  inch).

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