

## CMOS QUAD ANALOG SWITCH

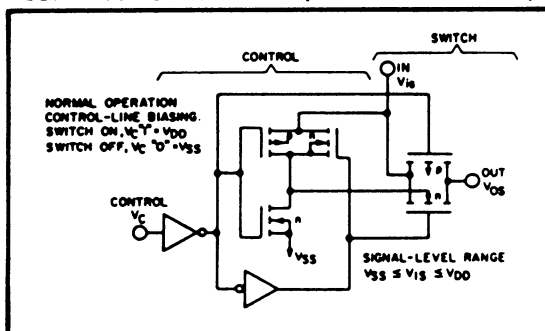
### FEATURES

- ◆ Transmission or Multiplexing of Analog or Digital Signals
- ◆  $80\Omega$  Typical ON-Resistance for 15-Volt operation
- ◆ Switch ON-Resistance Matched to within  $5\Omega$  over 15-Volt Signal-Input Range
- ◆ ON-Resistance Flat over Full Peak-to-Peak Signal Range
- ◆ High Degree of Linearity:  
 $\leq 0.5\%$  Distortion (typ) @  $f_{is} = 1\text{kHz}$ ,  
 $V_{is} = 5\text{V}_{\text{p-p}}$ ,  $V_{DD} - V_{SS} \geq 10\text{V}$ ,  $R_L = 10\text{k}\Omega$
- ◆ Extremely Low OFF switch Leakage Resulting in very Low Offset Current and High Effective OFF Resistance:  
 $10\text{pA}$  (typ) @  $V_{DD} - V_{SS} = 10\text{V}$ ,  $T_A = 25^\circ\text{C}$
- ◆ Extremely High Control Input Impedance (Control Circuit Isolated from Signal Circuit):  
 $10^{12}\Omega$  (typ)
- ◆ Low Crosstalk between Switches:  
 $-50\text{dB}$  (typ) @  $f_{is} = 0.9\text{MHz}$ ,  $R_L = 1\text{k}\Omega$
- ◆ Matched Control-Input to Signal-Output Capacitance Reduces Output Signal Transients
- ◆ Frequency Response, Switch ON =  $40\text{MHz}$  (typ)

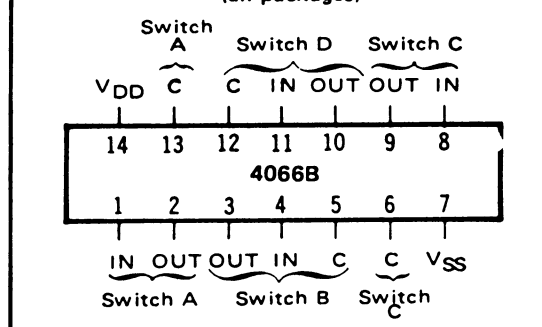
### DESCRIPTION

The 4066B is a Quad Bilateral Switch intended for the transmission or multiplexing of analog or digital signals. It is pin-for-pin compatible with the 4016B, but exhibits a much lower ON-resistance. In addition, the ON-resistance is relatively constant over the full input signal range. The 4066 consists of four independent bilateral switches. A single control signal is required per switch. Both the P and the N device in a given switch are biased ON or OFF simultaneously by the control signal. As shown below, the well of the N-channel device on each switch is either tied to the input when the switch is ON or to  $V_{SS}$  when the switch is OFF. This configuration minimizes the variation of the switch-transistor threshold voltage with input-signal, and thus keeps the ON-resistance low over the full operating range.

### SCHEMATIC DIAGRAM (one of four switches)



### CONNECTION DIAGRAM (all packages)



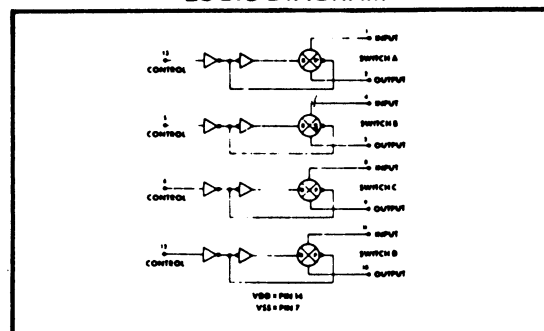
### RECOMMENDED OPERATING CONDITIONS

For maximum reliability:

|                       |                   |             |     |
|-----------------------|-------------------|-------------|-----|
| DC Supply Voltage     | $V_{DD} - V_{SS}$ | 3 to 15     | Vdc |
| Operating Temperature | $T_A$             | -55 to +125 | °C  |
|                       |                   | -40 to +85  | °C  |

The advantages over single-channel switches include peak input-signal voltage swings equal to the full supply voltage, and more constant ON-impedance over the input-signal range. For sample-and-hold applications, the 4016 is recommended. When the control input is high the switch will be ON. When the control input is low the switch will be OFF.

### LOGIC DIAGRAM



## ELECTRICAL CHARACTERISTICS

## STATIC CHARACTERISTICS

| PARAMETER                                     |                  | CONDITIONS                                                    | V <sub>SS</sub><br>(Vdc) | V <sub>DD</sub><br>(Vdc) | T <sub>LOW</sub> <sup>2</sup> |      | 25°C |        |      | T <sub>HIGH</sub> <sup>2</sup> |       | Units |
|-----------------------------------------------|------------------|---------------------------------------------------------------|--------------------------|--------------------------|-------------------------------|------|------|--------|------|--------------------------------|-------|-------|
|                                               |                  |                                                               |                          |                          | Min.                          | Max. | Min. | Typ.   | Max. | Min.                           | Max.  |       |
| QUIESCENT DEVICE CURRENT                      | I <sub>DD</sub>  | V <sub>IN</sub> = V <sub>SS</sub> or V <sub>DD</sub>          | 0                        | 5                        | —                             | 0.05 | —    | 0.0005 | 0.05 | —                              | 1.5   | μAdc  |
|                                               |                  | All valid input combinations                                  | 0                        | 10                       | —                             | 0.1  | —    | 0.001  | 0.1  | —                              | 3.0   |       |
|                                               |                  |                                                               | 0                        | 15                       | —                             | 0.2  | —    | 0.002  | 0.2  | —                              | 6.0   |       |
| MINIMUM INPUT HIGH VOLTAGE<br>(Control Input) | V <sub>IH</sub>  | V <sub>IS</sub> = V <sub>SS</sub>                             | 0                        | 5                        | —                             | 3.5  | —    | 2.75   | 3.5  | —                              | 3.5   | Vdc   |
|                                               |                  | V <sub>OS</sub> = V <sub>DD</sub>                             | 0                        | 10                       | —                             | 7.0  | —    | 5.5    | 7.0  | —                              | 7.0   |       |
|                                               |                  | I <sub>OS</sub> = 10μA                                        | 0                        | 15                       | —                             | 11.0 | —    | 8.25   | 11.0 | —                              | 11.0  |       |
| MAXIMUM INPUT LOW VOLTAGE<br>(Control Input)  | V <sub>IL</sub>  | V <sub>IS</sub> = V <sub>SS</sub>                             | 0                        | 5                        | 1.0                           | —    | 1.0  | 2.25   | —    | 1.0                            | —     | Vdc   |
|                                               |                  | V <sub>OS</sub> = V <sub>DD</sub>                             | 0                        | 10                       | 2.0                           | —    | 2.0  | 4.5    | —    | 2.0                            | —     |       |
|                                               |                  | I <sub>OS</sub> = 10μA                                        | 0                        | 15                       | 3.0                           | —    | 3.0  | 6.75   | —    | 3.0                            | —     |       |
| SWITCH INPUT/OUTPUT LEAKAGE                   | I <sub>OFF</sub> | V <sub>C</sub> = V <sub>SS</sub><br>V <sub>IS</sub> = ±7.5Vdc | -7.5                     | +7.5                     | —                             | ±100 | —    | ±0.01  | ±100 | —                              | ±1000 | nAdc  |
| ON-RESISTANCE                                 | R <sub>ON</sub>  | V <sub>C</sub> = V <sub>DD</sub>                              | -7.5                     | +7.5                     | —                             | —    | —    | —      | —    | —                              | —     | Ω     |
|                                               |                  | V <sub>IS</sub> = V <sub>SS</sub> /V <sub>DD</sub>            | 0                        | +15                      | —                             | 220  | —    | 80     | 280  | —                              | 320   |       |
|                                               |                  | V <sub>OS</sub> = $\frac{V_{DD}-V_{SS}}{2}$                   | -5                       | +5                       | —                             | 400  | —    | 120    | 500  | —                              | 550   |       |
|                                               |                  | R <sub>L</sub> = 10kΩ                                         | 0                        | +10                      | —                             | —    | —    | —      | —    | —                              | —     |       |
| ON-RESISTANCE MATCH<br>(Same package)         | ΔR <sub>ON</sub> | V <sub>C</sub> = V <sub>DD</sub>                              | -7.5                     | +7.5                     | —                             | —    | —    | —      | —    | —                              | —     | Ω     |
|                                               |                  | V <sub>IS</sub> = V <sub>SS</sub> /V <sub>DD</sub>            | 0                        | +15                      | —                             | —    | —    | 5      | —    | —                              | —     |       |
|                                               |                  | V <sub>OS</sub> = $\frac{V_{DD}-V_{SS}}{2}$                   | -5                       | +5                       | —                             | —    | —    | —      | 10   | —                              | —     |       |
|                                               |                  | R <sub>L</sub> = 10kΩ                                         | 0                        | +10                      | —                             | —    | —    | —      | —    | —                              | —     |       |
|                                               |                  | V <sub>C</sub> = V <sub>DD</sub>                              | -7.5                     | +7.5                     | —                             | —    | —    | —      | —    | —                              | —     | Ω     |
|                                               |                  | V <sub>IS</sub> = V <sub>SS</sub> /V <sub>DD</sub>            | 0                        | +15                      | —                             | —    | —    | —      | —    | —                              | —     |       |
|                                               |                  | V <sub>OS</sub> = $\frac{V_{DD}-V_{SS}}{2}$                   | -5                       | +5                       | —                             | —    | —    | —      | —    | —                              | —     |       |
|                                               |                  | V <sub>C</sub> = V <sub>DD</sub>                              | -7.5                     | +7.5                     | —                             | —    | —    | —      | —    | —                              | —     | Ω     |
|                                               |                  | V <sub>IS</sub> = V <sub>SS</sub> /V <sub>DD</sub>            | 0                        | +15                      | —                             | —    | —    | —      | —    | —                              | —     |       |
|                                               |                  | V <sub>OS</sub> = $\frac{V_{DD}-V_{SS}}{2}$                   | -5                       | +5                       | —                             | —    | —    | —      | —    | —                              | —     |       |

NOTES: <sup>1</sup> Remaining Static Electrical Characteristics are listed under 4000B Series Family Specifications.

<sup>2</sup> T<sub>LOW</sub> = -55°C for C

= -40°C for E

T<sub>HIGH</sub> = +125°C for C

= + 85°C for E

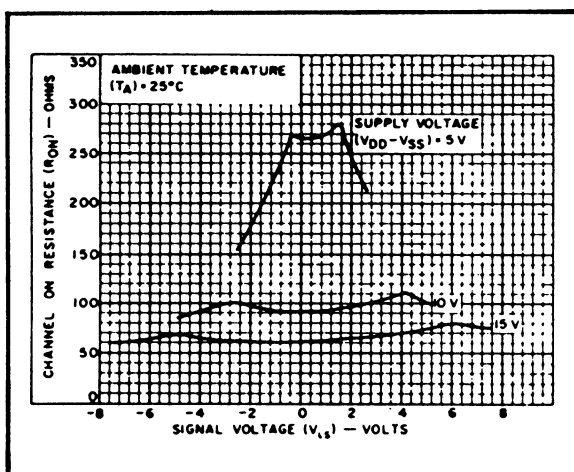
<sup>3</sup> Conditions for measuring V<sub>IH</sub>:

| V <sub>DD</sub> | V <sub>OS</sub> | V <sub>IS</sub> | I <sub>OS</sub>  |        | T <sub>HIGH</sub> | UNITS |
|-----------------|-----------------|-----------------|------------------|--------|-------------------|-------|
|                 |                 |                 | T <sub>LOW</sub> | 25°C   |                   |       |
| 5               | 5               | 4.6             | - .25            | - .20  | - .14             | mA    |
| 10              | 10              | 9.5             | - .62            | - .50  | - .35             |       |
| 15              | 15              | 13.5            | - 1.8            | - 1.50 | - 1.10            |       |

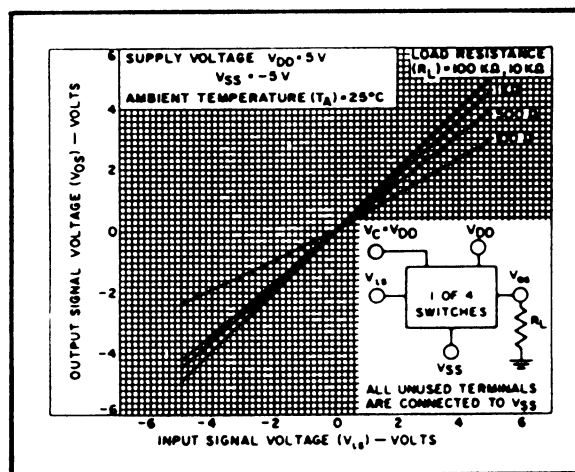
## ELECTRICAL CHARACTERISTICS (Continued)

DYNAMIC CHARACTERISTICS ( $C_L = 50\text{pF}$ ,  $T_A = 25^\circ\text{C}$ )

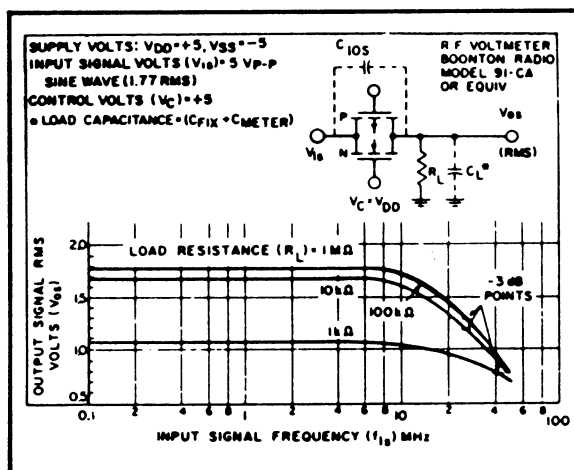
| PARAMETER                                                                    | CONDITIONS                                                                                                                                  | $V_{SS}$<br>(Vdc) | $V_{DD}$<br>(Vdc) | Min.             | Typ.                      | Max.             | Units |
|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|------------------|---------------------------|------------------|-------|
| <b>SIGNAL INPUTS (<math>V_{is}</math>) AND OUTPUTS (<math>V_{os}</math>)</b> |                                                                                                                                             |                   |                   |                  |                           |                  |       |
| PROPAGATION DELAY TIME<br>Signal Input to Signal Output                      | $t_{PLH}$ ,<br>$t_{PHL}$<br>$V_c = V_{DD}$<br>$V_{is} = \text{Square Wave}$<br>$R_L = 10\text{k}\Omega$                                     | 0<br>0<br>0       | 5<br>10<br>15     | —<br>—<br>—      | 20<br>10<br>7.5           | 40<br>20<br>15   | ns    |
| BANDWIDTH (-3dB)<br>(Sine Wave)                                              | BW<br>$V_c = V_{DD}$<br>$V_{is} = 5V_{p-p}$<br>centered<br>@ 0.0Vdc<br>$R_L$<br>1k $\Omega$<br>10k $\Omega$<br>100k $\Omega$<br>1M $\Omega$ | -5                | +5                | —<br>—<br>—<br>— | 54<br>40<br>38<br>37      | —<br>—<br>—<br>— | MHz   |
| INSERTION LOSS<br>( $= 20 \log_{10} \frac{V_{os}}{V_{is}}$ )                 | $V_c = V_{DD}$<br>$V_{is} = 5V_{p-p}$<br>centered<br>@ 0.0Vdc<br>$R_L$<br>1k $\Omega$<br>10k $\Omega$<br>100k $\Omega$<br>1M $\Omega$       | -5                | +5                | —<br>—<br>—<br>— | 2.3<br>0.2<br>0.1<br>0.05 | —<br>—<br>—<br>— | dB    |
| SIGNAL DISTORTION<br>(Sine Wave)                                             | $V_c = V_{DD}$<br>$V_{is} = 5V_{p-p}$<br>centered<br>@ 0.0Vdc<br>$f_{is} = 1.0\text{kHz}$<br>$R_L = 10\text{k}\Omega$                       | -5                | +5                | —                | 0.16                      | —                | %     |
| FEEDTHROUGH (-50dB)                                                          | $V_c = V_{SS}$<br>$V_{is} = 5V_{p-p}$<br>centered<br>@ 0.0Vdc<br>$R_L$<br>1k $\Omega$<br>10k $\Omega$<br>100k $\Omega$<br>1M $\Omega$       | -5                | +5                | —<br>—<br>—<br>— | 1250<br>140<br>18<br>2    | —<br>—<br>—<br>— | kHz   |
| CROSSTALK (-50dB)<br>Between two switches                                    | $V_c(A) = V_{DD}$<br>$V_c(B) = V_{SS}$<br>$V_{is}(A) = 5V_{p-p}$<br>centered<br>@ 0.0Vdc<br>$R_L = 10\text{k}\Omega$                        | -5                | +5                | —                | 0.9                       | —                | MHz   |
| CAPACITANCE                                                                  |                                                                                                                                             |                   |                   |                  |                           |                  |       |
| Input                                                                        | $C_{is}$                                                                                                                                    |                   |                   | —                | 8                         | —                | pF    |
| Output                                                                       | $C_{os}$                                                                                                                                    | $V_c = V_{SS}$    | -5                | +5               | —                         | 8                | pF    |
| Feedthrough                                                                  | $C_{ios}$                                                                                                                                   |                   |                   | —                | 0.5                       | —                | pF    |
| <b>CONTROL INPUT (<math>V_c</math>)</b>                                      |                                                                                                                                             |                   |                   |                  |                           |                  |       |
| PROPAGATION DELAY TIME<br>Turn on                                            | $t_{PC}$<br>$V_{SS} \leq V_{is} \leq V_{DD}$<br>$R_L = 10\text{k}\Omega$                                                                    | 0<br>0<br>0       | 5<br>10<br>15     | —<br>—<br>—      | 50<br>25<br>20            | 100<br>50<br>40  | ns    |
| MAXIMUM INPUT<br>FREQUENCY                                                   | $f_c$<br>$V_{SS} \leq V_{is} \leq V_{DD}$<br>$R_L = 1.0\text{k}\Omega$                                                                      | 0<br>0<br>0       | 5<br>10<br>15     | —<br>—<br>—      | 5<br>10<br>12             | —<br>—<br>—      | MHz   |
| CROSSTALK<br>(To signal port)                                                | $V_c = \text{Square Wave}$<br>$R_L = 10\text{k}\Omega$<br>$R_{in} = 1.0\text{k}\Omega$                                                      | 0<br>0<br>0       | 5<br>10<br>15     | —<br>—<br>—      | 30<br>50<br>100           | —<br>—<br>—      | mV    |



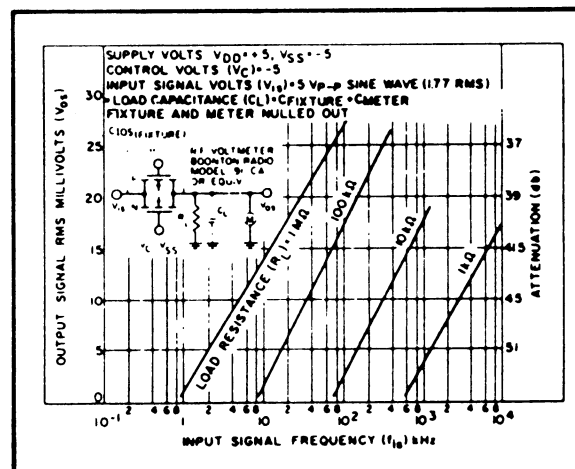
Typical channel ON resistance vs. signal voltage for three values of supply voltage ( $V_{DD} - V_{SS}$ )



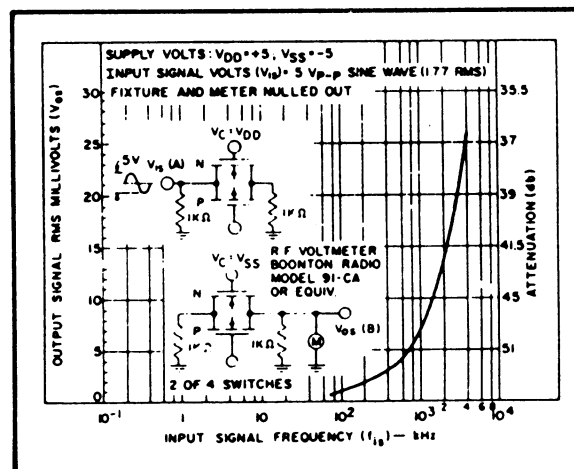
Typical ON characteristics for 1 of 4 channels.



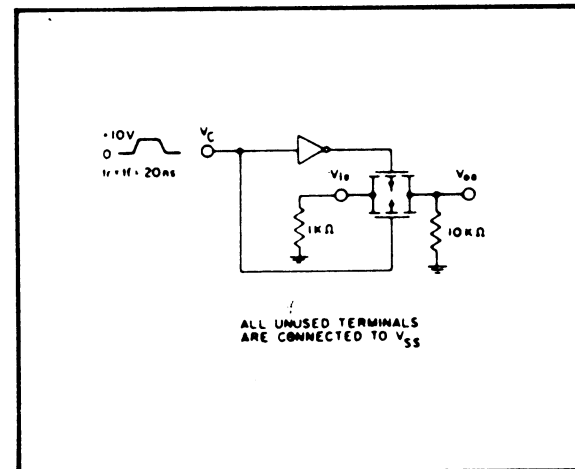
Typ. switch frequency response - switch "ON"



Typ. feedthru vs. freq. - switch "OFF"



Typ. crosstalk between switch circuits in the same package

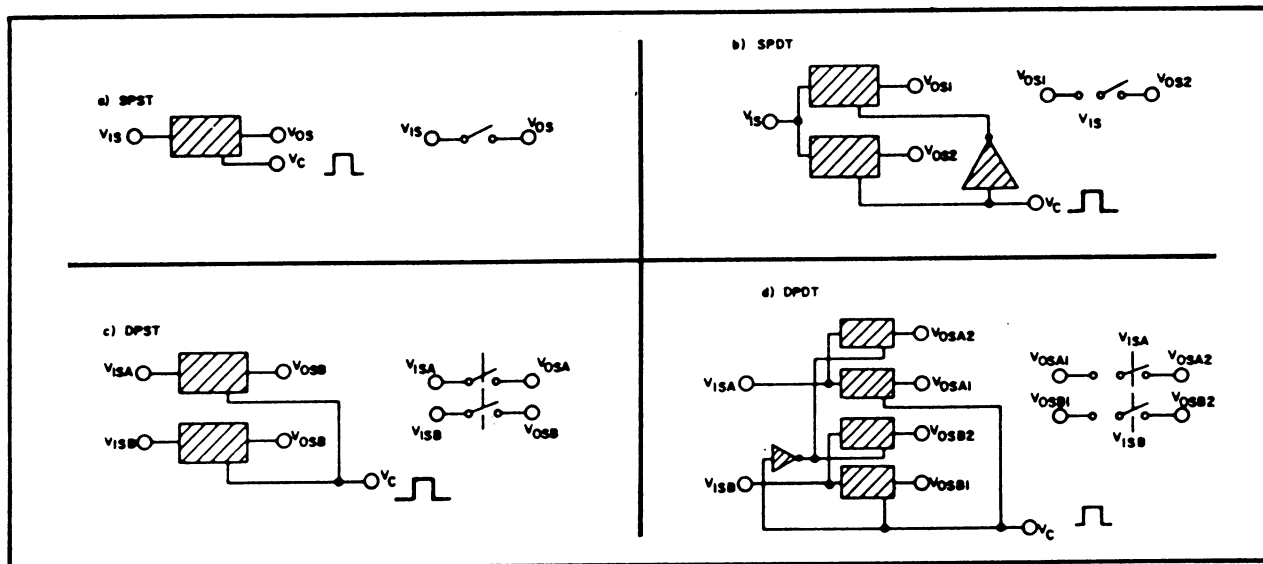


Test circuit, crosstalk-control input to signal output

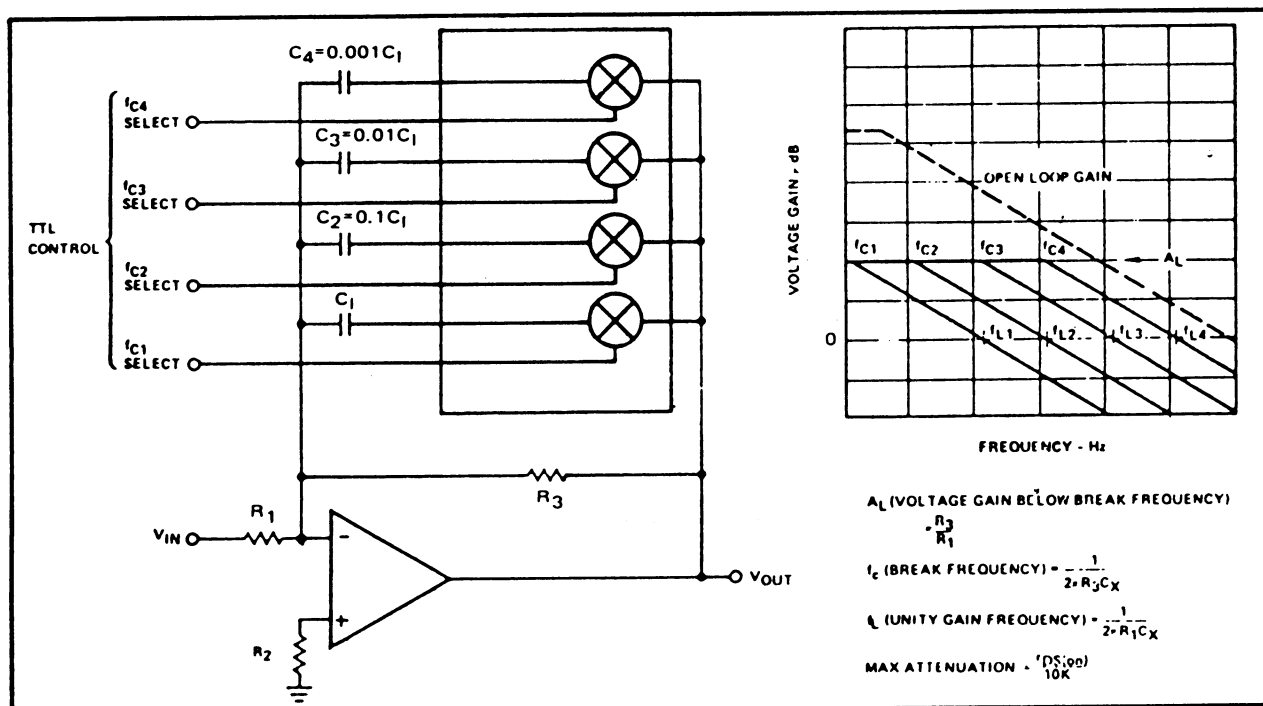
## SPECIAL CONSIDERATIONS – 4066B

1. 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 of the 4 4066B bilateral switches). This provision avoids any permanent current flow or clamp action on the  $V_{DD}$  supply when power is applied or removed from 4066B.
2. 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 terminals 1, 4, 8, or 11, the voltage drop across the bidirectional switch must not exceed 0.8 volt (calculated from  $R_{ON}$  values shown).  
No  $V_{DD}$  current will flow through  $R_L$  if the switch current flows into terminals 2, 3, 9, or 10. Failure to observe this condition may result in distortion of the signal.

## APPLICATIONS INFORMATION



Basic Switch Functions using the 4066B



Active Low Pass Filter with Digitally Selected Break Frequency