

# TC4016BP/BF

C<sup>2</sup>MOS DIGITAL INTEGRATED CIRCUIT  
SILICON MONOLITHIC

## TC4016BP/TC4016BF QUAD BILATERAL SWITCH

TC4016BP/BF contains four circuits of independent bidirectional switches. When control input CONT is placed at "H" level, the impedance between the input and output of switch becomes low and when CONT is placed at "L" level, it becomes high. This can be used for switching analog and digital signals.

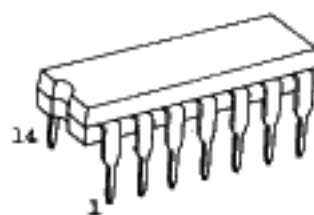
Resistance during ON,  $R_{ON}$

$2.5 \times 10^2 \Omega$  (TYP.) .....  $V_{DD}-V_{SS}=10V$

$1.5 \times 10^2 \Omega$  (TYP.) .....  $V_{DD}-V_{SS}=15V$

Resistance during OFF,  $R_{OFF}$

$R_{OFF}$  (TYP.)  $> 10^9 \Omega$

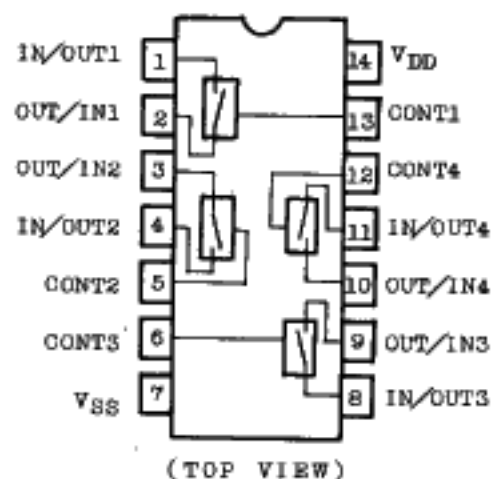


DIP14 (3D14A-P)



MFP14 (F14GB-P)

## PIN ASSIGNMENT

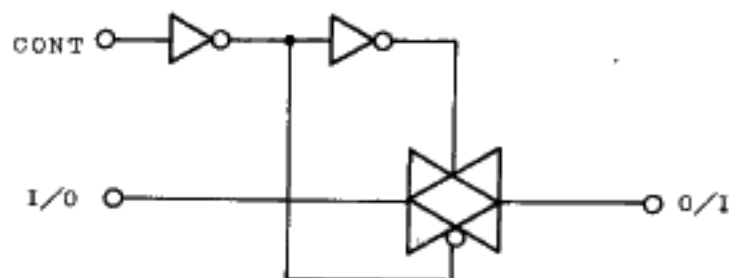


## ABSOLUTE MAXIMUM RATINGS

| CHARACTERISTIC              | SYMBOL    | RATING                              | UNITS       |
|-----------------------------|-----------|-------------------------------------|-------------|
| DC Supply Voltage           | $V_{DD}$  | $V_{SS}-0.5 \sim V_{SS}+20$         | V           |
| Control Input Voltage       | $V_{CIN}$ | $V_{SS}-0.5 \sim V_{DD}+0.5$        | V           |
| Switch I/O Voltage          | $V_{I/O}$ | $V_{SS}-0.5 \sim V_{DD}+0.5$        | V           |
| Control Input Current       | $I_C$     | $\pm 10$                            | mA          |
| Power Dissipation           | $P_D$     | 300 (DIP) / 180 (MFP)               | mW          |
| Operating Temperature Range | $T_A$     | $-40 \sim 85$                       | $^{\circ}C$ |
| Storage Temperature Range   | $T_{stg}$ | $-65 \sim 150$                      | $^{\circ}C$ |
| Lead Temp./Time             | $T_{sol}$ | $260^{\circ}C \cdot 10 \text{ sec}$ |             |

## LOGIC DIAGRAM

(1/4 TC4016BP/BF)



## TRUTH TABLE

| CONTROL | IMPEDANCE BETWEEN<br>IN/OUT - OUT/IN * |
|---------|----------------------------------------|
| H       | $1 \sim 20 \times 10^2 \Omega$         |
| L       | $> 10^9 \Omega$                        |

\* SEE STATIC ELECTRICAL  
CHARACTERISTICS

## RECOMMENDED OPERATING CONDITIONS

| CHARACTERISTIC       | SYMBOL           | MIN. | TYP. | MAX.     | UNITS |
|----------------------|------------------|------|------|----------|-------|
| DC Supply Voltage    | $V_{DD}$         | 3    | -    | 18       | V     |
| Input/Output Voltage | $V_{IN}/V_{OUT}$ | 0    | -    | $V_{DD}$ |       |

STATIC ELECTRICAL CHARACTERISTICS (In case not specifically appointed,  $V_{SS}=0V$ )

| CHARACTERISTIC                                           | SYMBOL         | TEST CONDITIONS              | $V_{SS}$<br>(V) | $V_{DD}$<br>(V) | -40°C |           | 25°C |            |           | 85°C |            | UNITS    |
|----------------------------------------------------------|----------------|------------------------------|-----------------|-----------------|-------|-----------|------|------------|-----------|------|------------|----------|
|                                                          |                |                              |                 |                 | MIN.  | MAX.      | MIN. | TYP.       | MAX.      | MIN. | MAX.       |          |
| Control Input High Voltage                               | $V_{IH}$       | $ I_{IS} =10\mu A$           | 5               | 5               | 3.5   | -         | 3.5  | 2.4        | -         | 3.5  | -          | V        |
|                                                          |                |                              |                 | 10              | 7.0   | -         | 7.0  | 4.8        | -         | 7.0  | -          |          |
|                                                          |                |                              |                 | 15              | 11.0  | -         | 11.0 | 7.2        | -         | 11.0 | -          |          |
| Control Input Low Voltage                                | $V_{IL}$       | $ I_{IS} =10\mu A$           | 5               | 5               | -     | 1.0       | -    | 1.7        | 1.0       | -    | 1.0        | V        |
|                                                          |                |                              |                 | 10              | -     | 1.0       | -    | 1.7        | 1.0       | -    | 1.0        |          |
|                                                          |                |                              |                 | 15              | -     | 1.0       | -    | 1.7        | 1.0       | -    | 1.0        |          |
| On-State Resistance                                      | $R_{ON}$       | $V_{IN}=5V$                  | 5               | 5               | -     | -         | -    | 300        | -         | -    | -          | $\Omega$ |
|                                                          |                | $V_{IN}=2.5V$                |                 | 5               | -     | -         | -    | 2000       | -         | -    | -          |          |
|                                                          |                | $V_{IN}=0.25V$               |                 | 5               | -     | -         | -    | 300        | -         | -    | -          |          |
|                                                          |                | $V_{IN}=10V$                 | 10              | 10              | -     | 600       | -    | 180        | 660       | -    | 840        |          |
|                                                          |                | $V_{IN}=5V$                  |                 | 10              | -     | 600       | -    | 300        | 660       | -    | 840        |          |
|                                                          |                | $V_{IN}=0.25V$               |                 | 10              | -     | 600       | -    | 130        | 660       | -    | 840        |          |
|                                                          |                | $V_{IN}=15V$                 | 15              | 15              | -     | 370       | -    | 140        | 400       | -    | 520        |          |
|                                                          |                | $V_{IN}=7.5V$                |                 | 15              | -     | 370       | -    | 160        | 400       | -    | 520        |          |
|                                                          |                | $V_{IN}=0.25V$               |                 | 15              | -     | 370       | -    | 100        | 400       | -    | 520        |          |
|                                                          |                | $V_{IN}=5V$                  | -5              | 5               | -     | 600       | -    | 180        | 660       | -    | 840        |          |
|                                                          |                | $V_{IN}=\pm 0.25V$           | -5              | 5               | -     | 600       | -    | 300        | 660       | -    | 840        |          |
|                                                          |                | $V_{IN}=-5V$                 | -5              | 5               | -     | 600       | -    | 130        | 660       | -    | 840        |          |
| $\Delta$ On-State Resistance<br>(Between Any 2 Switches) | $R_{ON\Delta}$ | $V_{IN}=7.5V$                | -7.5            | 7.5             | -     | 370       | -    | 140        | 400       | -    | 520        | $\Omega$ |
|                                                          |                | $V_{IN}=\pm 0.25V$           | -7.5            | 7.5             | -     | 370       | -    | 160        | 400       | -    | 520        |          |
|                                                          |                | $V_{IN}=-7.5V$               | -7.5            | 7.5             | -     | 370       | -    | 100        | 400       | -    | 520        |          |
| Input/Output Leakage Current                             | $I_{OFF}$      | $V_{IN}=18V, V_{OUT}=0V$     | 18              | 18              | -     | $\pm 100$ | -    | $\pm 0.1$  | $\pm 100$ | -    | $\pm 1000$ | nA       |
|                                                          |                | $V_{IN}=0V, V_{OUT}=18V$     |                 | 18              | -     | $\pm 100$ | -    | $\pm 0.1$  | $\pm 100$ | -    | $\pm 1000$ |          |
| Quiescent Device Current                                 | $I_{DD}$       | $V_{IN}=V_{DD}, V_{SS}$<br>* | 5               | 5               | -     | 0.25      | -    | 0.001      | 0.25      | -    | 7.5        | $\mu A$  |
|                                                          |                |                              | 10              | 10              | -     | 0.5       | -    | 0.001      | 0.5       | -    | 15         |          |
|                                                          |                |                              | 15              | 15              | -     | 1.0       | -    | 0.002      | 1.0       | -    | 30         |          |
| Input Current                                            | $I_{IH}$       | $V_{IH}=18V$                 | 18              | 18              | -     | 0.1       | -    | $10^{-5}$  | 0.1       | -    | 1.0        | $\mu A$  |
|                                                          | $I_{IL}$       | $V_{IL}=0V$                  |                 | 18              | -     | -0.1      | -    | $-10^{-5}$ | -0.1      | -    | -1.0       |          |

\* All valid input combinations.

## DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C)

| CHARACTERISTIC                            | SYMBOL                      | TEST CONDITIONS                                  | V <sub>SS</sub> (V) | V <sub>DD</sub> (V) | MIN. | TYP. | MAX. | UNITS |
|-------------------------------------------|-----------------------------|--------------------------------------------------|---------------------|---------------------|------|------|------|-------|
| Propagation Delay Time<br>(IN - OUT)      | t <sub>pLH</sub>            | C <sub>L</sub> =50pF                             | 0                   | 5                   | -    | 24   | 45   | ns    |
|                                           | t <sub>pHL</sub>            |                                                  | 0                   | 10                  | -    | 11   | 15   |       |
|                                           | t <sub>pHL</sub>            |                                                  | 0                   | 15                  | -    | 8    | 12   |       |
| Propagation Delay Time<br>(CONTROL - OUT) | t <sub>pLH</sub>            | R <sub>L</sub> =1kΩ                              | 0                   | 5                   | -    | 35   | 70   |       |
|                                           | t <sub>pHL</sub>            | C <sub>L</sub> =50pF                             | 0                   | 10                  | -    | 20   | 40   |       |
|                                           | t <sub>pHL</sub>            |                                                  | 0                   | 15                  | -    | 17   | 30   |       |
| Max. Control Input<br>Repetition Rate     | f <sub>MAX</sub><br>(CONT)  | R <sub>L</sub> =1kΩ                              | 0                   | 5                   | -    | 10   | -    |       |
|                                           |                             | C <sub>L</sub> =50pF                             | 0                   | 10                  | -    | 12   | -    |       |
|                                           |                             |                                                  | 0                   | 15                  | -    | 12   | -    |       |
| -3dB Cutoff Frequency                     | f <sub>MAX</sub><br>(I - O) | R <sub>L</sub> =1kΩ                              | -5                  | 5                   | -    | 24   | -    | MHz   |
|                                           |                             | R <sub>L</sub> =2kΩ                              |                     |                     | -    | 23   | -    |       |
|                                           |                             | R <sub>L</sub> =10kΩ                             |                     |                     | -    | 22   | -    |       |
|                                           |                             | R <sub>L</sub> =100kΩ                            |                     |                     | -    | 22   | -    |       |
|                                           |                             | R <sub>L</sub> =1MΩ<br>C <sub>L</sub> =15pF (*1) |                     |                     | -    | 22   | -    |       |
| Total Harmonic<br>Distortion              | -                           | R <sub>L</sub> =10kΩ<br>f=1MHz (*2)              | -5                  | 5                   | -    | 0.16 | -    | %     |
| -50dB Feedthrough<br>Frequency            | -                           | R <sub>L</sub> =1kΩ (*3)                         | -5                  | 5                   | -    | 600  | -    | kHz   |
| -50dB Crosstalk<br>Frequency              | -                           | R <sub>L</sub> =1kΩ (*4)                         | -5                  | 5                   | -    | 1    | -    | MHz   |
| Crosstalk<br>(CONTROL - OUT)              | -                           | R <sub>IN</sub> =1kΩ                             | 0                   | 5                   | -    | 50   | -    | mV    |
|                                           |                             | R <sub>OUT</sub> =10kΩ                           | 0                   | 10                  | -    | 100  | -    |       |
|                                           |                             | C <sub>L</sub> =15pF                             | 0                   | 15                  | -    | 150  | -    |       |
| Input Capacitance                         | C <sub>IN</sub>             | Control Input                                    | -                   |                     |      | 5    | 7.5  | pF    |
|                                           |                             | Switch I/O                                       | -                   |                     |      | 5    | -    |       |
| Feed through Capacitance                  | C <sub>IN-OUT</sub>         |                                                  | -                   |                     |      | 0.5  | -    |       |

\*1 Sine wave of ±2.5Vp-p shall be used for V<sub>is</sub> and the frequency of  $20 \log_{10} \frac{V_{os}}{V_{is}} = -3\text{dB}$  shall be f<sub>MAX</sub>.

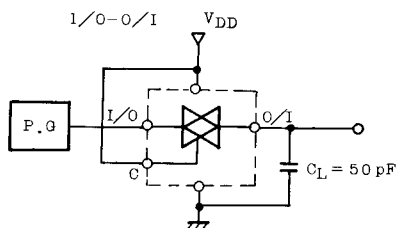
\*2 V<sub>is</sub> shall be sine wave of ±2.5Vp-p.

\*3 Sine wave of ±2.5Vp-p shall be used for V<sub>is</sub> and the frequency of  $20 \log_{10} \frac{V_{os}}{V_{is}} = -50\text{dB}$  shall be feed-through.

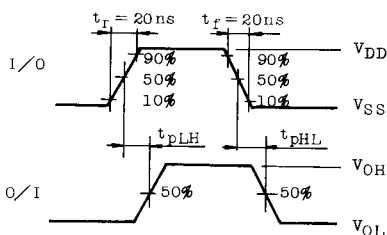
\*4 Sine wave of ±2.5Vp-p shall be used for V<sub>is</sub> and the frequency of  $20 \log_{10} \frac{V_{os}}{V_{is}} = -50\text{dB}$  shall be crosstalk.

# CIRCUIT FOR MEASUREMENT OF ELECTRICAL CHARACTERISTICS

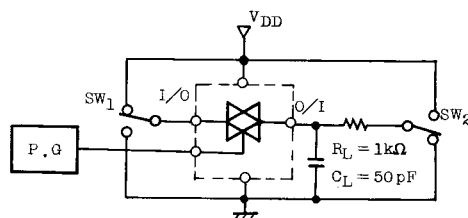
## 1. $t_{pLH}$ , $t_{pHL}$



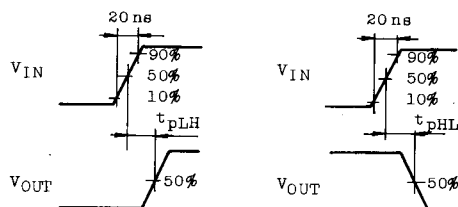
### WAVEFORM



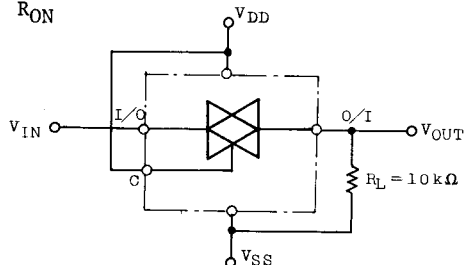
## 2. $t_{pLH}$ , $t_{pHL}$ (CONTROL - OUT)



### WAVEFORM

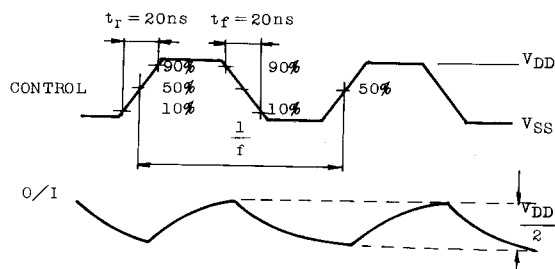
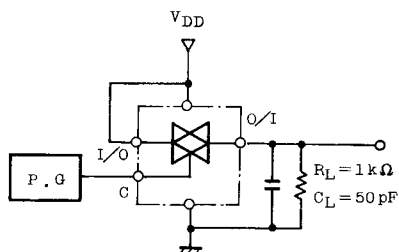


## 3. $R_{ON}$



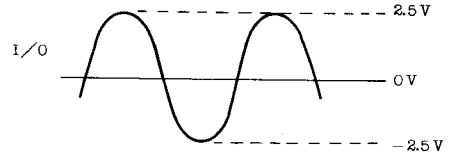
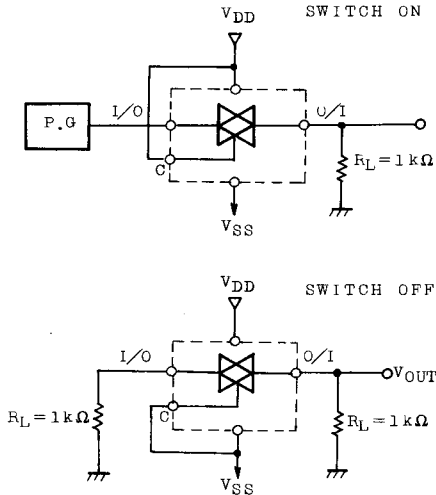
$$R_{ON} = 10 \times \frac{(V_{IN} - V_{OUT})}{V_{OUT}} \text{ (k}\Omega\text{)}$$

## 4. $f_{MAX}(C)$

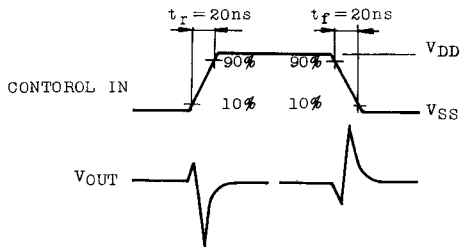
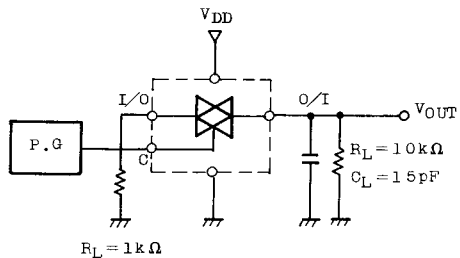


CIRCUIT FOR MEASUREMENT OF ELECTRICAL CHARACTERISTICS

5. CROSSTALK BETWEEN ANY TWO SWITCHES



6. CROSSTALK, CONTROL TO INPUT



7. TOTAL HARMONIC DISTORTION,  $f_{\text{MAX}}(I-O)$ , FEEDTHROUGH

