

# TC4016BP/BF

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

## TC4016BP/TC4016BF QUAD BILATERAL SWITCH

TC4016BP/BF contains for 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.

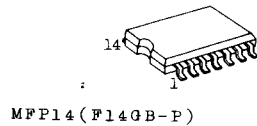
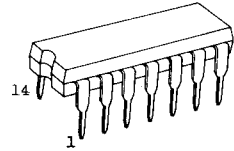
Resistance during ON,  $R_{ON}$

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

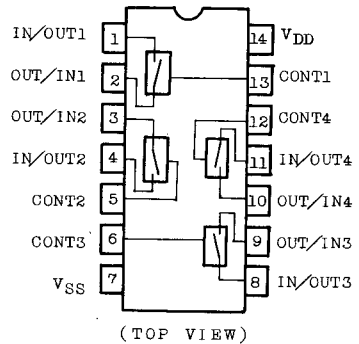
$1.5 \times 10^2 \Omega$  (TYP.) .....  $V_{DD}-V_{SS}=15V$

Resistance during OFF,  $R_{OFF}$

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



### PIN ASSIGNMENT

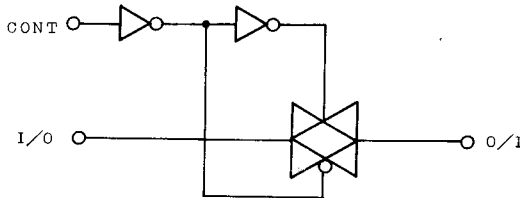


### ABSOLUTE MAXIMUM RATINGS

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 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 <sub>DD</sub>	3	-	18	V
Input/Output Voltage	V <sub>IN</sub> /V <sub>OUT</sub>	0	-	V <sub>DD</sub>	

STATIC ELECTRICAL CHARACTERISTICS (In case not specifically appointed, V<sub>SS</sub>=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V <sub>SS</sub> (V)	V <sub>DD</sub> (V)	-40°C		25°C			85°C		UNITS	
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Control Input High Voltage	V <sub>IH</sub>	I <sub>is</sub>  =10μA		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 <sub>IL</sub>	I <sub>is</sub>  =10μA		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 <sub>ON</sub>	V <sub>IN</sub> =5V V <sub>IN</sub> =2.5V V <sub>IN</sub> =0.25V		5	-	-	-	300	-	-	-	Ω	
				5	-	-	-	2000	-	-	-		
				5	-	-	-	300	-	-	-		
		V <sub>IN</sub> =10V V <sub>IN</sub> =5V V <sub>IN</sub> =0.25V		10	-	600	-	180	660	-	840		
				10	-	600	-	300	660	-	840		
				10	-	600	-	130	660	-	840		
		V <sub>IN</sub> =15V V <sub>IN</sub> =7.5V V <sub>IN</sub> =0.25V		15	-	370	-	140	400	-	520		
				15	-	370	-	160	400	-	520		
				15	-	370	-	100	400	-	520		
		V <sub>IN</sub> =5V V <sub>IN</sub> =±0.25V V <sub>IN</sub> =-5V		-5	5	-	600	-	180	660	-		840
				-5	5	-	600	-	300	660	-		840
				-5	5	-	600	-	130	660	-		840
V <sub>IN</sub> =7.5V V <sub>IN</sub> =±0.25V V <sub>IN</sub> =-7.5V		-7.5	7.5	-	370	-	140	400	-	520			
		-7.5	7.5	-	370	-	160	400	-	520			
		-7.5	7.5	-	370	-	100	400	-	520			
ΔOn-State Resistance (Between Any 2 Switches)	R <sub>ON</sub> <sup>Δ</sup>			-5	5	-	-	7	-	-	Ω		
				-7.5	7.5	-	-	5	-	-			
Input/Output Leakage Current	I <sub>OFF</sub>	V <sub>IN</sub> =18V, V <sub>OUT</sub> =0V V <sub>IN</sub> =0V, V <sub>OUT</sub> =18V		18	-	±100	-	±0.1	±100	-	±1000	nA	
				18	-	±100	-	±0.1	±100	-	±1000		
Quiescent Device Current	I <sub>DD</sub>	V <sub>IN</sub> =V <sub>DD</sub> , V <sub>SS</sub> *		5	-	0.25	-	0.001	0.25	-	7.5	μA	
				10	-	0.5	-	0.001	0.5	-	15		
				15	-	1.0	-	0.002	1.0	-	30		
Input Current	I <sub>IH</sub>	V <sub>IH</sub> =18V		18	-	0.1	-	10 <sup>-5</sup>	0.1	-	1.0		
	I <sub>IL</sub>	V <sub>IL</sub> =0V		18	-	-0.1	-	-10 <sup>-5</sup>	-0.1	-	-1.0		

\* All valid input combinations.

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V <sub>SS</sub> (V)		MIN.	TYP.	MAX.	UNITS
			0	V <sub>DD</sub> (V)				
Propagation Delay Time (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 (CONTROL - OUT)	t <sub>pLH</sub>	R <sub>L</sub> =1kΩ	0	5	-	35	70	ns
	t <sub>pHL</sub>	R <sub>L</sub> =1kΩ	0	10	-	20	40	
	t <sub>pHL</sub>	C <sub>L</sub> =50pF	0	15	-	17	30	
Max. Control Input Repetition Rate	f <sub>MAX</sub> (CONT)	R <sub>L</sub> =1kΩ	0	5	-	10	-	MHz
		C <sub>L</sub> =50pF	0	10	-	12	-	
		C <sub>L</sub> =50pF	0	15	-	12	-	
-3dB Cutoff Frequency	f <sub>MAX</sub> (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 C <sub>L</sub> =15pF (*1)			-	22	-	
Total Harmonic Distortion	-	R <sub>L</sub> =10kΩ f=1MHz (*2)	-5	5	-	0.16	-	%
-50dB Feedthrough Frequency	-	R <sub>L</sub> =1kΩ (*3)	-5	5	-	600	-	kHz
-50dB Crosstalk Frequency	-	R <sub>L</sub> =1kΩ (*4)	-5	5	-	1	-	MHz
Crosstalk (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>.

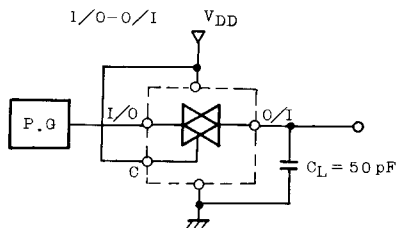
\*2 V<sub>is</sub> shall be sine wave of ±2.5Vp-p.

\*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.

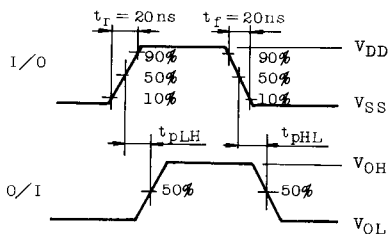
\*4 Sine wave of ±2.5Vp-p shall be used for V<sub>is</sub> and the frequency of  $20 \log_{10} \frac{V_{os}}{V_{is}} = -50\text{dB}$  shall be crosstalk.

CIRCUIT FOR MEASUREMENT OF ELECTRICAL CHARACTERISTICS

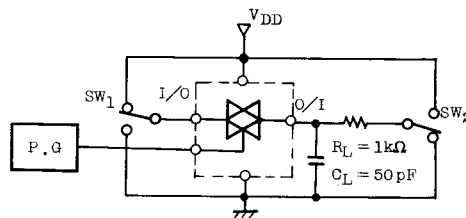
1.  $t_{pLH}$ ,  $t_{pHL}$



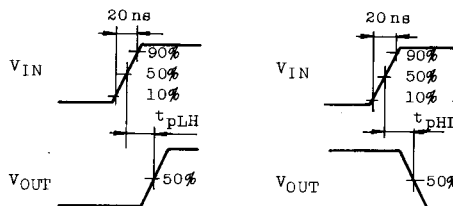
WAVEFORM



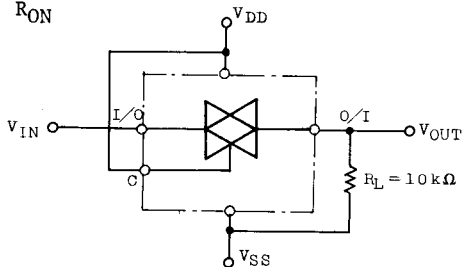
2.  $t_{pLH}$ ,  $t_{pHL}$  (CONTROL - OUT)



WAVEFORM

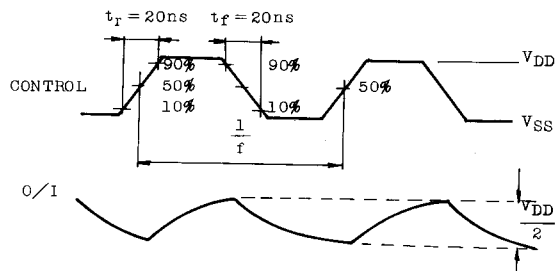
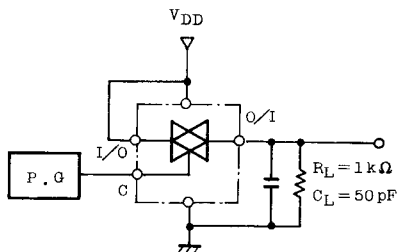


3.  $R_{ON}$



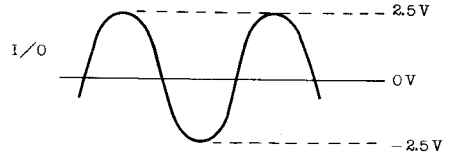
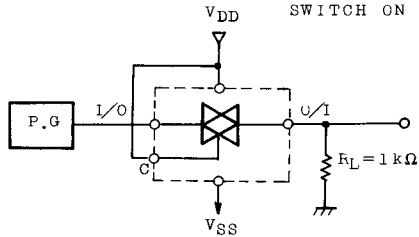
$$R_{ON} = 10 \times \frac{(V_{IN} - V_{OUT})}{V_{OUT}} \text{ (k}\Omega\text{)}$$

4.  $f_{MAX}(C)$

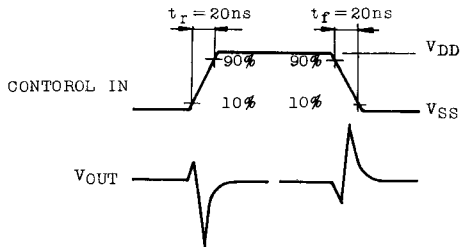
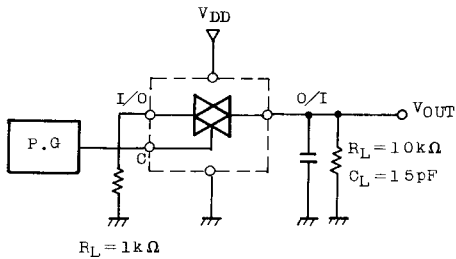


## CIRCUIT FOR MEASUREMENT OF ELECTRICAL CHARACTERISTICS

### 5. CROSSTALK BETWEEN ANY TWO SWITCHES



### 6. CROSSTALK, CONTROL TO INPUT



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

