

CD4016BM/CD4016BC Quad Bilateral Switch

General Description

The CD4016BM/CD4016BC is a quad bilateral switch intended for the transmission or multiplexing of analog or digital signals. It is pin-for-pin compatible with CD4066BM/CD4066BC.

Features

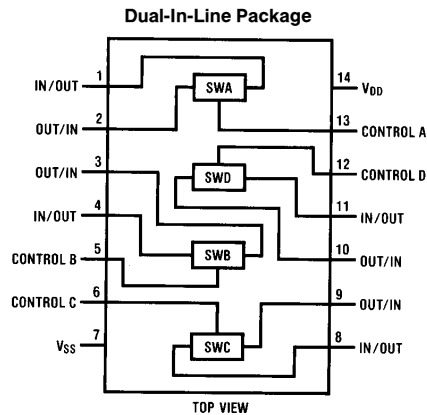
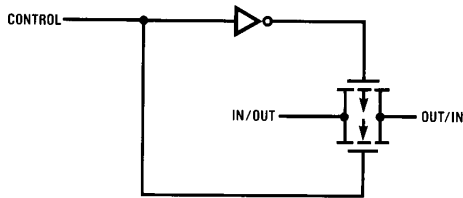
- Wide supply voltage range 3V to 15V
- Wide range of digital and analog switching $\pm 7.5 V_{PEAK}$
- "ON" resistance for 15V operation 400 Ω (typ.)
- Matched "ON" resistance over 15V signal input $\Delta R_{ON} = 10\Omega$ (typ.)
- High degree of linearity 0.4% distortion (typ.)
@ $f_{IS} = 1 \text{ kHz}$, $V_{IS} = 5 V_{p-p}$,
 $V_{DD} - V_{SS} = 10V$, $R_L = 10 \text{ k}\Omega$
- Extremely low "OFF" switch leakage 0.1 nA (typ.)
@ $V_{DD} - V_{SS} = 10V$
 $T_A = 25^\circ\text{C}$

- Extremely high control input impedance 10¹² Ω (typ.)
- Low crosstalk between switches -50 dB (typ.)
@ $f_{IS} = 0.9 \text{ MHz}$, $R_L = 1 \text{ k}\Omega$
- Frequency response, switch "ON" 40 MHz (typ.)

Applications

- Analog signal switching/multiplexing
 - Signal gating
 - Squelch control
 - Chopper
 - Modulator/Demodulator
 - Commutating switch
- Digital signal switching/multiplexing
- CMOS logic implementation
- Analog-to-digital/digital-to-analog conversion
- Digital control of frequency, impedance, phase, and analog-signal gain

Schematic and Connection Diagrams



Order Number CD4016B

TL/F/5661-1

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

(Notes 1 and 2)

V _{DD} Supply Voltage	−0.5V to +18V
V _{IN} Input Voltage	−0.5V to V _{DD} + 0.5V
T _S Storage Temperature Range	−65°C to +150°C
Power Dissipation (P _D)	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature (Soldering, 10 seconds)	260°C

Recommended Operating Conditions (Note 2)

V _{DD} Supply Voltage	3V to 15V
V _{IN} Input Voltage	0V to V _{DD}
T _A Operating Temperature Range	
CD4016BM	−55°C to +125°C
CD4016BC	−40°C to +85°C

DC Electrical Characteristics CD4016BM (Note 2)

Symbol	Parameter	Conditions	−55°C		25°C			125°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I _{DD}	Quiescent Device Current	V _{DD} =5V, V _{IN} =V _{DD} or V _{SS}		0.25		0.01	0.25		7.5	μA
		V _{DD} =10V, V _{IN} =V _{DD} or V _{SS}		0.5		0.01	0.5		15	μA
		V _{DD} =15V, V _{IN} =V _{DD} or V _{SS}		1.0		0.01	1.0		30	μA
Signal Inputs and Outputs										
R _{ON}	“ON” Resistance	R _L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$ V _C = V _{DD} , V _{IS} = V _{SS} or V _{DD} V _{DD} = 10V V _{DD} = 15V		600 360		250 200	660 400		960 600	Ω Ω
		R _L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$ V _C = V _{DD} V _{DD} = 10V, V _{IS} = 4.75 to 5.25V V _{DD} = 15V, V _{IS} = 7.25 to 7.75V		1870 775		850 400	2000 850		2600 1230	Ω Ω
ΔR _{ON}	Δ“ON” Resistance Between any 2 of 4 Switches (In Same Package)	R _L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$ V _C = V _{DD} , V _{IS} = V _{SS} to V _{DD} V _{DD} = 10V V _{DD} = 15V				15 10			Ω Ω	
I _{IS}	Input or Output Leakage Switch “OFF”	V _C = 0, V _{DD} = 15V V _{IS} = 15V and 0V, V _{OS} = 0V and 15V		±50		±0.1	±50		±500	nA
Control Inputs										
V _{ILC}	Low Level Input Voltage	V _{IS} = V _{SS} and V _{DD} V _{OS} = V _{DD} and V _{SS} I _{IS} = ±10 μA V _{DD} = 5V		0.9			0.7		0.5	V
		V _{DD} = 10V		0.9			0.7		0.5	V
		V _{DD} = 15V		0.9			0.7		0.5	V
V _{IHC}	High Level Input Voltage	V _{DD} = 5V	3.5		3.5			3.5		V
		V _{DD} = 10V (see Note 6 and Figure 8)	7.0		7.0			7.0		V
		V _{DD} = 15V	11.0		11.0			11.0		V
I _{IN}	Input Current	V _{DD} − V _{SS} = 15V V _{DD} ≥ V _{IS} ≥ V _{SS} V _{DD} ≥ V _C ≥ V _{SS}		±0.1		±10 ^{−5}	±0.1		±1.0	μA

DC Electrical Characteristics CD4016BC (Note 2) (Continued)

Symbol	Parameter	Conditions	-40°C		25°C			85°C		Units		
			Min	Max	Min	Typ	Max	Min	Max			
I _{DD}	Quiescent Device Current	V _{DD} = 5V, V _{IN} = V _{DD} or V _{SS}		1.0		0.01	1.0		7.5	μA		
		V _{DD} = 10V, V _{IN} = V _{DD} or V _{SS}		2.0		0.01	2.0		15	μA		
		V _{DD} = 15V, V _{IN} = V _{DD} or V _{SS}		4.0		0.01	4.0		30	μA		
Signal Inputs and Outputs												
R _{ON}	"ON" Resistance	R _L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$ V _C = V _{DD} , V _{IS} = V _{SS} or V _{DD} V _{DD} = 10V V _{DD} = 15V		610 370		275 200	660 400		840 520	Ω Ω		
		R _L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$ V _C = V _{DD} V _{DD} = 10V, V _{IS} = 4.75 to 5.25V V _{DD} = 15V, V _{IS} = 7.25 to 7.75V		1900 790		850 400	2000 850		2380 1080	Ω Ω		
ΔR _{ON}	Δ"ON" Resistance Between any 2 of 4 Switches (In Same Package)	R _L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$ V _C = V _{DD} , V _{IS} = V _{SS} to V _{DD} V _{DD} = 10V V _{DD} = 15V				15 10			Ω Ω			
I _{IS}	Input or Output Leakage Switch "OFF"	V _C = 0, V _{DD} = 15V V _{IS} = 0V or 15V, V _{OS} = 15V or 0V		±50		±0.1	±50		±200	nA		
Control Inputs												
V _{ILC}	Low Level Input Voltage	V _{IS} = V _{SS} and V _{DD} V _{OS} = V _{DD} and V _{SS} I _{IS} = ±10 μA V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		0.9 0.9 0.9			0.7 0.7 0.7		0.4 0.4 0.4	V V V		
			V _{IHC}	High Level Input Voltage	V _{DD} = 5V V _{DD} = 10V (see Note 6 and Figure 8) V _{DD} = 15V	3.5		3.5		3.5		V
						7.0		7.0		7.0		V
						11.0		11.0		11.0		V
I _{IN}	Input Current	V _{CC} - V _{SS} = 15V V _{DD} ≥ V _{IS} ≥ V _{SS} V _{DD} ≥ V _C ≥ V _{SS}		±0.3		±10 ⁻⁵	±0.3		±1.0	μA		

AC Electrical Characteristics* T_A = 25°C, t_r = t_f = 20 ns and V_{SS} = 0V unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t _{PHL} , t _{PLH}	Propagation Delay Time Signal Input to Signal Output	V _C = V _{DD} , C _L = 50 pF, (Figure 1) R _L = 200k				
		V _{DD} = 5V		58	100	ns
		V _{DD} = 10V V _{DD} = 15V		27 20	50 40	ns ns
t _{PZH} , t _{PZL}	Propagation Delay Time Control Input to Signal Output High Impedance to Logical Level	R _L = 1.0 kΩ, C _L = 50 pF, (Figures 2 and 3)				
		V _{DD} = 5V		20	50	ns
		V _{DD} = 10V V _{DD} = 15V		18 17	40 35	ns ns
t _{PHZ} , t _{PLZ}	Propagation Delay Time Control Input to Signal Output Logical Level to High Impedance	R _L = 1.0 kΩ, C _L = 50 pF, (Figures 2 and 3)				
		V _{DD} = 5V		15	40	ns
		V _{DD} = 10V		11	25	ns
		V _{DD} = 15V		10	22	ns
	Sine Wave Distortion	V _C = V _{DD} = 5V, V _{SS} = -5 R _L = 10 kΩ, V _{IS} = 5 V _{P-P} , f = 1 kHz, (Figure 4)		0.4		

AC Electrical Characteristics* (Continued)

T_A = 25°C, t_r = t_f = 20 ns and V_{SS} = 0V unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Frequency Response — Switch “ON” (Frequency at -3 dB)	V _C = V _{DD} = 5V, V _{SS} = -5V, R _L = 1 kΩ, V _{IS} = 5 V _{P-P} , 20 Log ₁₀ V _{OS} /V _{IS} (1 kHz) - dB, (Figure 4)		40		MHz
	Feedthrough — Switch “OFF” (Frequency at -50 dB)	V _{DD} = 5V, V _C = V _{SS} = -5V, R _L = 1 kΩ, V _{IS} = 5 V _{P-P} , 20 Log ₁₀ (V _{OS} /V _{IS}) = -50 dB, (Figure 4)		1.25		MHz
	Crosstalk Between Any Two Switches (Frequency at -50 dB)	V _{DD} = V _{C(A)} = 5V; V _{SS} = V _{C(B)} = -5V, R _L = 1 kΩ, V _{IS(A)} = 5 V _{P-P} , 20 Log ₁₀ (V _{OS(B)} /V _{OS(A)}) = -50 dB, (Figure 5)		0.9		MHz
	Crosstalk; Control Input to Signal Output	V _{DD} = 10V, R _L = 10 kΩ R _{IN} = 1 kΩ, V _{CC} = 10V Square Wave, C _L = 50 pF (Figure 6)		150		mV _{P-P}
	Maximum Control Input	R _L = 1 kΩ, C _L = 50 pF, (Figure 7) V _{OS(f)} = 1/2 V _{OS} (1 kHz)		6.5		MHz
		V _{DD} = 5V		8.0		MHz
		V _{DD} = 10V		9.0		MHz
		V _{DD} = 15V				
C _{IS}	Signal Input Capacitance			4		pF
C _{OS}	Signal Output Capacitance	V _{DD} = 10V		4		pF
C _{IOS}	Feedthrough Capacitance	V _C = 0V		0.2		pF
C _{IN}	Control Input Capacitance			5	7.5	pF

*AC Parameters are guaranteed by DC correlated testing.

Note 1: “Absolute Maximum Ratings” are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of “Recommended Operating Conditions” and “Electrical Characteristics” provide conditions for actual device operation.

Note 2: V_{SS} = 0V unless otherwise specified.

Note 3: These devices should not be connected to circuits with the power “ON”.

Note 4: In all cases, there is approximately 5 pF of probe and jig capacitance on the output; however, this capacitance is included in C_L wherever it is specified.

Note 5: V_{IS} is the voltage at the in/out pin and V_{OS} is the voltage at the out/in pin. V_C is the voltage at the control input.

Note 6: If the switch input is held at V_{DD}, V_{IHC} is the control input level that will cause the switch output to meet the standard “B” series V_{OH} and I_{OH} output levels. If the analog switch input is connected to V_{SS}, V_{IHC} is the control input level — which allows the switch to sink standard “B” series |I_{OH}|, high level current, and still maintain a V_{OL} ≤ “B” series. These currents are shown in Figure 8.

AC Test Circuits and Switching Time Waveforms

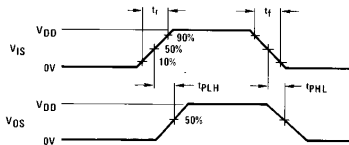
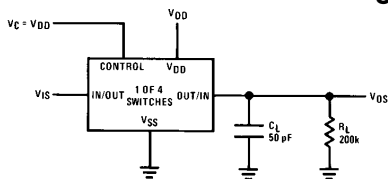


Figure 1. t_{PLH}, t_{PHL} Propagation Delay Time Signal Input to Signal Output

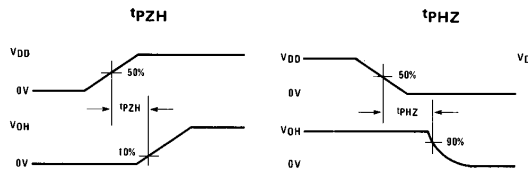
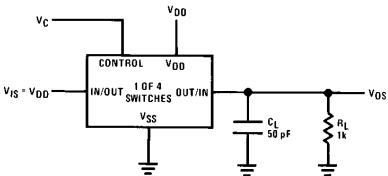


FIGURE 2. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output

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AC Test Circuits and Switching Time Waveforms (Continued)

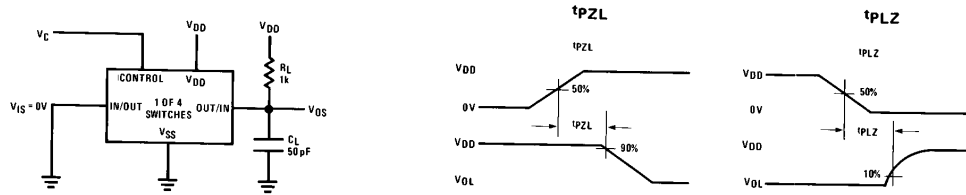


FIGURE 3. t_{PZH} , t_{PHZ} Propagation Delay Time Control to Signal Output

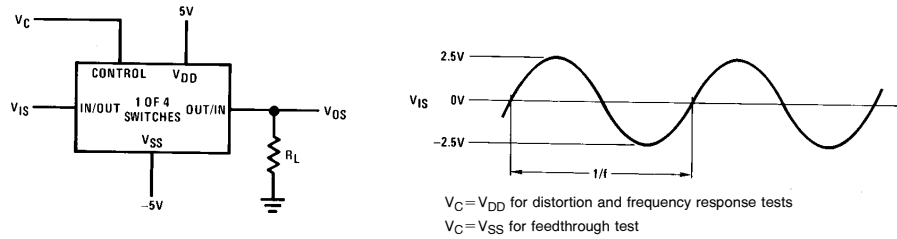


FIGURE 4. Sine Wave Distortion, Frequency Response and Feedthrough

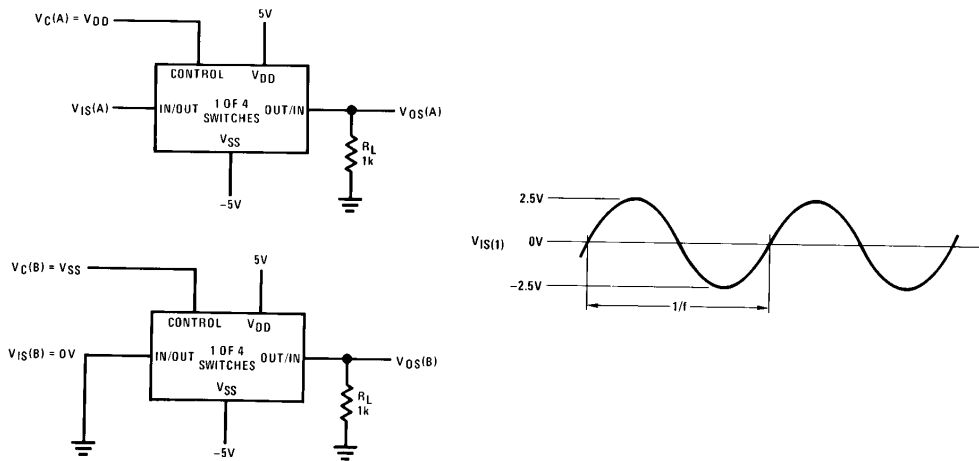


FIGURE 5. Crosstalk Between Any Two Switches

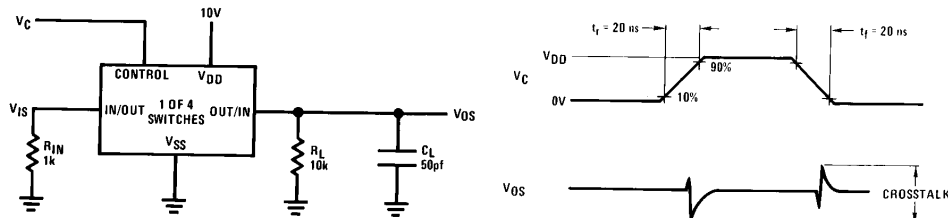


FIGURE 6. Crosstalk — Control to Input Signal Output

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AC Test Circuits and Switching Time Waveforms (Continued)

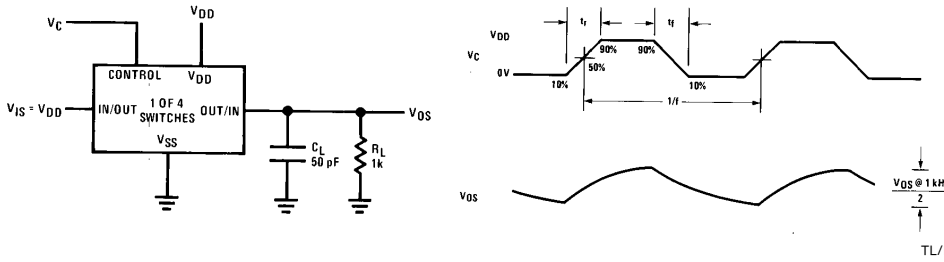


FIGURE 7. Maximum Control Input Frequency

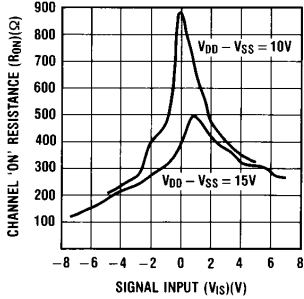
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Temperature Range	V _{DD}	Switch Input				Switch Output V _{OS} (V)	
		V _{IS}	I _S (mA)			Min	Max
			T _{LOW}	25°C	T _{HIGH}		
MILITARY	5	0	0.25	0.2	0.14	4.6	0.4
	5	5	-0.25	-0.2	-0.14	9.5	0.5
	10	0	0.62	0.5	0.35	13.5	1.5
	10	10	-0.62	-0.5	-0.35		
	15	0	1.8	1.5	1.1		
COMMERCIAL	5	0	0.2	0.16	0.12	4.6	0.4
	5	5	-0.2	-0.16	-0.12	9.5	0.5
	10	0	0.5	0.4	0.3	13.5	1.5
	10	10	-0.5	-0.4	-0.3		
	15	0	1.4	1.2	1.0		
	15	15	-1.4	-1.2	-1.0		

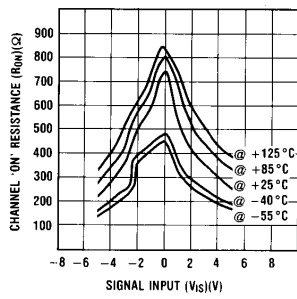
FIGURE 8. CD4016B Switch Test Conditions for V_{IHC}

Typical Performance Characteristics

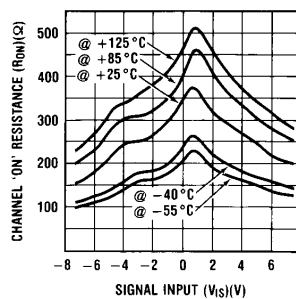
'ON' Resistance vs. Signal Voltage T_A = 25°C



'ON' Resistance Temperature Variation for V_{DD} - V_{SS} = 10V

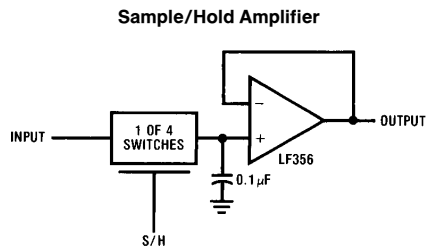
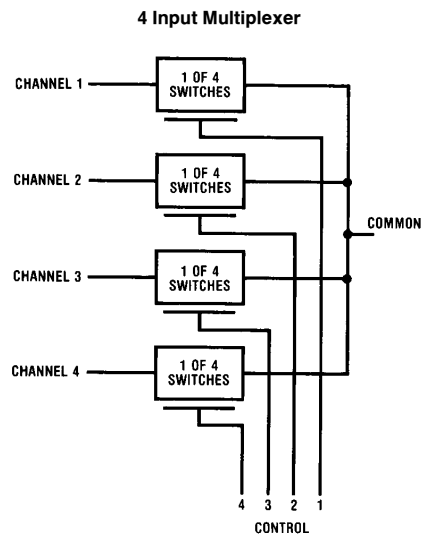


'ON' Resistance Temperature Variation for V_{DD} - V_{SS} = 15V



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Typical Applications



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Special Considerations

The CD4016B is composed of 4, two-transistor analog switches. These switches do not have any linearization or compensation circuitry for "R_{ON}" as do the CD4066B's. Because of this, the special operating considerations for the CD4066B do not apply to the CD4016B, but at low

supply voltages, $\leq 5V$, the CD4016B's on resistance becomes non-linear. It is recommended that at 5V, voltages on the in/out pins be maintained within about 1V of either V_{DD} or V_{SS}; and that at 3V the voltages on the in/out pins should be at V_{DD} or V_{SS} for reliable operation.

