

CD4016M/CD4016C Quad Bilateral Switch

General Description

The CD4016M/CD4016C is a quad bilateral switch which utilizes P-channel and N-channel complementary MOS (CMOS) circuits to provide an extremely high "OFF" resistance and low "ON" resistance switch. The switch will pass signals in either direction and is extremely useful in digital switching.

- Extremely low leakage
- Transmits frequencies up to 10 MHz

$$V_{IS} = 5 \text{ V}_{p-p}$$

$$V_{DD} - V_{SS} = 10\text{V}$$

$$R_L = 10 \text{ k}\Omega$$

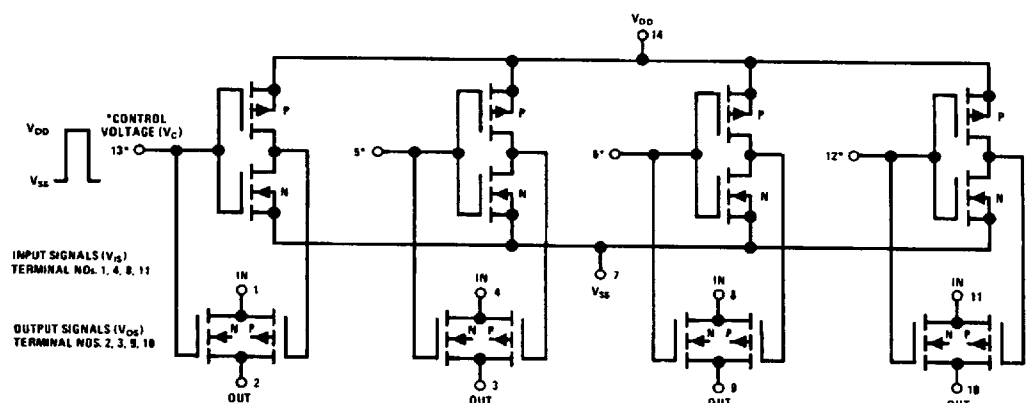
Features

- Wide supply voltage range
3V to 15V
- High noise immunity
0.45 V_{CC} typ.
- Wide range of digital and analog levels
 $\pm 7.5 \text{ V}_{PEAK}$
- Low "ON" resistance
300 Ω typ.
 $V_{DD} - V_{SS} = 15\text{V}$
- Matched switch characteristics
 $\Delta R_{ON} = 40 \Omega$ typ.
- High "ON/OFF" output voltage ratio
65 dB typ.
@ $f_{IS} = 10 \text{ kHz}$
 $R_L = 10\text{k}$
- High degree of linearity
.5% distortion typ.
@ $f_{IS} = 1 \text{ kHz}$

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

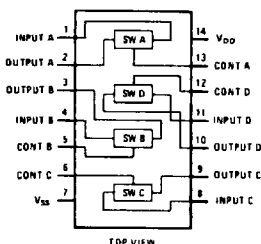


Note 1: All switch P-channel substrates are internally connected to terminal No. 14.

Note 2: All switch N-channel substrates are internally connected to terminal No. 7.

Signal-level range: $V_{SS} < V_{IS} < V_{DD}$

Normal operation: Control-line biasing, switch ON $V_C = V_{DD}$, switch OFF $V_C = V_{SS}$



Order Number CD4016MJ or CD4016CJ
See NS Package J14A

Order Number CD4016CN
See NS Package N14A

Order Number CD4016MW
See NS Package W14B

Absolute Maximum Ratings

Voltage at Any Pin (Note 1) $V_{SS} - 0.3V$ to $V_{SS} + 15.5V$
 Operating Temperature Range CD4016M $-55^{\circ}C$ to $+125^{\circ}C$
 CD4016C $-40^{\circ}C$ to $+85^{\circ}C$

Storage Temperature Range $-65^{\circ}C$ to $+150^{\circ}C$
 Package Dissipation 500 mW
 Lead Temp. (Soldering, 10 seconds) $300^{\circ}C$
 Operating V_{DD} Range $V_{SS} + 3V$ to $V_{SS} + 15V$

Electrical Characteristics CD4016M

Symbol	Characteristic	Test Conditions	Limits									Units	
			-55°C			25°C			125°C				
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max		
	Quiescent Dissipation per Package	Terminals	Volts Applied										
P _T	All Switches "OFF"	V _{DD} 14	+ 10										
		V _{SS} 7	GND										
		V _C 5, 6, 12, 13	GND			5		0.1	5			300 μW	
		V _{is} 1, 4, 8, 11	≤ +10										
		V _{os} 2, 3, 9, 10	≤ +10										
	All Switches "ON"	Terminals	Volts Applied										
		V _{DD} 14	+ 10										
		V _{SS} 7	GND										
		V _C 5, 6, 12, 13	+ 10			5		0.1	5			300 μW	
		V _{is} = V _{os} 1-4, 8-11	≤ +10										
V _{THN}	Threshold Voltage N-Channel	I _{DS} = 10 μA V _{DD} = 5V, 10V, or 15V		1.7			1.5			1.3		V	
V _{THP}	P-Channel	I _{DS} = 10 μA V _{DD} = 5V, 10V, or 15V		-1.7			-1.5			-1.3		V	
SIGNAL INPUTS (V _{is}) AND OUTPUTS (V _{os})													
R _{ON}	"ON" Resistance	V _C = V _{DD} V _{SS} V _{is} + 7.5V -7.5V ± 0.25V + 5V -5V ± 0.25V + 15V 0V +0.25V 9.3V +10V + 10V 0V +0.25V 5.6V											
				120	360		200	400		300	600		Ω
				120	360		200	400		300	600		
				130	775		280	850		470	1230		
				130	600		250	660		400	960		
				130	600		250	660		400	960		Ω
				325	1870		580	2000		900	2600		
				120	360		200	400		300	600		
				120	360		200	400		300	600		Ω
				150	775		300	850		490	1230		
				130	600		250	660		400	960		
				130	600		250	660		400	960		Ω
			300	1870		560	2000		880	2600			
ΔR _{ON}	Δ "ON" Resistance Between Any 2 of 4 Switches	+ 7.5V -7.5V ± 7.5V + 5V -5V ± 5V					10 15					Ω	
	Sine Wave Response (Distortion) V _C = V _{SS}	R _L = 10 kΩ f _{is} = 1 kHz V _{DD} + 5V -V V _{is} 5V(p-p) (Note 3)					0.4				%		
	Input or Output Leakage-Switch "OFF" (Effective "OFF" Resistance)	+ 7.5V -7.5V + 7.5V + 5V -5V + 5V -5V					± 100 ± 100 (Note 2) (Note 2)	125 125				pA nA	
	Frequency Response-Switch "ON" (Sine Wave Input)	V _C = V _{DD} = +5V, V _{SS} = -5V R _L = 1 kΩ 20 Log ₁₀ $\frac{V_{os}}{V_{is}}$ = -3 dB V _{is} = 5V(p-p) V _{DD} = +5V, V _C = V _{SS} = -5V					40					MHz	
	Feedthrough Switch "OFF"	20 Log ₁₀ $\frac{V_{os}}{V_{is}}$ = -50 dB					1.25					MHz	
	Crosstalk Between any 2 of the 4 switches (Frequency at -50 dB)	R _L = 1kΩ V _{is} (A) = V _C (A) = V _{DD} = +5V 5V(p-p) V _C (B) = V _{SS} = 5V 20 Log ₁₀ $\frac{V_{os}(B)}{V_{is}(A)}$ = -50 dB					0.9					MHz	

Note 1: The device should not be connected to circuits with the power on. **Note 2:** $\pm 10 \times 10^{-3}$. **Note 3:** Symmetrical about 0V.

Electrical Characteristics CD4016M (Continued)

Symbol	Characteristic	Test Conditions	Limits									Units	
			- 55°C			25°C			125°C				
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max		
SIGNAL INPUTS (V _{IS}) AND OUTPUTS (V _{OS}) (Continued)													
C _{IS} C _{OS} C _{IOS}	Capacitance Input Output Feedthrough	V _{DD} = - 5V, V _C = V _{SS} = - 5V					4 4 0.2					pF	
t _{pd}	Propagation Delay Signal Input to Signal Output	V _C = V _{DD} = - 10V, V _{SS} = GND, C _L = 15 pF V _{is} = 10V (square wave) t _r = t _f = 20 ns (input Signal)					10					ns	
CONTROL (V _C)													
V _{THC}	Switch Threshold Voltage	V _{is} ≤ V _{DD} V _{DD} - V _{SS} = 15V, 10V, 5V I _{IS} = 10 μA	0.7		2.9	0.5	1.5	2.7	0.2		2.4	V	
I _C	Input Current	V _{DD} - V _{SS} = 10V V _C ≤ V _{DD} - V _{SS}					± 10					pA	
C _C	Average Input Capacitance						5					pF	
	Crosstalk – Control Input to Signal Output	V _{DD} - V _{SS} = 10V V _C = 10V R _L = 10 kΩ (square wave)					50					mV	
t _{pdC}	Turn “ON” Propagation Delay	t _{rc} = t _{fc} = 20 ns V _{is} < 10V, C _L = 15 pF					20					ns	
	Maximum Allowable Control Input Repetition Rate	V _{DD} = 10V, V _{SS} = GND, R _L = 1 Ω C _L = 15 pF V _C = 10V (square wave) t _r = t _f = 20 ns					10					MHz	

Electrical Characteristics CD4016C

Symbol	Characteristic	Test Conditions	Limits									Units	
			-40°C			25°C			85°C				
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max		
	Quiescent Dissipation per Package	Terminals	Volts Applied										
P _T	All Switches "OFF"	V _{DD} 14	+10										
		V _{SS} 7	GND										
		V _C 5, 6, 12, 13	GND			5		0.1	5			80	μW
		V _{is} 1, 4, 8, 11	≤ +10										
		V _{os} 2, 3, 9, 10	≤ +10										
		Terminals	Volts Applied										
	All Switches "ON"	V _{DD} 14	+10										
		V _{SS} 7	GND										
		V _C 5, 6, 12, 13	+10			5		0.1	5			80	μW
		V _{is} = V _{os} 1-4, 8-11	≤ +10										
V _{THN}	Threshold Voltage N-Channel	I _{PS} = 10 μA											
		V _{DD} = 5V, 10V, or 15V		1.7				1.5			1.3		V
V _{THP}	P-Channel	I _{PS} = 10 μA											
		V _{DD} = 5V, 10V, or 15V		-1.7				-1.5			-1.3		V

Note 1: The device should not be connected to circuits with the power on.

Note 2: $\pm 10 \times 10^{-3}$.

Note 3: Symmetrical about 0V.

Electrical Characteristics CD4016C (Continued)

Sym.	Characteristic	Test Conditions	Limits									Units	
			-40°C			25°C			85°C				
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max		
SIGNAL INPUTS (V _{is}) AND OUTPUTS (V _{os})													
R _{ON}	"ON" Resistance	V _C = V _{DD} V _{SS} V _{is} + 7.5V -7.5V +7.5V ±0.25V + 5V -5V -5V ±0.25V + 15V + 15V + 10V + 10V + 0.25V 5.6V	R _L = 10 kΩ	130	370		200	400	260	520	Ω		
				130	370		200	400	260	520			
				160	790		280	850	400	1080	Ω		
				150	610		250	660	340	840			
				150	610		250	660	340	840	Ω		
				370	1900		580	2000	770	2380			
130	370		200	400	260	520	Ω						
180	790		300	850	400	1080							
150	610		250	660	340	840	Ω						
150	610		250	660	340	2380							
				350	1900		560	2000	750	2380			
ΔR _{ON}	Δ "ON" Resistance Between Any 2 of 4 Switches	+ 7.5V -7.5V ± 7.5V + 5V -5V ± 5V					10 15				Ω		
	Sine Wave Response (Distortion) V _C = V _{SS}	R _L = 10 kΩ f _{is} = 1 kHz V _{DD} + 5V -5V 5V(p-p) V _{is} (Note 3)					0.4				%		
	Input or Output Leakage-Switch "OFF" (Effective "OFF" Resistance)	+ 7.5V -7.5V + 7.5V + 5V -5V + 5V -5V					± 100 ± 100 (Note 2) (Note 2)	125 125			pA nA		
	Frequency Response-Switch "ON" (Sine Wave Input)	V _C = V _{DD} = + 5V, V _{SS} = -5V R _L = 1 kΩ 20 Log ₁₀ $\frac{V_{os}}{V_{is}}$ = -3 dB V _{is} = 5V(p-p) V _{DD} = + 5V, V _C = V _{SS} = -5V					40				MHz		
	Feedthrough Switch "OFF"	20 Log ₁₀ $\frac{V_{os}}{V_{is}}$ = -50 dB					1.25				MHz		
	Crosstalk Between any 2 of the 4 switches (Frequency at -50 dB)	R _L = 1kΩ V _C (A) = V _{DD} = + 5V V _C (B) = V _{SS} = -5V V _{is} (A) = 5V(p-p) 20 Log ₁₀ $\frac{V_{os}(B)}{V_{is}(A)}$ = -50 dB					0.9				MHz		
C _{IS} C _{OS} C _{IOS}	Capacitance Input Output Feedthrough	V _{DD} = -5V, V _C = V _{SS} = -5V					4 4 0.2				pF		
t _{pd}	Propagation Delay Signal Input to Signal Output	V _C = V _{DD} = + 10V, V _{SS} = GND, C _L = 15pF V _{is} = 10V (square wave) t _r = t _f = 20 ns (input Signal)					10				ns		
CONTROL (V _C)													
V _{THC}	Switch Threshold Voltage	V _{is} ≤ V _{CD} V _{DD} - V _{SS} = 15V, 10V, 5V I _{IS} = 10 μA					0.5	1.5	2.7		V		
I _C	Input Current	V _{DD} - V _{SS} = 10V V _C ≤ V _{DD} - V _{SS}					± 10				pA		
C _C	Average Input Capacitance						5				pF		
	Crosstalk - Control Input to Signal Output	V _{DD} - V _{SS} = 10V V _C = 10V R _L = 10 kΩ (square wave)					50				mV		
t _{pdC}	Turn "ON" Propagation Delay	t _{rc} = t _{fc} = 20 ns V _{is} < 10V, C _L = 15 pF					20				ns		
Note 1: The device should not be connected to circuits with the power on. Note 2: ± 10 × 10 ⁻³ . Note 3: Symmetrical about 0V.													

Electrical Characteristics CD4016C (Continued)

Sym.	Characteristic	Test Conditions	Limits									Units
			-40°C			25°C			85°C			
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
CONTROL (V _C) Continued												
	Maximum Allowable Control Input Repetition Rate	V _{DD} = 10V, V _{SS} = GND, R _L = 1 Ω C _i = 15 pF V _C = 10V (square wave) t _r = t _f = 20 ns					10					MHz

Note 1: The device should not be connected to circuits with the power on. Note 2: $\pm 10 \times 10^{-3}$. Note 3: Symmetrical about 0V.

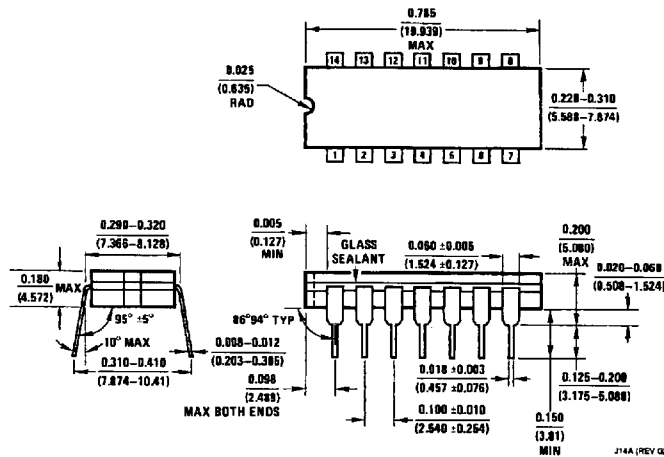
Typical ON Resistance Characteristics

Characteristic*	Supply Conditions		Load Conditions					
			R _L = 1 kΩ		R _L = 10 kΩ		R _L = 100 kΩ	
	V _{DD} (V)	V _{SS} (V)	Value (Ω)	V _{IS} (V)	Value (Ω)	V _{IS} (V)	Value (Ω)	V _{IS} (V)

R _{ON}	+15	0	200	+15	200	+15	180	+15
R _{ON(max)}	+15	0	200	0	200	0	200	0
R _{ON}	+10	0	300	+11	300	+9.3	320	+9.2
R _{ON(max)}	+10	0	290	+10	250	+10	240	+10
R _{ON}	+5	0	290	0	250	0	300	0
R _{ON(max)}	+5	0	500	+7.4	560	+5.6	610	+5.5
R _{ON}	+5	0	860	+5	470	+5	450	+5
R _{ON(max)}	+5	0	600	0	580	0	800	0
R _{ON}	+7.5	-7.5	1.7k	+4.2	7k	+2.9	33k	+2.7
R _{ON}	+7.5	-7.5	200	+7.5	200	+7.5	180	+7.5
R _{ON(max)}	+7.5	-7.5	200	-7.5	200	-7.5	180	-7.5
R _{ON}	+7.5	-7.5	290	±0.25	280	±25	400	±0.25
R _{ON}	+5	-5	260	+5	250	+5	240	+5
R _{ON(max)}	+5	-5	310	-5	250	-5	240	-5
R _{ON}	+5	-5	600	±0.25	580	±0.25	760	±0.25
R _{ON}	+2.5	-2.5	590	+2.5	450	+2.5	490	+2.5
R _{ON(max)}	+2.5	-2.5	720	-2.5	520	-2.5	520	-2.5
R _{ON}	+2.5	-2.5	232k	±0.25	300k	±0.25	870k	±0.25

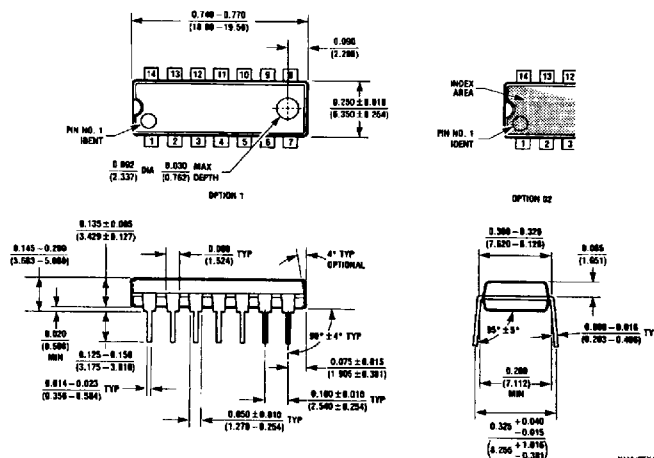
*Variation from a perfect switch: R_{ON} = 0Ω.

Physical Dimensions inches (millimeters)

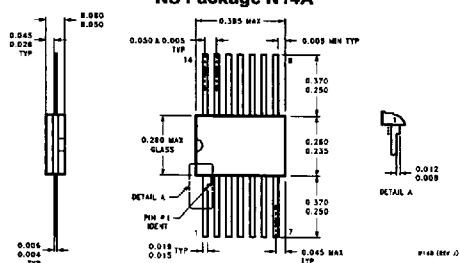


Dual-in-Line Package (J)
Order Number CD4016MJ or CD4016CJ
NS Package J14A

Physical Dimensions inches (millimeters) (Continued)



Dual-In-Line Package (N)
Order Number CD4016CN
NS Package N14A



Dual-In-Line Package (W)
Order Number CD4016MW
NS Package W14B

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