

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.

Features

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

- Extremely low leakage
- Transmits frequencies up to 10 MHz

Applications

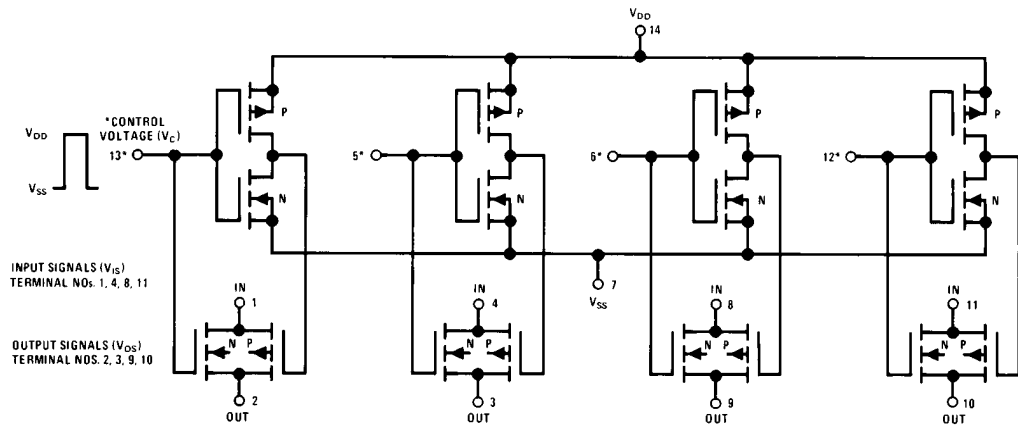
- Analog signal switching/multiplexing
 - Signal gating
 - Squelch control
 - Chopper
 - Modulator
 - Demodulator
 - Commutating switch
- Digital signal switching/multiplexing
- CMOS logic implementation
- Analog to digital/digital to analog conversion
- Digital control of frequency, impedance, phase,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

$$V_{IS}=5 V_{p-p}$$

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

$$R_L=10 k\Omega$$

Schematic and Connection Diagrams

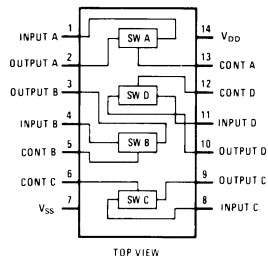


Note 1: All switch P-channel substrates are internally connected to terminal No. 14.

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 "1" = V_{DD} , switch OFF V_C "0" = V_{SS}



TL/H/6104-2

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			5		0.1	5		300	μW	
		V _C	5, 6, 12, 13	GND										
		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			5		0.1	5		300	μW	
		V _C	5, 6, 12, 13	+10										
		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} R _L = 10 kΩ	V _{is}											
			+7.5V	−7.5V	+7.5V	120	360		200	400		300	600	Ω
					−7.5V	120	360		200	400		300	600	
					±0.25V	130	775		280	850		470	1230	
					+5V	130	600		250	660		400	960	
			+5V	−5V	−5V	130	600		250	660		400	960	Ω
					±0.25V	325	1870		580	2000		900	2600	
					+15V	120	360		200	400		300	600	Ω
				0V	+0.25V	120	360		200	400		300	600	
					9.3V	150	775		300	850		490	1230	
ΔR _{ON}	Δ “ON” Resistance Between Any 2 of 4 Switches	+7.5V −7.5V ±7.5V +5V −5V ±5V					10					Ω		
							15							
	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)	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		

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 _{DS} = 10 μA			1.7			1.5			1.3	V
V _{THP}	P-Channel	V _{DD} = 5V, 10V, or 15V										
		I _{DS} = 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 + 7.5V − 7.5V − 7.5V ± 0.25V + 5V − 5V − 5V + 5V − 5V − 5V ± 0.25V + 15V 0V + 0.25V + 15V 0V + 0.25V 9.3V + 10V + 10V 0V + 0.25V 5.6V		130	370		200	400		260	520	Ω	
				130	370		200	400		260	520		
				160	790		280	850		400	1080		
				150	610		250	660		340	840		
				150	610		250	660		340	840		
				370	1900		580	2000		770	2380		
					130	370		200	400		260	520	Ω
					130	370		200	400		260	520	
					180	790		300	850		400	1080	
					150	610		250	660		340	840	
					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 + 7.5V − 7.5V − 7.5V + 5V − 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) = 5V(p-p) V _C (A) = V _{DD} = + 5V V _C (B) = V _{SS} = − 5V 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: $\pm 10 \times 10^{-3}$.

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		
CONTROL (V _C) Continued													
	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

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.

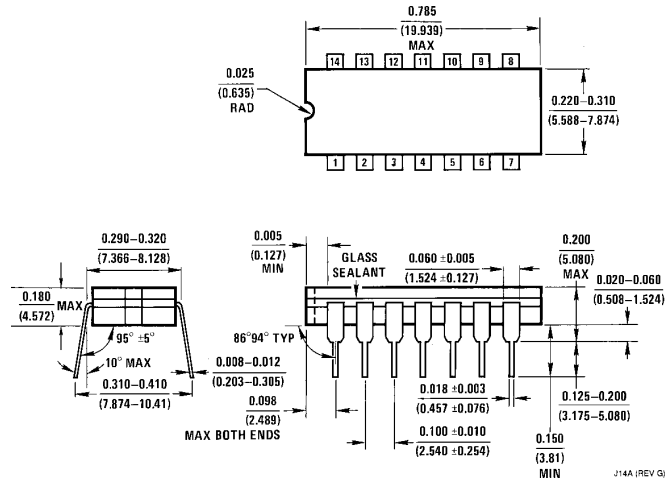
Typical ON Resistance Characteristics

Characteristic*	Supply Conditions		Load Conditions					
			R _L = 1 kΩ		R _L = 10 kΩ		R _L = 100 kΩ	
	V _{DO} (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}	+15	0	300	+11	300	+9.3	320	+9.2
R _{ON}	+10	0	290	+10	250	+10	240	+10
R _{ON(max.)}	+10	0	290	0	250	0	300	0
R _{ON}	+10	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}	+5	0	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

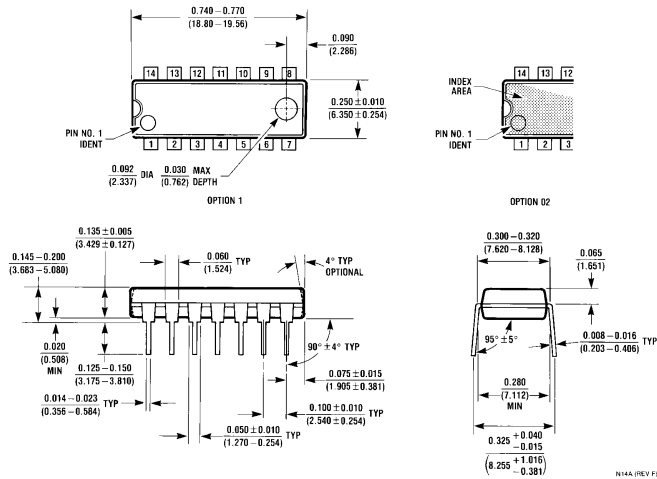
*Variation from a perfect switch: R_{ON} = 0Ω.

Physical Dimensions inches (millimeters)

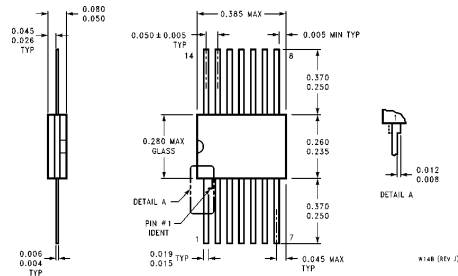


Dual-in-Line Package (J)
Order Number CD4016MJ or CD4016CJ
NS Package J14A

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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