

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

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

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

$$R_L = 10 k\Omega$$

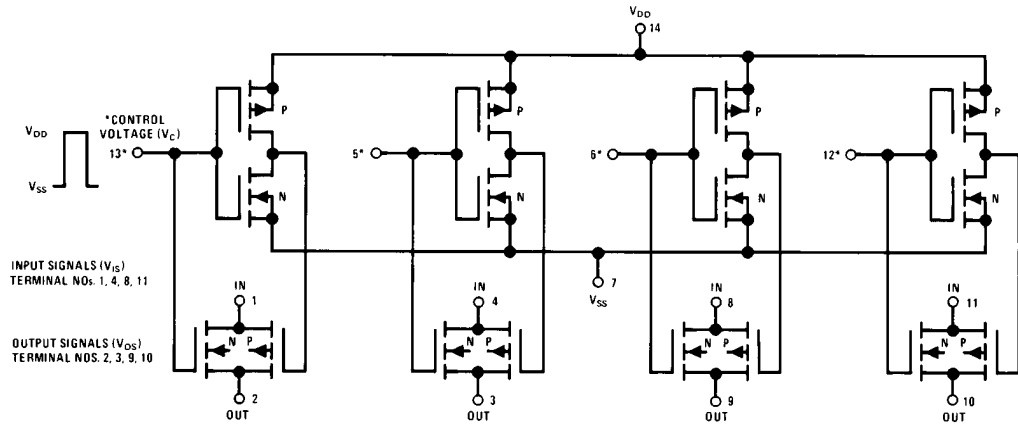
Features

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

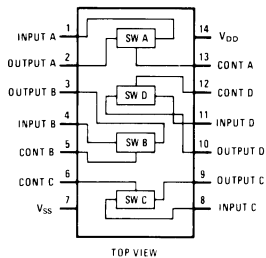


Note 1: All switch P-channel substrates are internally connected to terminal No. 14.

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

CD4016M/CD4016C Quad Bilateral Switch

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
			$-55^{\circ}C$			$25^{\circ}C$			$125^{\circ}C$			
			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 V_{is} 1, 4, 8, 11 $\leq +10$ V_{os} 2, 3, 9, 10 $\leq +10$			5	0.1	5			300	μW	
	All Switches "ON"	Terminals Volts Applied V_{DD} 14 +10 V_{SS} 7 GND V_C 5, 6, 12, 13 +10 $V_{is} = V_{os}$ 1-4, 8-11 $\leq +10$			5	0.1	5			300	μW	
V_{THN}	Threshold Voltage N-Channel	$I_{DS} = 10 \mu A$ $V_{DD} = 5V, 10V, \text{ or } 15V$		1.7		1.5			1.3		V	
V_{THP}	P-Channel	$I_{DS} = 10 \mu A$ $V_{DD} = 5V, 10V, \text{ or } 15V$		-1.7		-1.5			-1.3		V	
SIGNAL INPUTS (V_{is}) AND OUTPUTS (V_{os})												
R_{ON}	"ON" Resistance	$R_L = 10 \text{ k}\Omega$ $V_C = V_{DD}$ V_{SS} V_{is} +7.5V -7.5V +7.5V $\pm 0.25V$ +5V -5V -5V $\pm 0.25V$ +15V 0V +15V $\pm 0.25V$ +10V 0V +10V $\pm 0.25V$ 5.6V		120	360	200	400	300	600	300	600	Ω
ΔR_{ON}	Δ "ON" Resistance Between Any 2 of 4 Switches	+7.5V -7.5V $\pm 7.5V$ +5V -5V $\pm 5V$				10					Ω	
	Sine Wave Response (Distortion) $V_C = V_{SS}$	$R_L = 10 \text{ k}\Omega$ $f_{is} = 1 \text{ kHz}$ V_{DD} V_{is} +5V -V 5V(p-p) (Note 3) -7.5V -7.5V +5V -5V +5V -5V				0.4					%	
	Input or Output Leakage-Switch "OFF" (Effective "OFF" Resistance)	+7.5V -7.5V +7.5V -7.5V +5V -5V +5V -5V				± 100 ± 100 (Note 2) 125 (Note 2) 125					pA nA	
	Frequency Response-Switch "ON" (Sine Wave Input)	$V_C = V_{DD} = +5V, V_{SS} = -5V$ $R_L = 1 \text{ k}\Omega$ $20 \text{ Log}_{10} \frac{V_{os}}{V_{is}} = -3 \text{ dB}$ $V_{is} = 5V(p-p)$ $V_{DD} = +5V, V_C = V_{SS} = -5V$				40					MHz	
	Feedthrough Switch "OFF"	$20 \text{ Log}_{10} \frac{V_{os}}{V_{is}} = -50 \text{ dB}$				1.25					MHz	
	Crosstalk Between any 2 of the 4 switches (Frequency at -50 dB)	$R_L = 1 \text{ k}\Omega$ $V_{is}(A) = 5V(p-p)$ $V_C(A) = V_{DD} = +5V$ $V_C(B) = V_{SS} = -5V$ $20 \text{ Log}_{10} \frac{V_{os}(B)}{V_{is}(A)} = -50 \text{ dB}$				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	$V_{is} \leq V_{DD}$ $V_{DD} - V_{SS} = 15V, 10V, 5V$ $I_{IS} = 10 \mu A$	0.7		2.9	0.5	1.5	2.7	0.2		2.4	V
I_C	Input Current	$V_{DD} - V_{SS} = 10V$ $V_C \leq V_{DD} - V_{SS}$					± 10					pA
C_C	Average Input Capacitance						5					pF
	Crosstalk – Control Input to Signal Output	$V_{DD} - V_{SS} = 10V$ $V_C = 10V$ $R_L = 10 k\Omega$ (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	$V_{DD} = 10V, V_{SS} = GND, R_L = 1 \Omega$ $C_L = 15 pF$ $V_C = 10V$ (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 V_{is} 1, 4, 8, 11 $\leq +10$ V_{os} 2, 3, 9, 10 $\leq +10$			5		0.1	5			80	μW
	All Switches "ON"	Terminals Volts Applied V_{DD} 14 +10 V_{SS} 7 GND V_C 5, 6, 12, 13 +10 $V_{is} = V_{os}$ 1-4, 8-11 $\leq +10$			5		0.1	5			80	μW
V_{THN}	Threshold Voltage N-Channel	$I_{DS} = 10 \mu A$ $V_{DD} = 5V, 10V, \text{ or } 15V$		1.7			1.5				1.3	V
V_{THP}	P-Channel	$I_{DS} = 10 \mu A$ $V_{DD} = 5V, 10V, \text{ or } 15V$		-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	$R_L = 10\text{ k}\Omega$	$V_C = V_{DD}$	V_{SS}	$V_{is} + 7.5V$	130	370		200	400	260	520	Ω	
			$+7.5V$	$-7.5V$	$-7.5V$	130	370		200	400	260	520		
					$\pm 0.25V$	160	790		280	850	400	1080		
				$+5V$	$-5V$	$-5V$	150	610		250	660	340	840	Ω
						$\pm 0.25V$	150	610		250	660	340	840	
					$+15V$	$0V$	$+0.25V$	370	1900		580	2000	770	
						$+15V$	$0V$	$+15V$	130	370		200	400	260
				$+10V$	$0V$	$+0.25V$	130	370		200	400	260	520	
					$+10V$	$0V$	$+0.25V$	150	610		250	660	340	840
						$5.6V$	150	610		250	660	340	840	Ω
							350	1900		560	2000	750	2380	
ΔR_{ON}	Δ “ON” Resistance Between Any 2 of 4 Switches		$+7.5V$	$-7.5V$	$\pm 7.5V$				10				Ω	
			$+5V$	$-5V$	$\pm 5V$				15					
	Sine Wave Response (Distortion)	$R_L = 10\text{ k}\Omega$ $f_{is} = 1\text{ kHz}$ $V_C = V_{SS}$	$+5V$	$-5V$	$5V(p-p)$ V_{is} (Note 3)				0.4				%	
	Input or Output Leakage-Switch “OFF” (Effective “OFF” Resistance)		$+7.5V$	$-7.5V$	$+7.5V$ $-7.5V$				± 100 ± 100 (Note 2)				pA	
			$+5V$	$-5V$	$+5V$ $-5V$				(Note 2) 125				nA	
	Frequency Response-Switch “ON” (Sine Wave Input)	$V_C = V_{DD} = +5V, V_{SS} = -5V$ $R_L = 1\text{ k}\Omega$ $V_{is} = 5V(p-p)$			$20\text{ Log}_{10}\frac{V_{os}}{V_{is}} = -3\text{ dB}$				40				MHz	
	Feedthrough Switch “OFF”				$20\text{ Log}_{10}\frac{V_{os}}{V_{is}} = -50\text{ dB}$				1.25				MHz	
	Crosstalk Between any 2 of the 4 switches (Frequency at -50 dB)	$R_L = 1\text{ k}\Omega$ $V_{is}(A) = 5V(p-p)$			$V_C(A) = V_{DD} = +5V$ $V_C(B) = V_{SS} = -5V$ $20\text{ Log}_{10}\frac{V_{os}(B)}{V_{is}(A)} = -50\text{ dB}$				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	$V_C = V_{DD} = +10V, V_{SS} = GND, C_L = 15\text{ pF}$ $V_{is} = 10V$ (square wave) $t_r = t_f = 20\text{ ns}$ (input Signal)							10				ns	
CONTROL (V_C)														
V_{THC}	Switch Threshold Voltage	$V_{is} \leq V_{CD}$			$V_{DD} - V_{SS} = 15V, 10V, 5V$ $I_{IS} = 10\text{ }\mu A$				0.5	1.5	2.7		V	
I_C	Input Current				$V_{DD} - V_{SS} = 10V$ $V_C \leq V_{DD} - V_{SS}$				± 10				pA	
C_C	Average Input Capacitance								5				pF	
	Crosstalk - Control Input to Signal Output	$V_{DD} - V_{SS} = 10V$ $V_C = 10V$ (square wave)			$R_L = 10\text{ k}\Omega$				50				mV	
t_{pdC}	Turn “ON” Propagation Delay	$t_{rc} = t_{fc} = 20\text{ ns}$			$V_{is} < 10V, C_L = 15\text{ pF}$				20				ns	
<p>Note 1: The device should not be connected to circuits with the power on.</p> <p>Note 2: $\pm 10 \times 10^{-3}$.</p> <p>Note 3: Symmetrical about 0V.</p>														

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

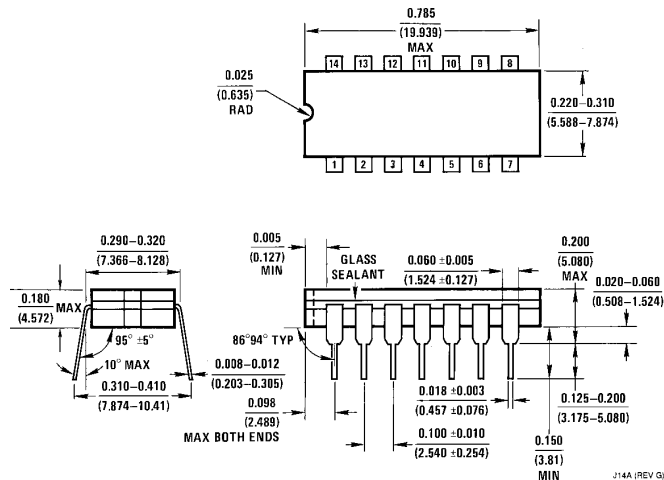
Note 1: The device should not be connected to circuits with the power on. Note 2: $\pm 10 \times 10^{-3}$. Note 3: Symmetrical about 0V.

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(max.)}	+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(max.)}	+10	0	860	+5	470	+5	450	+5
R _{ON}	+5	0	600	0	580	0	800	0
R _{ON(max.)}	+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(max.)}	+2.5	-2.5	232k	±0.25	300k	±0.25	870k	±0.25

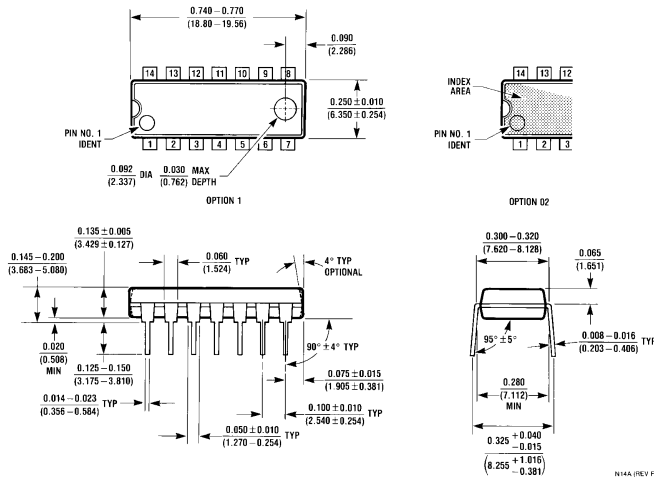
*Variation from a perfect switch: R_{ON} = 0Ω.

Physical Dimensions inches (millimeters)

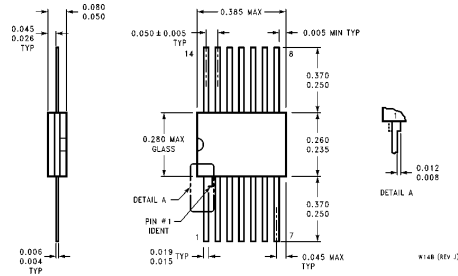


Dual-in-Line Package (J)
Order Number CD4016MJ or CD4016CJ
NS Package J14A

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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