

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

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

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

$$R_L = 10 k\Omega$$

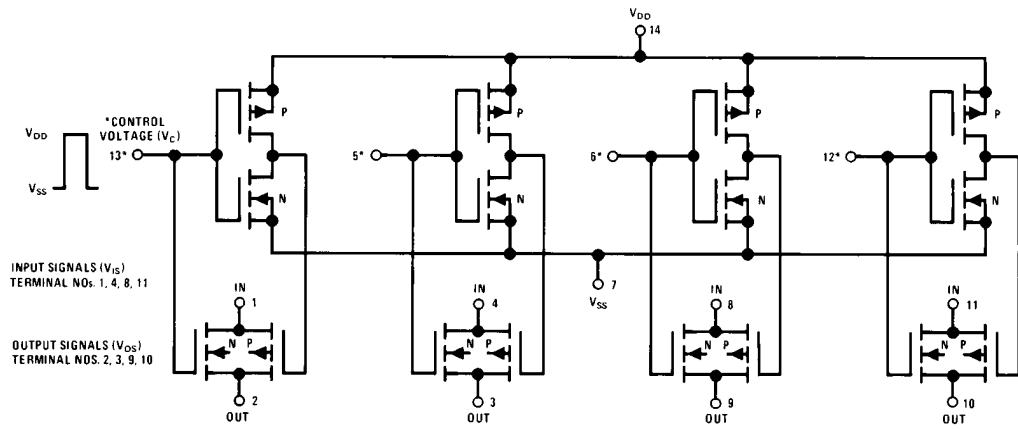
Features

- 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. $V_{DD} - V_{SS} = 15V$
- 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

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

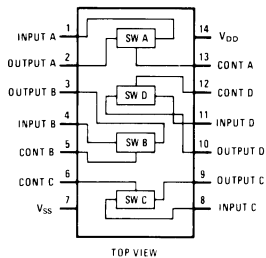


Note 1: All switch P-channel substrates are internally connected to terminal No. 14.

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

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	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	2380	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	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

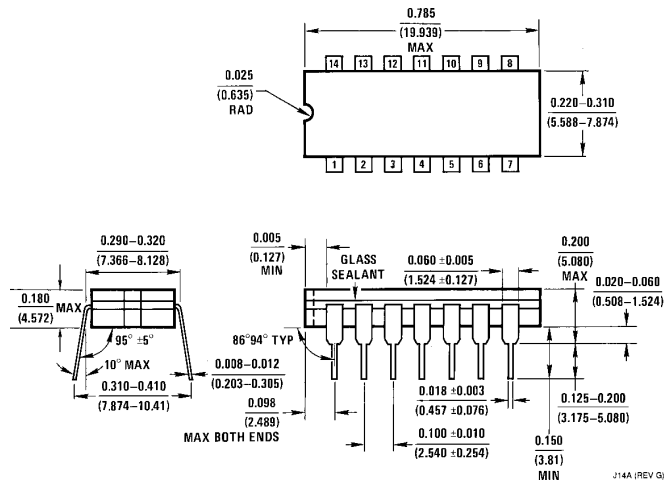
Note 1: The device should not be connected to circuits with the power on. **Note 2:** $\pm 10 \times 10^{-3}$. **Note 3:** Symmetrical about 0V.

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(max.)}	+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(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(max.)}	+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(max.)}	+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

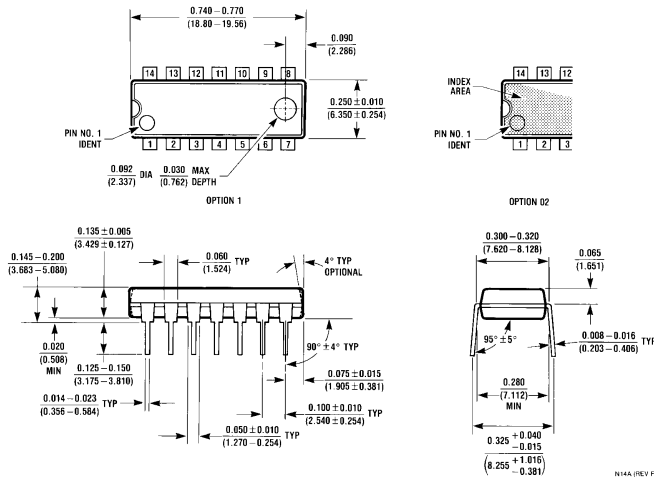
*Variation from a perfect switch: R_{ON} = 0Ω.

Physical Dimensions inches (millimeters)

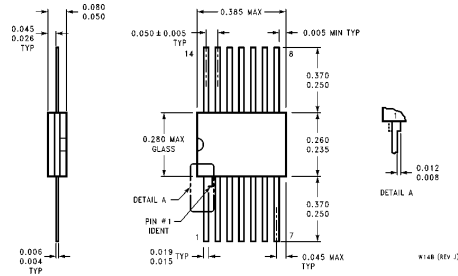


Dual-in-Line Package (J)
Order Number CD4016MJ or CD4016CJ
NS Package J14A

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**

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

 <p>National Semiconductor Corporation 1111 West Bardin Road Arlington, TX 76017 Tel: 1(800) 272-9959 Fax: 1(800) 737-7018</p>	<p>National Semiconductor Europe Fax: (+49) 0-180-530 85 86 Email: cnjwge@tevm2.nsc.com Deutsch Tel: (+49) 0-180-530 85 85 English Tel: (+49) 0-180-532 78 32 Français Tel: (+49) 0-180-532 93 58 Italiano Tel: (+49) 0-180-534 16 80</p>	<p>National Semiconductor Hong Kong Ltd. 19th Floor, Straight Block, Ocean Centre, 5 Canton Rd. Tsimshatsui, Kowloon Hong Kong Tel: (852) 2737-1600 Fax: (852) 2736-9960</p>	<p>National Semiconductor Japan Ltd. Tel: 81-043-299-2309 Fax: 81-043-299-2408</p>
--	--	---	---

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

This datasheet has been download from:

www.datasheetcatalog.com

Datasheets for electronics components.

National Semiconductor was acquired by Texas Instruments.

http://www.ti.com/corp/docs/investor_relations/pr_09_23_2011_national_semiconductor.html

This file is the datasheet for the following electronic components:

CD4016M - <http://www.ti.com/product/cd4016m?HQS=TI-null-null-dscatalog-df-pf-null-ww>

CD4016C - <http://www.ti.com/product/cd4016c?HQS=TI-null-null-dscatalog-df-pf-null-ww>