

CMOS Quad Bilateral Switch

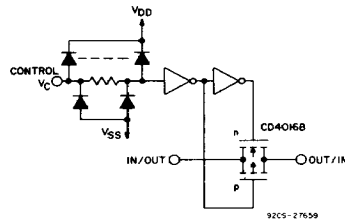
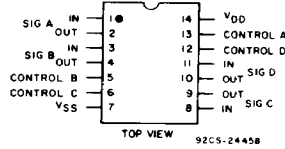
For Transmission or Multiplexing of Analog or Digital Signals

High-Voltage Types (20-Volt Rating)

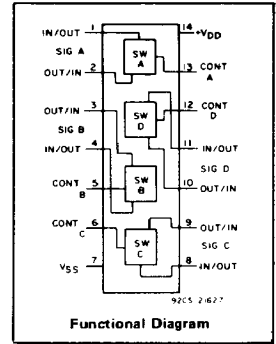
The RCA-CD4016B Series types are quad bilateral switches intended for the transmission or multiplexing of analog or digital signals. Each of the four independent bilateral switches has a single control signal input which simultaneously biases both the p and n device in a given switch on or off.

The CD4016 "B" Series types are supplied in 14-lead hermetic dual-in-line ceramic packages (D and F suffixes), 14-lead dual-in-line plastic packages (E suffix), 14-lead ceramic flat packages (K suffix), and in chip form (H suffix).

Terminal Assignment



Schematic diagram - 1 of 4 identical sections.



Features:

- 20-V digital or ± 10 -V peak-to-peak switching
- $280\text{-}\Omega$ typical on-state resistance for 15-V operation
- Switch on-state resistance matched to within $10\text{ }\Omega$ typ. over 15-V signal-input range
- High on/off output-voltage ratio: 65 dB typ. @ $f_{is} = 10\text{ kHz}$, $R_L = 10\text{ k}\Omega$
- High degree of linearity: $<0.5\%$ distortion typ. @ $f_{is} = 1\text{ kHz}$, $V_{is} = 5\text{ V}_{p-p}$, $V_{DD}-V_{SS} \geq 10\text{ V}$, $R_L = 10\text{ k}\Omega$
- Extremely low off-state switch leakage resulting in very low offset current and high effective off-state resistance 100 pA typ. @ $V_{DD}-V_{SS}=18$
- Extremely high control input i_{m1} (control circuit isolated from sig) $10^{12}\text{ }\Omega$ typ.
- Low crosstalk between switches: -50 dB typ. @ $f_{is} = 0.9\text{ MHz}$, R_L
- Matched control-input to signal-output capacitance: Reduces output signal transients
- Frequency response, switch on =

- 100% tested for quiescent current
- Maximum control input current at 18 V over full package temp range; 100 nA at 18 V at 25°C
- 5-V, 10-V, and 15-V parametric

Applications:

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

RECOMMENDED OPERATING CONDITIONS

For maximum reliability, nominal operating conditions should be selected so that operation is always within the following range:

CHARACTERISTIC	LIMITS		UNITS
	Min.	Max.	
Supply Voltage Range (For $T_A = \text{Full Package Temperature Range}$)	3	18	V

MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY VOLTAGE RANGE, (V_{DD})
(Voltages referenced to V_{SS} Terminal)
INPUT VOLTAGE RANGE, ALL INPUTS
DC INPUT CURRENT, ANY SIGNAL

0.5 to +20 V
0.5 to $V_{DD}+0.5\text{ V}$
 $\pm 10\text{ mA}$
500 mW
Derate Linearly at $12\text{ mW}/^\circ\text{C}$ to 200 mW
500 mW
Derate Linearly at $12\text{ mW}/^\circ\text{C}$ to 200 mW
II Package Types)
100 mW
55 to $+125^\circ\text{C}$
40 to $+85^\circ\text{C}$
65 to $+150^\circ\text{C}$
r 10 s max. $+265^\circ\text{C}$

Bob - Break - Polarity - Make - No - data - on - pins - blank -

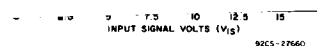


Fig. 1—Typ. on-state characteristics for 1 of 4 switches with $V_{DD} = +15\text{ V}$, $V_{SS} = 0\text{ V}$.

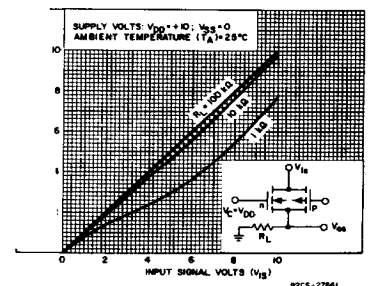


Fig. 2—Typ. on-state characteristics for 1 of 4 switches with $V_{DD} = +10\text{ V}$, $V_{SS} = 0\text{ V}$.

CD4016B Types

ELECTRICAL CHARACTERISTICS

Characteristic	Test Conditions	LIMITS AT INDICATED TEMPERATURE (°C)							U N I T S	
		Values at -55, +25, +125 Apply to D, F, K, H Packages Values at -40, +25, +85 Apply to E Package								
		V _{IN} (V)	V _{DD} (V)	-55	-40	+85	+125	+25 Typ. Max.		
Quiescent Device Current, I _{DD}		0,5	5	0.25	0.25	7.5	7.5	0.01	0.25	μA
		0,10	10	0.5	0.5	15	15	0.01	0.5	
		0,15	15	1	1	30	30	0.01	1	
		0,20	20	5	5	150	150	0.02	5	
Signal Inputs (V _{is}) and Output (V _{os})										
On-State Resistance, r _{on} Max.	V _C = V _{DD} R _L = 10kΩ Returned to V _{DD} -V _{SS} 2	V _{is} =V _{DD} or V _{SS}	10	600	610	840	960	—	660	Ω
		V _{is} =4.75 to 5.75 V	10	1870	1900	2380	2600	—	2000	
		V _{is} =V _{DD} or V _{SS}	15	360	370	520	600	—	400	
		V _{is} =7.25 to 7.75 V	15	775	790	1080	1230	—	850	
ΔOn-State Resistance Between Any 2 Switches, Δr _{on}	R _L = 10 kΩ, V _C = V _{DD}		5	—	—	—	—	15	—	Ω
			10	—	—	—	—	10	—	
			15	—	—	—	—	5	—	
Total Harmonic Distortion, THD	V _C =V _{DD} = 5 V, V _{SS} = -5 V, V _{is} (p-p) = 5 V (Sine wave centered on 0 V) R _L = 10 kΩ, f _{is} = 1 kHz sine wave			—	—	—	—	0.4	—	%
-3dB Cutoff Frequency (Switch on)	V _C =V _{DD} =5 V, V _{SS} = -5 V, V _{is} (p-p) = 5 V (Sine wave centered on 0 V) R _L = 1 kΩ,			—	—	—	—	40	—	MHz
-50dB Feed-through Frequency (Switch off)	V _C =V _{SS} = -5 V, V _{is} (p-p) = 5 V (Sine wave centered on 0 V) R _L = 1 kΩ			—	—	—	—	1.25	—	MHz
Input/Output Leakage Current (Switch off) I _s Max.	V _C = 0 V V _{is} = 18 V, V _{os} = 0 V; V _{is} = 0 V, V _{os} = 18 V	18	±0.1	±0.1	±1	±1	10 ⁻⁴	±0.1	μA	
-50 dB Crosstalk Frequency	V _C (A) = V _{DD} = +5 V, V _C (B) = V _{SS} = -5 V, V _{is} (A) = 5 V p-p, 50 Ω source R _L = 1 kΩ			—	—	—	—	0.9	—	MHz
Propagation Delay (Signal Input to Signal Output) t _{pd}	R _L = 200 kΩ V _C = V _{DD} , V _{SS} = GND, C _L = 50 pF V _{is} = Square Wave 0 to V _{DD} t _r , t _f = 20 ns	5	—	—	—	—	40	100	ns	
		10	—	—	—	—	20	40		
		15	—	—	—	—	15	30		
Capacitance: Input, C _{is} Output, C _{os} Feedthrough, C _{ios}	V _{DD} = +5 V V _C = V _{SS} = -5 V		—	—	—	—	4	—	pF	
			—	—	—	—	4	—		
			—	—	—	—	0.2	—		

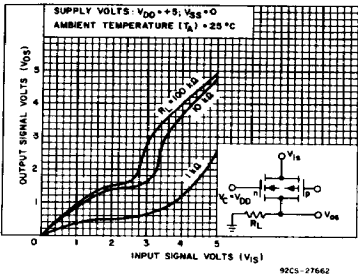


Fig. 3—Typ. on-state characteristics for 1 of 4 switches with VDD = +5 V, VSS = 0 V.

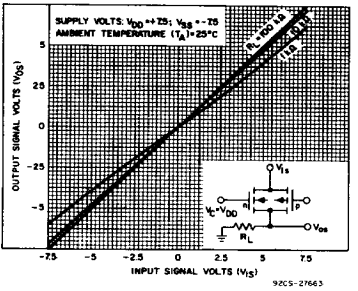


Fig. 4—Typ. on-state characteristics for 1 of 4 switches with VDD = +7.5 V, VSS = -7.5 V.

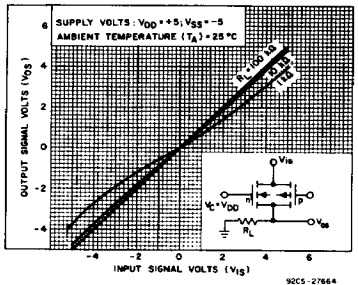


Fig. 5—Typ. on-state characteristics for 1 of 4 switches with VDD = +5 V, VSS = -5 V.

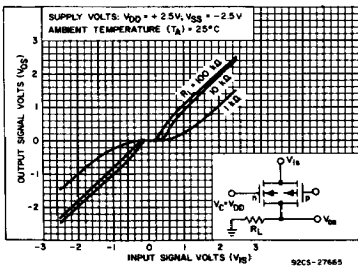


Fig. 6—Typ. on-state characteristics for 1 of 4 switches with VDD = +2.5 V, VSS = -2.5 V.

CD4016B Types

ELECTRICAL CHARACTERISTICS (cont'd)

Characteristic	Test Conditions	LIMITS AT INDICATED TEMPERATURE (°C)							UNITS
		Values at -55, +25, +125 Apply to D, F, K, H Packages							
		Values at -40, +25, +85 Apply to E Package				+25			
		V _{DD} (V)	-55	-40	+85	+125	Typ.	Max.	
Control (V _C)									
Control Input Low Voltage, V _{ILC} (Max.)	I _{is} < 10 μA V _{is} = V _{SS} , V _{OS} = V _{DD} and V _{is} = V _{DD} , V _{OS} = V _{SS}	5, 10, 15	0.9	0.9	0.4	0.4	—	0.7	V
Control Input High Voltage, V _{IHC}	See Fig. 10	5 10 15	3.5 (Min.) 7 (Min.) 11 (Min.)						V
Input Current, I _{IN} (Max.)	V _{is} ≤ V _{DD} V _{DD} - V _{SS} = 18 V V _{CC} ≤ V _{DD} - V _{SS}	18	±0.1	±0.1	±1	±1	±10-5	±0.1	μA
Crosstalk (Control Input to Signal Output)	V _C = 10 V (Sq. Wave) t _r , t _f = 20 ns R _L = 10 kΩ	10	—	—	—	—	50	—	mV
Turn-On Propagation Delay	t _r , t _f = 20 ns C _L = 50 pF R _L = 1 kΩ	5 10 15	—	—	—	—	35 20 15	70 40 30	ns
Maximum Control Input Repetition Rate	V _{is} = V _{DD} , V _{SS} = GND, R _L = 1 kΩ to gnd, C _L = 50 pF, V _C = 10 V (Square wave centered on 5 V) t _r , t _f = 20 ns, V _{OS} = ½ V _{OS} @ 1 kHz	10	—	—	—	—	10	—	MHz
Input Capacitance, C _{IN}			—	—	—	—	5	7.5	μF

V _{DD} (V)	V _{is} (V)	Switch Input I _{is} (mA)						Switch Output V _{OS} (V)	
		-55°C	-40°C	25°C*	25°C*	+85°C	+125°C	Min.	Max.
5	0	0.25	0.2	0.2	0.16	0.12	0.14	—	0.4
5	5	-0.25	-0.2	-0.2	-0.16	-0.12	-0.14	4.6	—
10	0	0.62	0.5	0.5	0.4	0.3	0.35	—	0.5
10	10	-0.62	-0.5	-0.5	-0.4	-0.3	-0.35	9.5	—
15	0	1.8	1.4	1.5	1.2	1	1.1	—	1.5
15	15	-1.8	-1.4	-1.5	-1.2	-1	-1.1	13.5	—

* Plastic package

▲ Ceramic package

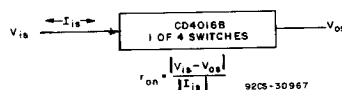


Fig. 10—Determination of r_{on} as a test condition for control input high voltage (V_{IHC}) specification.

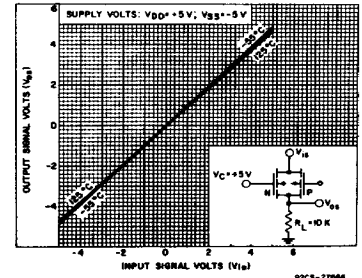


Fig. 7—Typ. on-state characteristics as a function of temp. for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = -5 V.

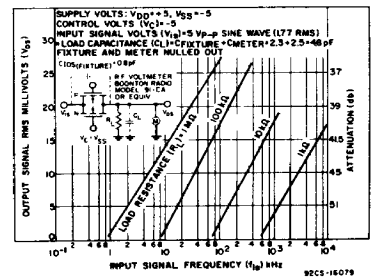


Fig. 8—Typ. feedthru vs. frequency—switch off.

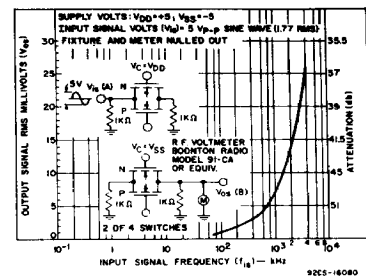


Fig. 9—Typical crosstalk between switch circuits in the same package.

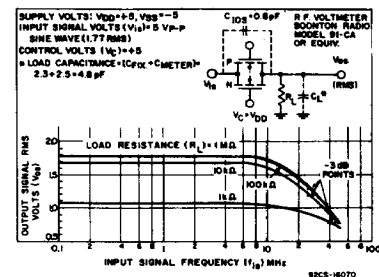


Fig. 11—Typical frequency response—switch on.

CD4016B Types

TYPICAL ON-STATE RESISTANCE CHARACTERISTICS, T_A = 25°C

CHARACTERISTIC*	SUPPLY CONDITIONS		LOAD CONDITIONS					
			R _L = 1kΩ		R _L = 10kΩ		R _L = 100kΩ	
	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	290	+10	250	+10	240	+10
r _{on} (max.)	+10	0	290	0	250	0	300	0
r _{on}	+5	0	500	+7.4	560	+5.6	610	+5.5
r _{on} (max.)	+5	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	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}	+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} = 0 Ω.

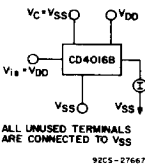


Fig. 12 – Off-state switch input or output leakage current test circuit.

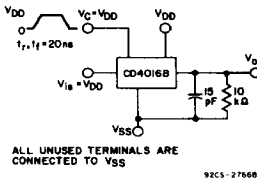
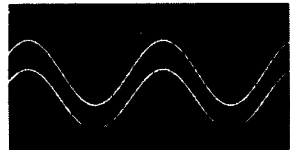


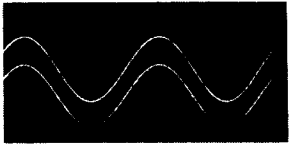
Fig. 13 – Test circuit for square-wave response.



SCALE: X = 0.2 ms/DIV Y = 2.0 V/DIV
VDD = V_C = +7.5V, VSS = -7.5V, R_L = 10KΩ
CL = 15 pF
f_{IS} = 1 KHz V_{IS} = 5V p-p
DISTORTION = 0.2 %

92CS-27612

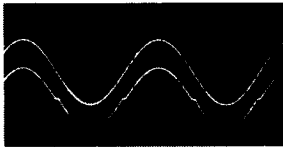
Fig. 14 – Typical sine wave response of V_{DD} = +7.5 V, V_{SS} = -7.5 V.



SCALE: X = 0.2 ms/DIV Y = 2.0 V/DIV
VDD = V_C = +5 V, VSS = -5 V, R_L = 10KΩ
CL = 15 pF
f_{IS} = 1 KHz V_{IS} = 5 V p-p
DISTORTION = 0.4 %

92CS-27613

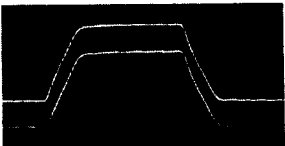
Fig. 15 – Typical sine wave response of V_{DD} = +5 V, V_{SS} = -5 V.



SCALE: X = 0.2 ms/DIV Y = 2.0 V/DIV
VDD = V_C = +2.5V, VSS = -2.5V, R_L = 10KΩ
CL = 15 pF
f_{IS} = 1 KHz V_{IS} = 5V p-p
DISTORTION = 3 %

92CS-27614

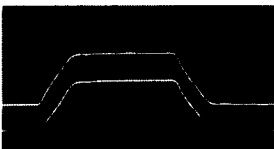
Fig. 16 – Typical sine wave response of V_{DD} = +2.5 V, V_{SS} = -2.5 V.



SCALE: X = 100 ns/DIV
Y = 5.0 V/DIV

92CS-27615

Fig. 17 – Typical square wave response at V_{DD} = V_C = +15 V, V_{SS} = Gnd.



SCALE: X = 100 ns/DIV
Y = 5.0 V/DIV

92CS-27616

Fig. 18 – Typical square wave response at V_{DD} = V_C = +10 V, V_{SS} = Gnd.

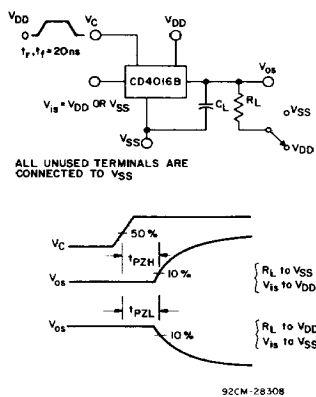
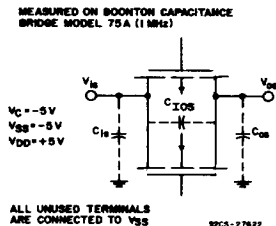
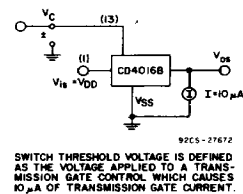
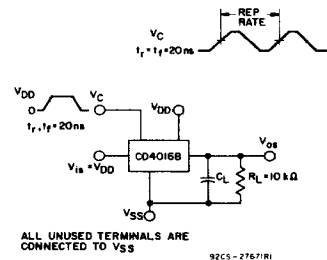
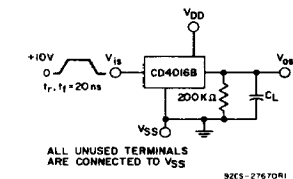
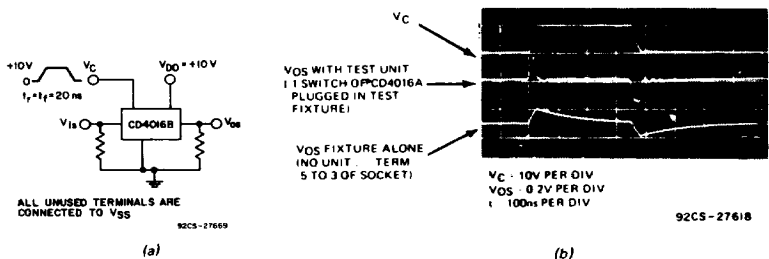


SCALE: X = 100 ns/DIV
Y = 2 V/DIV

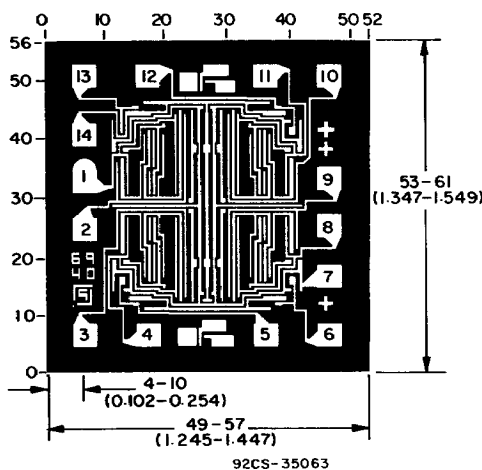
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Fig. 19 – Typical square wave response at V_{DD} = V_C = +5 V, V_{SS} = Gnd.

CD4016B Types



Dimensions and pad layout for CD4016BH



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils (10^{-3} inch).

The photographs and dimensions of each CMOS chip represent a chip when it is part of the wafer. When the wafer is separated into individual chips, the angle of cleavage may vary with respect to the chip face for different chips. The actual dimensions of the isolated chip, therefore, may differ slightly from the nominal dimensions shown. The user should consider a tolerance of -3 mils to $+16$ mils applicable to the nominal dimensions shown.