

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 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).

Features:

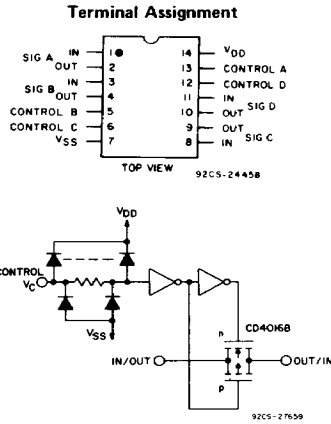
- 20-V digital or ± 10 -V peak-to-peak switching
- 280- Ω typical on-state resistance for 15-V operation
- Switch on-state resistance matched to within 10 Ω typ. over 15-V signal-input range
- High on/off output-voltage ratio: 65 dB typ. @ $f_{is} = 10$ kHz, $R_L = 10$ k Ω
- High degree of linearity: <0.5% distortion typ. @ $f_{is} = 1$ kHz, $V_{is} = 5$ V_{p-p}, $V_{DD} - V_{SS} \geq 10$ V, $R_L = 10$ k Ω
- 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_m (control circuit isolated from sig) 10¹² Ω typ.
- Low crosstalk between switches: -50 dB typ. @ $f_{is} = 0.9$ MHz, R_L
- Matched control-input to signal-to-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 r

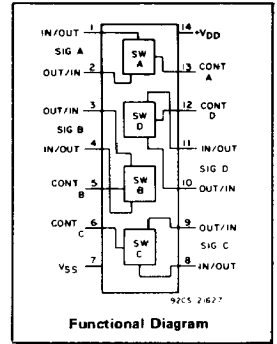
Applications:

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

alc



Schematic diagram - 1 of 4 identical sections.



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 = Full Package Temperature Range)	3	18	V

MAXIMUM RATINGS, Absolute-Maximum Values:

- DC SUPPLY VOLTAGE RANGE, (V_{DD}) (Voltages referenced to V_{SS} Terminal) -0.5 to +20 V
- INPUT VOLTAGE RANGE, ALL INPUTS 0.5 to V_{DD} + 0.5 V
- DC INPUT CURRENT, ANY SIGNAL SOURCE (TRANSMISSION GATE) ± 10 mA
- POWER RATING (DIP Package Types) 500 mW
- Derate Linearly at 12 mW/ $^{\circ}$ C to 200 mW
- 500 mW
- Derate Linearly at 12 mW/ $^{\circ}$ C to 200 mW
- II Package Types) 100 mW
- Storage Temperature Range (All Packages) 55 to +125 $^{\circ}$ C
- 40 to +85 $^{\circ}$ C
- 65 to +150 $^{\circ}$ C
- Control Input Current (All Packages) ± 10 mA
- Control Input Voltage (All Packages) $\pm 265^{\circ}$ C

Boop - Break - Polys - make - can't tell. No - blank.



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

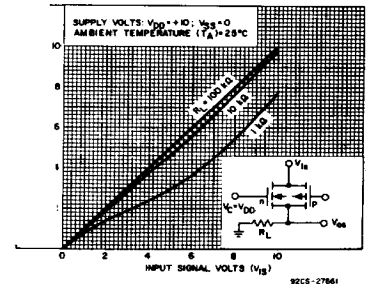


Fig. 2—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +10 V, V_{SS} = 0 V.

CD4016B Types

ELECTRICAL CHARACTERISTICS

Characteristic	Test Conditions	LIMITS AT INDICATED TEMPERATURE (°C)							UNITS	
								+25		
		V _{IN} (V)	V _{DD} (V)	-55	-40	+85	+125	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 = 10 kΩ 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	
Δ On-State Resistance Between Any 2 Switches, Δr _{on}	R _L = 10 kΩ, V _C = V _{DD}	V _{is} = V _{DD} or V _{SS}	15	360	370	520	600	-	400	Ω
		V _{is} = 7.25 to 7.75 V	15	775	790	1080	1230	-	850	
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 _{is} 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	-		

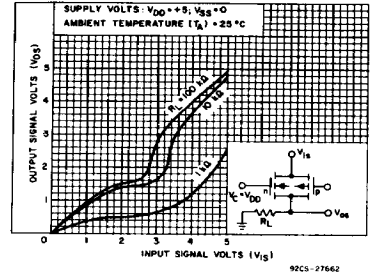


Fig. 3—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = 0 V.

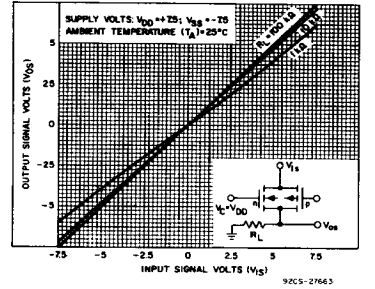


Fig. 4—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +7.5 V, V_{SS} = -7.5 V.

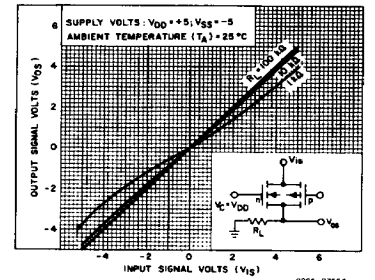


Fig. 5—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = -5 V.

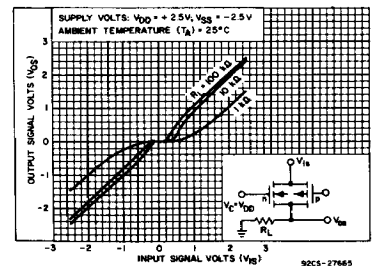


Fig. 6—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +2.5 V, V_{SS} = -2.5 V.

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							
		V _{DD} (V)	-55	-40	+85	+125	+25 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} = 1/2 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

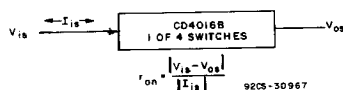


Fig. 10—Determination of r_{on} as a test condition for control input high voltage (V_{IHC}) specification.

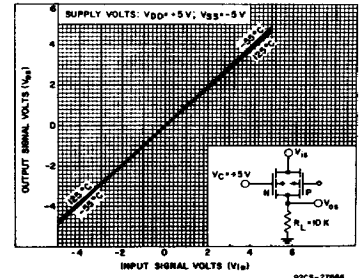


Fig. 7—Typ. on-state characteristics as a function of temp. for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = -5 V.

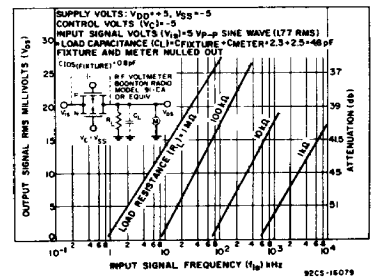


Fig. 8—Typ. feedthru vs. frequency—switch off.

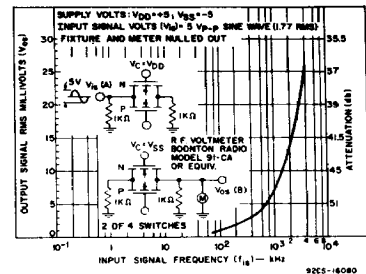


Fig. 9—Typical crosstalk between switch circuits in the same package.

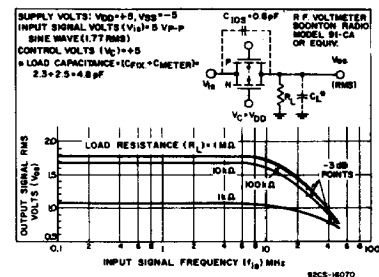


Fig. 11—Typical frequency response—switch on.

CD4016B Types

TYPICAL ON-STATE RESISTANCE CHARACTERISTICS, $T_A = 25^\circ\text{C}$

CHARACTERISTIC*	SUPPLY CONDITIONS		LOAD CONDITIONS					
	V_{DD} (V)	V_{SS} (V)	$R_L = 1k\Omega$		$R_L = 10k\Omega$		$R_L = 100k\Omega$	
			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	200	-7.5	200	-7.5	180	-7.5
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, $r_{on} = 0 \Omega$.

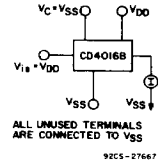


Fig. 12 - Off-state switch input or output leakage current test circuit.

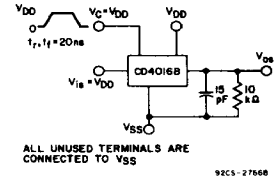
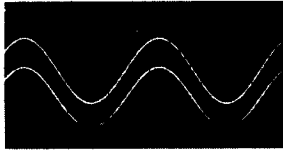


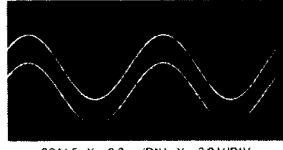
Fig. 13 - Test circuit for square-wave response.



SCALE: X = 0.2 ms/DIV Y = 2.0 V/DIV
 $V_{DD} = V_C = +7.5V$, $V_{SS} = -7.5V$, $R_L = 10k\Omega$
 $C_L = 15 pF$
 $f_{IS} = 1 KHz$, $V_{IS} = 5V p-p$
 DISTORTION = 0.2 %

92CS-27612

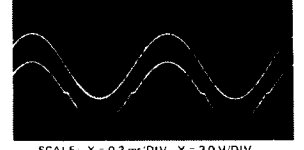
Fig. 14 - Typical sine wave response of $V_{DD} = +7.5 V$, $V_{SS} = -7.5 V$.



SCALE: X = 0.2 ms/DIV Y = 2.0 V/DIV
 $V_{DD} = V_C = +5V$, $V_{SS} = -5V$, $R_L = 10k\Omega$
 $C_L = 15 pF$
 $f_{IS} = 1 KHz$, $V_{IS} = 5V p-p$
 DISTORTION = 0.4 %

92CS-27613

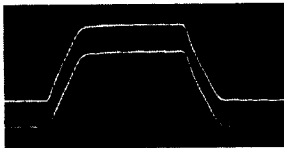
Fig. 15 - Typical sine wave response of $V_{DD} = +5 V$, $V_{SS} = -5 V$.



SCALE: X = 0.2 ms/DIV Y = 2.0 V/DIV
 $V_{DD} = V_C = +2.5V$, $V_{SS} = -2.5V$, $R_L = 10k\Omega$
 $C_L = 15 pF$
 $f_{IS} = 1 KHz$, $V_{IS} = 5V p-p$
 DISTORTION = 3 %

92CS-27614

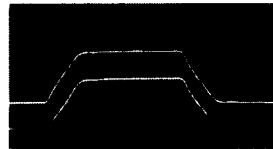
Fig. 16 - Typical sine wave response of $V_{DD} = +2.5 V$, $V_{SS} = -2.5 V$.



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 $V_{DD} = +10 V$, $V_{SS} = Gnd$.



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

92CS-27617

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

CD4016B Types

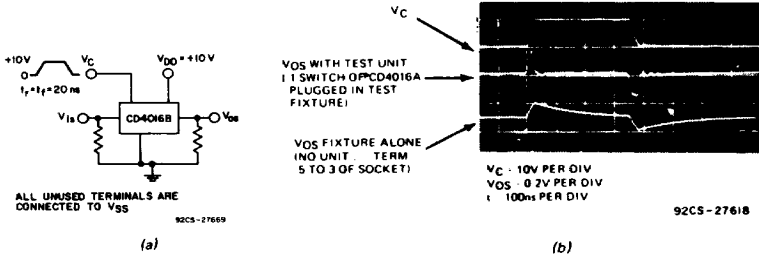


Fig. 20 - Crosstalk-control input to signal output.

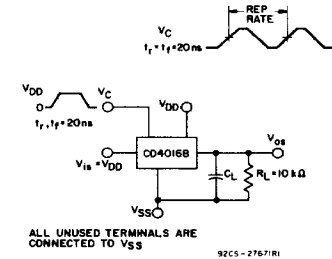


Fig. 22 - Max. control-input repetition rate.

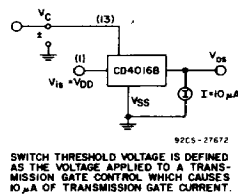


Fig. 23 - Switch threshold voltage.

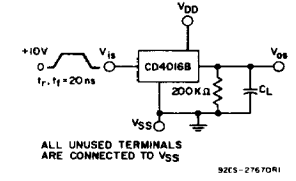


Fig. 21 - Propagation delay time signal input (V_{Is}) to signal output (V_{Os}).

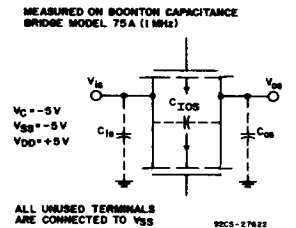


Fig. 24 - Capacitance C_{IOs} and C_{O_s} .

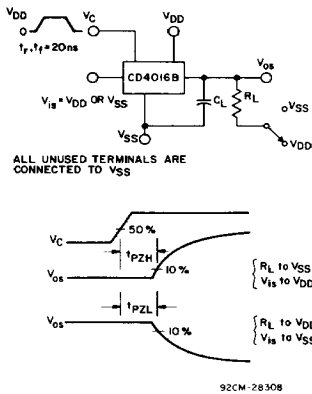
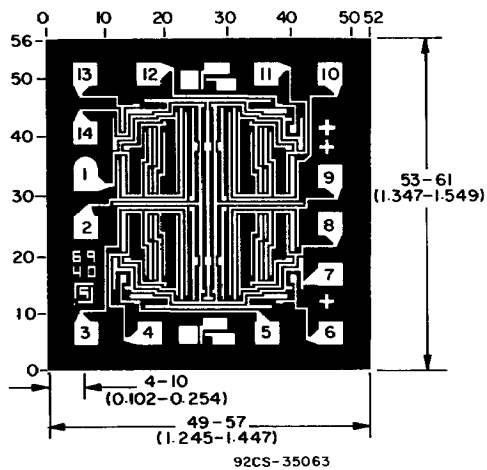


Fig. 25 - Turn-On propagation delay-control input.

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.