National Semiconductor

CD4066BM/CD4066BC Quad Bilateral Switch

General Description

The CD4066BM/CD4066BC is a quad bilateral switch intended for the transmission or multiplexing of analog or digital signals. It is pin-for-pin compatible with CD4016BM/CD4016BC, but has a much lower "ON" resistance, and "ON" resistance is relatively constant over the input-signal range.

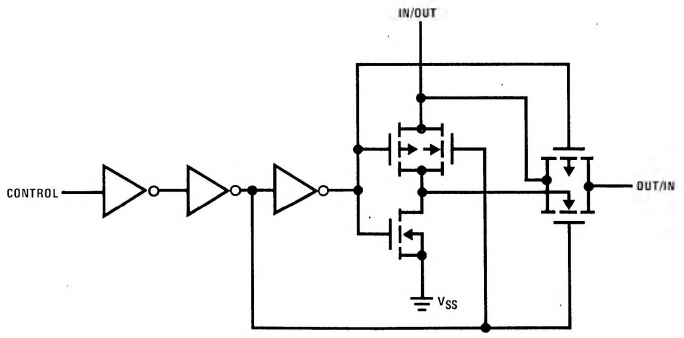
Features

- Wide supply voltage range — 3 V to 15 V
- High noise immunity — 0.45 V_{DD} (typ.)
- Wide range of digital and analog switching — ±7.5 V_{PEAK}
- "ON" resistance for 15 V operation — 80 Ω
- Matched "ON" resistance over 15 V signal input — ΔR_{ON} = 5 Ω (typ.)
- "ON" resistance flat over peak-to-peak signal range
- High "ON"/"OFF" output voltage ratio — 65 dB (typ.) @ f_{is} = 10 kHz, R_L = 10 kΩ
- High degree linearity — 0.1% distortion (typ.) @ f_{is} = 1 kHz, V_{is} = 5 V_{p-p}, $V_{DD} - V_{SS}$ = 10 V, R_L = 10 kΩ
- Extremely low "OFF" switch leakage — 0.1 nA (typ.) @ $V_{DD} - V_{SS}$ = 10 V, T_A = 25°C
- Extremely high control input impedance — 10^{12} Ω (typ.)
- Low crosstalk between switches — −50 dB (typ.) @ f_{is} = 0.9 MHz, R_L = 1 kΩ
- Frequency response, switch "ON" — 40 MHz (typ.)

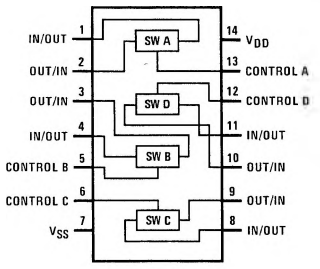
Applications

- 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



Dual-In-Line Package



TOP VIEW

Absolute Maximum Ratings

(Notes 1 and 2)

V_{DD} Supply Voltage	−0.5V to +18V
V_{IN} Input Voltage	−0.5V to V_{DD} + 0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 seconds)	300°C

Recommended Operating Conditions

(Note 2)

V_{DD} Supply Voltage	3V to 15V
V_{IN} Input Voltage	0V to V_{DD}
T_A Operating Temperature Range	
CD4066BM	−55°C to +125°C
CD4066BC	−40°C to +85°C

DC Electrical Characteristics CD4066BM (Note 2)

Parameter		Conditions	−55°C		25°C			125°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I_{DD}	Quiescent Device Current	V_{DD} = 5V		0.25		0.01	0.25		7.5	μA
		V_{DD} = 10V		0.5		0.01	0.5		15	μA
		V_{DD} = 15V		1.0		0.01	1.0		30	μA
Signal Inputs and Outputs										
R_{ON}	"ON" Resistance	R_L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$								
		V_C = V_{DD}, V_{IS} = V_{SS} to V_{DD}								
		V_{DD} = 5V		2000		270	2500		3500	Ω
		V_{DD} = 10V		400		120	500		550	Ω
		V_{DD} = 15V		220		80	280		320	Ω
ΔR_{ON}	Δ "ON" Resistance Between any 2 of 4 Switches	R_L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$								
		V_C = V_{DD}, V_{IS} = V_{SS} to V_{DD}								
		V_{DD} = 10V				10				Ω
		V_{DD} = 15V				5				Ω
I_{IS}	Input or Output Leakage Switch "OFF"	V_C = 0		±50		±0.1	±50		±500	nA
		V_{IS} = 15V and 0V,								
		V_{OS} = 0V and 15V								
Control Inputs										
V_{ILC}	Low Level Input Voltage	V_{IS} = V_{SS} and V_{DD}								
		V_{OS} = V_{DD} and V_{SS}								
		I_{IS} = ±10 μA								
		V_{DD} = 5V		1.5		2.25	1.5		1.5	V
		V_{DD} = 10V		3.0		4.5	3.0		3.0	V
		V_{DD} = 15V		4.0		6.75	4.0		4.0	V
V_{IHC}	High Level Input Voltage	V_{DD} = 5V	3.5		3.5	2.75		3.5		V
		V_{DD} = 10V (see note 6)	7.0		7.0	5.5		7.0		V
		V_{DD} = 15V	11.0		11.0	8.25		11.0		V
I_{IN}	Input Current	V_{DD} − V_{SS} = 15V		±0.1		$\pm 10^{-5}$	±0.1		±1.0	μA
		$V_{DD} \geq V_{IS} \geq V_{SS}$								
		$V_{DD} \geq V_C \geq V_{SS}$								

DC Electrical Characteristics CD4066BC (Note 2)

Parameter		Conditions	−40°C		25°C			85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I_{DD}	Quiescent Device Current	V_{DD} = 5V		1.0		0.01	1.0		7.5	μA
		V_{DD} = 10V		2.0		0.01	2.0		15	μA
		V_{DD} = 15V		4.0		0.01	4.0		30	μA

DC Electrical Characteristics (Cont'd.) CD4066BC (Note 2)

Parameter	Conditions	−40°C Min	−40°C Max	25°C Min	25°C Typ	25°C Max	85°C Min	85°C Max	Units
Signal Inputs and Outputs									
R_{ON} "ON" Resistance	$R_L = 10\ k\Omega$ to $\frac{V_{DD} - V_{SS}}{2}$ $V_C = V_{DD}$, V_{SS} to V_{DD}								
	$V_{DD} = 5V$		2000		270	2500		3200	Ω
	$V_{DD} = 10V$		450		120	500		520	Ω
	$V_{DD} = 15V$		250		80	280		300	Ω
ΔR_{ON} Δ"ON" Resistance Between Any 2 of 4 Switches	$R_L = 10\ k\Omega$ to $\frac{V_{DD} - V_{SS}}{2}$ $V_{CC} = V_{DD}$, $V_{IS} = V_{SS}$ to V_{DD}								
	$V_{DD} = 10V$				10				Ω
	$V_{DD} = 15V$				5				Ω
I_{IS} Input or Output Leakage Switch "OFF"	$V_C = 0$		±50		±0.1	±50		±200	nA
Control Inputs									
V_{ILC} Low Level Input Voltage	$V_{IS} = V_{SS}$ and V_{DD} $V_{OS} = V_{DD}$ and V_{SS} $I_{IS} = \pm 10\mu A$								
	$V_{DD} = 5V$		1.5		2.25	1.5		1.5	V
	$V_{DD} = 10V$		3.0		4.5	3.0		3.0	V
	$V_{DD} = 15V$		4.0		6.75	4.0		4.0	V
V_{IHC} High Level Input Voltage	$V_{DD} = 5V$	3.5		3.5	2.75		3.5		V
	$V_{DD} = 10V$ (See note 6)	7.0		7.0	5.5		7.0		V
	$V_{DD} = 15V$	11.0		11.0	8.25		11.0		V
I_{IN} Input Current	$V_{DD} - V_{SS} = 15V$ $V_{DD} \geq V_{IS} \geq V_{SS}$ $V_{DD} \geq V_C \geq V_{SS}$		±0.3		$\pm 10^{-5}$	±0.3		±1.0	μA

AC Electrical Characteristics $T_A = 25°C$, $t_r = t_f = 20$ ns and $V_{SS} = 0V$ unless otherwise specified

Parameter		Conditions	Min	Typ	Max	Units
t_{PHL}, t_{PLH}	Propagation Delay Time Signal Input to Signal Output	$V_C = V_{DD}$, $C_L = 50$ pF, *(Figure 1)* $R_L = 200k$				
		$V_{DD} = 5V$		25	55	ns
		$V_{DD} = 10V$		15	35	ns
		$V_{DD} = 15V$		10	25	ns
t_{PZH}, t_{PZL}	Propagation Delay Time Control Input to Signal Output High Impedance to Logical Level	$R_L = 1.0\ k\Omega$, $C_L = 50$ pF, *(Figures 2 and 3)*				
		$V_{DD} = 5V$			125	ns
		$V_{DD} = 10V$			60	ns
		$V_{DD} = 15V$			50	ns
t_{PHZ}, t_{PLZ}	Propagation Delay Time Control Input to Signal Output Logical Level to High Impedance	$R_L = 1.0\ k\Omega$, $C_L = 50$ pF, *(Figures 2 and 3)*				
		$V_{DD} = 5V$			125	ns
		$V_{DD} = 10V$			60	ns
		$V_{DD} = 15V$			50	ns
	Sine Wave Distortion	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$ $R_L = 10\ k\Omega$, $V_{IS} = 5\ V_{p-p}$, $f = 1$ kHz, *(Figure 4)*		0.1		%
	Frequency Response–Switch "ON" (Frequency at −3 dB)	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$, $R_L = 1\ k\Omega$, $V_{IS} = 5V_{p-p}$, $20\ \text{Log}_{10}\ V_{OS}/V_{OS}(1kHz)$-dB, *(Figure 4)*		40		MHz

AC Electrical Characteristics (Continued)

$T_A = 25°C$, $t_r = t_f = 20$ ns and $V_{SS} = 0$ V unless otherwise noted

	Parameter	Conditions	Min.	Typ.	Max.	Units
	Feedthrough — Switch "OFF" (Frequency at −50 dB)	$V_{DD} = 5.0$ V, $V_{CC} = V_{SS} = -5.0$ V, $R_L = 1$ kΩ, $V_{IS} = 5.0\ V_{p\text{-}p}$, 20 Log_{10}, $V_{OS}/V_{IS} = -50$ dB, *(Figure 4)*		1.25		
	Crosstalk Between Any Two Switches (Frequency at −50 dB)	$V_{DD} = V_{C(A)} = 5.0$ V; $V_{SS} = V_{C(B)} = -5.0$ V, $R_L = 1$ kΩ, $V_{IS(A)} = 5.0\ V_{p\text{-}p}$, 20 Log_{10}, $V_{OS(B)}/V_{IS(A)} = -50$ dB, *(Figure 5)*		0.9		MHz
	Crosstalk; Control Input to Signal Output	$V_{DD} = 10$ V, $R_L = 10$ kΩ, $R_{IN} = 1.0$ kΩ, $V_{CC} = 10$ V Square Wave, $C_L = 50$ pF *(Figure 6)*		150		$mV_{p\text{-}p}$
	Maximum Control Input	$R_L = 1.0$ kΩ, $C_L = 50$ pF, *(Figure 7)* $V_{OS(f)} = \frac{1}{2} V_{OS}$(1.0 kHz)				
		$V_{DD} = 5.0$ V		6.0		MHz
		$V_{DD} = 10$ V		8.0		MHz
		$V_{DD} = 15$ V		8.5		MHz
C_{is}	Signal Input Capactance			8.0		pF
C_{OS}	Signal Output Capacitance	$V_{DD} = 10$ V		8.0		pF
C_{ios}	Feedthrough Capacitance	$V_C = 0$ V		0.5		pF
C_{IN}	Control Input Capacitance			5.0	7.5	pF

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Recommended Operating Conditions" and "Electrical Characteristics" provide conditions for actual device operation.

Note 2: $V_{SS} = 0$ V unless otherwise specified.

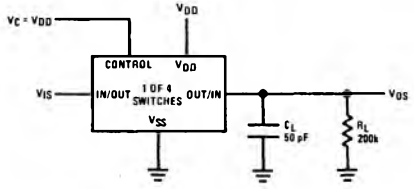
Note 3: These devices should not be connected to circuits with the power "ON".

Note 4: In all cases, there is approximately 5 pF of probe and jig capacitance in the output; however, this capacitance is included in C_L wherever it is specified.

Note 5: V_{IS} is the voltage at the in/out pin and V_{OS} is the voltage at the out/in pin. V_C is the voltage at the control input.

Note 6: Conditions for V_{IHC}:
a) $V_{IS} = V_{DD}$, I_{OS} = standard B series I_{OH} b) $V_{IS} = 0$ V, I_{OL} = standard B series I_{OL}.

AC Test Circuits and Switching Time Waveforms



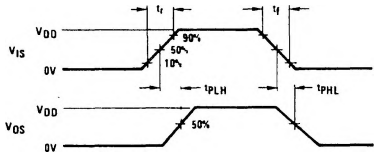
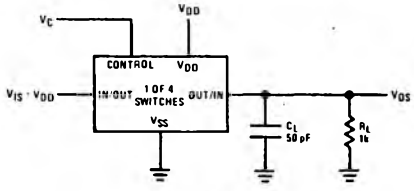


FIGURE 1. t_{PHL}, t_{PLH} Propagation Delay Time Signal Input to Signal Output



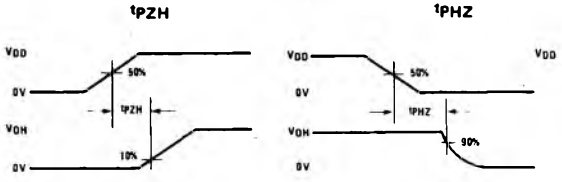
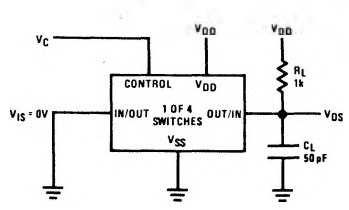


FIGURE 2. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output



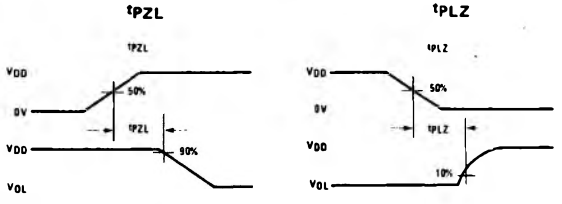
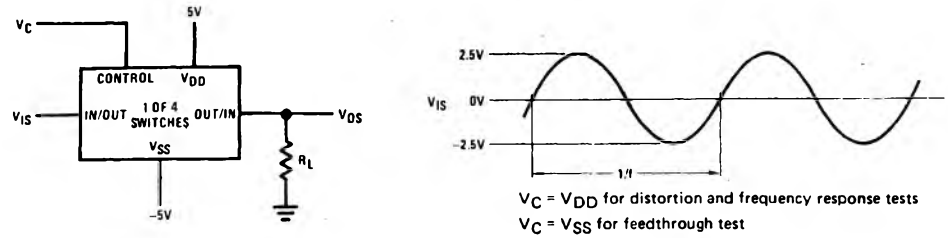


FIGURE 3. t_{PZL}, t_{PLZ} Propagation Delay Time Control to Signal Output

AC Test Circuits and Switching Time Waveforms (Cont'd.)



$V_C = V_{DD}$ for distortion and frequency response tests

$V_C = V_{SS}$ for feedthrough test

FIGURE 4. Sine Wave Distortion, Frequency Response and Feedthrough

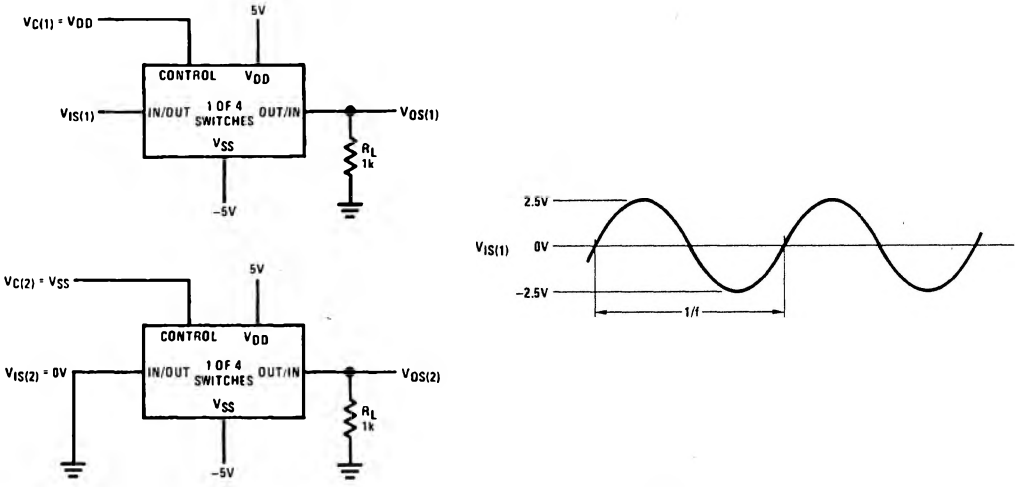


FIGURE 5. Crosstalk Between Any Two Switches

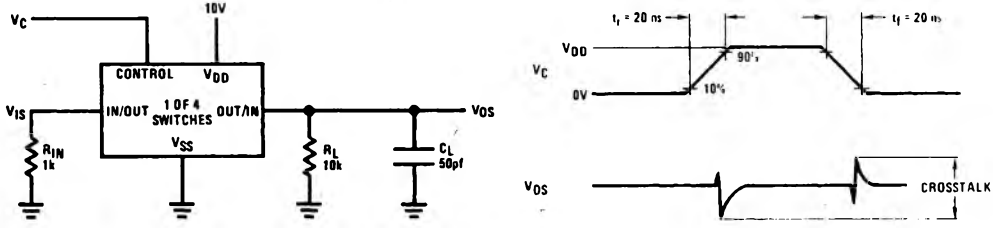


FIGURE 6. Crosstalk: Control Input to Signal Output

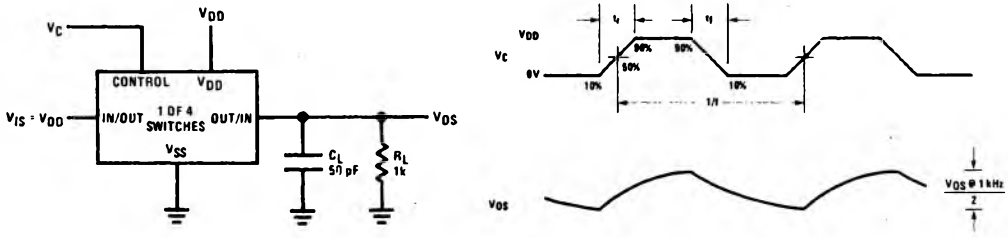
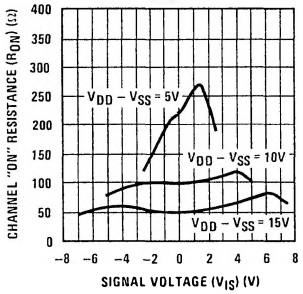


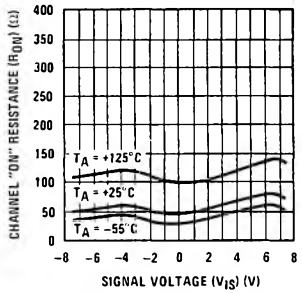
FIGURE 7. Maximum Control Input Frequency

Typical Performance Characteristics

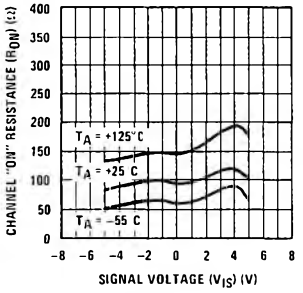
"ON" Resistance vs Signal Voltage for $T_A = 25°C$



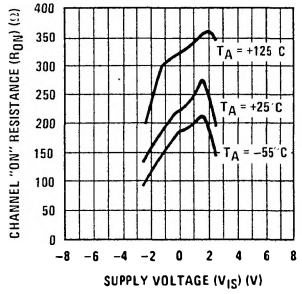
"ON" Resistance as a Function of Temperature for $V_{DD} - V_{SS} = 15V$



"ON" Resistance as a Function of Temperature for $V_{DD} - V_{SS} = 10V$



"ON" Resistance as a Function of Temperature for $V_{DD} - V_{SS} = 5V$



Special Considerations

In applications where separate power sources are used to drive V_{DD} and the signal input, the V_{DD} current capability should exceed V_{DD}/R_L (R_L = effective external load of the 4 CD4066BM/CD4066BC bilateral switches). This provision avoids any permanent current flow or clamp action on the V_{DD} supply when power is applied or removed from CD4066BM/CD4066BC.

In certain applications, the external load-resistor current may include both V_{DD} and signal-line components. To avoid drawing V_{DD} current when switch current flows into terminals 1, 4, 8 or 11, the voltage drop across the bidirectional switch must not exceed 0.6V at $T_A \leq 25°C$, or 0.4V at $T_A > 25°C$ (calculated from R_{ON} values shown).

No V_{DD} current will flow through R_L if the switch current flows into terminals 2, 3, 9 or 10.