National Semiconductor

June 1992

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.

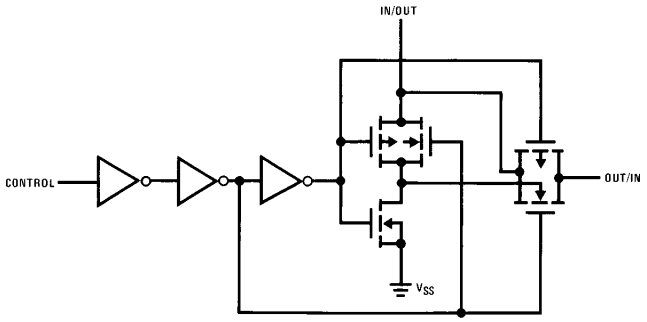
Features

- Wide supply voltage range — 3V to 15V
- High noise immunity — 0.45 V_{DD} (typ.)
- Wide range of digital and analog switching — ± 7.5 V_{PEAK}
- "ON" resistance for 15V operation — 80Ω
- Matched "ON" resistance over 15V signal input — $\Delta R_{ON} = 5\Omega$ (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, $V_{is} = 5V_{p-p}$, $V_{DD} - V_{SS} = 10V$, $R_L = 10$ kΩ
- Extremely low "OFF" switch leakage — 0.1 nA (typ.) @ $V_{DD} - V_{SS} = 10V$, $T_A = 25°C$
- Extremely high control input impedance — $10^{12}\Omega$ (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

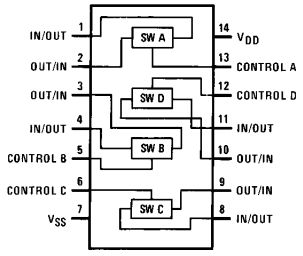
- Analog signal switching/multiplexing
  - Signal gating
  - Squelch control
  - Chopper
  - Modulator/Demodulator
  - Commutating switch
- Digital signal switching/multiplexing
- CMOS logic implementation
- Analog-to-digital/digital-to-analog conversion
- Digital control of frequency, impedance, phase,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

Schematic and Connection Diagrams



Order Number CD4066B

Dual-In-Line Package



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Top View

RRD-B30M105/Printed in U. S. A.

Absolute Maximum Ratings (Notes 1 & 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage (V_{DD})	−0.5V to +18V
Input Voltage (V_{IN})	−0.5V to V_{DD} +0.5V
Storage Temperature Range (T_S)	−65°C to +150°C
Power Dissipation (P_D)	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature (T_L) (Soldering, 10 seconds)	300°C

Recommended Operating Conditions (Note 2)

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

DC Electrical Characteristics CD4066BM (Note 2)

Symbol	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	$R_L=10\ k\Omega$ to $\frac{V_{DD}-V_{SS}}{2}$								
		$V_C=V_{DD}$, $V_{IS}=V_{SS}$ to V_{DD}								
		$V_{DD}=5V$		800		270	1050		1300	Ω
		$V_{DD}=10V$		310		120	400		550	Ω
		$V_{DD}=15V$		200		80	240		320	Ω
ΔR_{ON}	Δ"ON" Resistance Between any 2 of 4 Switches	$R_L=10\ k\Omega$ to $\frac{V_{DD}-V_{SS}}{2}$								
		$V_C=V_{DD}$, $V_{IS}=V_{SS}$ 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}								
		$I_{IS}=\pm 10\ \mu A$								
		$V_{DD}=5V$		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	$V_{DD}-V_{SS}=15V$		±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)

Symbol	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 (Continued) CD4066BC (Note 2)

Symbol	Parameter	Conditions	−40°C		+25°C			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
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}								
		$V_{DD} = 5V$		850		270	1050		1200	Ω
		$V_{DD} = 10V$		330		120	400		520	Ω
		$V_{DD} = 15V$		210		80	240		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 noted

Symbol	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	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$ $R_L = 10\ k\Omega$, $V_{IS} = 5V_{p\text{-}p}$, f = 1 kHz, (*Figure 4*)		0.1		%
	Frequency Response-Switch "ON" (Frequency at −3 dB)	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$, $R_L = 1\ k\Omega$, $V_{IS} = 5V_{p\text{-}p}$, 20 $\text{Log}_{10}\ V_{OS}/V_{OS}$ (1 kHz) − dB, (*Figure 4*)		40		MHz

AC Electrical Characteristics* (Continued) $T_A = 25°C$, $t_r = t_f = 20$ ns and $V_{SS} = 0V$ unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Feedthrough — Switch "OFF" (Frequency at −50 dB)	$V_{DD} = 5.0V$, $V_{CC} = V_{SS} = -5.0V$, $R_L = 1\ k\Omega$, $V_{IS} = 5.0V_{p-p}$, 20 Log_{10}, $V_{OS}/V_{IS} = -50$ dB, *(Figure 4)*		1.25		
	Crosstalk Between Any Two Switches (Frequency at −50 dB)	$V_{DD} = V_{C(A)} = 5.0V$; $V_{SS} = V_{C(B)} = 5.0V$, $R_L 1\ k\Omega$, $V_{IS(A)} = 5.0\ V_{p-p}$, 20 Log_{10}, $V_{OS(B)}/V_{IS(A)} = -50$ dB *(Figure 5)*		0.9		MHz
	Crosstalk; Control Input to Signal Output	$V_{DD} = 10V$, $R_L = 10\ k\Omega$, $R_{IN} = 1.0\ k\Omega$, $V_{CC} = 10V$ Square Wave, $C_L = 50$ pF *(Figure 6)*		150		mV_{p-p}
	Maximum Control Input	$R_L = 1.0\ k\Omega$, $C_L = 50$ pF, *(Figure 7)* $V_{OS(f)} = ½\ V_{OS}$(1.0 kHz)				
		$V_{DD} = 5.0V$		6.0		MHz
		$V_{DD} = 10V$		8.0		MHz
		$V_{DD} = 15V$		8.5		MHz
C_{IS}	Signal Input Capacitance			8.0		pF
C_{OS}	Signal Output Capacitance	$V_{DD} = 10V$		8.0		pF
C_{IOS}	Feedthrough Capacitance	$V_C = 0V$		0.5		pF
C_{IN}	Control Input Capacitance			5.0	7.5	pF

*AC Parameters are guaranteed by DC correlated testing.

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: $V_{SS} = 0V$ 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) $V_{IS} = 0V$, I_{OL} = standard B series I_{OL}.

AC Test Circuits and Switching Time Waveforms

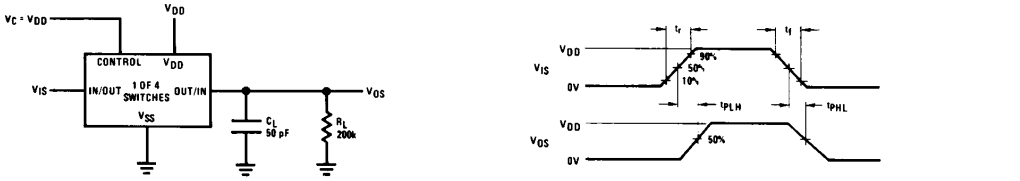

FIGURE 1. t_{PHL}, t_{PLH} Propagation Delay Time Signal Input to Signal Output

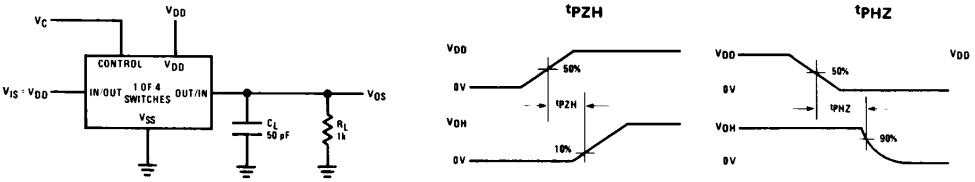

FIGURE 2. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output

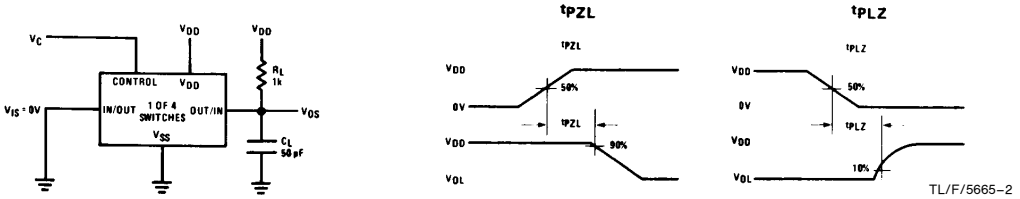

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FIGURE 3. t_{PZL}, t_{PLZ} Propagtion Delay Time Control to Signal Output

AC Test Circuits and Switching Time Waveforms (Continued)

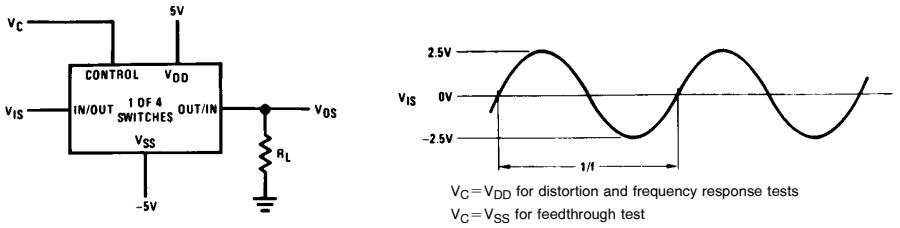

FIGURE 4. Sine Wave Distortion, Frequency Response and Feedthrough

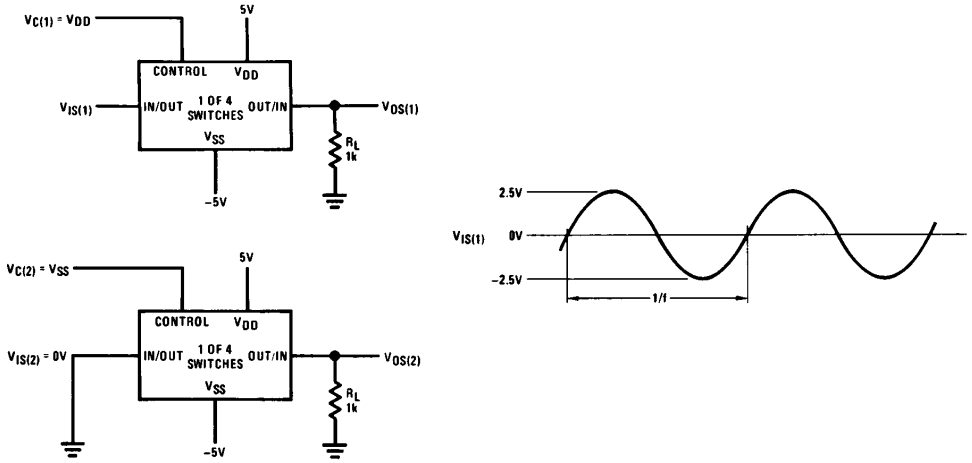

FIGURE 5. Crosstalk Between Any Two Switches

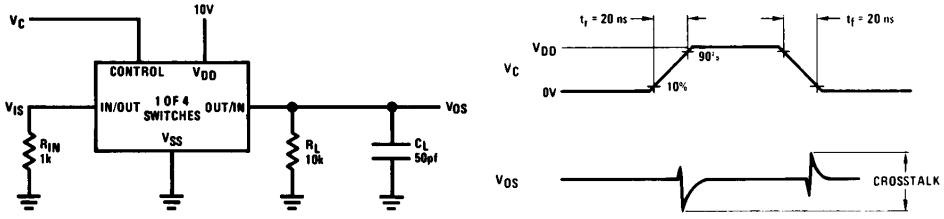

FIGURE 6. Crosstalk: Control Input to Signal Output

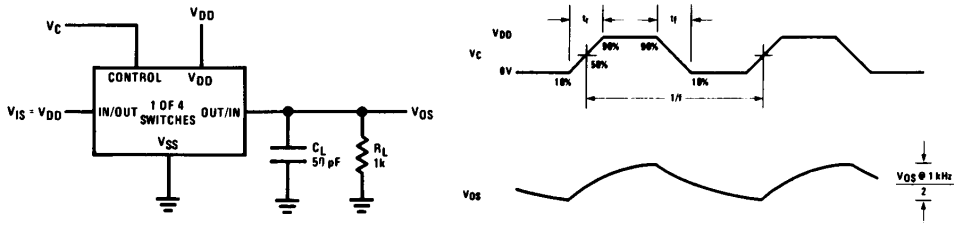

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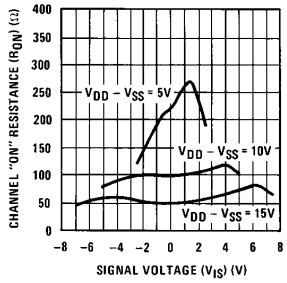
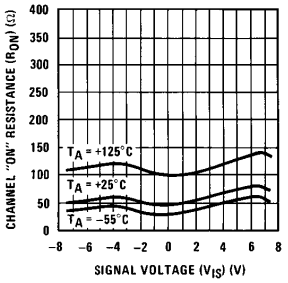
FIGURE 7. Maximum Control Input Frequency

Typical Performance Characteristics

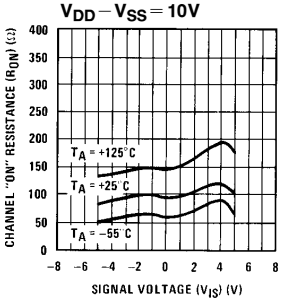
"ON" Resistance vs Signal Voltage for $T_A = 25°C$



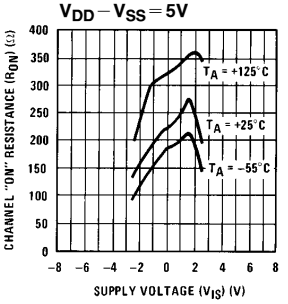
"ON" Resistance as a Function of Temperature for $V_{DD} - V_{SS} = 15V$



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



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



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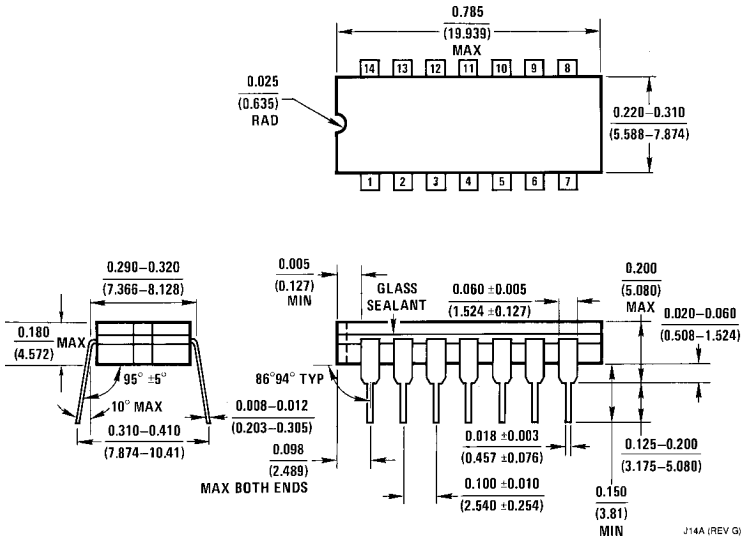
Special Considerations

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 of the V_{DD} supply when power is applied or removed from CD4066BM/CD4066BC.

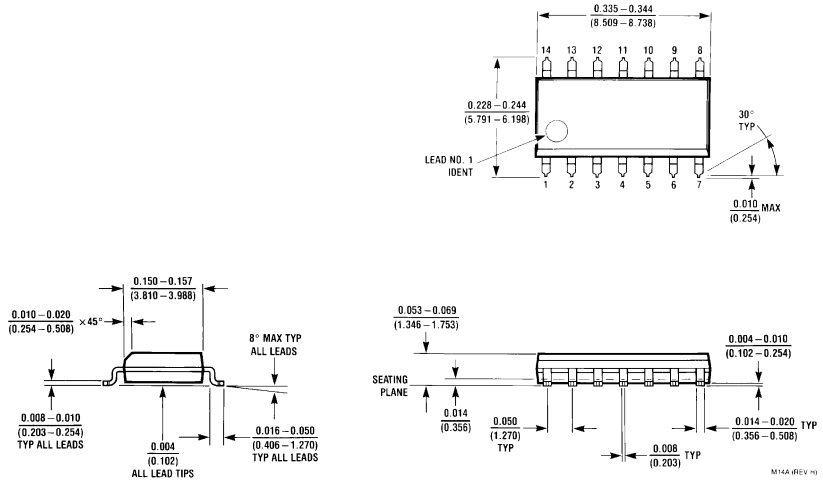
In certain applications, the external load-resistor current may include both V_{DD} and signal-line components. To avoid drawing V_{DD} current when switch current flows into terminals 1, 4, 8 or 11, the voltage drop across the bidirectional switch must not exceed 0.6V at $T_A \leq 25°C$, or 0.4V at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

Physical Dimensions inches (millimeters)

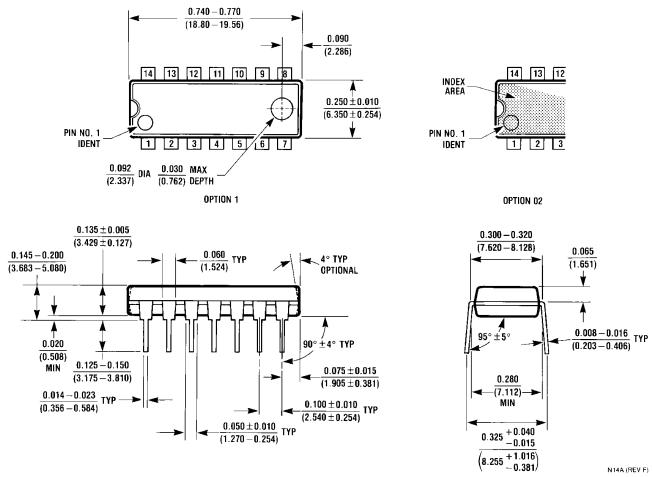


Cerdip (J)
Order Number CD4066BMJ or CD4066BCJ
NS Package Number J14A



S.O. Package (M)
Order Number CD4066BCM
NS Package Number M14A

Physical Dimensions inches (millimeters) (Continued)



Dual-In-Line Package (N)
Order Number CD4066BMN or CD4066BCN
NS Package Number N14A

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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.

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