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CD4016BC
Quad Bilateral Switch

General Description

The CD4016BC is a quad bilateral switch intended for the transmission or multiplexing of analog or digital signals. It is pin-for-pin compatible with CD4066BC.

Features

- Wide supply voltage range: 3V to 15V
- Wide range of digital and analog switching: ±7.5 V_{PEAK}
- "ON" resistance for 15V operation: 400Ω (typ.)
- Matched "ON" resistance over 15V signal input:
  $\Delta R_{ON} = 10\Omega$ (typ.)
- High degree of linearity:
  0.4% distortion (typ.)
  @ $f_{IS} = 1$ kHz, $V_{IS} = 5\ V_{p\text{-}p}$,
  $V_{DD}-V_{SS} = 10V$, $R_L = 10$ 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

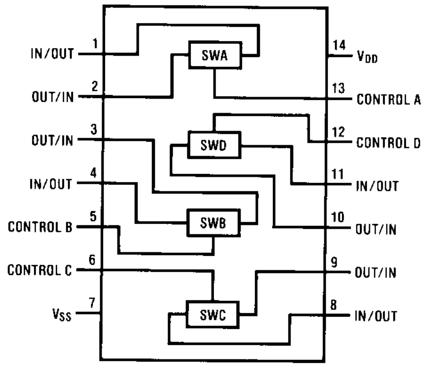
Ordering Code:

Order Number	Package Number	Package Description
CD4016BCM	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow
CD4016BCN	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

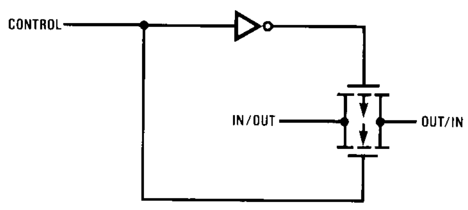
Devices also available in Tape and Reel. Specify by appending the letter suffix "X" to the ordering code.

Connection Diagram

Pin Assignments for DIP and SOIC



Schematic Diagram



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Absolute Maximum Ratings (Note 1)

(Note 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
Power Dissipation (P_D)	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature	
(Soldering, 10 seconds)	260°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	−40°C to +85°C

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.

DC Electrical Characteristics (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, V_{IN} = V_{DD} or V_{SS}		1.0		0.01	1.0		7.5	µA
		V_{DD} = 10V, V_{IN} = V_{DD} or V_{SS}		2.0		0.01	2.0		15	µA
		V_{DD} = 15V, V_{IN} = V_{DD} or V_{SS}		4.0		0.01	4.0		30	µA
Signal Inputs and Outputs										
R_{ON}	"ON" Resistance	R_L = 10kΩ to (V_{DD} − V_{SS})/2								
		V_C = V_{DD}, V_{IS} = V_{SS} or V_{DD}								
		V_{DD} = 10V		610		275	660		840	Ω
		V_{DD} = 15V		370		200	400		520	Ω
		R_L = 10kΩ to (V_{DD} − V_{SS})/2								
		V_C = V_{DD}								
		V_{DD} = 10V, V_{IS} = 4.75 to 5.25V		1900		850	2000		2380	Ω
		V_{DD} = 15V, V_{IS} = 7.25 to 7.75V		790		400	850		1080	Ω
ΔR_{ON}	Δ"ON" Resistance Between any 2 of 4 Switches (In Same Package)	R_L = 10kΩ to (V_{DD} − V_{SS})/2								
		V_C = V_{DD}, V_{IS} = V_{SS} to V_{DD}								
		V_{DD} = 10V				15				Ω
		V_{DD} = 15V				10				Ω
I_{IS}	Input or Output Leakage Switch "OFF"	V_C = 0, V_{DD} = 15V		±50		±0.1	±50		±200	nA
		V_{IS} = 0V or 15V,								
		V_{OS} = 15V or 0V								
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		0.9			0.7		0.4	V
		V_{DD} = 10V		0.9			0.7		0.4	V
		V_{DD} = 15V		0.9			0.7		0.4	V
V_{IHC}	HIGH Level Input Voltage	V_{DD} = 5V	3.5		3.5			3.5		V
		V_{DD} = 10V	7.0		7.0			7.0		V
		V_{DD} = 15V	11.0		11.0			11.0		V
		(Note 3) and Figure 8								
I_{IN}	Input Current	V_{CC} − V_{SS} = 15V		±0.3		$\pm10^{-5}$	±0.3		±1.0	µA
		V_{DD} ≥ V_{IS} ≥ V_{SS}								
		V_{DD} ≥ V_C ≥ V_{SS}								

Note 3: If the switch input is held at V_{DD}, V_{IHC} is the control input level that will cause the switch output to meet the standard "B" series V_{OH} and I_{OH} output levels. If the analog switch input is connected to V_{SS}, V_{IHC} is the control input level — which allows the switch to sink standard "B" series $|I_{OH}|$, high level current, and still maintain a V_{OL} ≤ "B" series. These currents are shown in Figure 8.

AC Electrical Characteristics (Note 4)

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PHL}, t_{PLH}	Propagation Delay Time	$V_C = V_{DD}$, $C_L = 50$ pF, (Figure 1)				
	Signal Input to Signal Output	$R_L = 200k$				
		$V_{DD} = 5V$		58	100	ns
		$V_{DD} = 10V$		27	50	ns
		$V_{DD} = 15V$		20	40	ns
t_{PZH}, t_{PZL}	Propagation Delay Time	$R_L = 1.0$ kΩ, $C_L = 50$ pF, (Figure 2, Figure 3)				
	Control Input to Signal	$V_{DD} = 5V$		20	50	ns
	Output HIGH Impedance to	$V_{DD} = 10V$		18	40	ns
	Logical Level	$V_{DD} = 15V$		17	35	ns
t_{PHZ}, t_{PLZ}	Propagation Delay Time	$R_L = 1.0$ kΩ, $C_L = 50$ pF, (Figure 2, Figure 3)				
	Control Input to Signal	$V_{DD} = 5V$		15	40	ns
	Output Logical Level to	$V_{DD} = 10V$		11	25	ns
	HIGH Impedance	$V_{DD} = 15V$		10	22	ns
	Sine Wave Distortion	$V_C = V_{DD} = 5V$, $V_{SS} = -5$ $R_L = 10$ kΩ, $V_{IS} = 5\ V_{P-P}$, f = 1 kHz, (Figure 4)		0.4		%
	Frequency Response — Switch "ON" (Frequency at −3 dB)	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$, $R_L = 1$ kΩ, $V_{IS} = 5\ V_{P-P}$, 20 Log_{10} V_{OS}/V_{OS} (1 kHz) −dB, (Figure 4)		40		MHz
	Feedthrough — Switch "OFF" (Frequency at −50 dB)	$V_{DD} = 5V$, $V_C = V_{SS} = -5V$, $R_L = 1$ kΩ, $V_{IS} = 5\ V_{P-P}$, 20 Log_{10} $(V_{OS}/V_{IS}) = -50$ dB, (Figure 4)		1.25		MHz
	Crosstalk Between Any Two Switches (Frequency at −50 dB)	$V_{DD} = V_{C(A)} = 5V$; $V_{SS} = V_{C(B)} = -5V$, $R_L = 1$ kΩ$V_{IS(A)} = 5\ V_{P-P}$, 20 Log_{10} $(V_{OS(B)}/V_{OS(A)}) = -50$ dB, (Figure 5)		0.9		MHz
	Crosstalk; Control Input to Signal Output	$V_{DD} = 10V$, $R_L = 10$ kΩ $R_{IN} = 1$ kΩ, $V_{CC} = 10V$ Square Wave, $C_L = 50$ pF (Figure 6)		150		mV_{P-P}
	Maximum Control Input	$R_L = 1$ kΩ, $C_L = 50$ pF, (Figure 7) $V_{OS(f)} = ½\ V_{OS}(1\ kHz)$				
		$V_{DD} = 5V$		6.5		MHz
		$V_{DD} = 10V$		8.0		MHz
		$V_{DD} = 15V$		9.0		MHz
C_{IS}	Signal Input Capacitance			4		pF
C_{OS}	Signal Output Capacitance	$V_{DD} = 10V$		4		pF
C_{IOS}	Feedthrough Capacitance	$V_C = 0V$		0.2		pF
C_{IN}	Control Input Capacitance			5	7.5	pF

Note 4: AC Parameters are guaranteed by DC correlated testing.

Note 5: These devices should not be connected to circuits with the power "ON".

Note 6: In all cases, there is approximately 5 pF of probe and jig capacitance on the output; however, this capacitance is included in C_L wherever it is specified.

Note 7: 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.

AC Test Circuits and Switching Time Waveforms

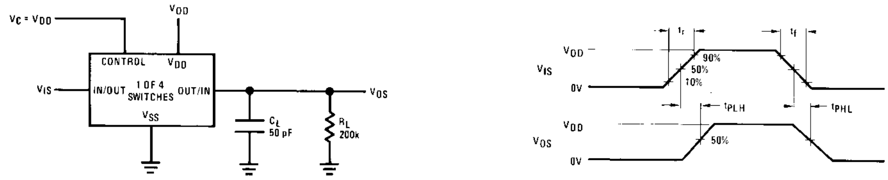


FIGURE 1. t_{PLH}, t_{PLH} Propagation Delay Time Control to Signal Output

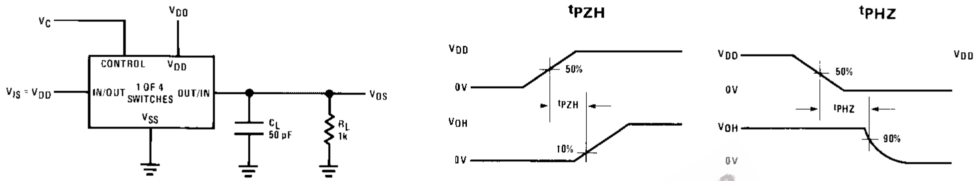


FIGURE 2. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output

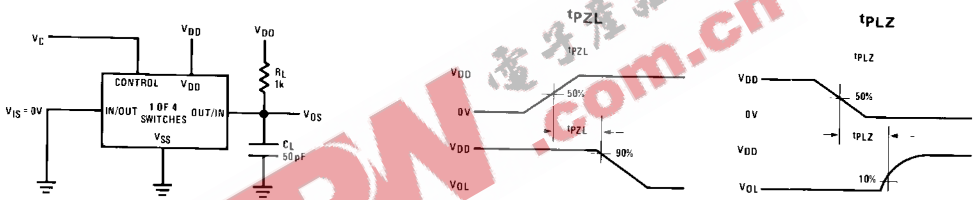
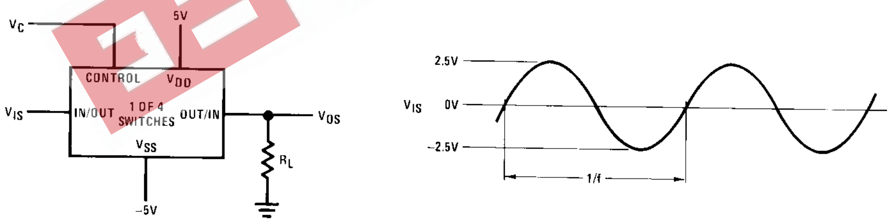


FIGURE 3. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output



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

$V_C = V_{SS}$ for feedthrough test

FIGURE 4. Sine Wave Distortion, Frequency Response and Feedthrough

AC Test Circuits and Switching Time Waveforms (Continued)

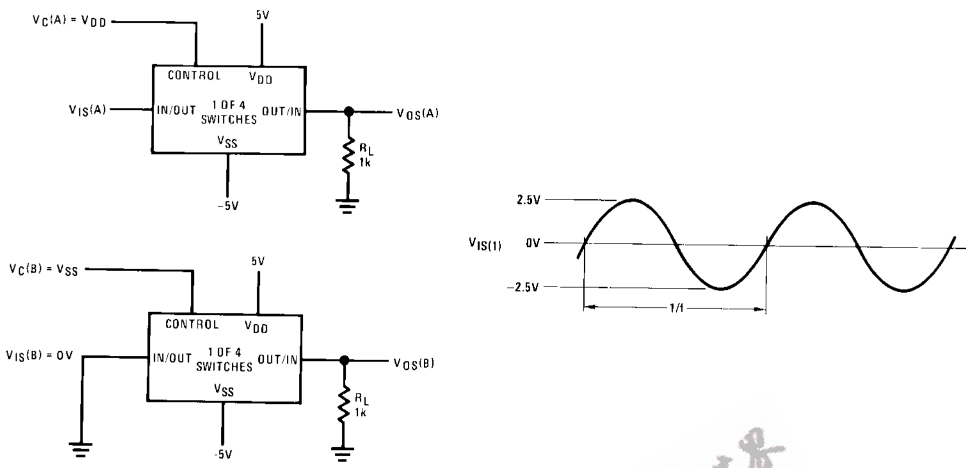


FIGURE 5. Crosstalk Between Any Two Switches

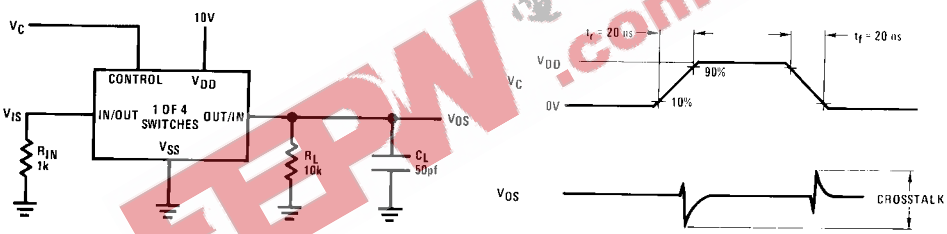


FIGURE 6. Crosstalk — Control to Input Signal Output

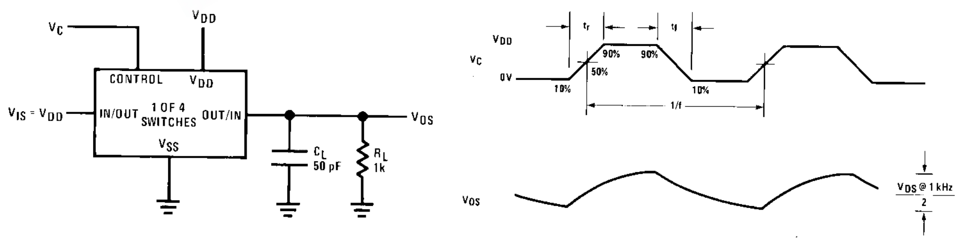


FIGURE 7. Maximum Control Input Frequency

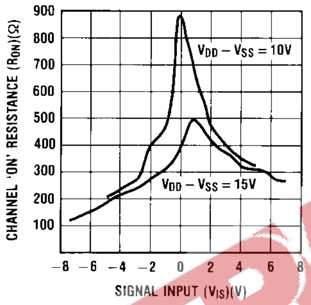
AC Test Circuits and Switching Time Waveforms (Continued)

Temperature Range	V_{DD}	Switch Input				Switch Output	
		V_{IS}	I_{IS} (mA)			V_{OS}(V)	
			−40°C	25°C	+85°C	Min	Max
COMMERCIAL	5	0	0.2	0.16	0.12		0.4
	5	5	−0.2	−0.16	−0.12	4.6	
	10	0	0.5	0.4	0.3		0.5
	10	10	−0.5	−0.4	−0.3	9.5	
	15	0	1.4	1.2	1.0		1.5
	15	15	−1.4	−1.2	−1.0	13.5	

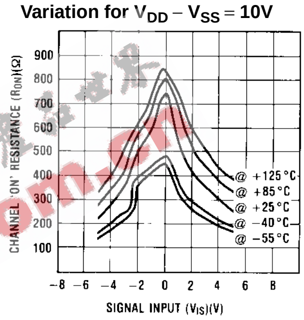
FIGURE 8. CD4016B Switch Test Conditions for V_{IHC}

Typical Performance Characteristics

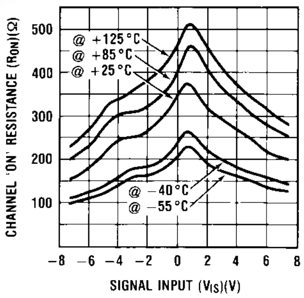
'ON' Resistance vs. Signal Voltage $T_A = 25°C$



'ON' Resistance Temperature Variation for $V_{DD} - V_{SS} = 10V$

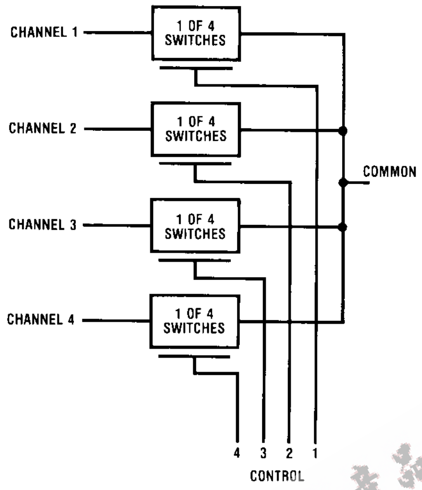


'ON' Resistance Temperature Variation for $V_{DD} - V_{SS} = 15V$

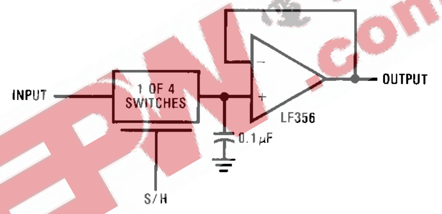


Typical Applications

4 Input Multiplexer



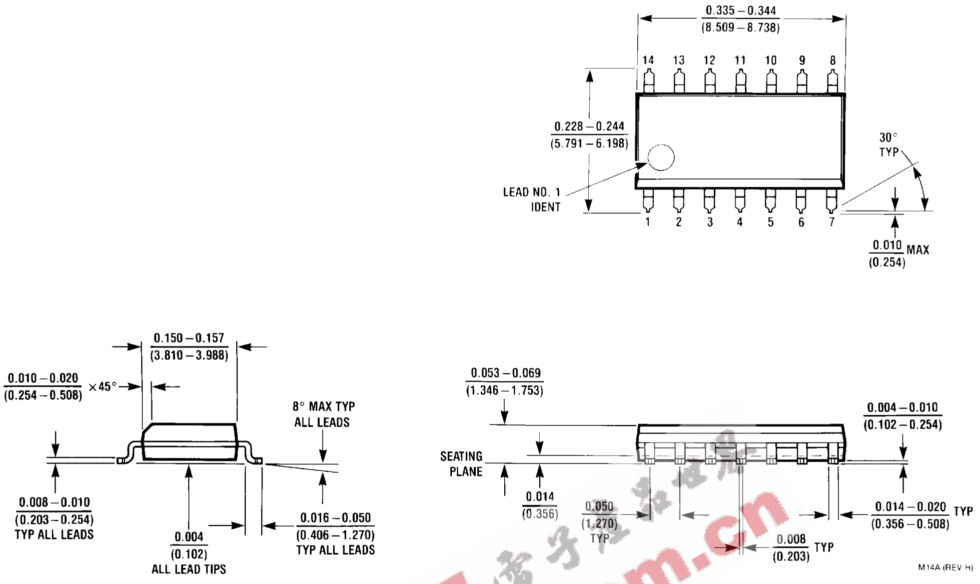
Sample/Hold Amplifier



Special Considerations

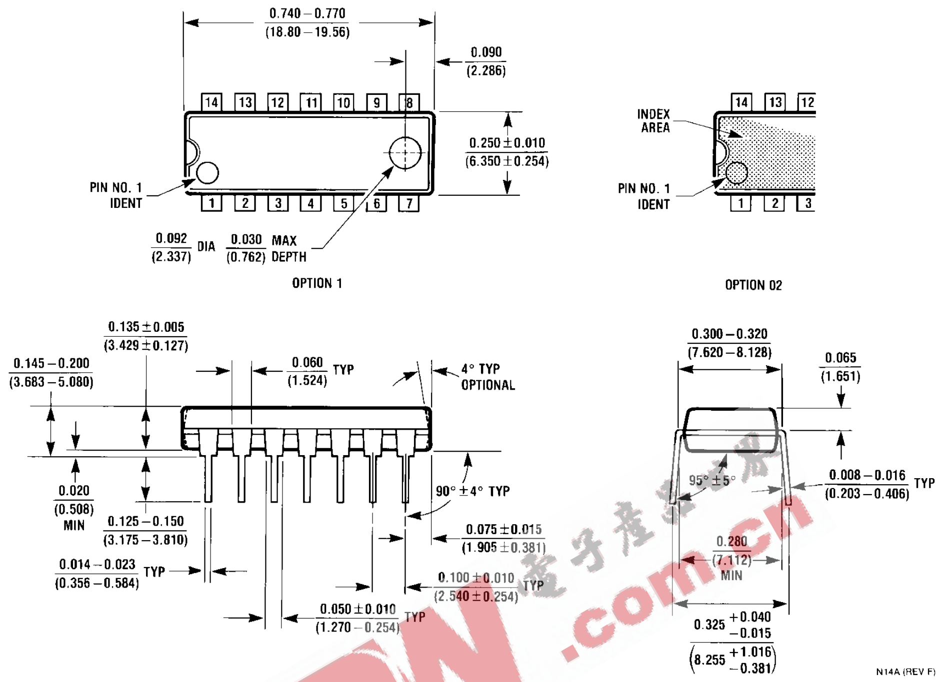
The CD4016B is composed of 4, two-transistor analog switches. These switches do not have any linearization or compensation circuitry for "R_{ON}" as do the CD4066B's. Because of this, the special operating considerations for the CD4066B do not apply to the CD4016B, but at low supply voltages, ≤5V, the CD4016B's on resistance becomes non-linear. It is recommended that at 5V, voltages on the in/out pins be maintained within about 1V of either V_{DD} or V_{SS}; and that at 3V the voltages on the in/out pins should be at V_{DD} or V_{SS} for reliable operation.

Physical Dimensions inches (millimeters) unless otherwise noted



14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150” Narrow
Package Number M14A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
Package Number N14A

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