FAIRCHILD

SEMICONDUCTOR TM

November 1983
Revised January 1999

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:
  ΔR_{ON} = 10Ω (typ.)

■ High degree of linearity:
  0.4% distortion (typ.)
  @ f_{IS} = 1 kHz, V_{IS} = 5 V_{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}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

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
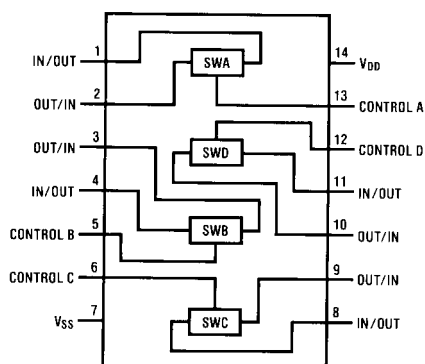
Schematic Diagram

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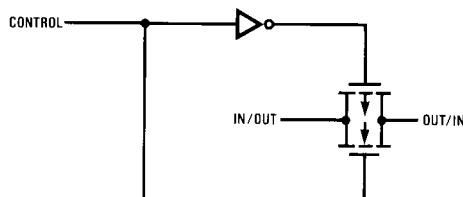
Absolute Maximum Ratings(Note 1)

(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	V$_{DD}$ = 5V, V$_{IN}$ = V$_{DD}$ or V$_{SS}$		1.0		0.01	1.0		7.5	µA
	Current	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	R$_L$ = 10kΩ to (V$_{DD}$ − V$_{SS}$)/2								
	Between any 2 of	V$_C$ = V$_{DD}$, V$_{IS}$ = V$_{SS}$ to V$_{DD}$								
	4 Switches	V$_{DD}$ = 10V				15				Ω
	(In Same Package)	V$_{DD}$ = 15V				10				Ω
I$_{IS}$	Input or Output	V$_C$ = 0, V$_{DD}$ = 15V		±50		±0.1	±50		±200	nA
	Leakage	V$_{IS}$ = 0V or 15V,								
	Switch "OFF"	V$_{OS}$ = 15V or 0V								
Control Inputs										
V$_{ILC}$	LOW Level Input	V$_{IS}$ = V$_{SS}$ and V$_{DD}$								
	Voltage	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	V$_{DD}$ = 5V	3.5		3.5			3.5		V
	Voltage	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		±10^{-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)

$T_A = 25^{\circ}C$, $t_r = t_f = 20$ 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	$V_C = V_{DD} = 5V$, $V_{SS} = -5$		0.4		%
		$R_L = 10$ kΩ, $V_{IS} = 5$ V_{P-P}, f = 1 kHz,				
		(Figure 4)				
	Frequency Response — Switch	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$,		40		MHz
	"ON" (Frequency at -3 dB)	$R_L = 1$ kΩ, $V_{IS} = 5$ V_{P-P},				
		$20 \log_{10} V_{OS}/V_{OS}$ (1 kHz) $-$dB,				
		(Figure 4)				
	Feedthrough — Switch "OFF"	$V_{DD} = 5V$, $V_C = V_{SS} = -5V$,		1.25		MHz
	(Frequency at -50 dB)	$R_L = 1$ kΩ, $V_{IS} = 5$ V_{P-P},				
		$20 \log_{10} (V_{OS}/V_{IS}) = -50$ dB,				
		(Figure 4)				
	Crosstalk Between Any Two	$V_{DD} = V_{C(A)} = 5V$; $V_{SS} = V_{C(B)} = -5V$,		0.9		MHz
	Switches (Frequency at -50 dB)	$R_L = 1$ kΩ $V_{IS(A)} = 5$ V_{P-P},				
		$20 \log_{10} (V_{OS(B)}/V_{OS(A)}) = -50$ dB,				
		(Figure 5)				
	Crosstalk; Control Input to	$V_{DD} = 10V$, $R_L = 10$ kΩ		150		mV_{P-P}
	Signal Output	$R_{IN} = 1$ kΩ, $V_{CC} = 10V$ Square Wave,				
		$C_L = 50$ pF (Figure 6)				
	Maximum Control Input	$R_L = 1$ kΩ, $C_L = 50$ pF, (Figure 7)				
		$V_{OS(f)} = \frac{1}{2} V_{OS}$(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.
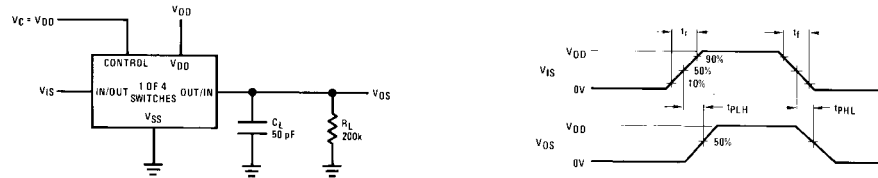
AC Test Circuits and Switching Time Waveforms

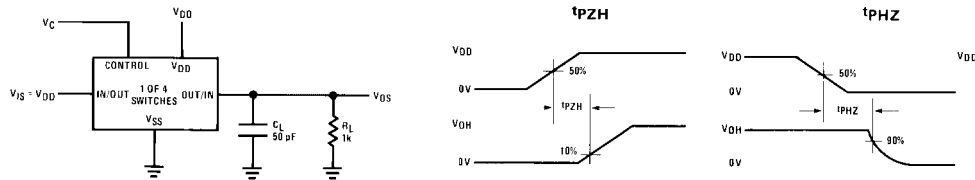FIGURE 1. t_{PLH}, t_{PLH} Propagation Delay Time Control to Signal Output

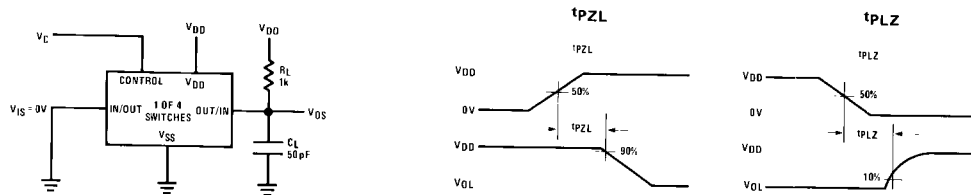FIGURE 2. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output

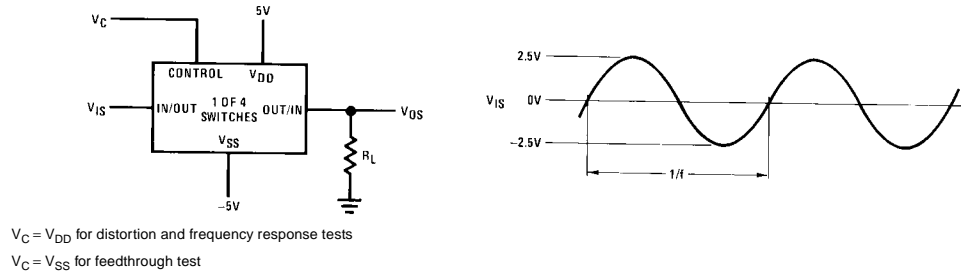FIGURE 3. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output

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

$V_C = V_{SS}$ for feedthrough test

FIGURE 4. Sine Wave Distortion, Frequency Response and Feedthrough

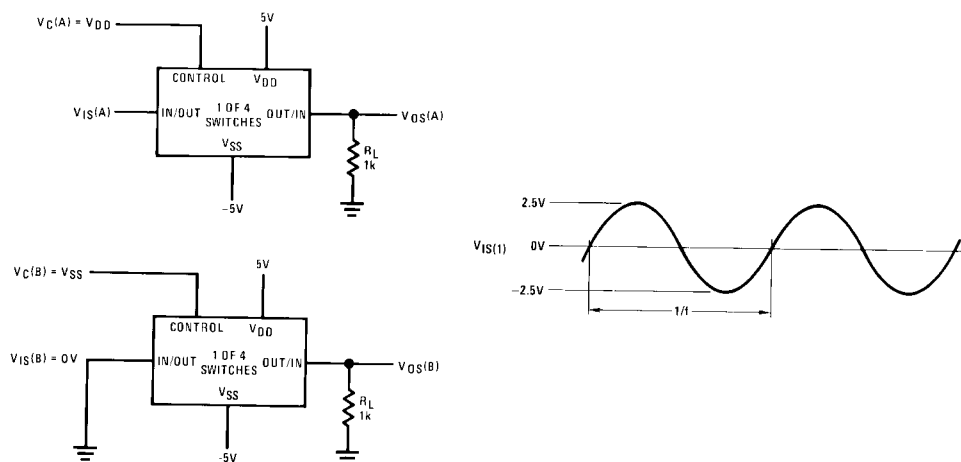# AC Test Circuits and Switching Time Waveforms (Continued)
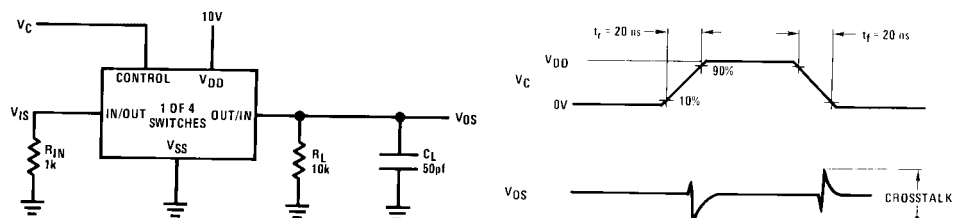
FIGURE 5. Crosstalk Between Any Two Switches

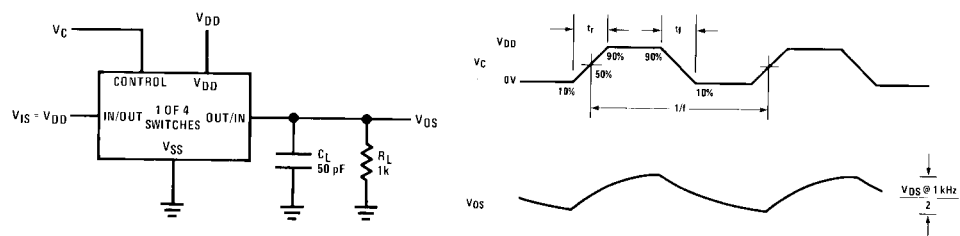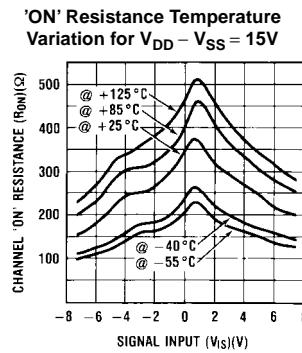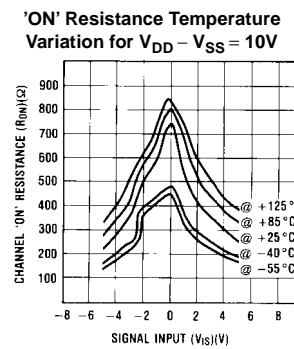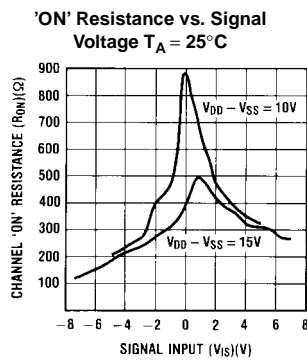FIGURE 6. Crosstalk — Control to Input Signal Output

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
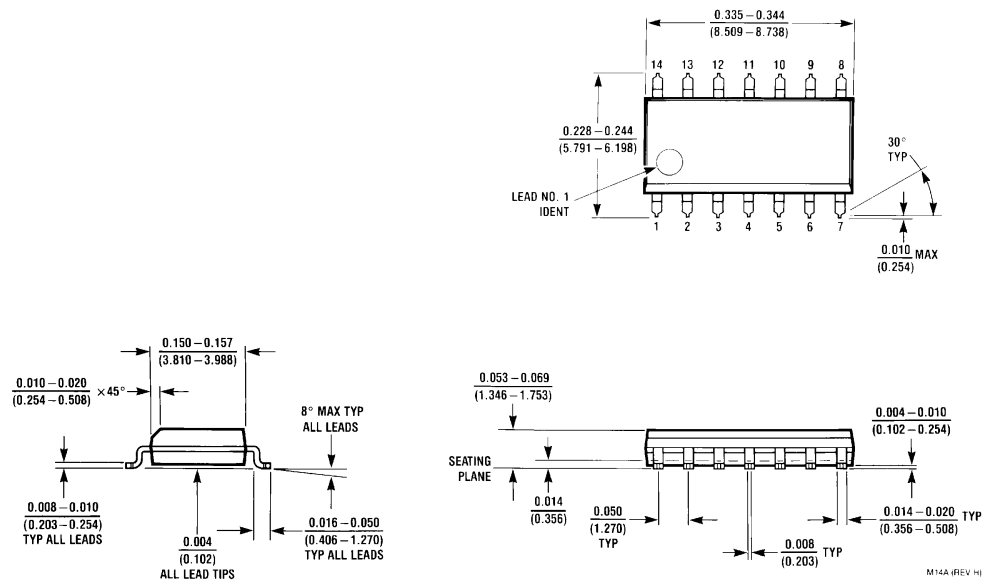
4 Input Multiplexer

Sample/Hold Amplifier
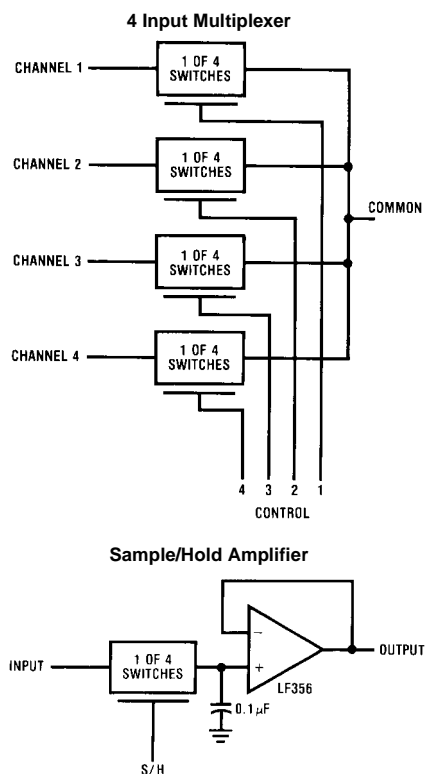
Special Considerations

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

0.335 − 0.344
(8.509 − 8.738)

14 13 12 11 10 9 8

0.228 − 0.244
(5.791 − 6.198)

LEAD NO. 1
IDENT

1 2 3 4 5 6 7

30°
TYP

0.010
(0.254) MAX

0.150 − 0.157
(3.810 − 3.988)

0.010 − 0.020
(0.254 − 0.508) × 45°

8° MAX TYP
ALL LEADS

0.008 − 0.010
(0.203 − 0.254)
TYP ALL LEADS

0.004
(0.102)
ALL LEAD TIPS

0.016 − 0.050
(0.406 − 1.270)
TYP ALL LEADS

0.053 − 0.069
(1.346 − 1.753)

0.004 − 0.010
(0.102 − 0.254)

SEATING
PLANE

0.014
(0.356)

0.050
(1.270)
TYP

0.008
(0.203) TYP

0.014 − 0.020
(0.356 − 0.508) TYP

M14A (REV H)

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

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)
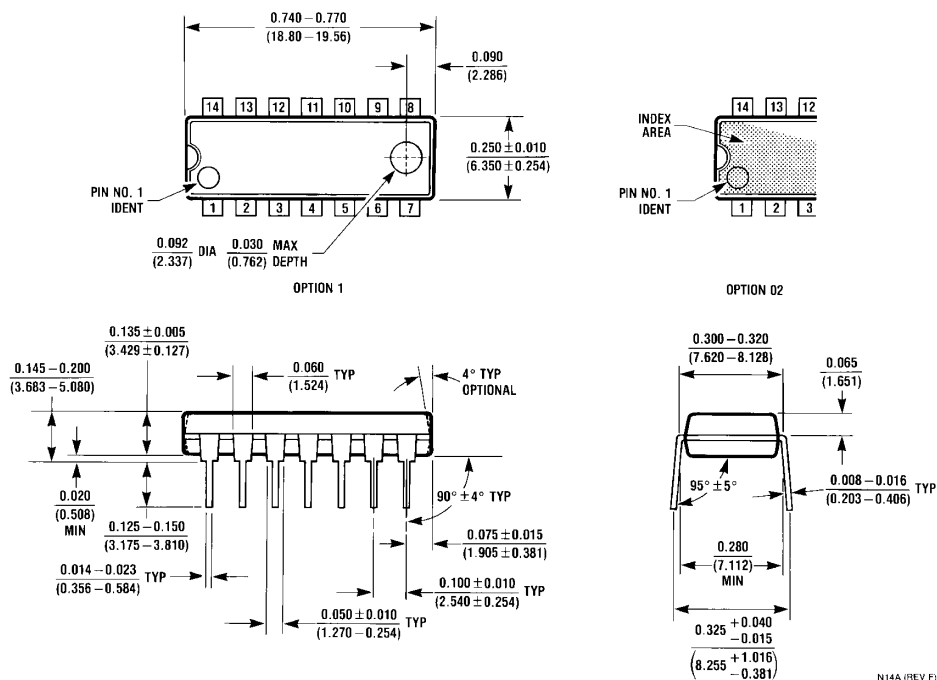
14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
Package Number N14A

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