

CMOS Quad Bilateral Switch

For Transmission or Multiplexing of Analog or Digital Signals

High-Voltage Types (20-Volt Rating)

■ 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 input 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 (F3A suffix), 14-lead dual-in-line plastic packages (E suffix), 14-lead small-outline packages (M, MT, M96, and NSR suffixes), and 14-lead thin shrink small-outline packages (PW and PWR suffixes).

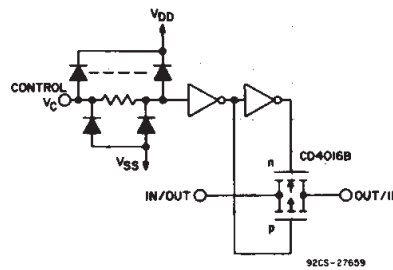
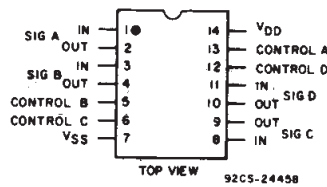
Features:

- 20-V digital or ± 10 -V peak-to-peak switching
- $280\text{-}\Omega$ typical on-state resistance for 15-V operation
- Switch on-state resistance matched to within $10\ \Omega$ typ. over 15-V signal-input range
- High on/off output-voltage ratio: 65 dB typ. @ $f_{is} = 10\ \text{kHz}$, $R_L = 10\ \text{k}\Omega$
- High degree of linearity: $<0.5\%$ distortion typ. @ $f_{is} = 1\ \text{kHz}$, $V_{is} = 5\ \text{V}_{p-p}$, $V_{DD} - V_{SS} \geq 10\ \text{V}$, $R_L = 10\ \text{k}\Omega$
- Extremely low off-state switch leakage resulting in very low offset current and high effective off-state resistance: 100 pA typ. @ $V_{DD} - V_{SS} = 18\ \text{V}$, $T_A = 25^\circ\text{C}$
- Extremely high control input impedance (control circuit isolated from signal circuit): $10^{12}\ \Omega$ typ.
- Low crosstalk between switches: $-50\ \text{dB}$ typ. @ $f_{is} = 0.9\ \text{MHz}$, $R_L = 1\ \text{k}\Omega$
- Matched control-input to signal-output capacitance: Reduces output signal transients
- Frequency response, switch on = 40 MHz (typ.)
- 100% tested for quiescent current at 20 V
- Maximum control input current of $1\ \mu\text{A}$ at 18 V over full package temperature range; 100 nA at 18 V at 25°C
- 5-V, 10-V, and 15-V parametric ratings

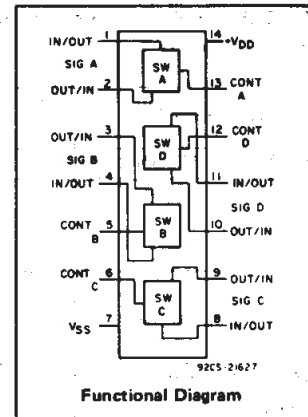
Applications:

- Analog signal switching/multiplexing
 - Signal gating ■ Modulator
 - Squelch control ■ Demodulator
 - Chopper ■ 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

Terminal Assignment



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) $-0.5\text{V to }+20\text{V}$
- INPUT VOLTAGE RANGE, ALL INPUTS $-0.5\text{V to }V_{DD} + 0.5\text{V}$
- DC INPUT CURRENT, ANY ONE INPUT $\pm 10\text{mA}$
- POWER DISSIPATION PER PACKAGE (P_D):
 - For $T_A = -55^\circ\text{C to }+100^\circ\text{C}$ 500mW
 - For $T_A = +100^\circ\text{C to }+125^\circ\text{C}$ Derate Linearly at $12\text{mW}/^\circ\text{C}$ to 200mW
- DEVICE DISSIPATION PER OUTPUT TRANSISTOR
 - FOR $T_A =$ FULL PACKAGE-TEMPERATURE RANGE (All Package Types) 100mW
- OPERATING-TEMPERATURE RANGE (T_A) $-55^\circ\text{C to }+125^\circ\text{C}$
- STORAGE TEMPERATURE RANGE (T_{stg}) $-65^\circ\text{C to }+150^\circ\text{C}$
- LEAD TEMPERATURE (DURING SOLDERING):
 - At distance $1/16 \pm 1/32$ inch ($1.59 \pm 0.79\text{mm}$) from case for 10s max $+265^\circ\text{C}$

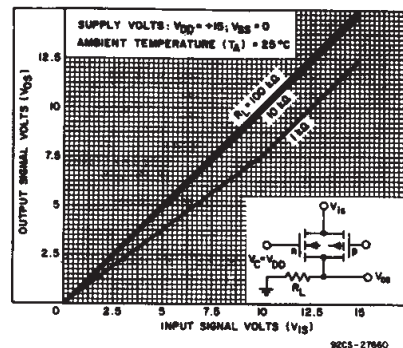


Fig. 1— Typ. on-state characteristics for 1 of 4 switches with $V_{DD} = +15\ \text{V}$, $V_{SS} = 0\ \text{V}$.

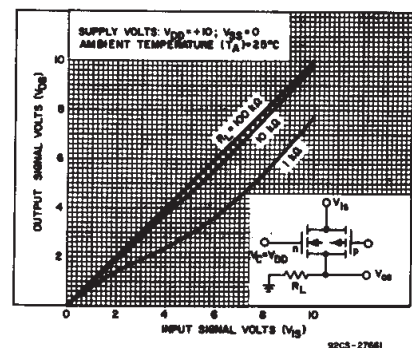


Fig. 2— Typ. on-state characteristics for 1 of 4 switches with $V_{DD} = +10\ \text{V}$, $V_{SS} = 0\ \text{V}$.

CD4016B Types

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS	LIMITS AT INDICATED TEMPERATURES (°C)							UNITS	
		V _{IN} (V)	V _{DD} (V)					+25		
				-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	-		

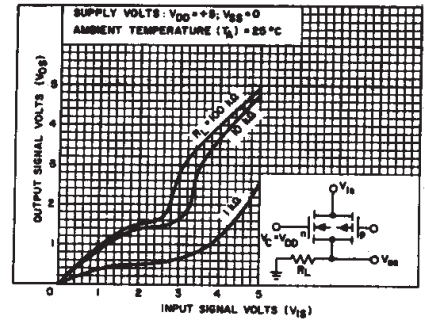


Fig. 3—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = 0 V.

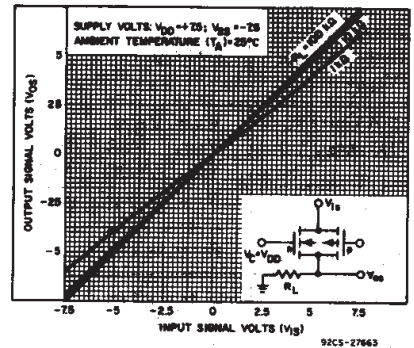


Fig. 4—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +7.5 V, V_{SS} = -7.5 V.

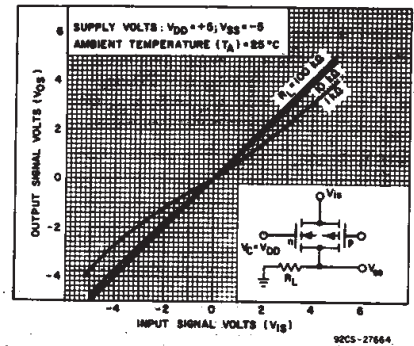


Fig. 5—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = -5 V.

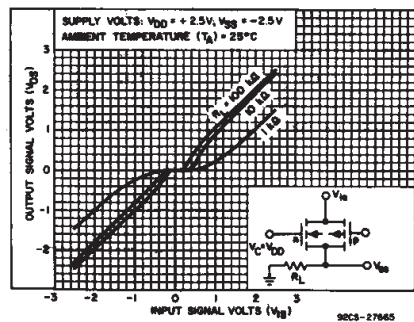


Fig. 6—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +2.5 V, V_{SS} = -2.5 V.

3
COMMERCIAL CMOS
HIGH VOLTAGE ICs

CD4016B Types

ELECTRICAL CHARACTERISTICS (cont'd)

CHARACTERISTIC	TEST CONDITIONS	LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
		V _{DD} (V)					+25		
			-55	-40	+85	+125	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} = ½ V _{os} @ 1 kHz	10	-	-	-	-	10	-	MHz
Input Capacitance, C _{IN}			-	-	-	-	5	7.5	μF

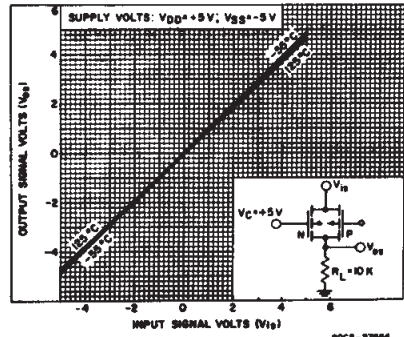


Fig. 7—Typ. on-state characteristics as a function of temp. for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = -5 V.

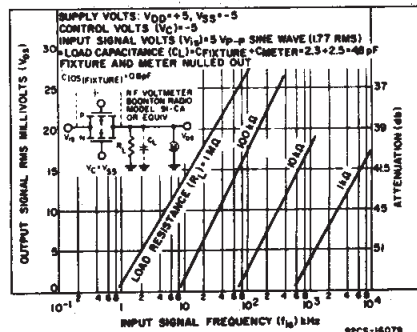


Fig. 8—Typ. feedthrough vs. frequency—switch off.

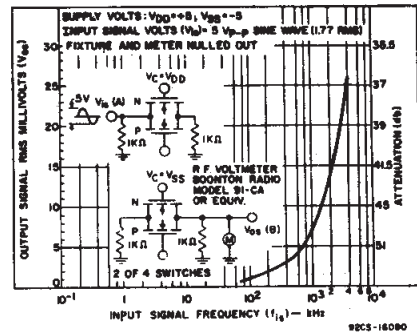


Fig. 9—Typical crosstalk between switch circuits in the same package.

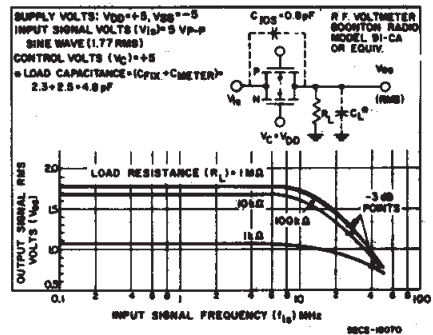


Fig. 11—Typical frequency response—switch on.

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
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

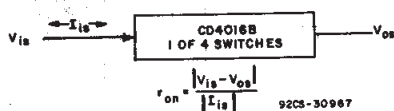


Fig. 10—Determination of r_{on} as a test condition for control input high voltage (V_{IHC}) specification.

CD4016B Types

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

CHARACTERISTIC*	SUPPLY CONDITIONS		LOAD CONDITIONS					
			$R_L = 1k\Omega$		$R_L = 10k\Omega$		$R_L = 100k\Omega$	
			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	860	+5	470	+5	450	+5
r_{on} (max.)	+5	0	600	0	580	0	800	0
r_{on}	+7.5	-7.5	200	+7.5	200	+7.5	180	+7.5
r_{on} (max.)	+7.5	-7.5	290	± 0.25	280	± 25	400	± 0.25
r_{on}	+5	-5	260	+5	250	+5	240	+5
r_{on} (max.)	+5	-5	310	-5	250	-5	240	-5
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}	+2.5	-2.5	232k	± 0.25	300k	± 0.25	870k	± 0.25

* Variation from perfect switch, $r_{on} = 0 \Omega$.

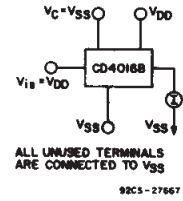


Fig. 12 - Off-state switch input or output leakage current test circuit.

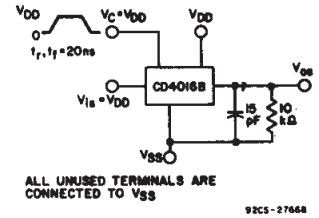
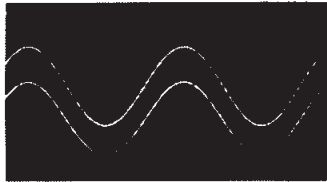


Fig. 13 - Test circuit for square-wave response.



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

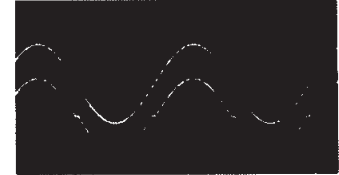
Fig. 14 - Typical sine wave response of $V_{DD} = +7.5 V, V_{SS} = -7.5 V$.



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

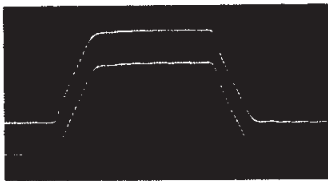
Fig. 15 - Typical sine wave response of $V_{DD} = +5 V, V_{SS} = -5 V$.



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



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

92CS-27617

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

3
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 HIGH VOLTAGE ICs

CD4016B Types

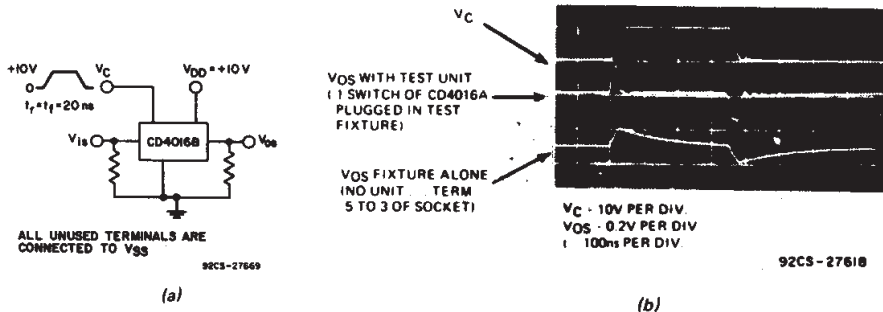


Fig. 20 - Crosstalk-control input to signal output.

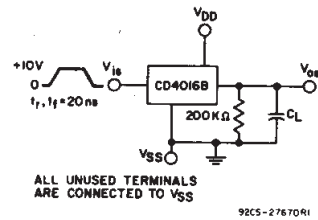


Fig. 21 - Propagation delay time signal input (V_{IS}) to signal output (V_{OS}).

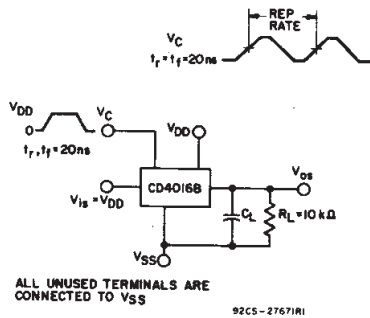


Fig. 22 - Max. control-input repetition rate.

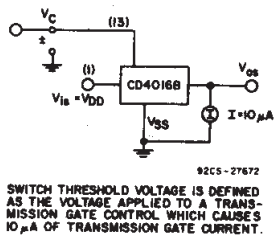


Fig. 23 - Switch threshold voltage.

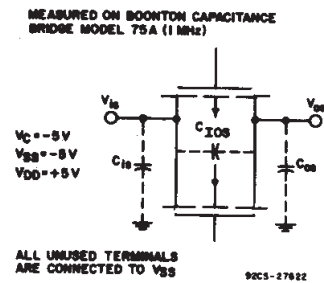


Fig. 24 - Capacitance C_{IOs} and C_{OS} .

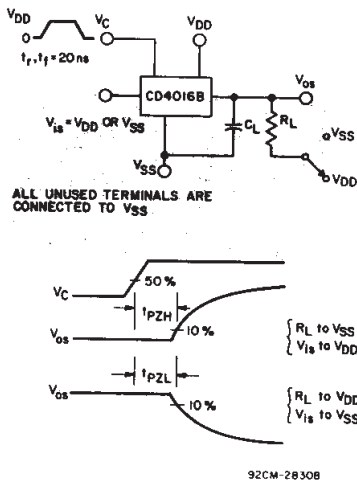
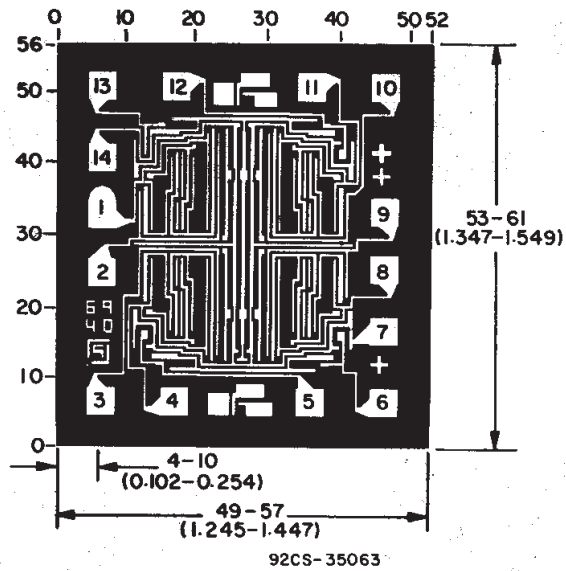


Fig. 25 - Turn-On propagation delay-control input.

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).

J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package is hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

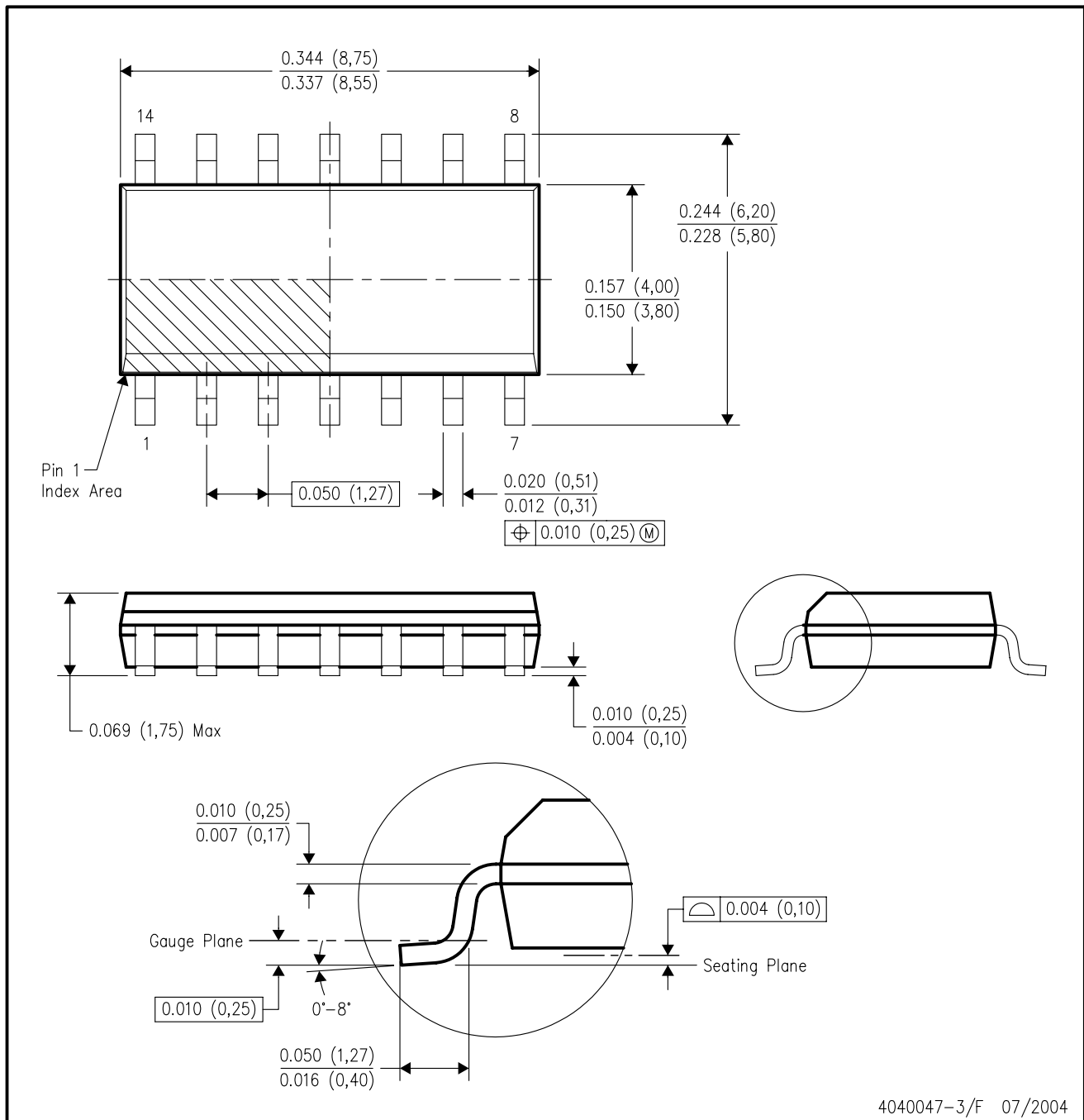
16 PINS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - The 20 pin end lead shoulder width is a vendor option, either half or full width.

D (R-PDSO-G14)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - D. Falls within JEDEC MS-012 variation AB.

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

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