

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 (D and F suffixes), 14-lead dual-in-line plastic packages (E suffix), and in chip form (H suffix).

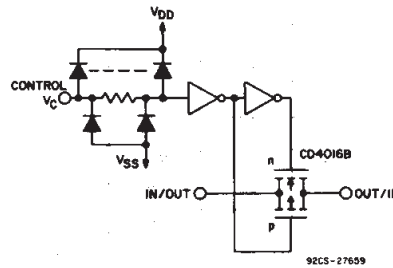
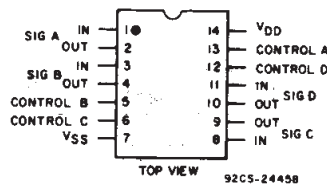
Features:

- 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: $100\ \text{pA}$ 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; $100\ \text{nA}$ at 18 V at 25°C
- 5-V, 10-V, and 15-V parametric ratings

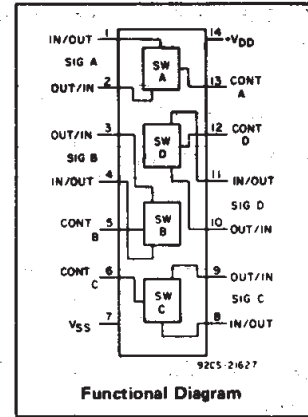
Applications:

- 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 $T_A = -55^\circ\text{C to }+100^\circ\text{C}$ $500\ \text{mW}$
For $T_A = +100^\circ\text{C to }+125^\circ\text{C}$ Derate Linearly at $12\ \text{mW}/^\circ\text{C}$ to $200\ \text{mW}$
- DEVICE DISSIPATION PER OUTPUT TRANSISTOR
FOR $T_A =$ FULL PACKAGE-TEMPERATURE RANGE (All Package Types) $100\ \text{mW}$
- 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 $+265^\circ\text{C}$

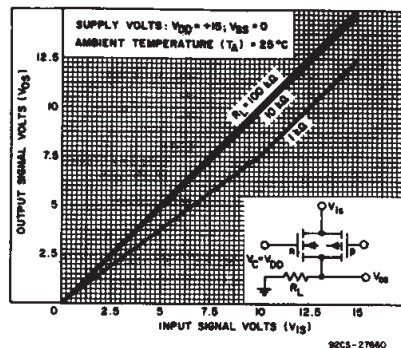


Fig. 1— Typ. on-state characteristics for 1 of 4 switches with $V_{DD} = +15\ \text{V}$, $V_{SS} = 0\ \text{V}$.

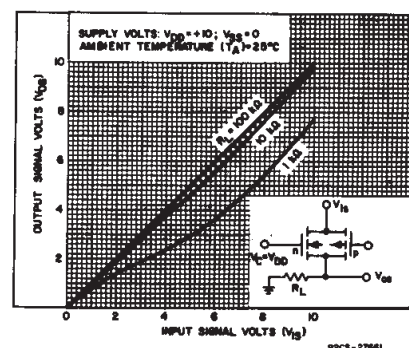


Fig. 2— Typ. on-state characteristics for 1 of 4 switches with $V_{DD} = +10\ \text{V}$, $V_{SS} = 0\ \text{V}$.

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	
		V _{is} = V _{DD} or V _{SS}	15	360	370	520	600	-	400	
Δ On-State Resistance Between Any 2 Switches, Δr _{on}	R _L = 10 kΩ, V _C = V _{DD}		5	-	-	-	-	15	-	Ω
			10	-	-	-	-	10	-	
			15	-	-	-	-	5	-	
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	-		

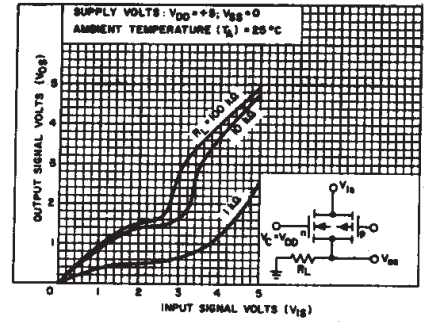


Fig. 3—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = 0 V.

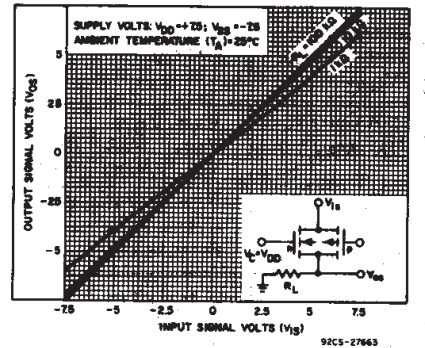


Fig. 4—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +7.5 V, V_{SS} = -7.5 V.

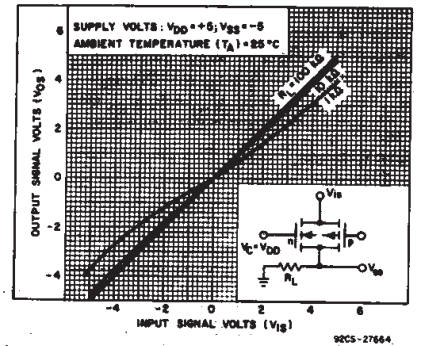


Fig. 5—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = -5 V.

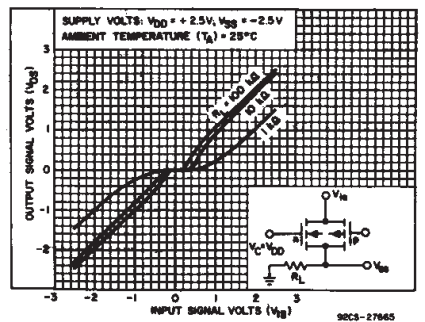


Fig. 6—Typ. on-state characteristics for 1 of 4 switches with V_{DD} = +2.5 V, V_{SS} = -2.5 V.

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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

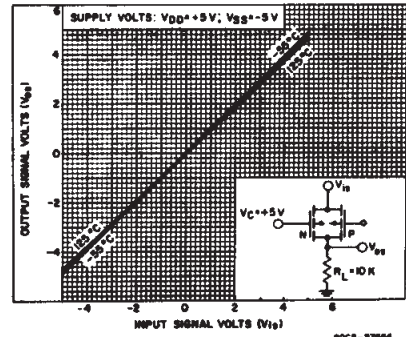


Fig. 7—Typ. on-state characteristics as a function of temp. for 1 of 4 switches with V_{DD} = +5 V, V_{SS} = -5 V.

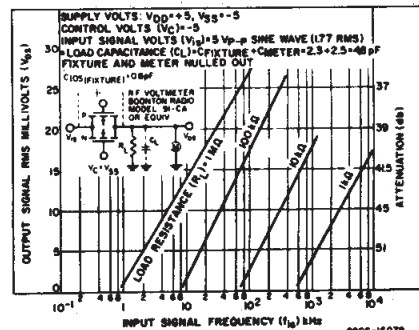


Fig. 8—Typ. feedthrough vs. frequency—switch off.

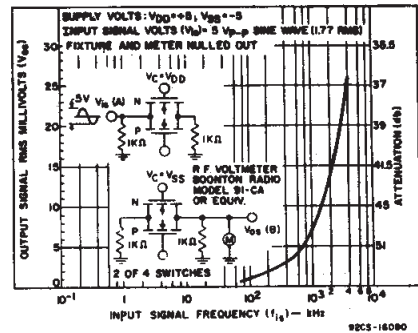


Fig. 9—Typical crosstalk between switch circuits in the same package.

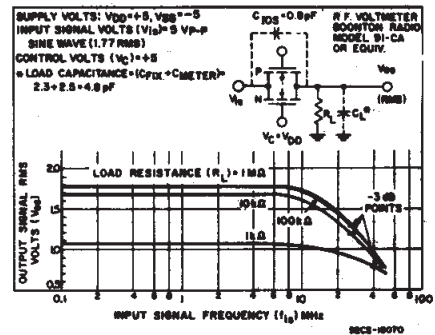


Fig. 11—Typical frequency response—switch on.

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

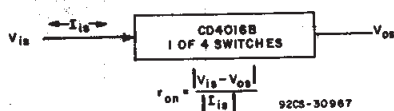


Fig. 10—Determination of r_{on} as a test condition for control input high voltage (V_{IHC}) specification.

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	± 0.25	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, $r_{on} = 0 \Omega$.

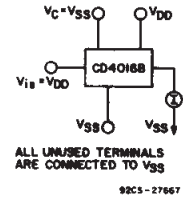


Fig. 12 – Off-state switch input or output leakage current test circuit.

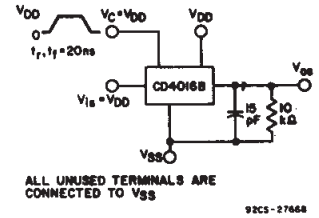
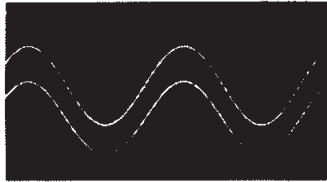


Fig. 13 – Test circuit for square-wave response.



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 %

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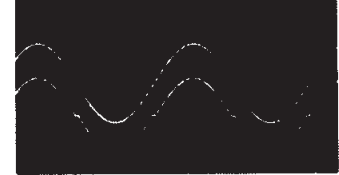
Fig. 14 – Typical sine wave response of $V_{DD} = +7.5 V, V_{SS} = -7.5 V$.



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 $V_{DD} = V_C = +5 V, V_{SS} = Gnd$.

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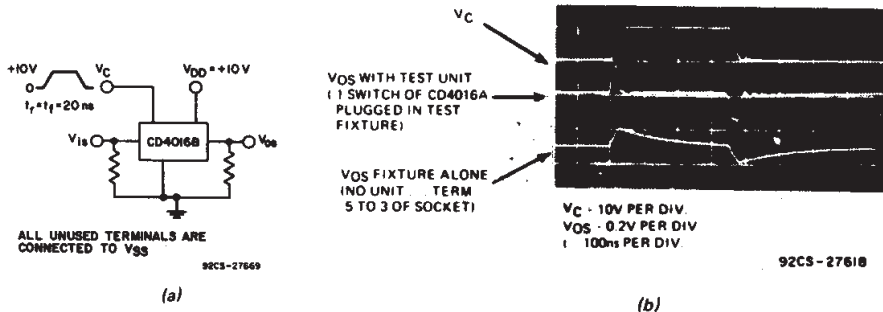


Fig. 20 - Crosstalk-control input to signal output.

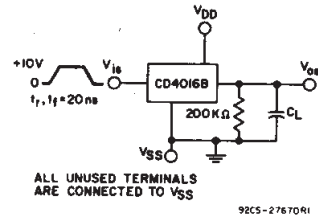


Fig. 21 - Propagation delay time signal input (V_{IS}) to signal output (V_{OS}).

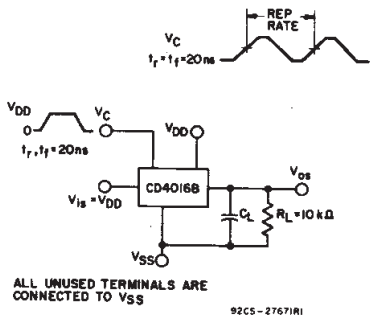


Fig. 22 - Max. control-input repetition rate.

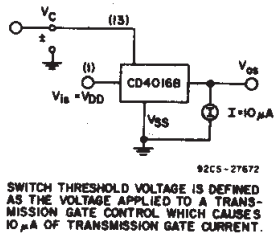


Fig. 23 - Switch threshold voltage.

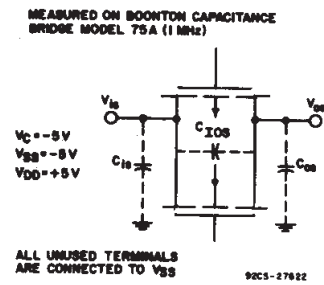


Fig. 24 - Capacitance C_{IOs} and C_{OS} .

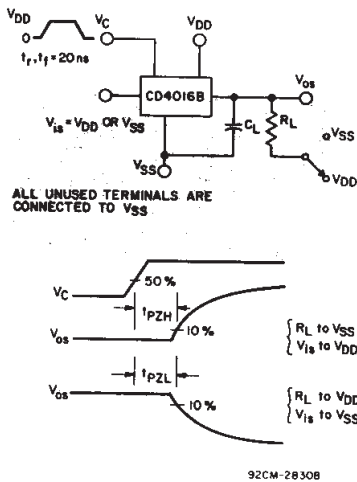
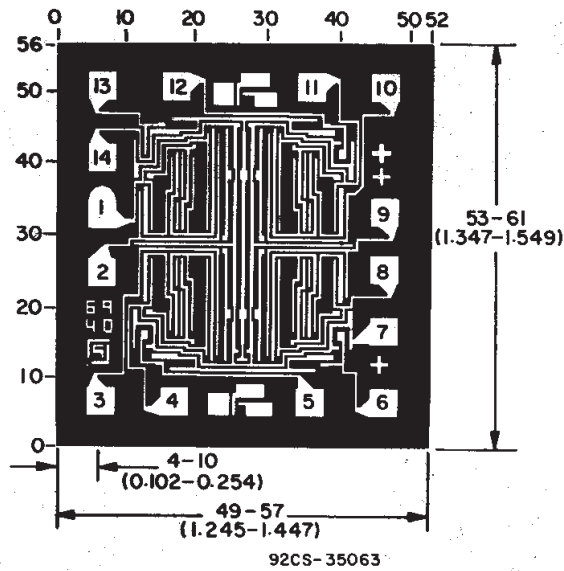


Fig. 25 - Turn-On propagation delay-control input.

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).

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