

CD4051B, CD4052B, CD4053B Typ s

COS/MOS Analog Multiplexers/Demultiplexers*

With Logic-Level Conversion

High-Voltages Types (20-Volt Rating)

- CD4051B — Single 8-Channel
- CD4052B — Differential 4-Channel
- CD4053B — Triple 2-Channel

RCA-CD4051B, CD4052B, and CD4053B analog multiplexers/demultiplexers are digitally controlled analog switches having low ON impedance and very low OFF leakage current. Control of analog signals up to 20 V peak-to-peak can be achieved by digital signal amplitudes of 4.5 to 20 V (if $V_{DD}-V_{SS} = 3$ V, a $V_{DD}-V_{EE}$ of up to 13 V can be controlled, for $V_{DD}-V_{EE}$ level differences above 13 V, a $V_{DD}-V_{SS}$ of at least 4.5 V is required). For example, if $V_{DD} = +4.5$ V, $V_{SS} = 0$, and $V_{EE} = -13.5$ V, analog signals from -13.5 V to $+4.5$ V can be controlled by digital inputs of 0 to 5 V. These multiplexer circuits dissipate extremely low quiescent power over the full $V_{DD}-V_{SS}$ and $V_{DD}-V_{EE}$ supply-voltage ranges, independent of the logic state of the control signals. When a logic "1" is present at the inhibit input terminal all channels are off.

The CD4051B is a single 8-channel multiplexer having three binary control inputs, A, B, and C, and an inhibit input. The three binary signals select 1 of 8 channels to be turned on, and connect one of the 8 inputs to the output.

The CD4052B is a differential 4-channel multiplexer having two binary control inputs, A and B, and an inhibit input. The two binary input signals select 1 of 4 pairs of channels to be turned on and connect the analog inputs to the outputs.

The CD4053B is a triple 2-channel multiplexer having three separate digital control inputs, A, B, and C, and an inhibit input. Each control input selects one of a pair of channels which are connected in a single-pole double-throw configuration.

The CD4051B, CD4052B, and CD4053B are supplied in 16-lead ceramic dual-in-line packages (D and F suffixes), 16-lead plastic dual-in-line packages (E suffix), 16-lead ceramic flat packages (K suffix), and in chip form (H suffix).

Applications:

- Analog and digital multiplexing and demultiplexing
- A/D and D/A conversion
- Signal gating

Features:

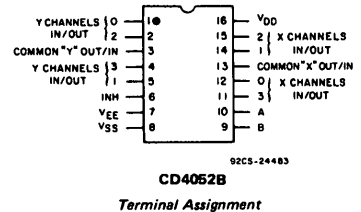
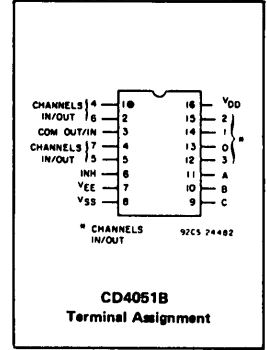
- Wide range of digital and analog signal levels: digital 3 to 20 V, analog to 20 V_{p-p}
- Low ON resistance: 125 Ω (typ.) over 15 V_{p-p} signal-input range for $V_{DD}-V_{EE} = 15$ V
- High OFF resistance: channel leakage of ± 100 pA (typ.) @ $V_{DD}-V_{EE} = 18$ V
- Logic-level conversion for digital addressing signals of 3 to 20 V ($V_{DD}-V_{SS} = 3$ to 20 V) to switch analog signals to 20 V p-p ($V_{DD}-V_{EE} = 20$ V); see introductory text
- Matched switch characteristics: $R_{ON} = 5$ Ω (typ.) for $V_{DD}-V_{EE} = 15$ V
- Very low quiescent power dissipation under all digital-control input and supply conditions: 0.2 μ W (typ.) @ $V_{DD}-V_{SS} = V_{DD}-V_{EE} = 10$ V
- Binary address decoding on chip
- 5-, 10-, and 15-V parametric ratings
- 100% tested for quiescent current at 20 V
- Maximum input current of 1 μ A at 18 V over full package temperature range; 100 nA at 18 V and 25°C

RECOMMENDED OPERATING CONDITIONS AT $T_A = 25^\circ\text{C}$ (Unless Otherwise Specified)

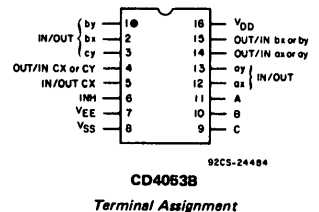
For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges. Values shown apply to all types except as noted.

CHARACTERISTIC	V_{DD}	Min.	Max.	Units
Supply-Voltage Range ($T_A =$ Full Package-Temp. Range)	—	3	18	V
Multiplexer Switch Input Current Capability*	—	—	25	mA
Output Load Resistance	—	100	—	Ω

* 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 the transmission gate inputs, the voltage drop across the bidirectional switch must not exceed 0.8 volt (calculated from R_{ON} values shown in ELECTRICAL CHARACTERISTICS CHART). No V_{DD} current will flow through R_L if the switch current flows into terminal 3 on the CD4051; terminals 3 and 13 on the CD4052; terminals 4, 14, and 15 on the CD4053.



* When these devices are used as demultiplexers, the "CHANNEL IN/OUT" terminals are the outputs and the "COMMON OUT/IN" terminals are the inputs.



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MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, (V_{DD}) (Voltages referenced to V_{SS} or V_{EE} , whichever is more negative)	-0.5 to +20 V
INPUT VOLTAGE RANGE, ALL INPUTS	-0.5 to $V_{DD} + 0.5$ V
DC INPUT CURRENT, ANY ONE INPUT	± 10 mA
POWER DISSIPATION PER PACKAGE (P_D):	
For $T_A = -40$ to $+60^\circ\text{C}$ (PACKAGE TYPE E)	500 mW
For $T_A = +63$ to $+85^\circ\text{C}$ (PACKAGE TYPE E)	Derate Linearly at 12 mW/ $^\circ\text{C}$ to 200 mW
For $T_A = -55$ to $+100^\circ\text{C}$ (PACKAGE TYPES D, F)	500 mW
For $T_A = +100$ to $+125^\circ\text{C}$ (PACKAGE TYPES D, F)	Derate Linearly at 12 mW/ $^\circ\text{C}$ to 200 mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR FOR $T_A = \text{FULL PACKAGE-TEMPERATURE RANGE (All Package Types)}$	100 mW
OPERATING-TEMPERATURE RANGE (T_A)	
PACKAGE TYPES D, F, H K	-55 to $+125^\circ\text{C}$
PACKAGE TYPE E	-40 to $+85^\circ\text{C}$
STORAGE TEMPERATURE RANGE (T_{stg})	-65 to $+150^\circ\text{C}$
LEAD TEMPERATURE (DURING SOLDERING)	
At distance 1/16 \pm 1/32 inch (1.59 \pm 0.79 mm) from case for 10 s max	$+265^\circ\text{C}$

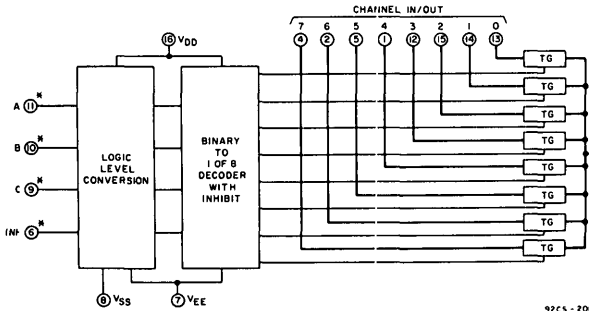


Fig. 1 - Functional diagram of CD4051B.

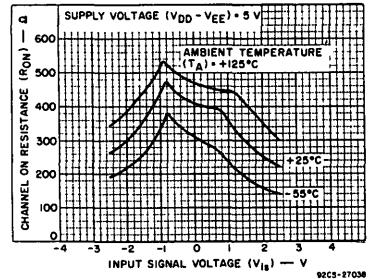


Fig. 4 - Typical channel ON resistance vs input signal voltage (all types).

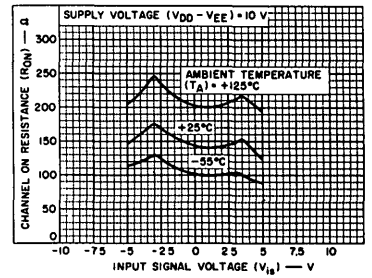


Fig. 5 - Typical channel ON resistance vs. input signal voltage (all types).

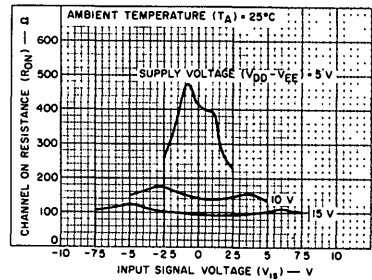


Fig. 6 - Typical channel ON resistance vs. input signal voltage (all types).

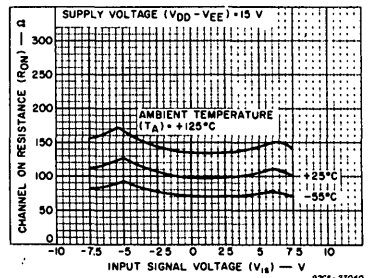


Fig. 7 - Typical channel ON resistance vs. input signal voltage (all types).

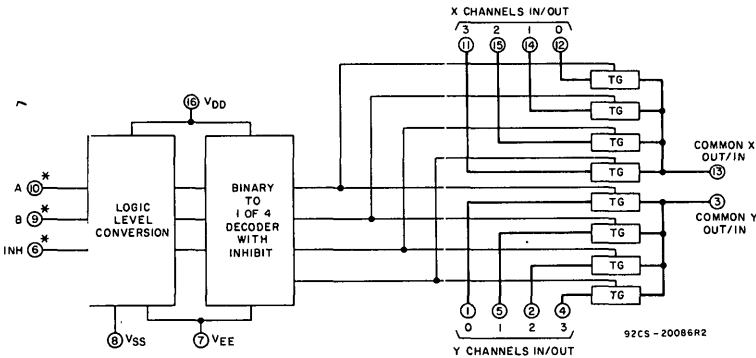


Fig. 2 - Functional diagram of CD4052B.

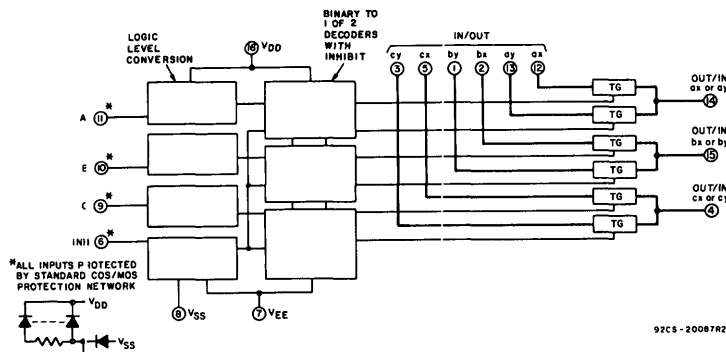


Fig. 3 - Functional diagram of CD4053B.

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ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS				LIMITS at Indicated Temperature (°C)							Units				
	V _{is} (V)	V _{EE} (V)	V _{SS} (V)	V _{DD} (V)	Values at -55,+25,+125, apply to D,F,H pkg				Values at -40,+25,+85, apply to E pks							
					-55	-40	+85	+125	Min.	Typ.	Max.					
SIGNAL INPUTS (V_{is}) AND OUTPUTS (V_{Os})																
Quiescent Device Current, I _{DD} Max.				5	5	5	150	150	-	0.04	5	μA				
				10	10	10	300	300	-	0.04	10					
				15	20	20	600	600	-	0.04	20					
				20	100	100	3000	3000	-	0.08	100					
On-State Resistance 0 ≤ V _{is} ≤ V _{DD} r _{on} Max.				0	0	5	800	850	1200	1300	-	470	1050	Ω		
				0	0	10	310	330	520	550	-	180	400			
				0	0	15	200	210	300	320	-	125	240			
Change in On-State Resistance (Between Any Two Channels) Δr _{on}				0	0	5	-	-	-	-	-	15	-	Ω		
				0	0	10	-	-	-	-	-	10	-			
				0	0	15	-	-	-	-	-	5	-			
OFF Channel Leakage Current: Any Channel OFF Max. or All Channels OFF (Common OUT/IN) Max.				0	0	18	±100*	±1000*	-	±0.01	±100*	nA				
Capacitance: Input, C _{is} Output, C _{Os} CD4051 CD4052 CD4053 Feedthrough, C _{ios}												5	-	pF		
												30	-			
												18	-			
												9	-			
Propagation Delay Time (Signal Input to Output)	V _{DD}	R _L = 200 kΩ C _L = 50 pF tr, tf = 20 ns													ns	

* Determined by minimum feasible leakage measurement for automatic testing.

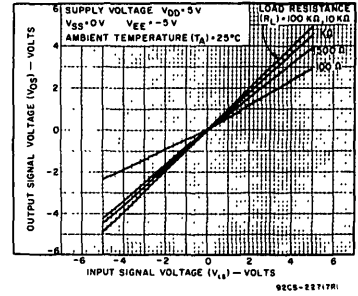


Fig.8 - Typical ON characteristics for 1 of 8 channels (CD4051B).

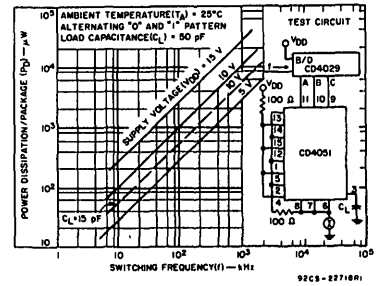


Fig.9 - Typical dynamic power dissipation vs. switching frequency (CD4051B).

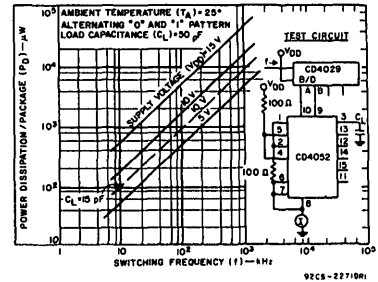


Fig.10 - Typical dynamic power dissipation vs. switching frequency (CD4052B).

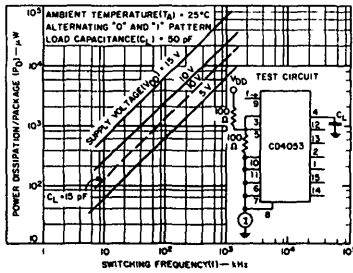
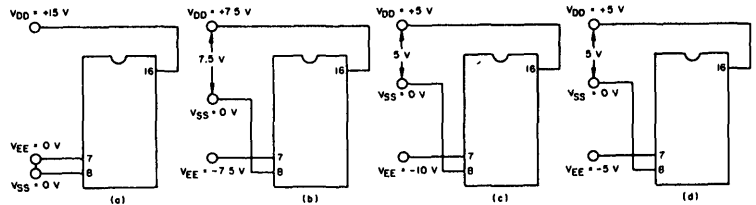


Fig.11 - Typical dynamic power dissipation vs. switching frequency (CD4053B).



The ADDRESS (digital-control inputs) and INHIBIT logic levels are: "0" = V_{SS} and "1" = V_{DD}. The analog signal (through the TG) may swing from V_{EE} to V_{DD}.

Fig.12 - Typical bias voltages.

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ELECTRICAL CHARACTERISTICS (Cont'd)

CHARACTERISTIC	CONDITIONS				LIMITS at Indicated Temperature (°C)							Units		
	V _{is} (V)	V _{EE} (V)	V _{SS} (V)	V _{DD} (V)	Values at -55, +25, +125, apply to D, F, H pkg				Values at -40, +25, +85, apply to E pkg					
					-55	-40	+85	+125	+25					
											Min.	Typ.	Max.	
CONTROL (ADDRESS or INHIBIT) V_C														
Input Low Voltage, V _{IL} Max.	=V _{DD} thru 1 kΩ	V _{EE} =V _{SS} R _L =1 kΩ to V _{SS} I _{IS} < 2 μA on all OFF Channels	5	1.5				-	-	1.5		V		
			10	3				-	-	3				
			15	4				-	-	4				
Input High Voltage, V _{IH} Min.			5	3.5				3.5		-	-	V		
			10	7				7		-	-			
			15	11				11		-	-			
Input Current, I _{IN} Max.	V _{IN} = 0, 18		18	±0.1	±0.1	±1	±1	-	±10 ⁻⁵	±0.1	μA			
Propagation Delay Time: Address-to-Signal OUT (Channel; ON or OFF) See Figs.14,15,18	t _r , t _f = 20 ns, C _L = 50 pF	R _L =10 kΩ, C _L =50 pF t _r , t _f = 20 ns	0	0	5	-	-	-	-	360	720	ns		
			0	0	10	-	-	-	-	160	320			
			0	0	15	-	-	-	-	120	240			
			-5	0	5	-	-	-	-	225	450			
Inhibit-to-Signal OUT (Channel turning ON)	t _r , t _f = 20 ns	R _L =10 kΩ, C _L =50 pF t _r , t _f = 20 ns	0	0	5	-	-	-	-	360	720	ns		
			0	0	10	-	-	-	-	160	320			
			0	0	15	-	-	-	-	120	240			
			-10	0	5	-	-	-	-	200	400			
Inhibit-to-Signal OUT (Channel turning OFF)	t _r , t _f = 20 ns	R _L =300 Ω, C _L =50 pF t _r , t _f = 20 ns	0	0	5	-	-	-	-	200	450	ns		
			0	0	10	-	-	-	-	90	210			
			0	0	15	-	-	-	-	70	160			
			-10	0	5	-	-	-	-	130	300			
Input Capacitance, C _{IN} (Any Address or Inhibit Input)										5	7.5	pF		

INPUT STATES				"ON" CHANNEL(S)
INHIBIT	C	B	A	
CD4051B				
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	X	X	X	NONE
CD4052B				
INHIBIT	B	A		
0	0	0	0x, 0y	
0	0	1	1x, 1y	
0	1	0	2x, 2y	
0	1	1	3x, 3y	
1	X	X	NONE	
CD4053B				
INHIBIT	A or B or C			
0	0	ax or bx or cx		
0	1	ay or by or cy		
1	X	NONE		

X = Don't care

Fig. 13 - Truth tables.

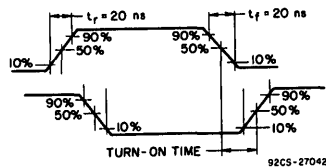


Fig. 14 - Waveforms, channel being turned ON (R_L = 10 kΩ).

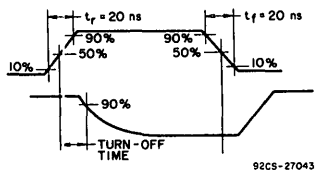


Fig. 15 - Waveforms, channel being turned OFF (R_L = 300 Ω).

TEST CIRCUITS

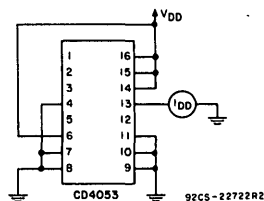
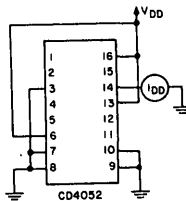
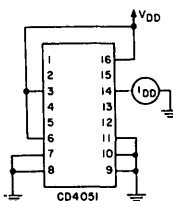


Fig. 16 - OFF channel leakage current - any channel OFF.

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ELECTRICAL CHARACTERISTICS (Cont'd)

CHARACTERISTIC	TEST CONDITIONS			LIMITS		UNITS
	V _{is} (V)	V _{DD} (V)	R _L (kΩ)	TYPICAL VALUE		
Cutoff (-3-dB) Frequency Channel ON (Sine Wave Input)	5#	10	1	CD4053	30	MHz
	V _{EE} = V _{SS} .			CD4052	25	
	20 log $\frac{V_{OS}}{V_{IS}} = -3\text{dB}$			CD4051	20	
	V _{OS} at Any Channel				60	
Total Harmonic Distortion, THD	2#	5	10		0.3	%
	3#	10			0.2	
	5#	15			0.12	
	V _{EE} = V _{SS} . f _{is} = 1 kHz sine wave					
-40-dB Feedthrough Frequency (All Channels OFF)	5#	10	1	CD4053	8	MHz
	V _{EE} = V _{SS} .			CD4052	10	
	20 log $\frac{V_{OS}}{V_{IS}} = -40\text{dB}$			CD4051	12	
	V _{OS} at Any Channel				8	
-40-dB Signal Crosstalk, Frequency				Between Any 2 Channels		MHz
	5#	10	1	Measured on Common	3	
	V _{EE} = V _{SS} .			Measured on Any Channel	6	
	20 log $\frac{V_{OS}}{V_{IS}} = -40\text{dB}$			CD4052 Only	10	
				Between Any 2 Sections CD4053 Only	In Pin 2, Out Pin 14: 2.5 In Pin 15, Out Pin 14: 6	
Address-or-Inhibit- to Signal Crosstalk	- 10 10#				65	mV (Peak)
	V _{EE} =0, V _{SS} =0, t _r , t _f = 20 ns, V _C = V _{DD} -V _{SS} (Square Wave)					

Peak-to-peak voltage symmetrical about $\frac{V_{DD} - V_{EE}}{2}$

Both ends of channel

TEST CIRCUITS (Cont'd)

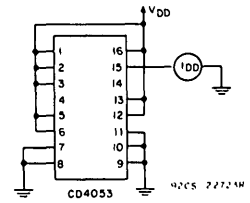
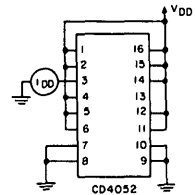
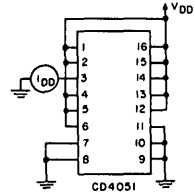


Fig.17 - OFF channel leakage current - all channels OFF.

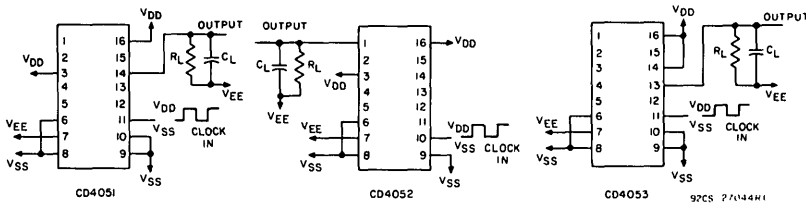


Fig.18 - Propagation delay - address input to signal output.

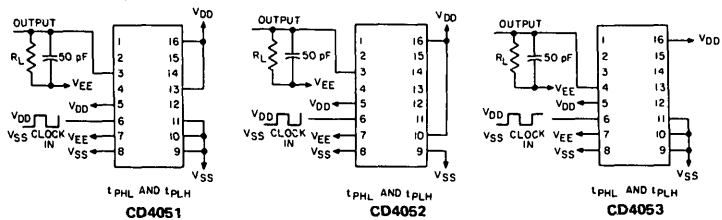


Fig.19 - Propagation delay - inhibit input to signal output.

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TEST CIRCUITS (Cont'd)

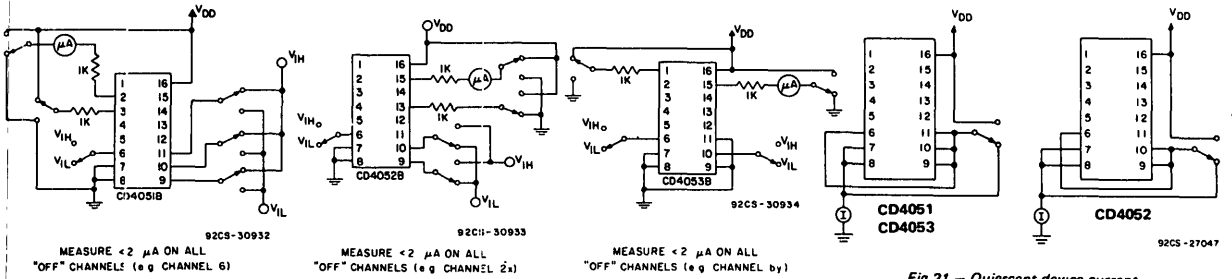


Fig. 20 - Input voltage test circuits (noise immunity).

Fig. 21 - Quiescent device current.

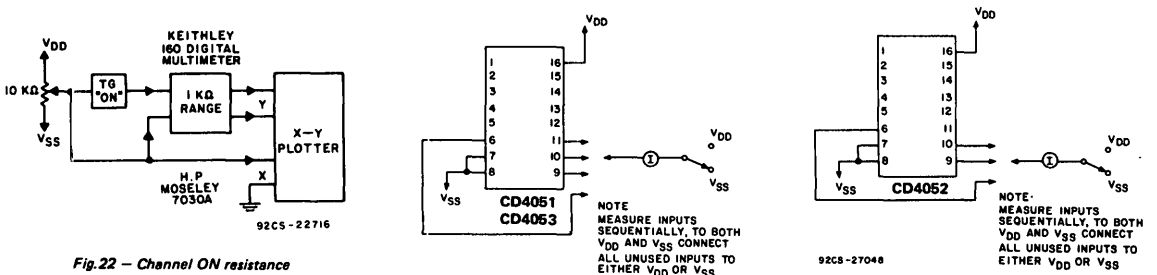


Fig. 22 - Channel ON resistance measurement circuit.

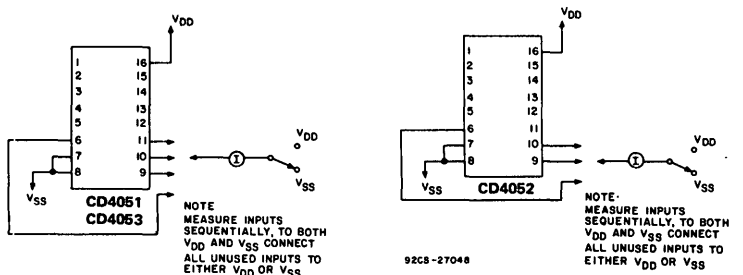


Fig. 23 - Input current.

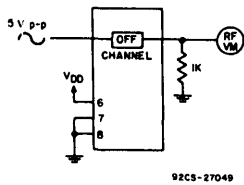


Fig. 24 - Feedthrough (all types).

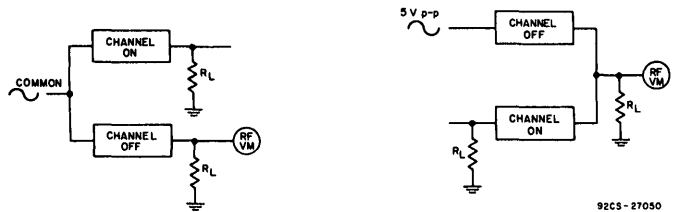


Fig. 25 - Crosstalk between any two channels (all types).

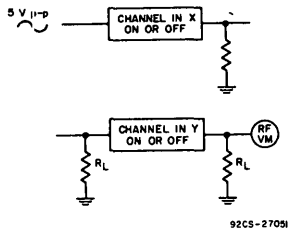


Fig. 26 - Crosstalk between duals or triplets (CD4052B, CD4053B).

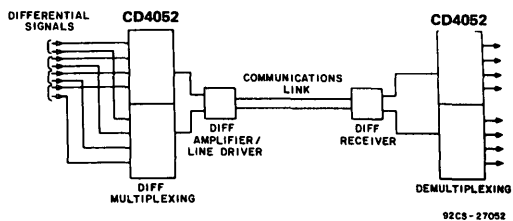


Fig. 27 - Typical time-division application of the CD4052B.

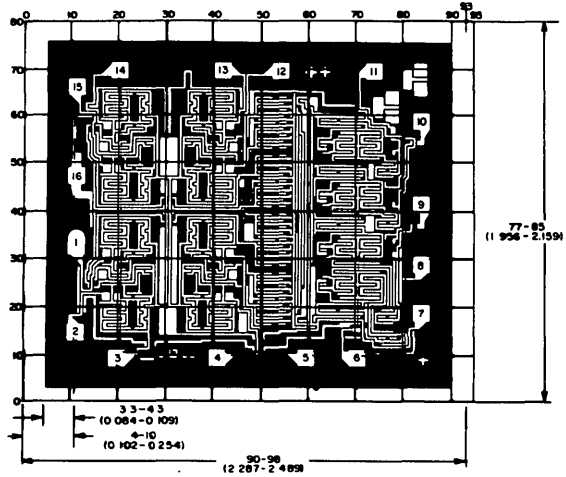
CD4051B, CD4052B, CD4053B Typ s

SPECIAL CONSIDERATIONS

In applications where separate power sources are used to drive VDD and the signal inputs, the VDD current capability should exceed V_{DD}/R_L (R_L = effective external load). This provision avoids permanent current flow or clamp action on the VDD supply when power is applied or removed from the CD4051B, CD4052B, or CD4053B.

When switching from one address to another, some of the ON periods of the channels of the multiplexers will overlap momentarily, which may be objectionable in certain applications. Also when a channel is turned ON or OFF by an address input, there is a momentary conductive path from the channel to VEE, which will dump some charge from any capacitor connected to the input or output of the channel. The inhibit input turning ON a channel will similarly dump some charge to VEE.

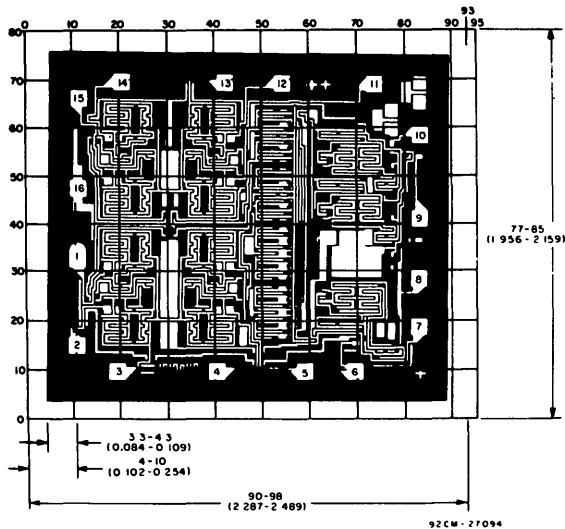
The amount of charge dumped is mostly a function of the signal level above VEE. Typically, at $V_{DD}-V_{EE} = 10$ V, a 100 pF capacitor connected to the input or output of the channel will lose 3-4 % of its voltage at the moment the channel turns ON or OFF. This loss of voltage is essentially independent of the address or inhibit signal transition time, if the transition time is less than 1-2 μ s. When the inhibit signal turns a channel OFF, there is no charge dumping to VEE. Rather, there is a slight rise in the channel voltage level (65 mV typ.) due to capacitive coupling from inhibit input to channel input or output. Address inputs also couple some voltage steps onto the channel signal levels.



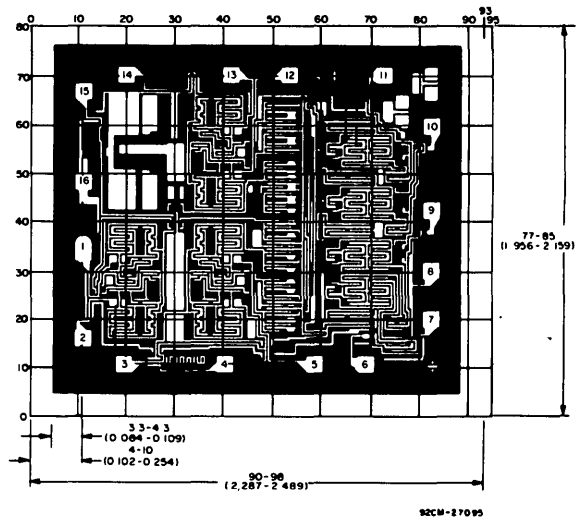
Dimensions and pad layout for CD4051BH. 92CM-27093

The photographs and dimensions of each COS/MOS chip represent a chip when it is part of the wafer. When the wafer is cut into chips, the cleavage angles are 57° instead of 90° with respect to the face of the chip. Therefore, the isolated chip is actually 7 mils (0.17 mm) larger in both dimensions.

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid Graduations are in Mils (10^{-3} inch).



Dimensions and pad layout for CD4052BH.



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