



CD4051BM/CD4051BC Single 8-Channel Analog Multiplexer/Demultiplexer **CD4052BM/CD4052BC Dual 4-Channel Analog Multiplexer/Demultiplexer** **CD4053BM/CD4053BC Triple 2-Channel Analog Multiplexer/Demultiplexer**

General Description

These analog multiplexers/demultiplexers are digitally controlled analog switches having low "ON" impedance and very low "OFF" leakage currents. Control of analog signals up to $15V_{p-p}$ can be achieved by digital signal amplitudes of 3-15V. For example, if $V_{DD} = 5V$, $V_{SS} = 0V$ and $V_{EE} = -5V$, analog signals from $-5V$ to $+5V$ can be controlled by digital inputs of 0-5V. The 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 logical "1" is present at the inhibit input terminal all channels are "OFF".

CD4051BM/CD4051BC 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 the input to the output.

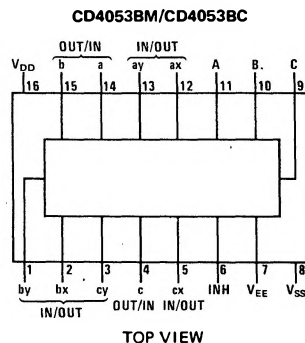
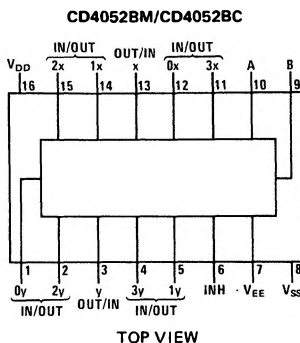
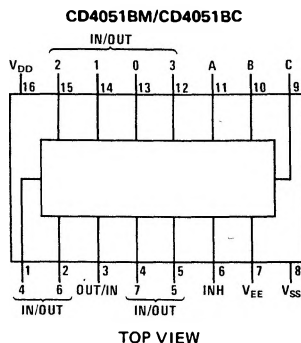
CD4052BM/CD4052BC is a differential 4-channel multiplexer having two binary control inputs, A and B, and an inhibit input. The two binary input signals select 1 of 4 pairs of channels to be turned on and connect the differential analog inputs to the differential outputs.

CD4053BM/CD4053BC 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.

Features

- Wide range of digital and analog signal levels: digital 3-15V, analog to $15V_{p-p}$
- Low "ON" resistance: 80Ω (typ.) over entire $15V_{p-p}$ signal-input range for $V_{DD} - V_{EE} = 15V$
- High "OFF" resistance: channel leakage of $\pm 10pA$ (typ.) at $V_{DD} - V_{EE} = 10V$
- Logic level conversion for digital addressing signals of 3-15V ($V_{DD} - V_{SS} = 3-15V$) to switch analog signals to $15V_{p-p}$ ($V_{DD} - V_{EE} = 15V$)
- Matched switch characteristics: $\Delta R_{ON} = 5\Omega$ (typ.) for $V_{DD} - V_{EE} = 15V$
- Very low quiescent power dissipation under all digital-control input and supply conditions: $1\mu W$ (typ.) at $V_{DD} - V_{SS} = V_{DD} - V_{EE} = 10V$
- Binary address decoding on chip

Connection Diagrams



Absolute Maximum Ratings

V_{DD}	DC Supply Voltage	-0.5 Vdc to +18 Vdc
V_{IN}	Input Voltage	-0.5 Vdc to $V_{DD} + 0.5$ Vdc
T_S	Storage Temperature Range	-65°C to +150°C
P_D	Package Dissipation	500 mW
T_L	Lead Temperature (soldering, 10 seconds)	300°C

Recommended Operating Conditions

V_{DD}	DC Supply Voltage	+5 Vdc to +15 Vdc
V_{IN}	Input Voltage	0 V to V_{DD} Vdc
T_A	Operating Temperature Range	-55°C to +125°C
	4051BM/4052BM/4053BM	-40°C to +85°C
	4051BC/4052BC/4053BC	

DC Electrical Characteristics (Note 2)

	Parameter	Conditions	-55°C		+25°C		+125°C		Units	
			Min	Max	Min	Typ	Max	Min		Max
I _{DD}	Quiescent Device Current	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		5 10 20			5 20 20		150 600 600	μA μA μA
Signal Inputs (V _{IS}) and Outputs (V _{OS})										
R _{ON}	“ON” Resistance (Peak for V _{EE} ≤ V _{IS} ≤ V _{DD})	R _L = 10 kΩ (any channel selected)	V _{DD} = 2.5V, V _{EE} = -2.5V or V _{DD} = 5V, V _{EE} = 0V		2000		270	2500	3500	Ω
			V _{DD} = 5V V _{EE} = -5V or V _{DD} = 10V, V _{EE} = 0V		310		120	400	580	Ω
			V _{DD} = 7.5V, V _{EE} = -7.5V or V _{DD} = 15V, V _{EE} = 0V		220		80	280	400	Ω
ΔR _{ON}	Δ“ON” Resistance Between Any Two Channels	R _L = 10 kΩ (any channel selected)	V _{DD} = 2.5V, V _{EE} = -2.5V or V _{DD} = 5V, V _{EE} = 0V				10			Ω
			V _{DD} = 5V, V _{EE} = -5V or V _{DD} = 10V, V _{EE} = 0V				10			Ω
			V _{DD} = 7.5V, V _{EE} = -7.5V or V _{DD} = 15V, V _{EE} = 0V				5			Ω
	“OFF” Channel Leakage Current, any channel “OFF”	V _{DD} = 7.5V, V _{EE} = -7.5V O/I = ±7.5V, I/O = 0V		±50		±0.01	±50		±500	nA
	“OFF” Channel Leakage Current, all channels “OFF” (Common OUT/IN)	Inhibit = 7.5V CD4051 V _{DD} = 7.5V, V _{EE} = -7.5V, CD4052 O/I = 0V, I/O = ±7.5V CD4053		±200 ±200 ±200		±0.08 ±0.04 ±0.02	±200 ±200 ±200		±2000 ±2000 ±2000	nA nA nA
Control Inputs A, B, C and Inhibit										
V _{IL}	Low Level Input Voltage	V _{EE} = V _{SS} R _L = 1kΩ to V _{SS} I _{IS} < 2 μA on all OFF channels V _{IS} = V _{DD} thru 1kΩ V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		1.5 3.0 4.0			1.5 3.0 4.0		1.5 3.0 4.0	V V V
V _{IH}	High Level Input Voltage	V _{DD} = 5 V _{DD} = 10 V _{DD} = 15	3.5 7 11		3.5 7 11			3.5 7 11		V V V
I _{IN}	Input Current	V _{DD} = 15V, V _{EE} = 0V V _{IN} = 0V V _{DD} = 15V, V _{EE} = 0V V _{IN} = 15V		-0.1 0.1		-10 ⁻⁵ 10 ⁻⁵	-0.1 0.1		-1.0 1.0	μA μA

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: All voltages measured with respect to V_{SS} unless otherwise specified.

DC Electrical Characteristics (Cont'd.) (Note 2)

	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 _{DD} = 10V V _{DD} = 15V		20 40 80			20 40 80		150 300 600	μA μA μA
Signal Inputs (V _{IS}) and Outputs (V _{OS})										
R _{ON}	"ON" Resistance (Peak for V _{EE} ≤ V _{IS} ≤ V _{DD})	R _L = 10 kΩ (any channel selected)	V _{DD} = 2.5V, V _{EE} = -2.5V or V _{DD} = 5V, V _{EE} = 0V		2100		270	2500	3200	Ω
			V _{DD} = 5V, V _{EE} = -5V or V _{DD} = 10V, V _{EE} = 0V		330		120	400	520	Ω
			V _{DD} = 7.5V, V _{EE} = -7.5V or V _{DD} = 15V, V _{EE} = 0V		230		80	280	360	Ω
ΔR _{ON}	Δ "ON" Resistance Between Any Two Channels	R _L = 10 kΩ (any channel selected)	V _{DD} = 2.5V, V _{EE} = -2.5V or V _{DD} = 5V, V _{EE} = 0V				10			Ω
			V _{DD} = 5V, V _{EE} = -5V or V _{DD} = 10V, V _{EE} = 0V				10			Ω
			V _{DD} = 7.5V, V _{EE} = -7.5V or V _{DD} = 15V, V _{EE} = 0V				5			Ω
	"OFF" Channel Leakage Current, any channel "OFF"	V _{DD} = 7.5V, V _{EE} = -7.5V O/I = ±7.5V, I/O = 0V	±50				±0.01	±50	±500	nA
	"OFF" Channel Leakage Current, all channels "OFF" (Common OUT/IN)	Inhibit = 7.5V CD4051 V _{DD} = 7.5V, V _{EE} = -7.5V, CD4052 O/I = 0V	±200				±0.08	±200	±2000	nA
		I/O = ±7.5V CD4053	±200				±0.04	±200	±2000	nA
Control Inputs A, B, C and Inhibit										
V _{IL}	Low Level Input Voltage	V _{EE} = V _{SS} R _L = 1 kΩ to V _{SS} I _{IS} < 2μA on all OFF Channels V _{IS} = V _{DD} thru 1kΩ V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		1.5 3.0 4.0			1.5 3.0 4.0		1.5 3.0 4.0	V V V
V _{IH}	High Level Input Voltage	V _{DD} = 5 V _{DD} = 10 V _{DD} = 15	3.5 7 11		3.5 7 11			3.5 7 11		V V V
I _{IN}	Input Current	V _{DD} = 15V, V _{EE} = 0V V _{IN} = 0V V _{DD} = 15V, V _{EE} = 0V V _{IN} = 15V		-0.1 0.1		-10 ⁻⁵ 10 ⁻⁵	-0.1 0.1		-1.0 1.0	μA μA

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: All voltages measured with respect to V_{SS} unless otherwise specified.

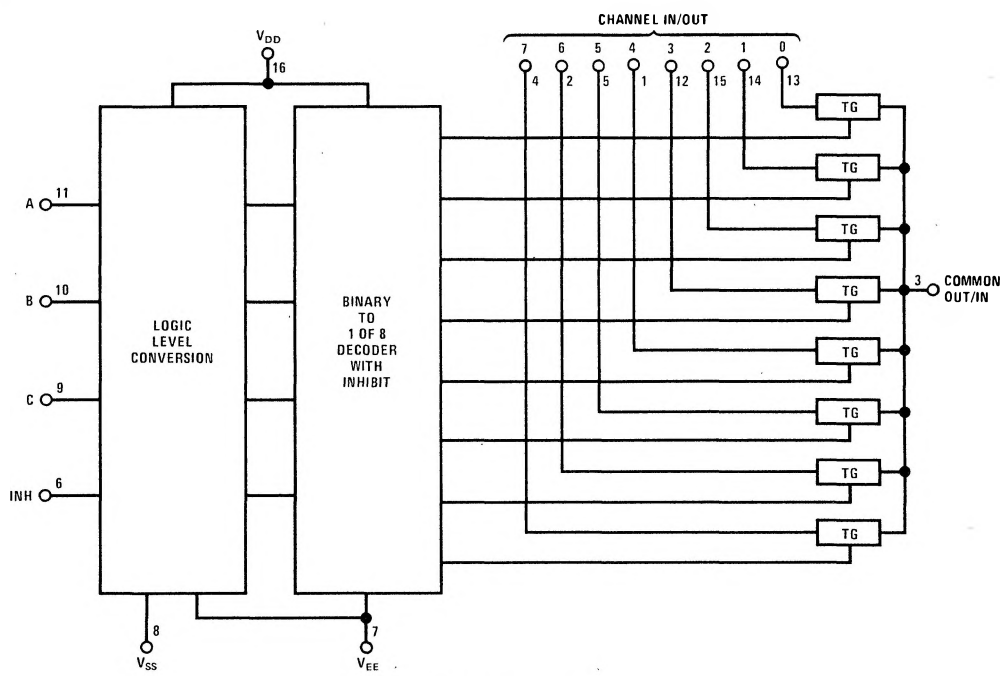
AC Electrical Characteristics

$T_A = 25^\circ\text{C}$, $t_r = t_f = 20\text{ ns}$, unless otherwise specified.

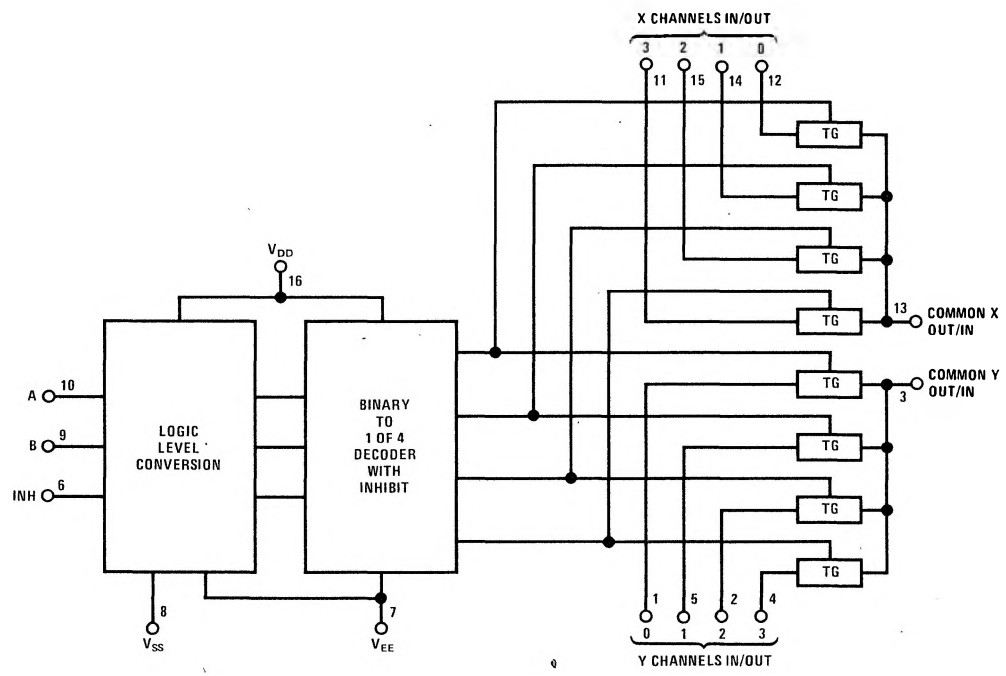
Parameter		Conditions	V _{pp}	Min	Typ	Max	Units
t _{PZH} , t _{PZL}	Propagation Delay Time from Inhibit to Signal Output (channel turning on)	V _{EE} = V _{SS} = 0 V R _L = 1 kΩ C _L = 50 pF	5 V		600	1200	ns
			10 V		225	450	ns
			15 V		160	320	ns
t _{PHZ} , t _{PLZ}	Propagation Delay Time from Inhibit to Signal Output (channel turning off)	V _{EE} = V _{SS} = 0 V R _L = 1 kΩ C _L = 50 pF	5 V		210	420	ns
			10 V		100	200	ns
			15 V		75	150	ns
C _{IN}	Input Capacitance Control Input Signal Input (IN/OUT)				5	7.5	pF
					10	15	pF
C _{OUT}	Output Capacitance (common OUT/IN)						
	CD4051 CD4052 CD4053	V _{EE} = V _{SS} = 0 V	10 V 10 V 10 V		30 15 8		pF pF pF
C _{IOS}	Feedthrough Capacitance				0.2		pF
C _{PD}	Power Dissipation Capacitance						
	CD4051 CD4052 CD4053				110 140 70		pF pF pF
Signal Inputs (V _{IS}) and Outputs (V _{OS})							
	Sine Wave Response (Distortion)	R _L = 10 kΩ f _{IS} = 1 kHz V _{IS} = 5 V _{p-p} V _{EE} = V _{SI} = 0 V	10 V		0.04		%
	Frequency Response, Channel "ON" (Sine Wave Input)	R _L = 1 kΩ, V _{EE} = V _{SS} = 0 V, V _{IS} = 5 V _{p-p} , 20 log ₁₀ V _{OS} /V _{IS} = -3 dB	10 V		40		MHz
	Feedthrough, Channel "OFF"	R _L = 1 kΩ, V _{EE} = V _{SS} = 0 V, V _{IS} = 5 V _{p-p} , 20 log ₁₀ V _{OS} /V _{IS} = -40 dB	10 V		10		MHz
	Crosstalk Between Any Two Channels (frequency at 40 dB)	R _L = 1 kΩ, V _{EE} = V _{SS} = 0 V, V _{IS} (A) = 5 V _{p-p} , 20 log ₁₀ V _{OS} (B)/V _{IS} (A) = -40 dB (Note 3)	10 V		3		MHz
t _{PHL} , t _{PLH}	Propagation Delay Signal Input to Signal Output	V _{EE} = V _{SS} = 0 V C _L = 50 pF	5 V		25	55	ns
			10 V		15	35	ns
			15 V		10	25	ns
Control Inputs, A, B, C and Inhibit							
	Control Input to Signal Crosstalk	V _{EE} = V _{SS} = 0 V, R _L = 10 kΩ at both ends of channel. Input Square Wave Amplitude = 10 V	10 V		65		mV (peak)
t _{PHL} , t _{PLH}	Propagation Delay Time from Address to Signal Output (channels "ON" or "OFF")	V _{EE} = V _{SS} = 0 V C _L = 50 pF	5 V		500	1000	ns
			10 V		180	360	ns
			15 V		120	240	ns

Note 3: A, B are two arbitrary channels with A turned "ON" and B "OFF".

Block Diagrams

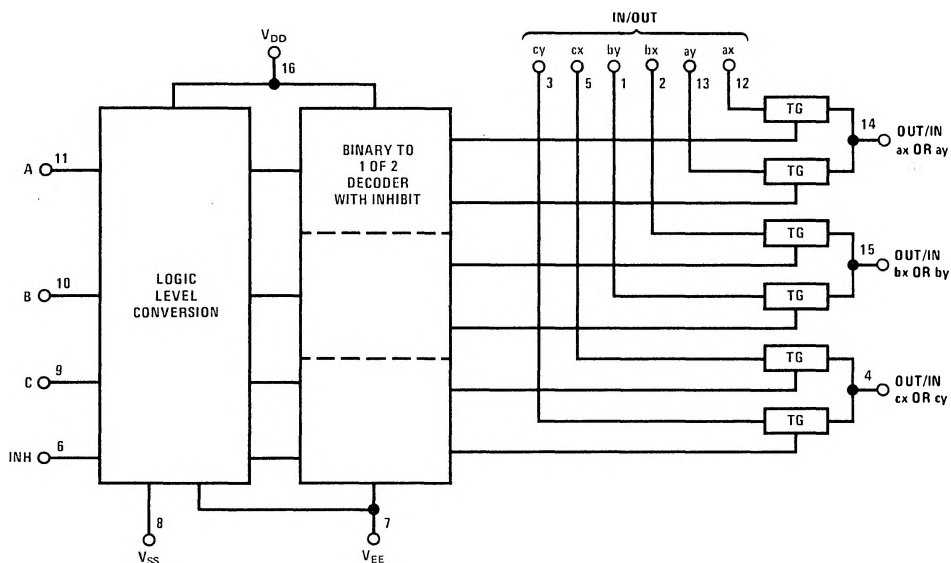


CD4051BM/CD4051BC



CD4052BM/CD4052BC

Block Diagrams (Cont'd.)



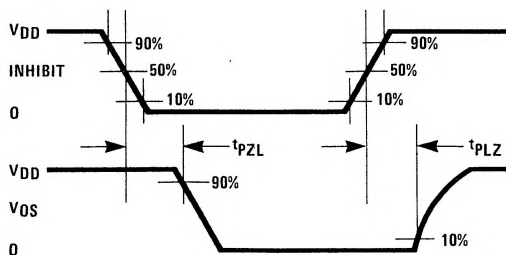
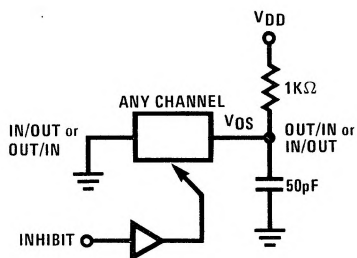
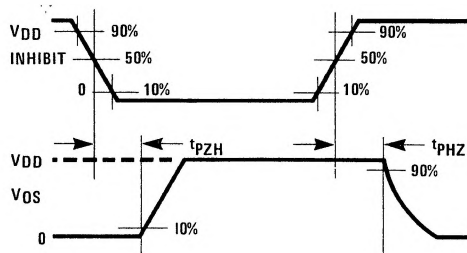
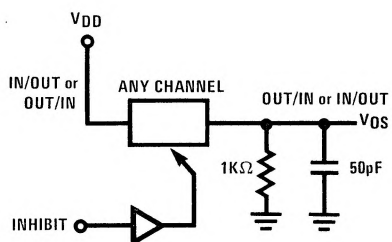
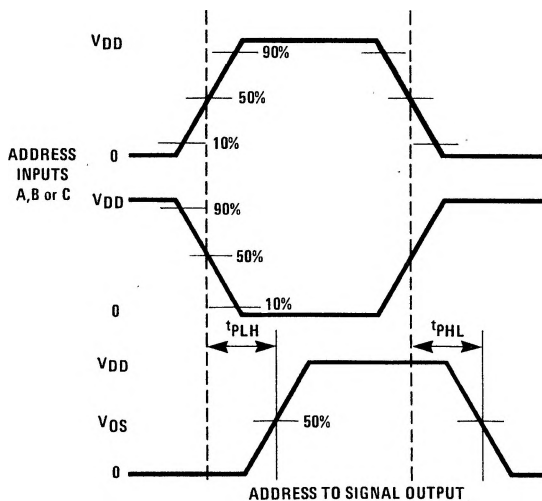
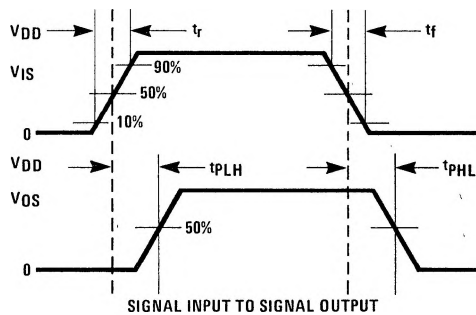
CD4053BM/CD4053BC

Truth Table

INPUT STATES				"ON" CHANNELS		
INHIBIT	C	B	A	CD4051B	CD4052B	CD4053B
0	0	0	0	0	0X, 0Y	cx, bx, ax
0	0	0	1	1	1X, 1Y	cx, bx, ay
0	0	1	0	2	2X, 2Y	cx, by, ax
0	0	1	1	3	3X, 3Y	cx, by, ay
0	1	0	0	4		cy, bx, ax
0	1	0	1	5		cy, bx, ay
0	1	1	0	6		cy, by, ax
0	1	1	1	7		cy, by, ay
1	*	*	*	NONE	NONE	NONE

* Don't Care condition.

Switching Time Waveforms



Special Considerations

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 IN/OUT pin, the voltage drop across the bidirec-

tional switch must not exceed 0.6 V at $T_A \leq 25^\circ\text{C}$, or 0.4 V at $T_A > 25^\circ\text{C}$ (calculated from R_{ON} values shown). No V_{DD} current will flow through R_L if the switch current flows into OUT/IN pin.

Typical Performance Characteristics

