APPENDIX-H

National Semiconductor

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 or 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.

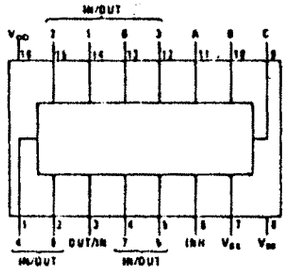
Features

- 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 ±10 pA (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 15 V_{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 μW (typ.) at $V_{DD}-V_{SS} = V_{DD}-V_{EE} = 10V$
- Binary address decoding on chip

Connection Diagrams

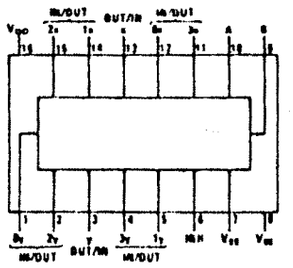
Dual-In-Line Packages

CD4051BM/CD4051BC



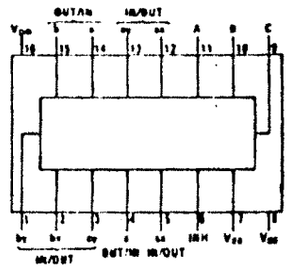
TOP VIEW

CD4052BM/CD4052BC



TOP VIEW

CD4053BM/CD4053BC



TOP VIEW

TL/F/5663-1

Order Number CD4051BMN, CD4051BCN,
CD4052BMN, CD4052BCN, CD4053BMN, CD4053BCN
See NS Package N16A

Absolute Maximum Ratings

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

Recommended Operating Conditions

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

DC Electrical Characteristics (Note 2)

Symbol	Parameter	Conditions		−55°C Min	−55°C Max	+25° Min	+25° Typ	+25° Max	+125°C Min	+125°C Max	Units
I_D	Quiescent Device Current	V_{DD} = 5V			5			5		150	μA
		V_{DD} = 10V			10			20		600	μA
		V_{DD} = 15V			20			20		600	μA
	Inputs (V_{IS}) and Outputs (V_{OS})										
R_{ON}	"ON" Resistance (Peak for $V_{EE} \le V_{IS} \le V_{DD}$)	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
I_{OFF}	"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
I_{OFF}	"OFF" Channel Leakage Current, all channels "OFF" (Common OUT/IN)	Inhibit = 7.5V, V_{DD} = 7.5V, V_{EE} = −7.5V, O/I = 0V, I/O = ±7.5V	CD4051		±200		±0.08	±200		±2000	nA
			CD4052		±200		±0.04	±200		±2000	nA
			CD4053		±200		±0.02	±200		±2000	nA
	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} < 2 μA on all OFF channels, V_{IS} = V_{DD} thru 1 kΩ									
		V_{DD} = 5V			1.5			1.5		1.5	V
		V_{DD} = 10V			3.0			3.0		3.0	V
		V_{DD} = 15V			4.0			4.0		4.0	V
V_{IH}	High Level Input Voltage	V_{DD} = 5		3.5		3.5			3.5		V
		V_{DD} = 10		7		7			7		V
		V_{DD} = 15		11		11			11		V
I_{IN}	Input Current	V_{DD} = 15V, V_{EE} = 0V, V_{IN} = 0V			−0.1		-10^{-5}	−0.1		−1.0	μA
		V_{DD} = 15V, V_{EE} = 0V, V_{IN} = 15V			0.1		10^{-5}	0.1		1.0	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 (Note 2) (Continued)

Symbol	Parameter	Conditions		−40°C		+25°C		+85°C	
				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
Signal Inputs (V_{IS}) and Outputs (V_{OS})										
R_{ON}	"ON" Resistance (Peak for $V_{EE} \le V_{IS} \le V_{DD}$)	$R_L = 10\ k\Omega$ (any channel selected)	$V_{DD} = 2.5V$, $V_{EE} = -2.5V$ or $V_{DD} = 5V$, $V_{EE} = 0V$		2100		270	2500		3200
			$V_{DD} = 5V$, $V_{EE} = -5V$ or $V_{DD} = 10V$, $V_{EE} = 0V$		330		120	400		520
			$V_{DD} = 7.5V$, $V_{EE} = -7.5V$ or $V_{DD} = 15V$, $V_{EE} = 0V$		230		80	280		360
ΔR_{ON}	Δ"ON" Resistance Between Any Two Channels	$R_L = 10\ k\Omega$ (any channel selected)	$V_{DD} = 2.5V$, $V_{EE} = -2.5V$ or $V_{DD} = 5V$, $V_{EE} = 0V$				10			
			$V_{DD} = 5V$ $V_{EE} = -5V$ or $V_{DD} = 10V$, $V_{EE} = 0V$				10			
			$V_{DD} = 7.5V$, $V_{EE} = -7.5V$ or $V_{DD} = 15V$, $V_{EE} = 0V$				5			
	"OFF" Channel Leakage Current, any channel "OFF"	$V_{DD} = 7.5V$, $V_{EE} = -7.5V$ $O/I = \pm 7.5V$, $I/O = 0V$			± 50		± 0.01	± 50		± 500
	"OFF" Channel Leakage Current, all channels "OFF" (Common OUT/IN)	Inhibit = 7.5V $V_{DD} = 7.5V$, $V_{EE} = -7.5V$, $O/I = 0V$ $I/O = \pm 7.5V$	CD4051 CD4052 CD4053		± 200 ± 200 ± 200		± 0.08 ± 0.04 ± 0.02	± 200 ± 200 ± 200		± 1000 ± 1000 ± 1000
Control Inputs A, B, C and Inhibit										
V_{IL}	Low Level Input Voltage	$V_{EE} = V_{SS}$ $R_L = 1\ k\Omega$ to V_{SS} $I_{IS} < 2\ \mu A$ on all OFF Channels $V_{IS} = V_{DD}$ thru $1\ k\Omega$ $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$			1.5 3.0 4.0			1.5 3.0 4.0		1.5 3.0 4.0
V_{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	
I_{IN}	Input Current	$V_{DD} = 15V$, $V_{IN} = 0V$ $V_{DD} = 15V$, $V_{IN} = 15V$	$V_{EE} = 0V$ $V_{EE} = 0V$		-0.1 0.1		-10^{-5} 10^{-5}	-0.1 0.1		-1.0 1.0

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 (Note 2) (Continued)

Symbol	Parameter	Conditions		−40°C		+25°C			+85°C	
				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
Signal Inputs (V_{IS}) and Outputs (V_{OS})										
R_{ON}	"ON" Resistance (Peak for $V_{EE} \le V_{IS} \le V_{DD}$)	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
			V_{DD} = 5V, V_{EE} = −5V or V_{DD} = 10V, V_{EE} = 0V		330		120	400		520
			V_{DD} = 7.5V, V_{EE} = −7.5V or V_{DD} = 15V, V_{EE} = 0V		230		80	280		360
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			
			V_{DD} = 5V V_{EE} = −5V or V_{DD} = 10V, V_{EE} = 0V				10			
			V_{DD} = 7.5V, V_{EE} = −7.5V or V_{DD} = 15V, V_{EE} = 0V				5			
	"OFF" Channel Leakage Current, any channel "OFF"	V_{DD} = 7.5V, V_{EE} = −7.5V O/I = ±7.5V, I/O = 0V			±60		±0.01	±50		±500
	"OFF" Channel Leakage Current, all channels "OFF" (Common OUT/IN)	Inhibit = 7.5V V_{DD} = 7.5V, V_{EE} = −7.5V, O/I = 0V I/O = ±7.5V	CD4051 CD4052 CD4053		±200 ±200 ±200		±0.08 ±0.04 ±0.02	±200 ±200 ±200		±2000 ±2000 ±2000
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} < 2 μA on all OFF Channels V_{IS} = V_{DD} thru 1 kΩ 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_{IN}	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	
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

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°C, $t_r = t_f$ = 20 ns, unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	Min	Typ	Max	Units
t_{PHL}	Propagation Delay Time from	$V_{EE} = V_{SS} = 0V$	5V		800	1200	ns
t_{PLH}	Inhibit to Signal Output	$R_L = 1\ k\Omega$	10V		225	450	ns
	(channel turning on)	$C_L = 50\ pF$	15V		160	320	ns
t_{PHL}	Propagation Delay Time from	$V_{EE} = V_{SS} = 0V$	5V		210	420	ns
t_{PLH}	Inhibit to Signal Output	$R_L = 1\ k\Omega$	10V		100	200	ns
	(channel turning off)	$C_L = 50\ pF$	15V		75	150	ns
C_{IN}	Input Capacitance						
	Control Input				5	7.5	pF
	Signal Input (IN/OUT)				10	15	pF
C_{OUT}	Output Capacitance						
	(common OUT/IN)						
	CD4051	$V_{EE} = V_{SS} = 0V$	10V		30		pF
	CD4052		10V		15		pF
	CD4053		10V		8		pF
C_{IOS}	Feedthrough Capacitance				0.2		pF
C_{PD}	Power Dissipation Capacitance						
	CD4051				110		pF
	CD4052				140		pF
	CD4053				70		pF
Signal Inputs (V_{IS}) and Outputs (V_{OS})							
	Sine Wave Response	$R_L = 10\ k\Omega$					
	(Distortion)	$f_{IS} = 1\ kHz$	10V		0.04		%
		$V_{IS} = 5\ V_{p-p}$					
		$V_{EE} = V_{SS} = 0V$					
	Frequency Response, Channel "ON" (Sine Wave Input)	$R_L = 1\ k\Omega$, $V_{EE} = 0V$, $V_{IS} = 5V_{p-p}$, $20 \log_{10} V_{OS}/V_{IS} = -3\ dB$	10V		40		MHz
	Feedthrough, Channel "OFF"	$R_L = 1\ k\Omega$, $V_{EE} = V_{SS} = 0V$, $V_{IS} = 5V_{p-p}$, $20 \log_{10} V_{OS}/V_{IS} = -40\ dB$	10V		10		MHz
	Crosstalk Between Any Two Channels (frequency at 40 dB)	$R_L = 1\ k\Omega$, $V_{EE} = V_{SS} = 0V$, $V_{IS}(A) = 5V_{p-p}$ $20 \log_{10} V_{OS}(B)/V_{IS}(A) = -40\ dB$ (Note 3)	10V		3		MHz
t_{PHL}	Propagation Delay Signal	$V_{EE} = V_{SS} = 0V$	5V		25	55	ns
t_{PLH}	Input to Signal Output	$C_L = 50\ pF$	10V		15	35	ns
			15V		10	25	ns
Control Inputs, A, B, C and Inhibit							
	Control Input to Signal Crosstalk	$V_{EE} = V_{SS} = 0V$, $R_L = 10\ k\Omega$ at both ends of channel. Input Square Wave Amplitude = 10V	10V		65		mV (peak)
t_{PHL}	Propagation Delay Time from	$V_{EE} = V_{SS} = 0V$	5V		500	1000	ns
t_{PLH}	Address to Signal Output	$C_L = 50\ pF$	10V		180	360	ns
	(Channels "ON" or "OFF")		15V		120	240	ns

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