

# MC14051B, MC14052B, MC14053B



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## Analog Multiplexers/Demultiplexers

The MC14051B, MC14052B, and MC14053B analog multiplexers are digitally-controlled analog switches. The MC14051B effectively implements an SP8T solid state switch, the MC14052B a DP4T, and the MC14053B a Triple SPDT. All three devices feature low ON impedance and very low OFF leakage current. Control of analog signals up to the complete supply voltage range can be achieved.

### Features

- Triple Diode Protection on Control Inputs
- Switch Function is Break Before Make
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Analog Voltage Range ( $V_{DD} - V_{EE}$ ) = 3.0 to 18 V  
Note:  $V_{EE}$  must be  $\leq V_{SS}$
- Linearized Transfer Characteristics
- Low-noise –  $12 \text{ nV}/\sqrt{\text{Cycle}}$ ,  $f \geq 1.0 \text{ kHz}$  Typical
- Pin-for-Pin Replacement for CD4051, CD4052, and CD4053
- For 4PDT Switch, See MC14551B
- For Lower  $R_{ON}$ , Use the HC4051, HC4052, or HC4053 High-Speed CMOS Devices
- Pb-Free Packages are Available\*

### MAXIMUM RATINGS (Voltages Referenced to $V_{SS}$ )

Symbol	Parameter	Value	Unit
$V_{DD}$	DC Supply Voltage Range (Referenced to $V_{EE}$ , $V_{SS} \geq V_{EE}$ )	-0.5 to +18.0	V
$V_{in}$ , $V_{out}$	Input or Output Voltage Range (DC or Transient) (Referenced to $V_{SS}$ for Control Inputs and $V_{EE}$ for Switch I/O)	-0.5 to $V_{DD}$ + 0.5	V
$I_{in}$	Input Current (DC or Transient) per Control Pin	+10	mA
$I_{SW}$	Switch Through Current	$\pm 25$	mA
$P_D$	Power Dissipation per Package (Note 21)	500	mW
$T_A$	Ambient Temperature Range	-55 to +125	°C
$T_{stg}$	Storage Temperature Range	-65 to +150	°C
$T_L$	Lead Temperature (8-Second Soldering)	260	°C

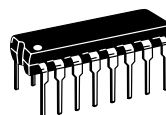
Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

21. Temperature Derating: Plastic "P and D/DW" Packages: - 7.0 mW/°C From 65°C To 125°C

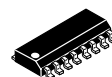
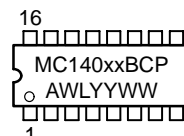
This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either  $V_{SS}$ ,  $V_{EE}$  or  $V_{DD}$ ). Unused outputs must be left open.

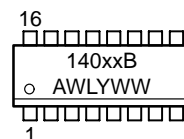
### MARKING DIAGRAMS



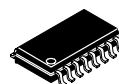
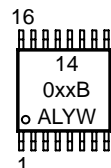
PDIP-16  
P SUFFIX  
CASE 648



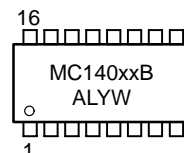
SOIC-16  
D SUFFIX  
CASE 751B



TSSOP-16  
DT SUFFIX  
CASE 948F



SOEIAJ-16  
F SUFFIX  
CASE 966



xx = Specific Device Code  
A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week

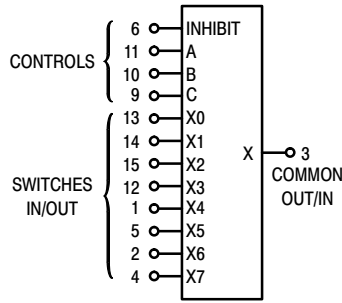
### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 155 of this data sheet.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

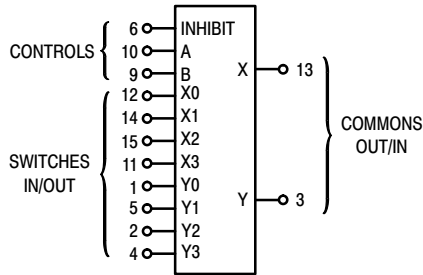
# MC14051B, MC14052B, MC14053B

## MC14051B 8-Channel Analog Multiplexer/Demultiplexer



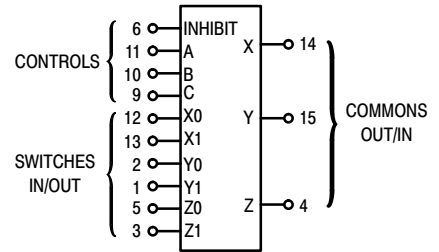
$V_{DD}$  = PIN 16  
 $V_{SS}$  = PIN 8  
 $V_{EE}$  = PIN 7

## MC14052B Dual 4-Channel Analog Multiplexer/Demultiplexer



$V_{DD}$  = PIN 16  
 $V_{SS}$  = PIN 8  
 $V_{EE}$  = PIN 7

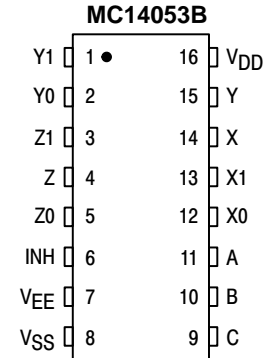
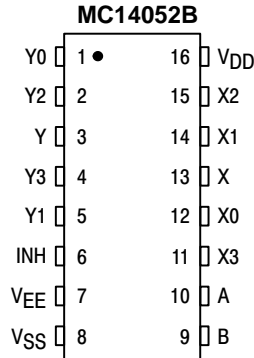
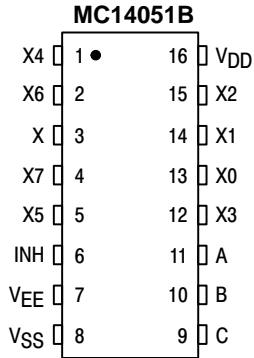
## MC14053B Triple 2-Channel Analog Multiplexer/Demultiplexer



$V_{DD}$  = PIN 16  
 $V_{SS}$  = PIN 8  
 $V_{EE}$  = PIN 7

Note: Control Inputs referenced to  $V_{SS}$ , Analog Inputs and Outputs reference to  $V_{EE}$ .  $V_{EE}$  must be  $\leq V_{SS}$ .

### PIN ASSIGNMENT



# MC14051B, MC14052B, MC14053B

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	V <sub>DD</sub>	Test Conditions	- 55°C		25°C			125°C		Unit
				Min	Max	Min	Typ (Note 22)	Max	Min	Max	

### SUPPLY REQUIREMENTS (Voltages Referenced to V<sub>EE</sub>)

Power Supply Voltage Range	V <sub>DD</sub>	-	V <sub>DD</sub> - 3.0 ≥ V <sub>SS</sub> ≥ V <sub>EE</sub>	3.0	18	3.0	-	18	3.0	18	V	
Quiescent Current Per Package	I <sub>DD</sub>	5.0 10 15	Control Inputs: V <sub>in</sub> = V <sub>SS</sub> or V <sub>DD</sub> . Switch I/O: V <sub>EE</sub> ≤ V <sub>I/O</sub> ≤ V <sub>DD</sub> , and ΔV <sub>switch</sub> ≤ 500 mV (Note 23)	- - -	5.0 10 20	- - -	0.005 0.010 0.015	5.0 10 20	- - -	150 300 600	μA	
Total Supply Current (Dynamic Plus Quiescent, Per Package)	I <sub>D(AV)</sub>	5.0 10 15	T <sub>A</sub> = 25°C only (The channel component, (V <sub>in</sub> - V <sub>out</sub> )/R <sub>on</sub> , is not included.)	Typical						(0.07 μA/kHz) f + I <sub>DD</sub> (0.20 μA/kHz) f + I <sub>DD</sub> (0.36 μA/kHz) f + I <sub>DD</sub>		μA

### CONTROL INPUTS — INHIBIT, A, B, C (Voltages Referenced to V<sub>SS</sub>)

Low-Level Input Voltage	V <sub>IL</sub>	5.0 10 15	R <sub>on</sub> = per spec, I <sub>off</sub> = per spec	- - -	1.5 3.0 4.0	- - -	2.25 4.50 6.75	1.5 3.0 4.0	- - -	1.5 3.0 4.0	V
High-Level Input Voltage	V <sub>IH</sub>	5.0 10 15	R <sub>on</sub> = per spec, I <sub>off</sub> = per spec	3.5 7.0 11	- - -	3.5 7.0 11	2.75 5.50 8.25	- - -	3.5 7.0 11	- - -	V
Input Leakage Current	I <sub>in</sub>	15	V <sub>in</sub> = 0 or V <sub>DD</sub>	-	± 0.1	-	± 0.00001	± 0.1	-	1.0	μA
Input Capacitance	C <sub>in</sub>	-		-	-	-	5.0	7.5	-	-	pF

### SWITCHES IN/OUT AND COMMONS OUT/IN — X, Y, Z (Voltages Referenced to V<sub>EE</sub>)

Recommended Peak-to-Peak Voltage Into or Out of the Switch	V <sub>I/O</sub>	-	Channel On or Off	0	V <sub>DD</sub>	0	-	V <sub>DD</sub>	0	V <sub>DD</sub>	V <sub>PP</sub>
Recommended Static or Dynamic Voltage Across the Switch (Note 23) (Figure 5)	ΔV <sub>switch</sub>	-	Channel On	0	600	0	-	600	0	300	mV
Output Offset Voltage	V <sub>OO</sub>	-	V <sub>in</sub> = 0 V, No Load	-	-	-	10	-	-	-	μV
ON Resistance	R <sub>on</sub>	5.0 10 15	ΔV <sub>switch</sub> ≤ 500 mV (Note 23) V <sub>in</sub> = V <sub>IL</sub> or V <sub>IH</sub> (Control), and V <sub>in</sub> = 0 to V <sub>DD</sub> (Switch)	- - -	800 400 220	- - -	250 120 80	1050 500 280	- - -	1200 520 300	Ω
ΔON Resistance Between Any Two Channels in the Same Package	ΔR <sub>on</sub>	5.0 10 15		- - -	70 50 45	- - -	25 10 10	70 50 45	- - -	135 95 65	Ω
Off-Channel Leakage Current (Figure 10)	I <sub>off</sub>	15	V <sub>in</sub> = V <sub>IL</sub> or V <sub>IH</sub> (Control) Channel to Channel or Any One Channel	-	± 100	-	± 0.05	± 100	-	± 1000	nA
Capacitance, Switch I/O	C <sub>I/O</sub>	-	Inhibit = V <sub>DD</sub>	-	-	-	10	-	-	-	pF
Capacitance, Common O/I	C <sub>O/I</sub>	-	Inhibit = V <sub>DD</sub> (MC14051B) (MC14052B) (MC14053B)	- - -	- - -	- - -	60 32 17	- - -	- - -	- - -	pF
Capacitance, Feedthrough (Channel Off)	C <sub>I/O</sub>	- -	Pins Not Adjacent Pins Adjacent	- -	- -	- -	0.15 0.47	- -	- -	- -	pF

22. Data labeled "Typ" is not to be used for design purposes, but is intended as an indication of the IC's potential performance.

23. For voltage drops across the switch (ΔV<sub>switch</sub>) > 600 mV (> 300 mV at high temperature), excessive V<sub>DD</sub> current may be drawn, i.e. the current out of the switch may contain both V<sub>DD</sub> and switch input components. The reliability of the device will be unaffected unless the Maximum Ratings are exceeded. (See first page of this data sheet.)

# MC14051B, MC14052B, MC14053B

## ELECTRICAL CHARACTERISTICS (Note 24) ( $C_L = 50 \text{ pF}$ , $T_A = 25^\circ\text{C}$ ) ( $V_{EE} \leq V_{SS}$ unless otherwise indicated)

Characteristic	Symbol	$V_{DD} - V_{EE}$ Vdc	Typ (Note 25) All Types	Max	Unit
Propagation Delay Times (Figure 6) Switch Input to Switch Output ( $R_L = 10 \text{ k}\Omega$ ) MC14051 $t_{PLH}, t_{PHL} = (0.17 \text{ ns/pF}) C_L + 26.5 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.08 \text{ ns/pF}) C_L + 11 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.06 \text{ ns/pF}) C_L + 9.0 \text{ ns}$ MC14052 $t_{PLH}, t_{PHL} = (0.17 \text{ ns/pF}) C_L + 21.5 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.08 \text{ ns/pF}) C_L + 8.0 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.06 \text{ ns/pF}) C_L + 7.0 \text{ ns}$ MC14053 $t_{PLH}, t_{PHL} = (0.17 \text{ ns/pF}) C_L + 16.5 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.08 \text{ ns/pF}) C_L + 4.0 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.06 \text{ ns/pF}) C_L + 3.0 \text{ ns}$	$t_{PLH}, t_{PHL}$	5.0	35	90	ns
		10	15	40	
		15	12	30	
		5.0	30	75	ns
		10	12	30	
		15	10	25	
		5.0	25	65	ns
		10	8.0	20	
		15	6.0	15	
Inhibit to Output ( $R_L = 10 \text{ k}\Omega$ , $V_{EE} = V_{SS}$ ) Output "1" or "0" to High Impedance, or High Impedance to "1" or "0" Level MC14051B  MC14052B  MC14053B	$t_{PHZ}, t_{PLZ},$ $t_{PZH}, t_{PZL}$	5.0	350	700	ns
		10	170	340	
		15	140	280	
		5.0	300	600	ns
		10	155	310	
		15	125	250	
		5.0	275	550	ns
		10	140	280	
		15	110	220	
Control Input to Output ( $R_L = 10 \text{ k}\Omega$ , $V_{EE} = V_{SS}$ ) MC14051B  MC14052B  MC14053B	$t_{PLH}, t_{PHL}$	5.0	360	720	ns
		10	160	320	
		15	120	240	
		5.0	325	650	ns
		10	130	260	
		15	90	180	
		5.0	300	600	ns
		10	120	240	
		15	80	160	
Second Harmonic Distortion ( $R_L = 10 \text{ k}\Omega$ , $f = 1 \text{ kHz}$ ) $V_{in} = 5 \text{ V}_{PP}$	–	10	0.07	–	%
Bandwidth (Figure 7) ( $R_L = 1 \text{ k}\Omega$ , $V_{in} = 1/2 (V_{DD} - V_{EE})$ p-p, $C_L = 50 \text{ pF}$ $20 \text{ Log} (V_{out}/V_{in}) = -3 \text{ dB}$ )	BW	10	17	–	MHz
Off Channel Feedthrough Attenuation (Figure 7) $R_L = 1 \text{ k}\Omega$ , $V_{in} = 1/2 (V_{DD} - V_{EE})$ p-p $f_{in} = 4.5 \text{ MHz}$ — MC14051B $f_{in} = 30 \text{ MHz}$ — MC14052B $f_{in} = 55 \text{ MHz}$ — MC14053B	–	10	– 50	–	dB
Channel Separation (Figure 8) ( $R_L = 1 \text{ k}\Omega$ , $V_{in} = 1/2 (V_{DD} - V_{EE})$ p-p, $f_{in} = 3.0 \text{ MHz}$ )	–	10	– 50	–	dB
Crosstalk, Control Input to Common O/I (Figure 9) ( $R_1 = 1 \text{ k}\Omega$ , $R_L = 10 \text{ k}\Omega$ Control $t_{TLH} = t_{THL} = 20 \text{ ns}$ , Inhibit = $V_{SS}$ )	–	10	75	–	mV

24. The formulas given are for the typical characteristics only at  $25^\circ\text{C}$ .

25. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

# MC14051B, MC14052B, MC14053B

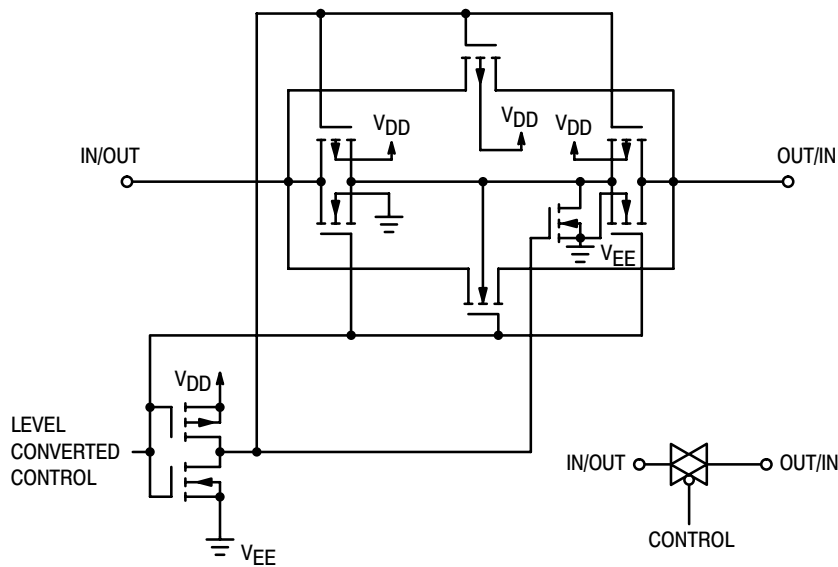


Figure 1. Switch Circuit Schematic

## TRUTH TABLE

Control Inputs			ON Switches		
Inhibit	Select		MC14051B	MC14052B	MC14053B
	C*	B A			
0	0	0 0	X0	Y0 X0	Z0 Y0 X0
0	0	0 1	X1	Y1 X1	Z0 Y0 X1
0	0	1 0	X2	Y2 X2	Z0 Y1 X0
0	0	1 1	X3	Y3 X3	Z0 Y1 X1
0	1	0 0	X4		Z1 Y0 X0
0	1	0 1	X5		Z1 Y0 X1
0	1	1 0	X6		Z1 Y1 X0
0	1	1 1	X7		Z1 Y1 X1
1	x	x x	None	None	None

\*Not applicable for MC14052  
x = Don't Care

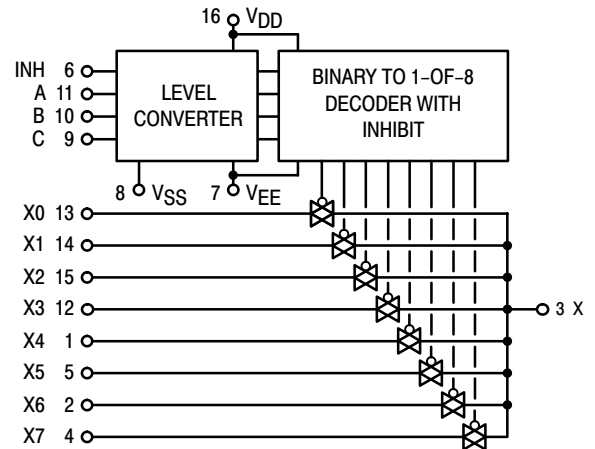


Figure 2. MC14051B Functional Diagram

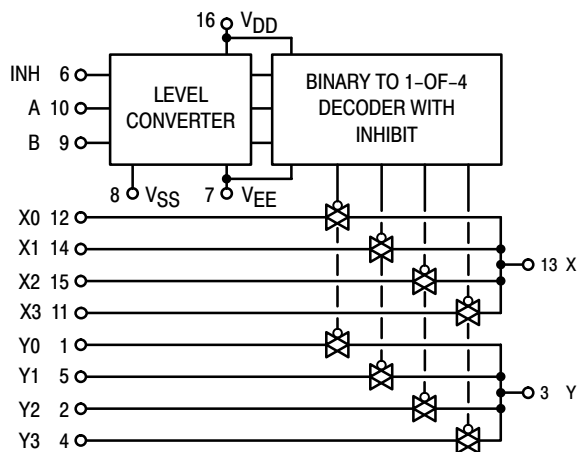


Figure 3. MC14052B Functional Diagram

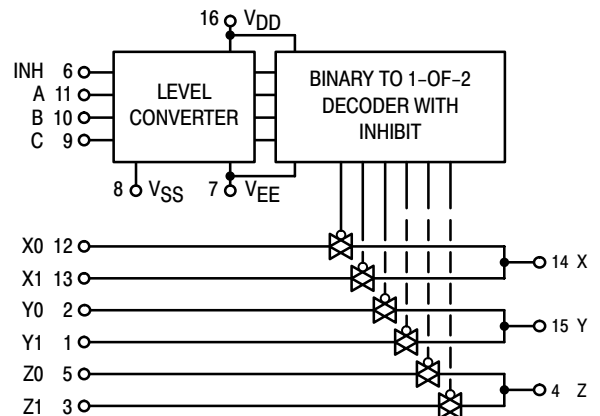


Figure 4. MC14053B Functional Diagram

TEST CIRCUITS

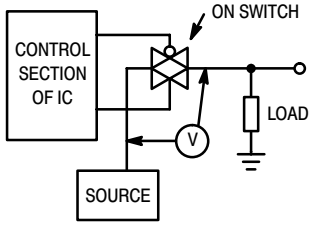


Figure 5.  $\Delta V$  Across Switch

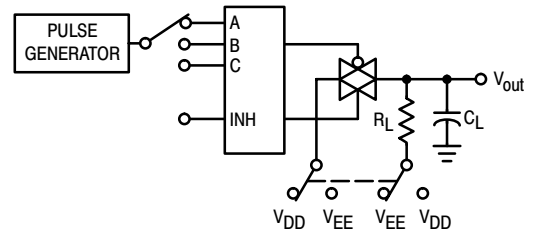


Figure 6. Propagation Delay Times, Control and Inhibit to Output

A, B, and C inputs used to turn ON or OFF the switch under test.

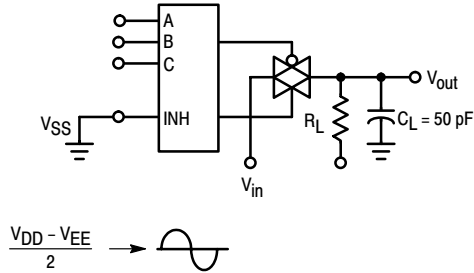


Figure 7. Bandwidth and Off-Channel Feedthrough Attenuation

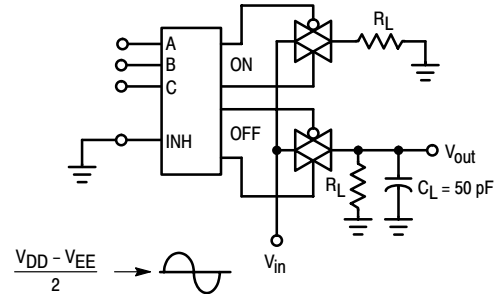


Figure 8. Channel Separation (Adjacent Channels Used For Setup)

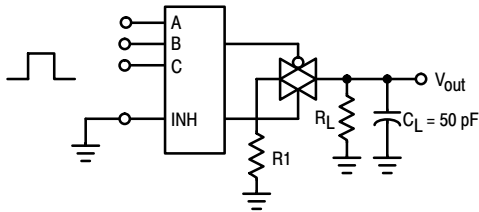


Figure 9. Crosstalk, Control Input to Common O/I

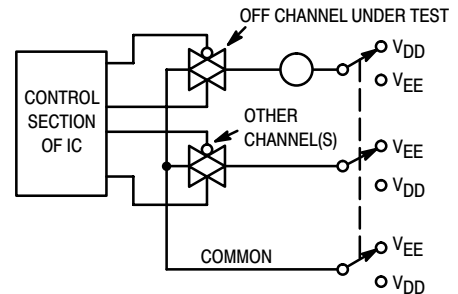


Figure 10. Off Channel Leakage

NOTE: See also Figures 7 and 8 in the MC14016B data sheet.

# MC14051B, MC14052B, MC14053B

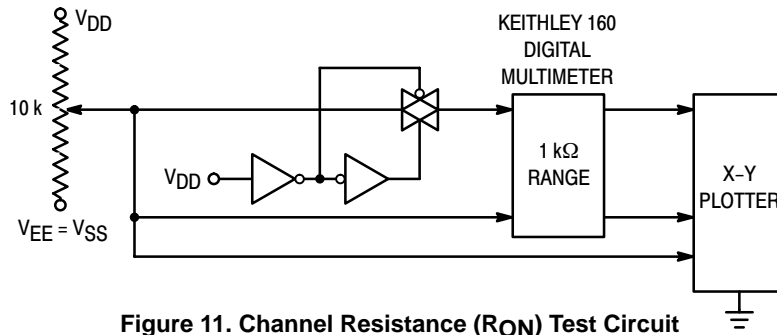


Figure 11. Channel Resistance ( $R_{ON}$ ) Test Circuit

## TYPICAL RESISTANCE CHARACTERISTICS

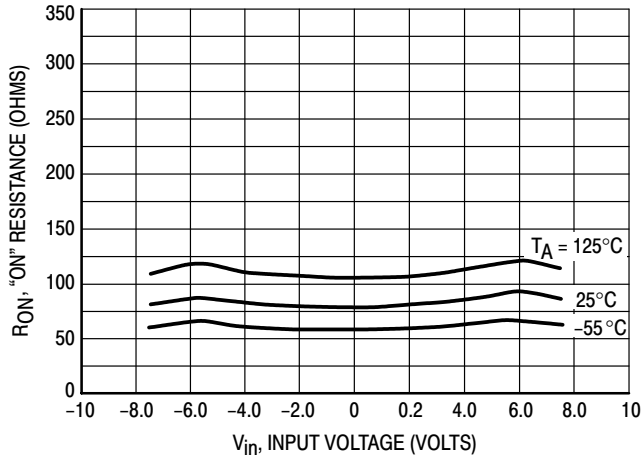


Figure 12.  $V_{DD} = 7.5\text{ V}$ ,  $V_{EE} = -7.5\text{ V}$

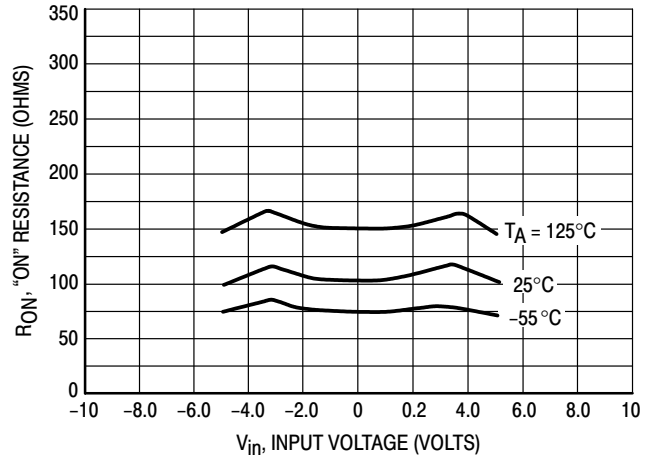


Figure 13.  $V_{DD} = 5.0\text{ V}$ ,  $V_{EE} = -5.0\text{ V}$

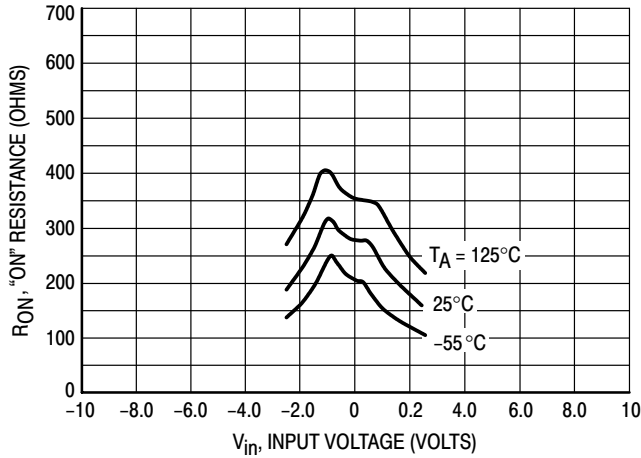


Figure 14.  $V_{DD} = 2.5\text{ V}$ ,  $V_{EE} = -2.5\text{ V}$

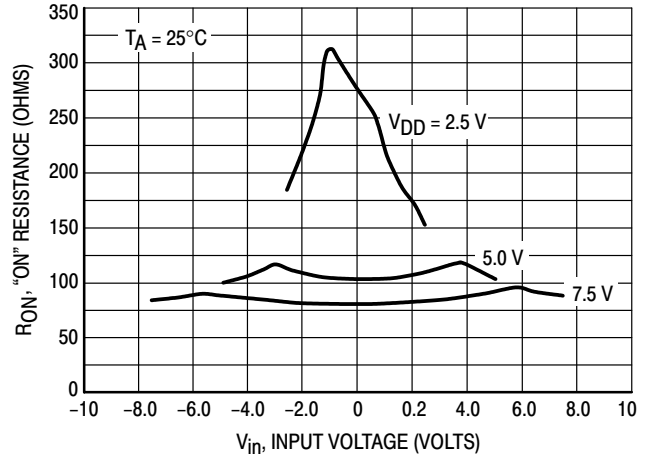


Figure 15. Comparison at  $25^\circ\text{C}$ ,  $V_{DD} = -V_{EE}$

APPLICATIONS INFORMATION

Figure A illustrates use of the on-chip level converter detailed in Figures 2, 3, and 4. The 0-to-5 V Digital Control signal is used to directly control a 9 V<sub>p-p</sub> analog signal.

The digital control logic levels are determined by V<sub>DD</sub> and V<sub>SS</sub>. The V<sub>DD</sub> voltage is the logic high voltage; the V<sub>SS</sub> voltage is logic low. For the example, V<sub>DD</sub> = +5 V = logic high at the control inputs; V<sub>SS</sub> = GND = 0 V = logic low.

The maximum analog signal level is determined by V<sub>DD</sub> and V<sub>EE</sub>. The V<sub>DD</sub> voltage determines the maximum recommended peak above V<sub>SS</sub>. The V<sub>EE</sub> voltage determines the maximum swing below V<sub>SS</sub>. For the example, V<sub>DD</sub> - V<sub>SS</sub> = 5 V maximum swing above V<sub>SS</sub>; V<sub>SS</sub> - V<sub>EE</sub> = 5 V maximum swing below V<sub>SS</sub>. The example shows a ±4.5 V signal which allows a 1/2 volt margin at each

peak. If voltage transients above V<sub>DD</sub> and/or below V<sub>EE</sub> are anticipated on the analog channels, external diodes (D<sub>x</sub>) are recommended as shown in Figure B. These diodes should be small signal types able to absorb the maximum anticipated current surges during clipping.

The *absolute* maximum potential difference between V<sub>DD</sub> and V<sub>EE</sub> is 18.0 V. Most parameters are specified up to 15 V which is the *recommended* maximum difference between V<sub>DD</sub> and V<sub>EE</sub>.

Balanced supplies are not required. However, V<sub>SS</sub> must be greater than or equal to V<sub>EE</sub>. For example, V<sub>DD</sub> = +10 V, V<sub>SS</sub> = +5 V, and V<sub>EE</sub> = -3 V is acceptable. See the Table below.

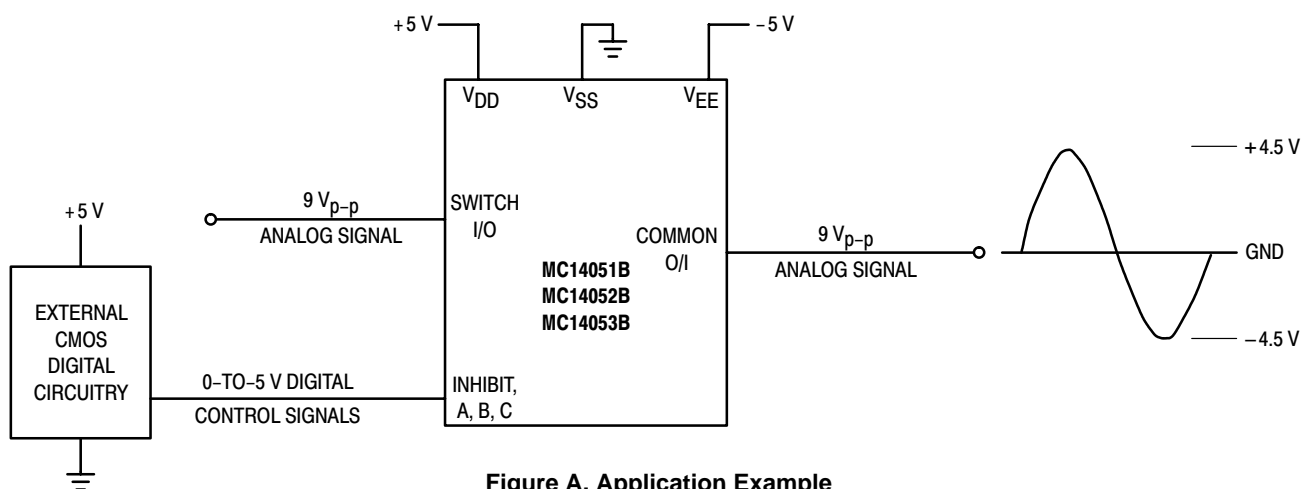


Figure A. Application Example

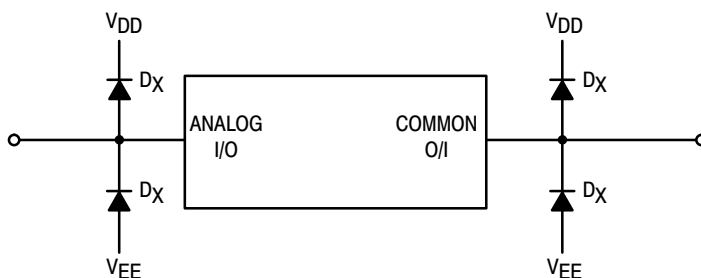


Figure B. External Germanium or Schottky Clipping Diodes

POSSIBLE SUPPLY CONNECTIONS

V <sub>DD</sub> In Volts	V <sub>SS</sub> In Volts	V <sub>EE</sub> In Volts	Control Inputs Logic High/Logic Low In Volts	Maximum Analog Signal Range In Volts
+ 8	0	- 8	+ 8/0	+ 8 to - 8 = 16 V <sub>p-p</sub>
+ 5	0	- 12	+ 5/0	+ 5 to - 12 = 17 V <sub>p-p</sub>
+ 5	0	0	+ 5/0	+ 5 to 0 = 5 V <sub>p-p</sub>
+ 5	0	- 5	+ 5/0	+ 5 to - 5 = 10 V <sub>p-p</sub>
+ 10	+ 5	- 5	+ 10/+ 5	+ 10 to - 5 = 15 V <sub>p-p</sub>



## MC14051B, MC14052B, MC14053B

### ORDERING INFORMATION

Device	Package	Shipping†
MC14051BCP	PDIP-16	2,000 Units / Box
MC14051BCPG	PDIP-16 (Pb-Free)	2,000 Units / Box
MC14051BD	SOIC-16	48 Units / Rail
MC14051BDG	SOIC-16 (Pb-Free)	48 Units / Rail
MC14051BDR2	SOIC-16	2,500 / Tape & Reel
MC14051BDR2G	SOIC-16 (Pb-Free)	2,500 / Tape & Reel
MC14051BDT	TSSOP-16*	96 Units / Rail
MC14051BDTEL	TSSOP-16	2,500 / Tape & Reel
MC14051BDTR2	TSSOP-16*	2,500 / Tape & Reel
MC14051BF	SOEIAJ-16	See Note 26
MC14051BFEL	SOEIAJ-16	See Note 26
MC14052BCP	PDIP-16	2,000 Units / Box
MC14052BCPG	PDIP-16 (Pb-Free)	2,000 Units / Box
MC14052BD	SOIC-16	48 Units / Rail
MC14052BDG	SOIC-16 (Pb-Free)	48 Units / Rail
MC14052BDR2	SOIC-16	2,500 / Tape & Reel
MC14052BDR2G	SOIC-16 (Pb-Free)	2,500 / Tape & Reel
MC14052BDT	TSSOP-16	96 Units / Rail
MC14052BDTR2	TSSOP-16*	2,500 / Tape & Reel
MC14052BF	SOEIAJ-16	See Note 26
MC14052BFEL	SOEIAJ-16	See Note 26
MC14053BCP	PDIP-16	2,000 Units / Box
MC14053BCPG	PDIP-16 (Pb-Free)	2,000 Units / Box
MC14053BD	SOIC-16	48 Units / Rail
MC14053BDG	SOIC-16 (Pb-Free)	48 Units / Rail
MC14053BDR2	SOIC-16	2,500 / Tape & Reel
MC14053BDR2G	SOIC-16 (Pb-Free)	2,500 / Tape & Reel
MC14053BDT	TSSOP-16	96 Units / Rail
MC14053BDTR2	TSSOP-16*	2,500 / Tape & Reel
MC14053BF	SOEIAJ-16	See Note 26
MC14053BFEL	SOEIAJ-16	See Note 26

26. For ordering information on the EIAJ version of the SOIC packages, please contact your local ON Semiconductor representative.

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*This package is inherently Pb-Free.