

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
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free and are RoHS Compliant

MAXIMUM RATINGS (Voltages Referenced to V_{SS})

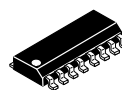
| Symbol | Parameter | Value | Unit |
|-------------------------|---|------------------------|------|
| V_{DD} | DC Supply Voltage Range (Referenced to V_{EE} , $V_{SS} \geq V_{EE}$) | -0.5 to +18.0 | V |
| V_{in} , V_{out} | Input or Output Voltage Range (DC or Transient) (Referenced to V_{SS} for Control 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 | ± 25 | mA |
| P_D | Power Dissipation per Package (Note 1) | 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 |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

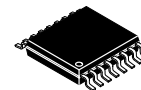
1. Temperature Derating: "D/DW" Packages: $-7.0 \text{ mW}/^\circ\text{C}$ From 65°C To 125°C

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.

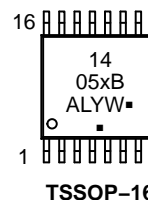
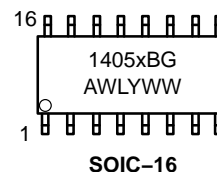


1
SOIC-16
D SUFFIX
CASE 751B



1
TSSOP-16
DT SUFFIX
CASE 948F

MARKING DIAGRAMS



- x = 1, 2, or 3
- A = Assembly Location
- WL, L = Wafer Lot
- Y = Year
- WW, W = Work Week
- G or ■ = Pb-Free Package

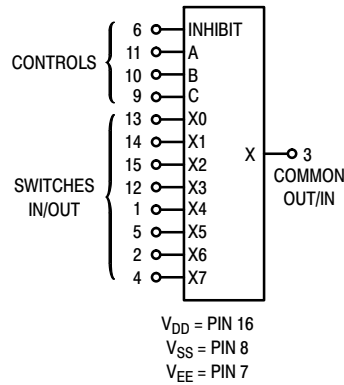
(Note: Microdot may be in either location)

ORDERING INFORMATION

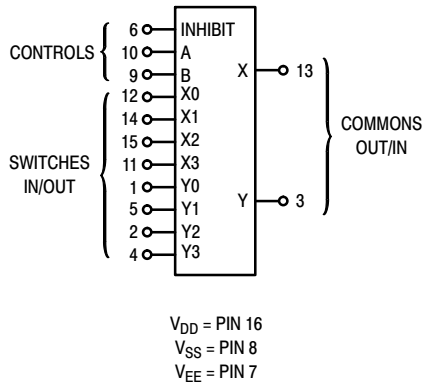
See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

MC14051B, MC14052B, MC14053B

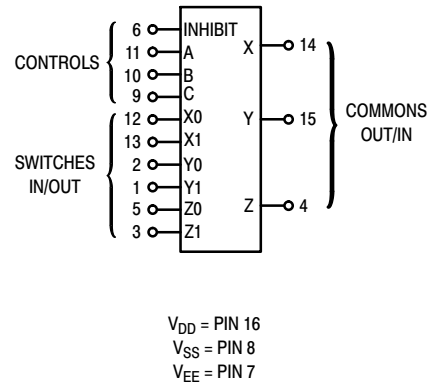
MC14051B
8-Channel Analog
Multiplexer/Demultiplexer



MC14052B
Dual 4-Channel Analog
Multiplexer/Demultiplexer

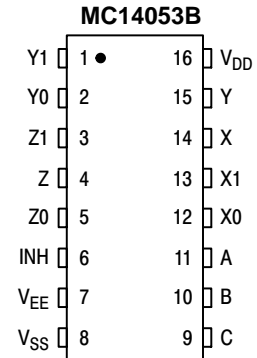
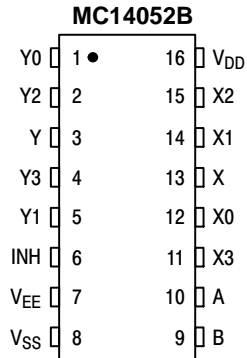
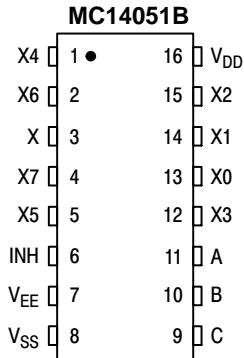


MC14053B
Triple 2-Channel Analog
Multiplexer/Demultiplexer



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 _{DD} | Test Conditions | -55°C | | 25°C | | | 125°C | | Unit |
|----------------|--------|-----------------|-----------------|-------|-----|------|-----------------|-----|-------|-----|------|
| | | | | Min | Max | Min | Typ (Note 2) | Max | Min | Max | |

SUPPLY REQUIREMENTS (Voltages Referenced to V_{EE})

| | | | | | | | | | | | | |
|--|--------------------|-----------------|--|-------------|-----------------|-------------|-------------------------|-----------------|-------------|---|----|----|
| Power Supply Voltage Range | V _{DD} | - | V _{DD} - 3.0 ≥ V _{SS} ≥ V _{EE} | 3.0 | 18 | 3.0 | - | 18 | 3.0 | 18 | V | |
| Quiescent Current Per Package | I _{DD} | 5.0 10 15 | Control Inputs: V _{in} = V _{SS} or V _{DD} , Switch I/O: V _{EE} ≤ V _{I/O} ≤ V _{DD} , and ΔV _{switch} ≤ 500 mV (Note 3) | - - - | 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 _{D(AV)} | 5.0 10 15 | T _A = 25°C only (The channel component, (V _{in} - V _{out})/R _{on} , is not included.) | Typical | | | | | | (0.07 μA/kHz) f + I _{DD} (0.20 μA/kHz) f + I _{DD} (0.36 μA/kHz) f + I _{DD} | | μA |

CONTROL INPUTS — INHIBIT, A, B, C (Voltages Referenced to V_{SS})

| | | | | | | | | | | | |
|--------------------------|-----------------|-----------------|--|------------------|-------------------|------------------|----------------------|-------------------|------------------|-------------------|----|
| Low-Level Input Voltage | V _{IL} | 5.0 10 15 | R _{on} = per spec, I _{off} = 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 _{IH} | 5.0 10 15 | R _{on} = per spec, I _{off} = 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 _{in} | 15 | V _{in} = 0 or V _{DD} | - | ±0.1 | - | ±0.00001 | ±0.1 | - | 1.0 | μA |
| Input Capacitance | C _{in} | - | | - | - | - | 5.0 | 7.5 | - | - | pF |

SWITCHES IN/OUT AND COMMONS OUT/IN — X, Y, Z (Voltages Referenced to V_{EE})

| | | | | | | | | | | | |
|---|----------------------|-----------------|---|-------------|-------------------|-------------|------------------|--------------------|-------------|--------------------|-----------------|
| Recommended Peak-to-Peak Voltage Into or Out of the Switch | V _{I/O} | - | Channel On or Off | 0 | V _{DD} | 0 | - | V _{DD} | 0 | V _{DD} | V _{PP} |
| Recommended Static or Dynamic Voltage Across the Switch (Note 3) (Figure 5) | ΔV _{switch} | - | Channel On | 0 | 600 | 0 | - | 600 | 0 | 300 | mV |
| Output Offset Voltage | V _{OO} | - | V _{in} = 0 V, No Load | - | - | - | 10 | - | - | - | μV |
| ON Resistance | R _{on} | 5.0 10 15 | ΔV _{switch} ≤ 500 mV (Note 3) V _{in} = V _{IL} or V _{IH} (Control), and V _{in} = 0 to V _{DD} (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 _{on} | 5.0 10 15 | | - - - | 70 50 45 | - - - | 25 10 10 | 70 50 45 | - - - | 135 95 65 | Ω |
| Off-Channel Leakage Current (Figure 10) | I _{off} | 15 | V _{in} = V _{IL} or V _{IH} (Control) Channel to Channel or Any One Channel | - | ±100 | - | ±0.05 | ±100 | - | ±1000 | nA |
| Capacitance, Switch I/O | C _{I/O} | - | Inhibit = V _{DD} | - | - | - | 10 | - | - | - | pF |
| Capacitance, Common O/I | C _{O/I} | - | Inhibit = V _{DD} (MC14051B) (MC14052B) (MC14053B) | - - - | - - - | - - - | 60 32 17 | - - - | - - - | - - - | pF |
| Capacitance, Feedthrough (Channel Off) | C _{I/O} | - - | Pins Not Adjacent Pins Adjacent | - - | - - | - - | 0.15 0.47 | - - | - - | - - | pF |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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

3. For voltage drops across the switch (ΔV_{switch}) > 600 mV (> 300 mV at high temperature), excessive V_{DD} current may be drawn, i.e. the current out of the switch may contain both V_{DD} 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 4) ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$) ($V_{EE} \leq V_{SS}$ unless otherwise indicated)

| Characteristic | Symbol | $V_{DD} - V_{EE}$ Vdc | Typ (Note 5) All Types | Max | Unit |
|--|---|--------------------------|---------------------------|-------------------|------|
| Propagation Delay Times (Figure 6) Switch Input to Switch Output ($R_L = 1 \text{ k}\Omega$) 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 10 15 | 35 15 12 | 90 40 30 | ns |
| 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 | $t_{PHZ}, t_{PLZ},$ t_{PZH}, t_{PZL} | 5.0 10 15 | 350 170 140 | 700 340 280 | ns |
| MC14052B | | 5.0 10 15 | 300 155 125 | 600 310 250 | ns |
| MC14053B | | 5.0 10 15 | 275 140 110 | 550 280 220 | ns |
| Control Input to Output ($R_L = 1 \text{ k}\Omega$, $V_{EE} = V_{SS}$) MC14051B | t_{PLH}, t_{PHL} | 5.0 10 15 | 360 160 120 | 720 320 240 | ns |
| MC14052B | | 5.0 10 15 | 325 130 90 | 650 260 180 | ns |
| MC14053B | | 5.0 10 15 | 300 120 80 | 600 240 160 | ns |
| 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) ($R_L = 50 \Omega$, $V_{in} = 1/2 (V_{DD} - V_{EE})$ 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 |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. The formulas given are for the typical characteristics only at 25°C .

5. 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

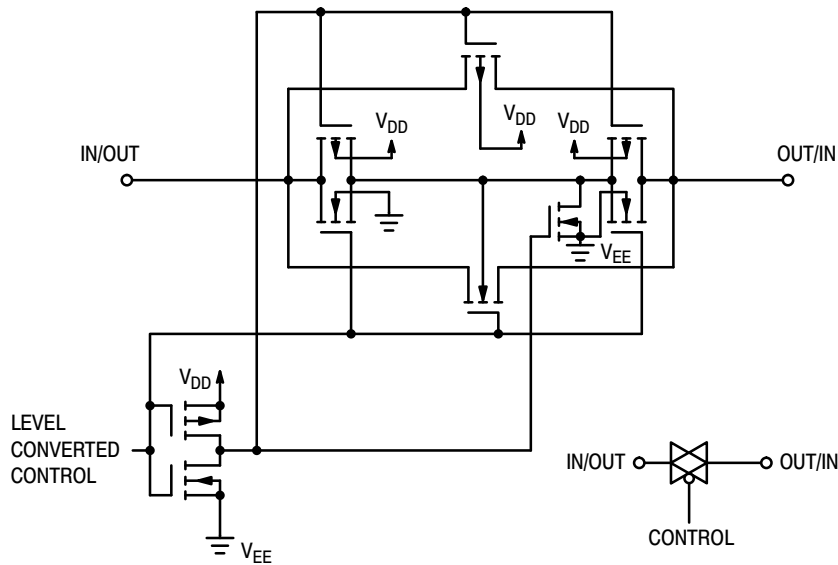


Figure 1. Switch Circuit Schematic

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

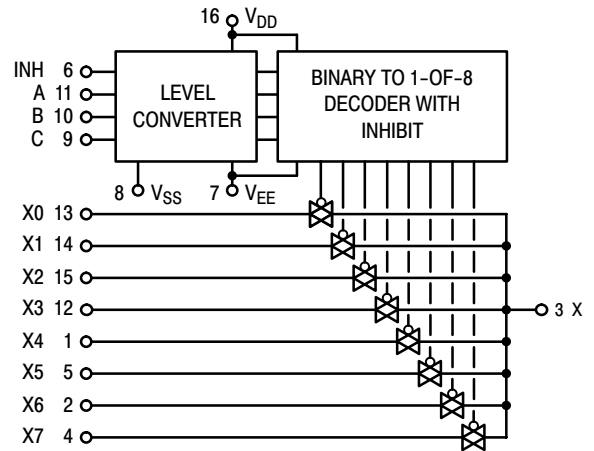


Figure 2. MC14051B Functional Diagram

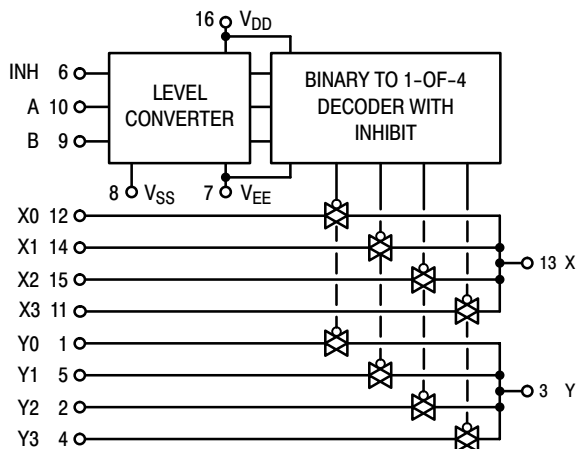


Figure 3. MC14052B Functional Diagram

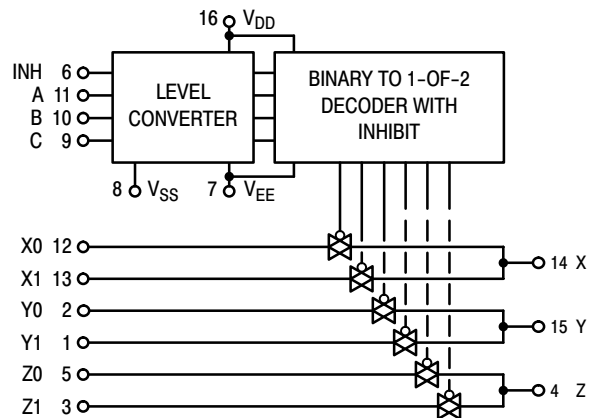


Figure 4. MC14053B Functional Diagram

TEST CIRCUITS

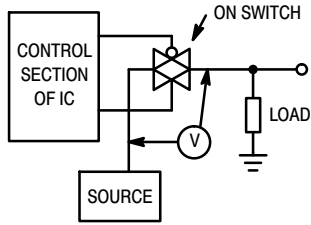


Figure 5. ΔV Across Switch

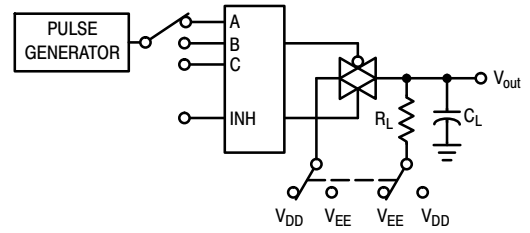


Figure 6. Propagation Delay Times, Control and Inhibit to Output

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

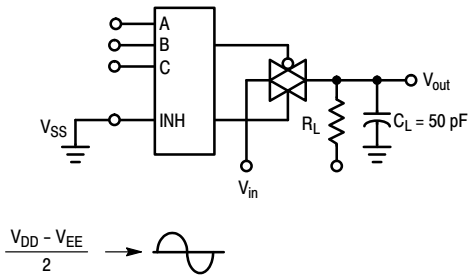


Figure 7. Bandwidth and Off-Channel Feedthrough Attenuation

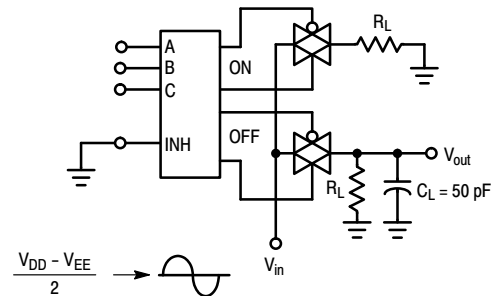


Figure 8. Channel Separation (Adjacent Channels Used For Setup)

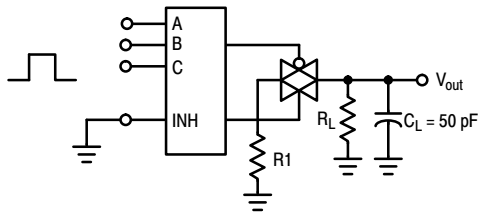


Figure 9. Crosstalk, Control Input to Common O/I

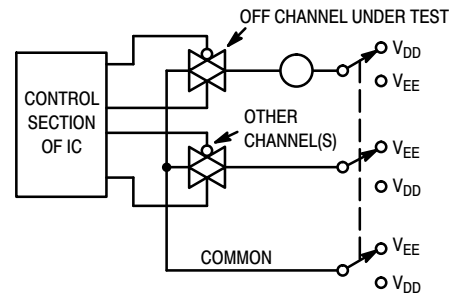


Figure 10. Off Channel Leakage

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

MC14051B, MC14052B, MC14053B

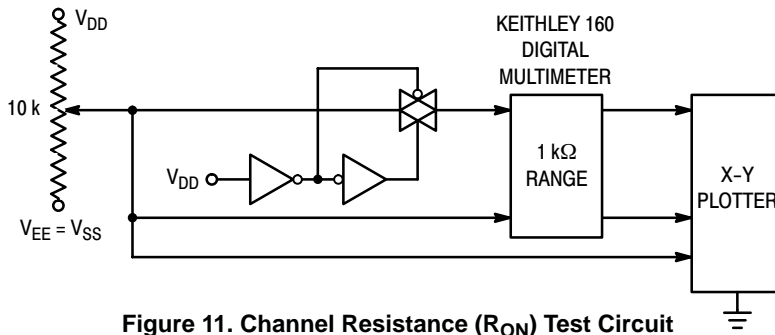


Figure 11. Channel Resistance (R_{ON}) Test Circuit

TYPICAL RESISTANCE CHARACTERISTICS

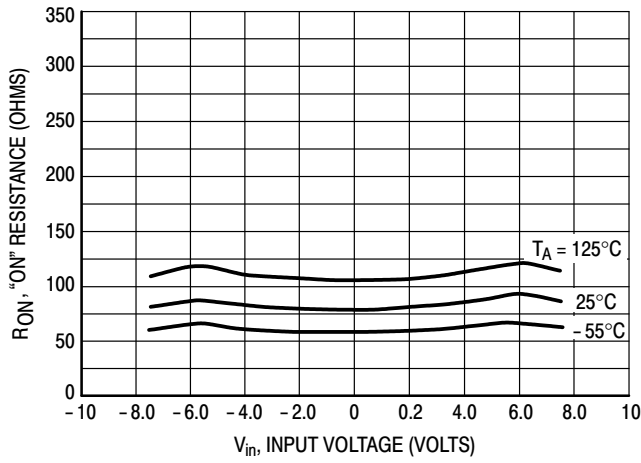


Figure 12. $V_{DD} = 7.5\text{ V}$, $V_{EE} = -7.5\text{ V}$

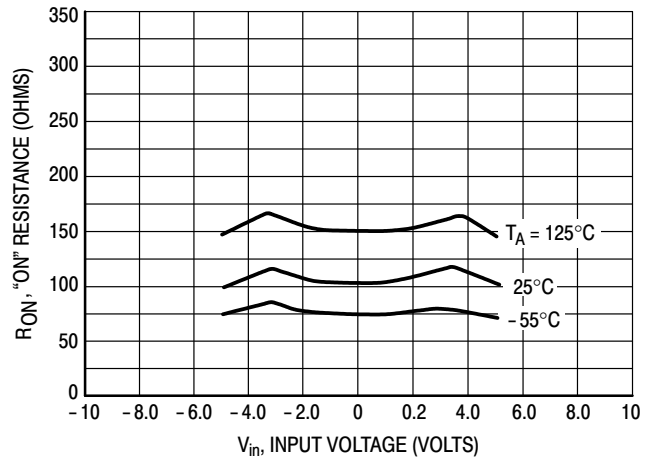


Figure 13. $V_{DD} = 5.0\text{ V}$, $V_{EE} = -5.0\text{ V}$

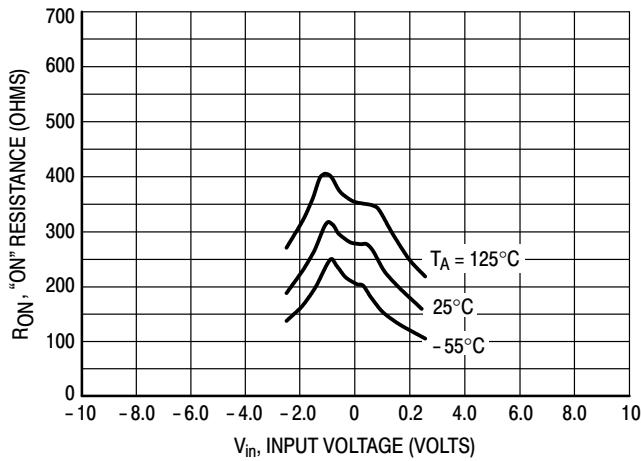


Figure 14. $V_{DD} = 2.5\text{ V}$, $V_{EE} = -2.5\text{ V}$

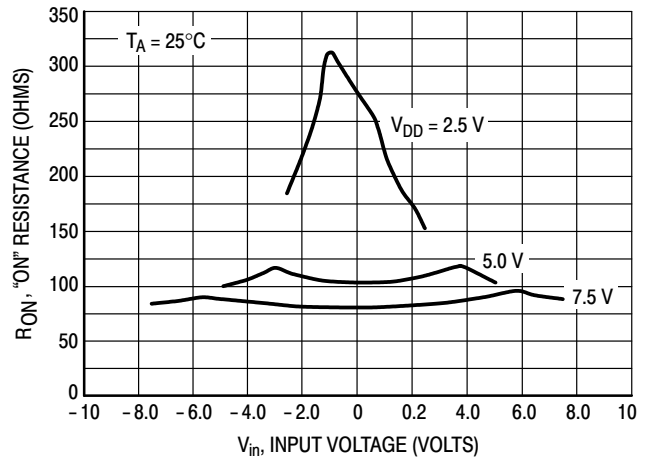


Figure 15. Comparison at 25°C , $V_{DD} = -V_{EE}$

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_{p-p} analog signal.

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

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

peak. If voltage transients above V_{DD} and/or below V_{EE} are anticipated on the analog channels, external diodes (D_X) 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_{DD} and V_{EE} is 18.0 V. Most parameters are specified up to 15 V which is the *recommended* maximum difference between V_{DD} and V_{EE}.

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

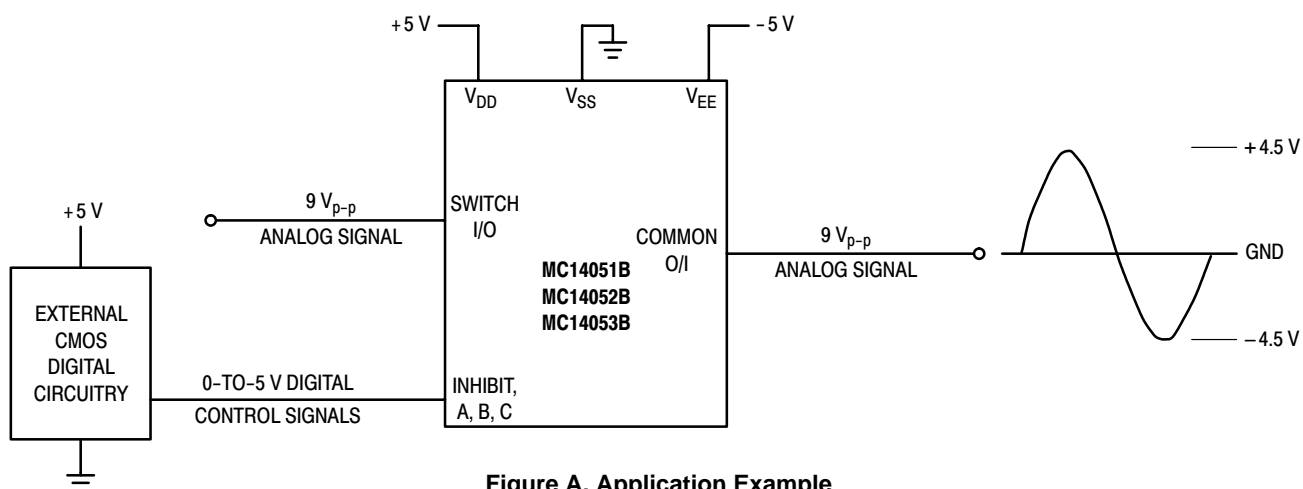


Figure A. Application Example

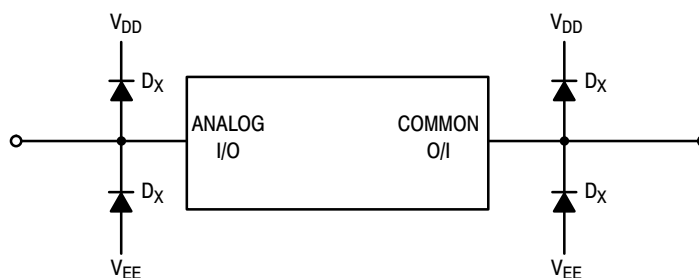


Figure B. External Germanium or Schottky Clipping Diodes

POSSIBLE SUPPLY CONNECTIONS

| V _{DD} In Volts | V _{SS} In Volts | V _{EE} 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 _{p-p} |
| +5 | 0 | -12 | +5/0 | +5 to -12 = 17 V _{p-p} |
| +5 | 0 | 0 | +5/0 | +5 to 0 = 5 V _{p-p} |
| +5 | 0 | -5 | +5/0 | +5 to -5 = 10 V _{p-p} |
| +10 | +5 | -5 | +10/+5 | +10 to -5 = 15 V _{p-p} |

MC14051B, MC14052B, MC14053B

ORDERING INFORMATION

| Device | Package | Shipping† |
|-----------------|-----------------------|--------------------|
| MC14051BDG | SOIC-16 (Pb-Free) | 48 Units / Rail |
| NLV14051BDG* | SOIC-16 (Pb-Free) | 48 Units / Rail |
| MC14051BDR2G | SOIC-16 (Pb-Free) | 2500 / Tape & Reel |
| NLV14051BDR2G* | SOIC-16 (Pb-Free) | 2500 / Tape & Reel |
| MC14051BDTR2G | TSSOP-16 (Pb-Free) | 2500 / Tape & Reel |
| NLV14051BDTR2G* | TSSOP-16 (Pb-Free) | 2500 / Tape & Reel |

| | | |
|-----------------|-----------------------|--------------------|
| MC14052BDG | SOIC-16 (Pb-Free) | 48 Units / Rail |
| NLV14052BDG* | SOIC-16 (Pb-Free) | 48 Units / Rail |
| MC14052BDR2G | SOIC-16 (Pb-Free) | 2500 / Tape & Reel |
| NLV14052BDR2G* | SOIC-16 (Pb-Free) | 2500 / Tape & Reel |
| MC14052BDTR2G | TSSOP-16 (Pb-Free) | 2500 / Tape & Reel |
| NLV14052BDTR2G* | TSSOP-16 (Pb-Free) | 2500 / Tape & Reel |

| | | |
|-----------------|-----------------------|--------------------|
| MC14053BDG | SOIC-16 (Pb-Free) | 48 Units / Rail |
| NLV14053BDG* | SOIC-16 (Pb-Free) | 48 Units / Rail |
| MC14053BDR2G | SOIC-16 (Pb-Free) | 2500 / Tape & Reel |
| NLV14053BDR2G* | SOIC-16 (Pb-Free) | 2500 / Tape & Reel |
| MC14053BDTR2G | TSSOP-16 (Pb-Free) | 2500 / Tape & Reel |
| NLV14053BDTR2G* | TSSOP-16 (Pb-Free) | 2500 / Tape & Reel |

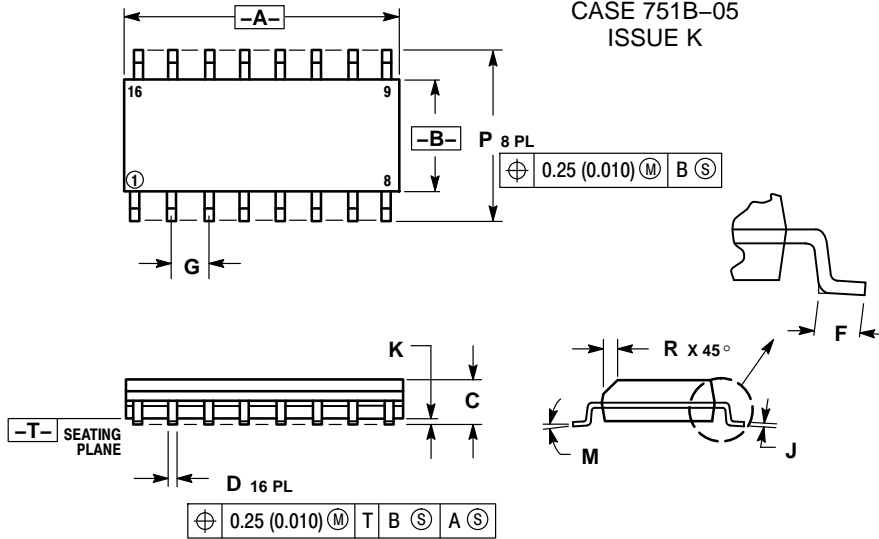
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

MC14051B, MC14052B, MC14053B

PACKAGE DIMENSIONS

SOIC-16
D SUFFIX
CASE 751B-05
ISSUE K

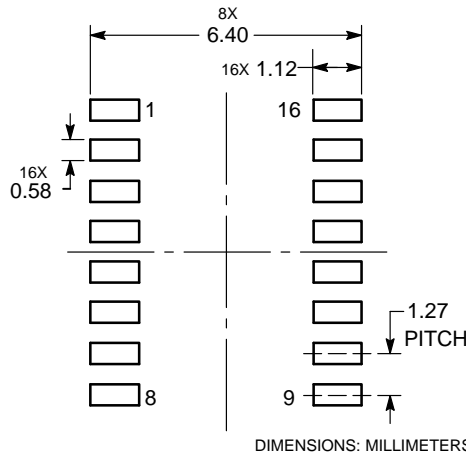


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 9.80 | 10.00 | 0.386 | 0.393 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.054 | 0.068 |
| D | 0.35 | 0.49 | 0.014 | 0.019 |
| F | 0.40 | 1.25 | 0.016 | 0.049 |
| G | 1.27 BSC | | 0.050 BSC | |
| J | 0.19 | 0.25 | 0.008 | 0.009 |
| K | 0.10 | 0.25 | 0.004 | 0.009 |
| M | 0° | 7° | 0° | 7° |
| P | 5.80 | 6.20 | 0.229 | 0.244 |
| R | 0.25 | 0.50 | 0.010 | 0.019 |

SOLDERING FOOTPRINT*



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

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