

MC14551B

Quad 2-Channel Analog Multiplexer/Demultiplexer

The MC14551B is a digitally-controlled analog switch. This device implements a 4PDT solid state switch with 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 All Control Inputs
- 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
- For Low R_{ON} , Use The HC4051, HC4052, or HC4053 High-Speed CMOS Devices
- Switch Function is Break Before Make
- These Devices are Pb-Free and are RoHS Compliant

MAXIMUM RATINGS

| Parameter | Symbol | Value | Unit |
|--|----------------------|----------------------------|--------------------|
| DC Supply Voltage Range (Referenced to V_{EE} , $V_{SS} \geq V_{EE}$) | V_{DD} | - 0.5 to + 18.0 | V |
| Input or Output Voltage (DC or Transient) (Referenced to V_{SS} for Control Input and V_{EE} for Switch I/O) | V_{in} , V_{out} | - 0.5 to V_{DD} + 0.5 | V |
| Input Current (DC or Transient), per Control Pin | I_{in} | ± 10 | mA |
| Switch Through Current | I_{sw} | ± 25 | mA |
| Power Dissipation, per Package (Note 1) | P_D | 500 | mW |
| Ambient Temperature Range | T_A | - 55 to + 125 | $^{\circ}\text{C}$ |
| Storage Temperature Range | T_{stg} | - 65 to + 150 | $^{\circ}\text{C}$ |
| Lead Temperature (8-Second Soldering) | T_L | 260 | $^{\circ}\text{C}$ |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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

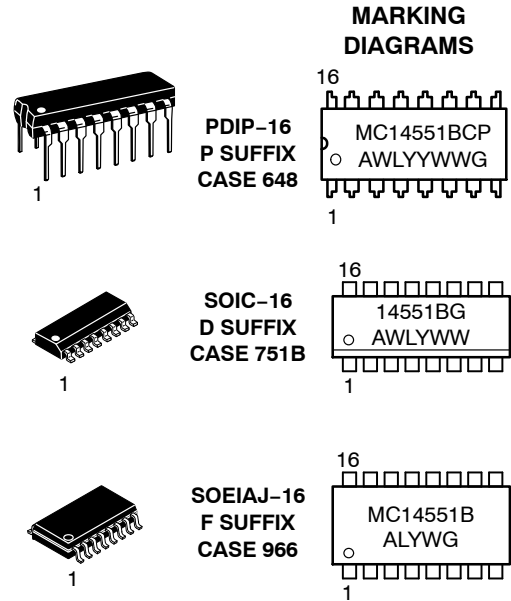
This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should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

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.



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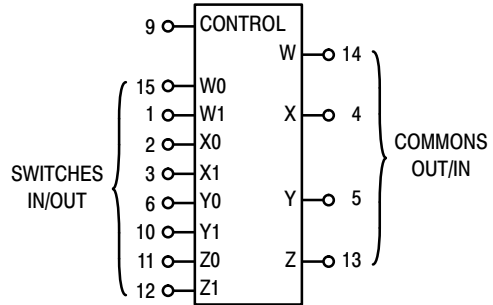
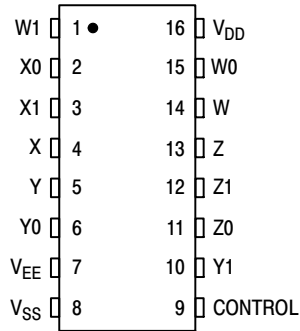
A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week
G = Pb-Free Package

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

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PIN ASSIGNMENT



V_{DD} = Pin 16
 V_{SS} = Pin 8
 V_{EE} = Pin 7

| Control | ON |
|---------|-------------|
| 0 | W0 X0 Y0 Z0 |
| 1 | W1 X1 Y1 Z1 |

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

ORDERING INFORMATION

| Device | Package | Shipping [†] |
|--------------|------------------------|-----------------------|
| MC14551BCPG | PDIP-16 (Pb-Free) | 25 Units / Rail |
| MC14551BDG | SOIC-16 (Pb-Free) | 48 Units / Rail |
| MC14551BDR2G | SOIC-16 (Pb-Free) | 2500 / Tape & Reel |
| MC14551BFG | SOEIAJ-16 (Pb-Free) | 50 Units / Rail |

[†]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.

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ELECTRICAL CHARACTERISTICS

| Characteristic | V _{DD} | Test Conditions | Symbol | - 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 | - | $V_{DD} - 3.0 \geq V_{SS} \geq V_{EE}$ | V _{DD} | 3.0 | 18 | 3.0 | - | 18 | 3.0 | 18 | V |
| Quiescent Current Per Package | 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) | I _{DD} | - | 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) | 5.0 10 15 | T _A = 25°C only (The channel component, (V _{in} - V _{out})/R _{on} , is not included.) | I _{D(AV)} | Typical (0.07 μA/kHz) f + I _{DD} (0.20 μA/kHz) f + I _{DD} (0.36 μA/kHz) f + I _{DD} | | | | | | | μA |

CONTROL INPUT (Voltages Referenced to V_{SS})

| | | | | | | | | | | | |
|--------------------------|-----------------|--|-----------------|------------------|-------------------|------------------|----------------------|-------------------|------------------|-------------------|----|
| Low-Level Input Voltage | 5.0 10 15 | R _{on} = per spec, I _{off} = per spec | V _{IL} | - | 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 | 5.0 10 15 | R _{on} = per spec, I _{off} = per spec | V _{IH} | 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 | 15 | V _{in} = 0 or V _{DD} | I _{in} | - | ±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 — W, X, Y, Z (Voltages Referenced to V_{EE})

| | | | | | | | | | | | |
|---|-----------------|--|----------------------|---|-------------------|---|------------------|--------------------|---|--------------------|------------------|
| Recommended Peak-to-Peak Voltage Into or Out of the Switch | - | Channel On or Off | V _{I/O} | 0 | V _{DD} | 0 | - | V _{DD} | 0 | V _{DD} | V _{p-p} |
| Recommended Static or Dynamic Voltage Across the Switch (Note 3) (Figure 3) | - | Channel On | ΔV _{switch} | 0 | 600 | 0 | - | 600 | 0 | 300 | mV |
| Output Offset Voltage | - | V _{in} = 0 V, No Load | V _{OO} | - | - | - | 10 | - | - | - | μV |
| ON Resistance | 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) | R _{on} | - | 800 400 220 | - | 250 120 80 | 1050 500 280 | - | 1200 520 300 | Ω |
| ΔON Resistance Between Any Two Channels in the Same Package | 5.0 10 15 | | ΔR _{on} | - | 70 50 45 | - | 25 10 10 | 70 50 45 | - | 135 95 65 | Ω |
| Off-Channel Leakage Current (Figure 8) | 15 | V _{in} = V _{IL} or V _{IH} (Control) Channel to Channel or Any One Channel | I _{off} | - | ±100 | - | ±0.05 | ±100 | - | ±1000 | nA |
| Capacitance, Switch I/O | - | Switch Off | C _{I/O} | - | - | - | 10 | - | - | - | pF |
| Capacitance, Common O/I | - | | C _{O/I} | - | - | - | 17 | - | - | - | pF |
| Capacitance, Feedthrough (Channel Off) | - | Pins Not Adjacent Pins Adjacent | C _{I/O} | - | - | - | 0.15 0.47 | - | - | - | pF |

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

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ELECTRICAL CHARACTERISTICS ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$, $V_{EE} \leq V_{SS}$)

| Characteristic | Symbol | $V_{DD} - V_{EE}$ Vdc | Min | Typ (Note 4) | Max | Unit |
|---|--------------------|--------------------------|-----|-------------------|-------------------|------|
| Propagation Delay Times Switch Input to Switch Output ($R_L = 10 \text{ k}\Omega$) $t_{PLH}, t_{PHL} = (0.17 \text{ ns/pF}) C_L + 26.5 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.08 \text{ ns/pF}) C_L + 11 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.06 \text{ ns/pF}) C_L + 9.0 \text{ ns}$ | t_{PLH}, t_{PHL} | 5.0 10 15 | – | 35 15 12 | 90 40 30 | ns |
| Control Input to Output ($R_L = 10 \text{ k}\Omega$) $V_{EE} = V_{SS}$ (Figure 4) | t_{PLH}, t_{PHL} | 5.0 10 15 | – | 350 140 100 | 875 350 250 | ns |
| Second Harmonic Distortion $R_L = 10 \text{ k}\Omega$, $f = 1 \text{ kHz}$, $V_{in} = 5 V_{p-p}$ | – | 10 | – | 0.07 | – | % |
| Bandwidth (Figure 5) $R_L = 1 \text{ k}\Omega$, $V_{in} = 1/2 (V_{DD} - V_{EE})_{p-p}$, $20 \text{ Log} (V_{out}/V_{in}) = -3 \text{ dB}$, $C_L = 50 \text{ pF}$ | BW | 10 | – | 17 | – | MHz |
| Off Channel Feedthrough Attenuation, Figure 5 $R_L = 1 \text{ k}\Omega$, $V_{in} = 1/2 (V_{DD} - V_{EE})_{p-p}$, $f_{in} = 55 \text{ MHz}$ | – | 10 | – | –50 | – | dB |
| Channel Separation (Figure 6) $R_L = 1 \text{ k}\Omega$, $V_{in} = 1/2 (V_{DD} - V_{EE})_{p-p}$, $f_{in} = 3 \text{ MHz}$ | – | 10 | – | –50 | – | dB |
| Crosstalk, Control Input to Common O/I, Figure 7 $R_1 = 1 \text{ k}\Omega$, $R_L = 10 \text{ k}\Omega$, Control $t_r = t_f = 20 \text{ ns}$ | – | 10 | – | 75 | – | mV |

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

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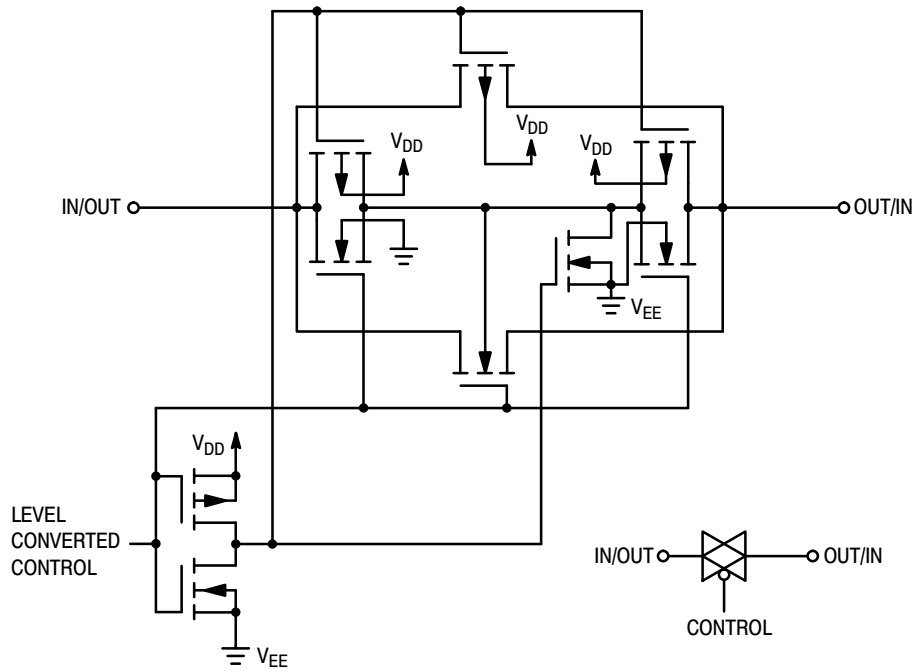


Figure 1. Switch Circuit Schematic

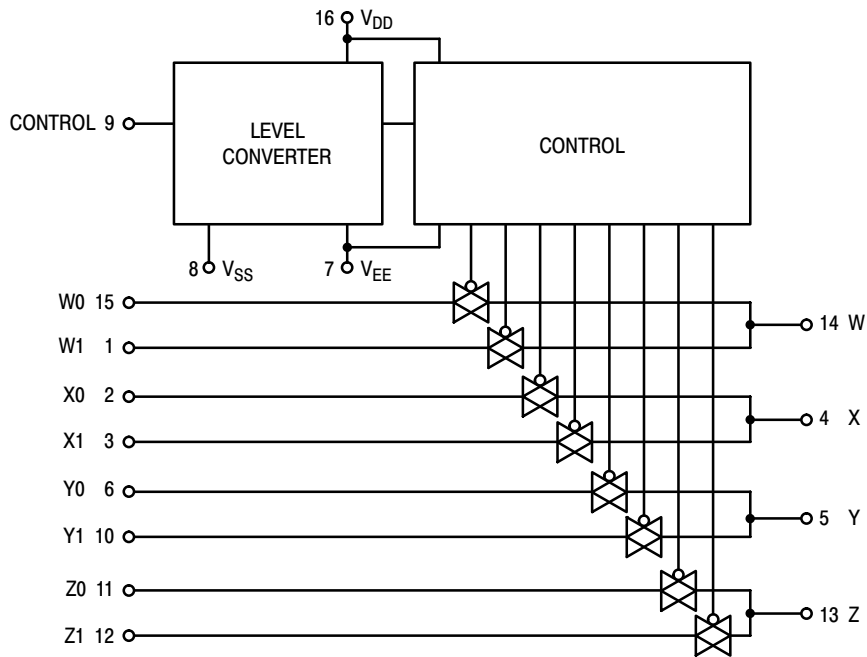


Figure 2. MC14551B Functional Diagram

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TEST CIRCUITS

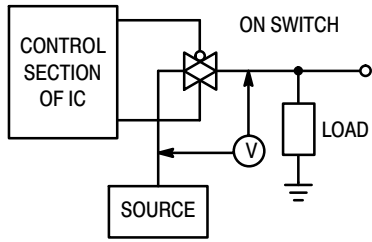


Figure 3. ΔV Across Switch

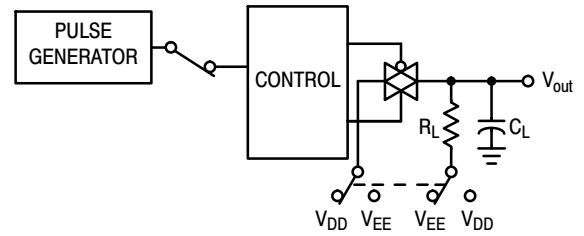


Figure 4. Propagation Delay Times, Control to Output

Control input used to turn ON or OFF the switch under test.

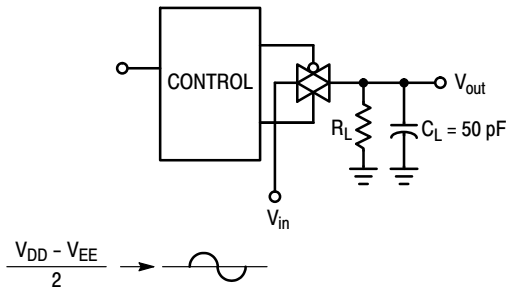


Figure 5. Bandwidth and Off-Channel Feedthrough Attenuation

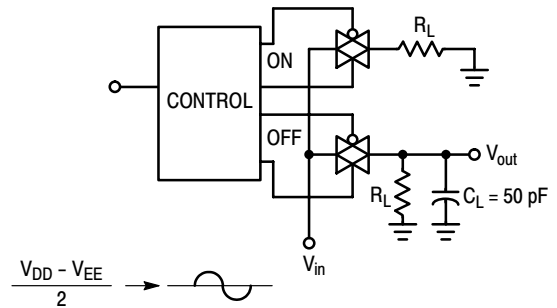


Figure 6. Channel Separation (Adjacent Channels Used for Setup)

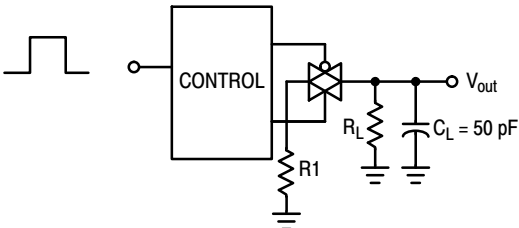


Figure 7. Crosstalk, Control Input to Common O/I

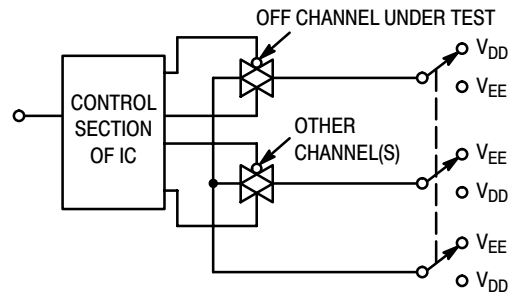


Figure 8. Off Channel Leakage

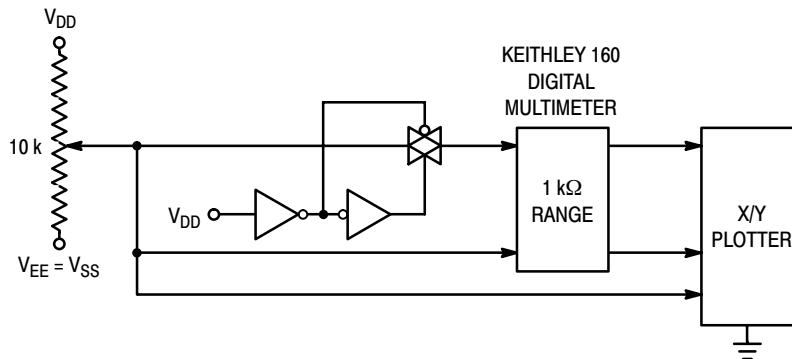


Figure 9. Channel Resistance (R_{ON}) Test Circuit

TYPICAL RESISTANCE CHARACTERISTICS

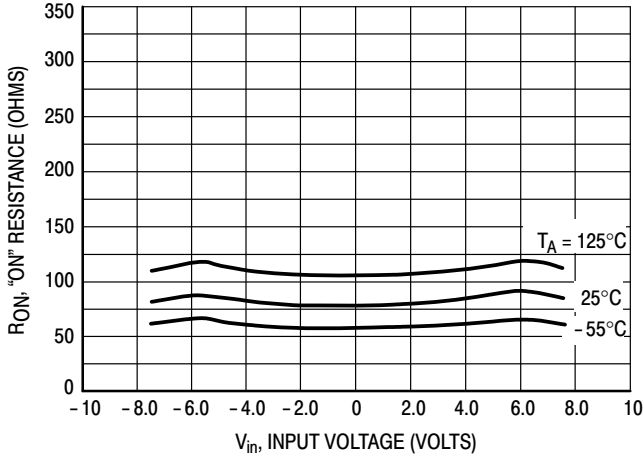


Figure 10. V_{DD} @ 7.5 V, V_{EE} @ -7.5 V

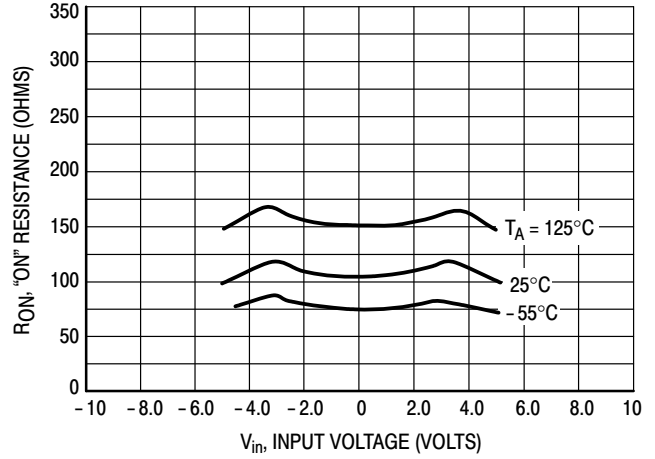


Figure 11. V_{DD} @ 5.0 V, V_{EE} @ -5.0 V

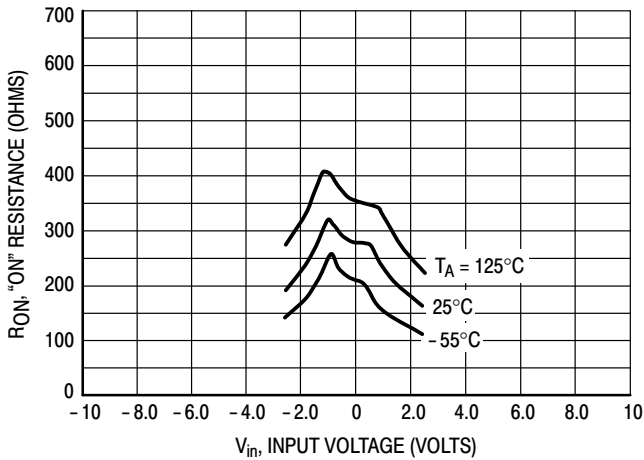


Figure 12. V_{DD} @ 2.5 V, V_{EE} @ -2.5 V

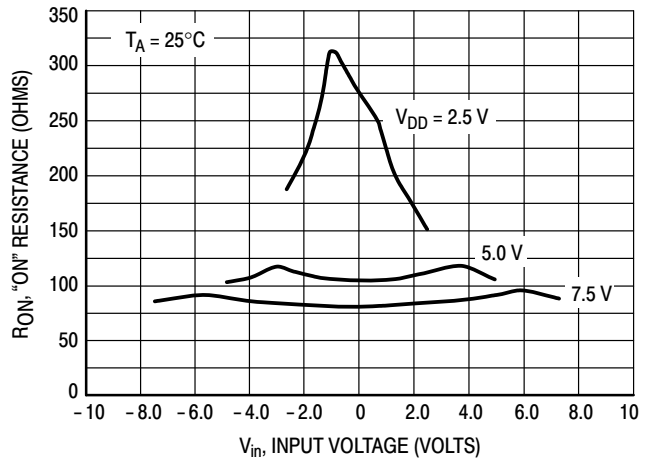


Figure 13. Comparison at 25°C, V_{DD} @ - V_{EE}

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APPLICATIONS INFORMATION

Figure A illustrates use of the on-chip level converter detailed in Figure 2. The 0-to-5.0 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} = +5.0 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} = 5.0 V maximum swing above V_{SS}; V_{SS} - V_{EE} = 5.0 V maximum swing below V_{SS}. The example shows a ±4.5 V

signal which allows a 1/2 V 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 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} = +5.0 V, and V_{EE} = -3.0 V is acceptable. See the table below.

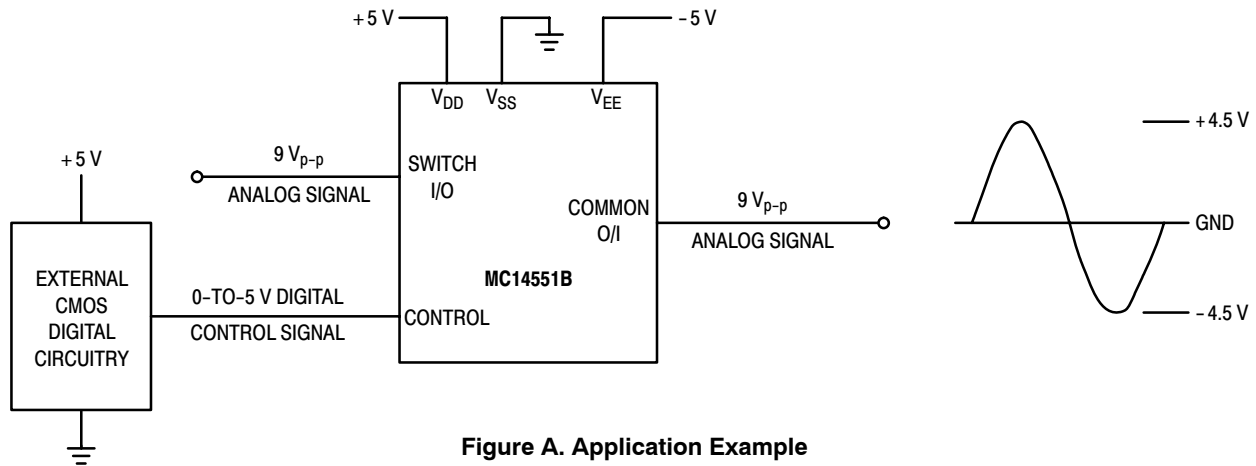


Figure A. Application Example

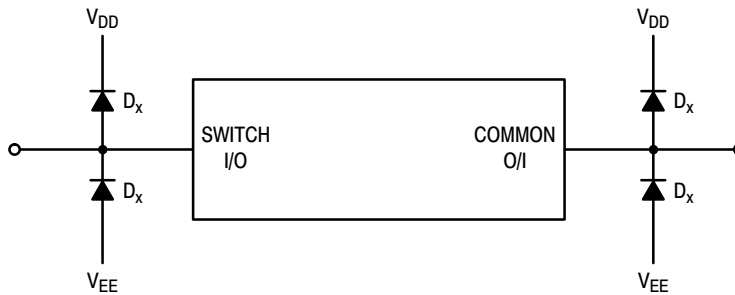


Figure B. External Schottky or Germanium Clipping Diodes

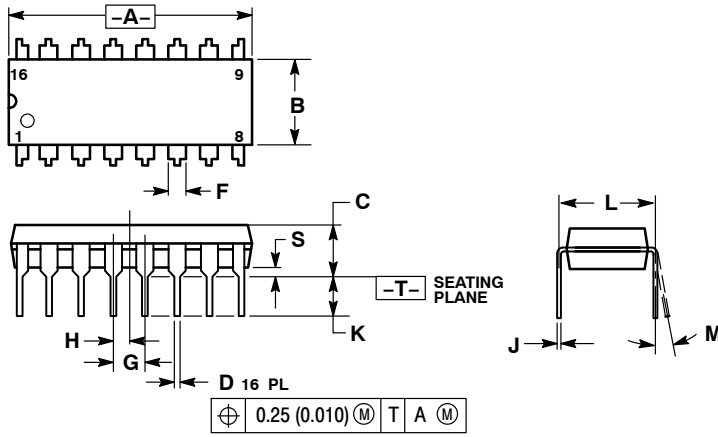
POSSIBLE SUPPLY CONNECTIONS

| 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 | + 10/ + 5 | + 10 to - 5 = 15 V _{p-p} |

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PACKAGE DIMENSIONS

PDIP-16
CASE 648-08
ISSUE T

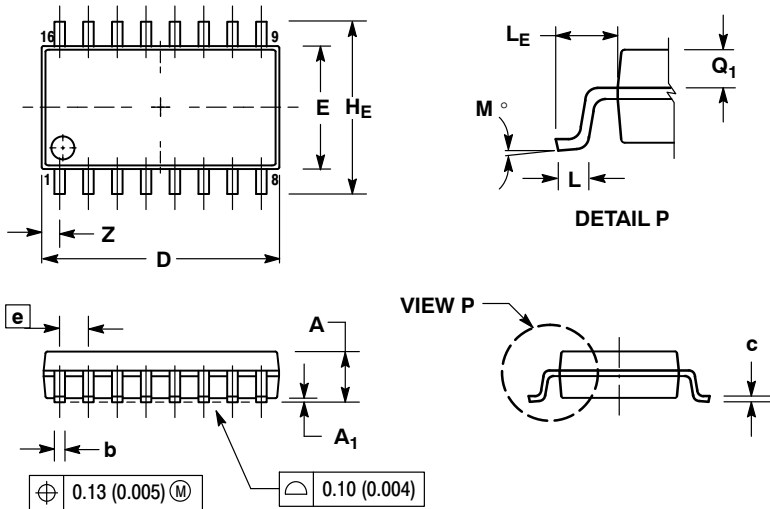


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.740 | 0.770 | 18.80 | 19.55 |
| B | 0.250 | 0.270 | 6.35 | 6.85 |
| C | 0.145 | 0.175 | 3.69 | 4.44 |
| D | 0.015 | 0.021 | 0.39 | 0.53 |
| F | 0.040 | 0.70 | 1.02 | 1.77 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.050 BSC | | 1.27 BSC | |
| J | 0.008 | 0.015 | 0.21 | 0.38 |
| K | 0.110 | 0.130 | 2.80 | 3.30 |
| L | 0.295 | 0.305 | 7.50 | 7.74 |
| M | 0° | 10° | 0° | 10° |
| S | 0.020 | 0.040 | 0.51 | 1.01 |

SOEIAJ-16
CASE 966-01
ISSUE A



NOTES:

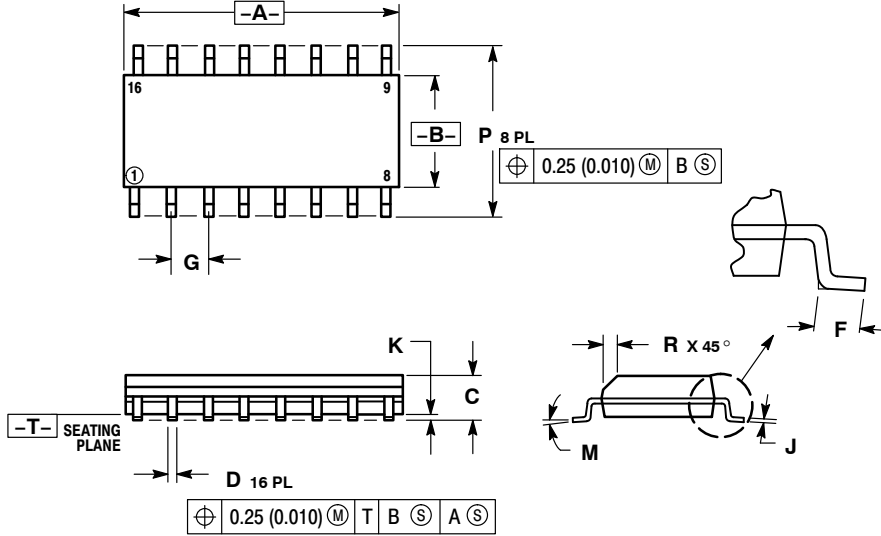
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

| DIM | MILLIMETERS | | INCHES | |
|----------------|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | --- | 2.05 | --- | 0.081 |
| A ₁ | 0.05 | 0.20 | 0.002 | 0.008 |
| b | 0.35 | 0.50 | 0.014 | 0.020 |
| c | 0.10 | 0.20 | 0.007 | 0.011 |
| D | 9.90 | 10.50 | 0.390 | 0.413 |
| E | 5.10 | 5.45 | 0.201 | 0.215 |
| e | 1.27 BSC | | 0.050 BSC | |
| H _E | 7.40 | 8.20 | 0.291 | 0.323 |
| L | 0.50 | 0.85 | 0.020 | 0.033 |
| L _E | 1.10 | 1.50 | 0.043 | 0.059 |
| M | 0° | 10° | 0° | 10° |
| Q ₁ | 0.70 | 0.90 | 0.028 | 0.035 |
| Z | --- | 0.78 | --- | 0.031 |

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PACKAGE DIMENSIONS

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

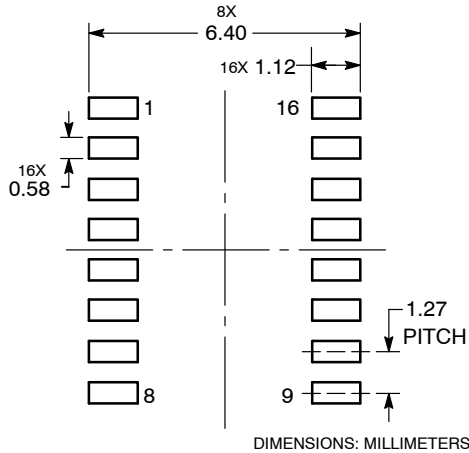


NOTES:

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 |

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