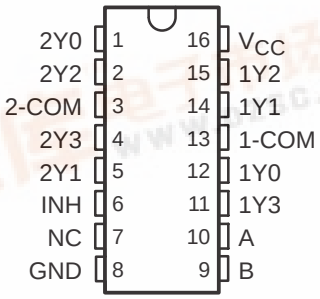
# DUAL 4-TO-1 CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER WITH INJECTION-CURRENT EFFECT CONTROL

SCLS573 − MARCH 2004

- **Injection Current Cross−Coupling <1mV/mA (see Figure 1)**
- **Low Crosstalk Between Switches**
- **Pin Compatible with SN74HC4052, SN74LV4052A, and CD4052B**
- **2-V to 6-V $V_{CC}$ Operation**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **ESD Protection Exceeds JESD 22**
  - **2000-V Human-Body Model (A114-A)**
  - **200-V Machine Model (A115-A)**
  - **1000-V Charged-Device Model (C101)**

**D, DGV, N, OR PW PACKAGE**
**(TOP VIEW)**




NC − No internal connection

## description/ordering information

This dual 4-to-1 CMOS analog multiplexer/demultiplexer is pin compatible with the 4052 function and also features injection-current effect control. This feature has excellent value in automotive applications where voltages in excess of normal supply voltages are common.

The injection-current effect control allows signals at disabled analog input channels to exceed the supply voltage without affecting the signal of the enabled analog channel. This eliminates the need for external diode/resistor networks typically used to keep the analog channel signals within the supply voltage range.

**ORDERING INFORMATION**

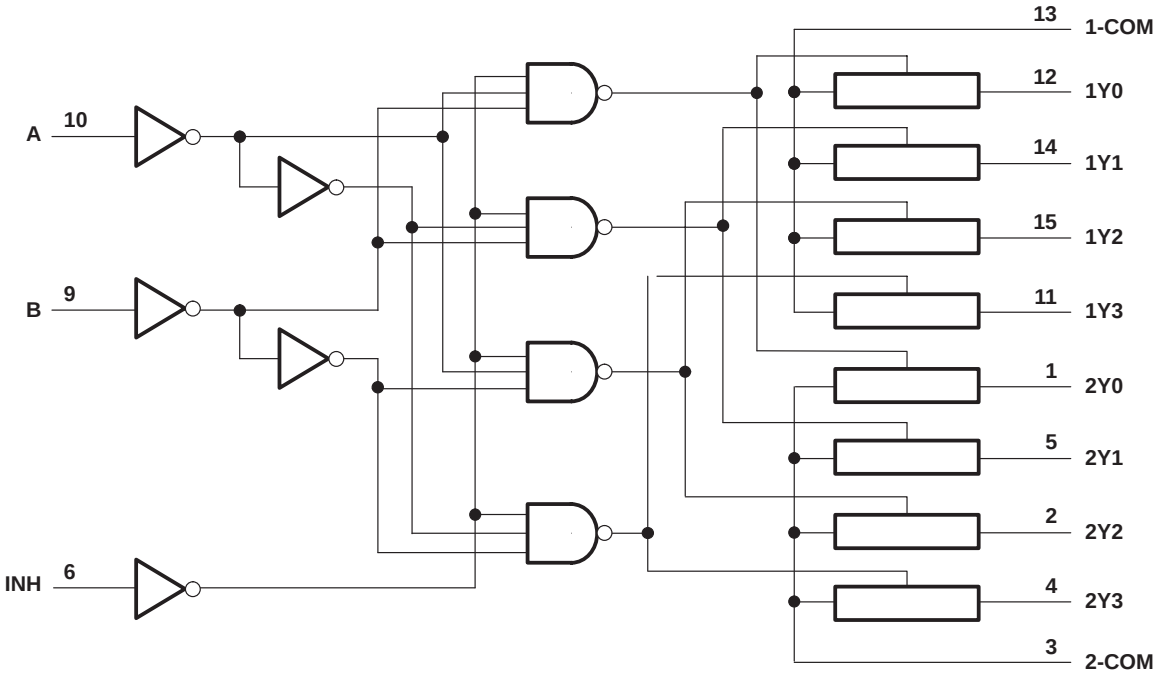
| $T_A$ | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| −40°C to 125°C | PDIP − N | Tube | SN74HC4852N | SN74HC4852N |
| | SOIC − D | Tube | SN74HC4852D | HC4852 |
| | | Tape and reel | SN74HC4852DR | |
| | TSSOP − PW | Tube | SN74HC4852PW | HC4852 |
| | | Tape and reel | SN74HC4852PWR | |
| | TVSOP − DGV | Tape and reel | SN74HC4852DGVR | HC4852 |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

**FUNCTION TABLE**

| INPUTS | | | ON CHANNEL |
|---|---|---|---|
| INH | B | A | |
| L | L | L | 1Y0, 2Y0 |
| L | L | H | 1Y1, 2Y1 |
| L | H | L | 1Y2, 2Y2 |
| L | H | H | 1Y3, 2Y3 |
| H | X | X | None |

## logic diagram (positive logic)




## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, $V_{CC}$ . . . . . −0.5 V to 7.0 V
Input voltage range, $V_I$ (see Note 1) . . . . . −0.5 V to $V_{CC}$ + 0.5 V
Switch I/O voltage range, $V_{IO}$ (see Notes 1 and 2) . . . . . −0.5 V to $V_{CC}$ + 0.5 V
Input clamp current, $I_{IK}$ ($V_I$ < 0 or $V_I$ > $V_{CC}$) . . . . . ±20 mA
I/O diode current, $I_{IOK}$ ($V_{IO}$ < 0 or $V_{IO}$ > $V_{CC}$) . . . . . ±20 mA
Switch through current, $I_S$ ($V_{IO}$ = 0 to $V_{CC}$) . . . . . ±25 mA
Continuous current through $V_{CC}$ or GND . . . . . ±50 mA
Package thermal impedance, $\theta_{JA}$ (see Note 3): D package . . . . . 73°C/W
DGV package . . . . . 120°C/W
N package . . . . . 67°C/W
PW package . . . . . 108°C/W
Storage temperature range, $T_{stg}$ . . . . . −65°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. This value is limited to 5.5 V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51-7.

## recommended operating conditions (see Note 4)

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | | 2 | 6 | V |
| $V_{IH}$ | High-level input voltage, control inputs | $V_{CC}$ = 2 V | 1.5 | | V |
| | | $V_{CC}$ = 3 V | 2.1 | | |
| | | $V_{CC}$ = 3.3 V | 2.3 | | |
| | | $V_{CC}$ = 4.5 V | 3.15 | | |
| | | $V_{CC}$ = 6 V | 4.2 | | |
| $V_{IL}$ | Low-level input voltage, control inputs | $V_{CC}$ = 2 V | | 0.5 | V |
| | | $V_{CC}$ = 3 V | | 0.9 | |
| | | $V_{CC}$ = 3.3 V | | 1 | |
| | | $V_{CC}$ = 4.5 V | | 1.35 | |
| | | $V_{CC}$ = 6 V | | 1.8 | |
| $V_I$ | Control input voltage | | 0 | $V_{CC}$ | V |
| $V_{IO}$ | Input/output voltage | | 0 | $V_{CC}$ | V |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | $V_{CC}$ = 2 V | | 1000 | ns |
| | | $V_{CC}$ = 3 V | | 800 | |
| | | $V_{CC}$ = 3.3 V | | 700 | |
| | | $V_{CC}$ = 4.5 V | | 500 | |
| | | $V_{CC}$ = 6 V | | 400 | |
| $T_A$ | Operating free-air temperature | | −40 | 125 | °C |

NOTE 4: All unused control inputs of the device must be held at $V_{CC}$ or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | $V_{CC}$ | $T_A$ = 25°C | | | −40 TO 85°C | | −40 TO 125°C | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $r_{on}$ | On-state switch resistance | $I_S \le 2$ mA, $V_I = V_{CC}$ to GND, $V_{INH} = V_{IL}$ (see Figure 5) | 2.V | | 500 | 650 | | 670 | | 700 | Ω |
| | | | 3 V | | 215 | 280 | | 320 | | 360 | |
| | | | 3.3 V | | 210 | 270 | | 305 | | 345 | |
| | | | 4.5 V | | 160 | 210 | | 240 | | 270 | |
| | | | 6 V | | 150 | 195 | | 220 | | 250 | |
| $\Delta r_{on}$ | Difference in on-state resistance between switches | $I_S \le 2$ mA, $V_I = V_{CC}/2$, $V_{INH} = V_{IL}$ | 2.V | | 4 | 18 | | 22 | | 24 | Ω |
| | | | 3 V | | 2 | 12 | | 14 | | 16 | |
| | | | 3.3 V | | 2 | 12 | | 14 | | 16 | |
| | | | 4.5 V | | 2 | 8 | | 12 | | 16 | |
| | | | 6 V | | 3 | 9 | | 13 | | 18 | |
| $I_I$ | Control input current | $V_I = V_{CC}$ or GND | 6 V | | | ±0.1 | | ±0.1 | | ±1 | µA |
| $I_{S(off)}$ | Off-state switch leakage current (any one channel) | $V_I = V_{CC}$ or GND, $V_{INH} = V_{IH}$ (see Figure 6) | 6 V | | | ±0.1 | | ±0.5 | | ±1 | µA |
| | Off-state switch leakage current (common channel) | $V_I = V_{CC}$ or GND, $V_{INH} = V_{IH}$ (see Figure 7) | | | | ±0.2 | | ±2 | | ±4 | |
| $I_{S(on)}$ | On-state switch leakage current | $V_I = V_{CC}$ or GND, $V_{INH} = V_{IL}$ (see Figure 8) | 6 V | | | ±0.1 | | ±0.5 | | ±1 | µA |
| $I_{CC}$ | Supply current | $V_I = V_{CC}$ or GND | 6 V | | | 2 | | 5 | | 10 | µA |
| $C_{IC}$ | Control input capacitance | A, B, INH | | | 3.5 | 10 | | 10 | | 10 | pF |
| $C_{IS}$ | Common terminal capacitance | Switch off | | | 22 | 40 | | 40 | | 40 | pF |
| $C_{OS}$ | Switch terminal capacitance | Switch off | | | 6.7 | 15 | | 15 | | 15 | pF |

## injection-current coupling specifications, $T_A$ = −40°C to 125°C (see Figure 1)

| PARAMETER | | $V_{CC}$ | TEST CONDITIONS | | TYP† | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $V\Delta_{out}$ | Maximum shift of output voltage of enabled analog channel | 3.3 V | $I_I$‡ ≤ 1 mA, | $R_S \le 3.9$ kΩ | 0.05 | 1 | mV |
| | | 5 V | | | 0.1 | 1 | |
| | | 3.3 V | $I_I$‡ ≤ 10 mA, | | 0.345 | 5 | |
| | | 5 V | | | 0.067 | 5 | |
| | | 3.3 V | $I_I$‡ ≤ 1 mA, | $R_S \le 20$ kΩ | 0.05 | 2 | |
| | | 5 V | | | 0.11 | 2 | |
| | | 3.3 V | $I_I$‡ ≤ 10 mA, | | 0.05 | 20 | |
| | | 5 V | | | 0.024 | 20 | |

† Typical values are measured at $T_A$ = 25°C.
‡ $I_I$ = total current injected into all disabled channels.

**switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 2 V, $C_L$ = 50 pF (unless otherwise noted) (see Figures 9−14)**

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $T_A$ = 25°C | | | −40 TO 85°C | | −40 TO 125°C | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | COM or Yn | Yn or COM | 14.5 | 19.5 | 33 | 12 | 34 | 11 | 35 | ns |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | Channel Select | COM or Yn | 19.6 | 24.5 | 38 | 15.4 | 40 | 13.8 | 42 | ns |
| $t_{PZH}$ $t_{PZL}$ | Enable delay time | INH | COM or Yn | 19.4 | 23.6 | 47.5 | 15.8 | 52.5 | 14.5 | 57.5 | ns |
| $t_{PHZ}$ $t_{PLZ}$ | Disable delay time | INH | COM or Yn | 39.5 | 48.4 | 100 | 39.3 | 105 | 39 | 115 | ns |

**switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 3 V, $C_L$ = 50 pF (unless otherwise noted) (see Figures 9−14)**

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $T_A$ = 25°C | | | −40 TO 85°C | | −40 TO 125°C | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | COM or Yn | Yn or COM | 8.6 | 12 | 16.5 | 6.5 | 18 | 5.8 | 19.5 | ns |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | Channel Select | COM or Yn | 12.4 | 14.6 | 20 | 9.3 | 21.5 | 8.2 | 23 | ns |
| $t_{PZH}$ $t_{PZL}$ | Enable delay time | INH | COM or Yn | 12.1 | 13.8 | 45 | 9.2 | 50 | 8.5 | 55 | ns |
| $t_{PHZ}$ $t_{PLZ}$ | Disable delay time | INH | COM or Yn | 35.2 | 44.5 | 90 | 35.5 | 100 | 35 | 110 | ns |

**switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 3.3 V, $C_L$ = 50 pF (unless otherwise noted) (see Figures 9−14)**

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $T_A$ = 25°C | | | −40 TO 85°C | | −40 TO 125°C | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | COM or Yn | Yn or COM | 7.9 | 11 | 15 | 5.8 | 16.5 | 5 | 18.5 | ns |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | Channel Select | COM or Yn | 11.4 | 13.5 | 17.5 | 8.5 | 19 | 7.5 | 22 | ns |
| $t_{PZH}$ $t_{PZL}$ | Enable delay time | INH | COM or Yn | 11.2 | 12.7 | 42.5 | 8.4 | 47.5 | 7.4 | 52.5 | ns |
| $t_{PHZ}$ $t_{PLZ}$ | Disable delay time | INH | COM or Yn | 34.6 | 43.9 | 85 | 34.6 | 95 | 34.5 | 105 | ns |

### switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 4.5 V, $C_L$ = 50 pF (unless otherwise noted) (see Figures 9−14)

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $T_A$ = 25°C | | | −40 TO 85°C | | −40 TO 125°C | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | COM or Yn | Yn or COM | 6.3 | 8.6 | 11.6 | 4.6 | 12.5 | 4.5 | 13.5 | ns |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | Channel Select | COM or Yn | 9.3 | 11 | 14 | 6.5 | 15 | 5.6 | 17 | ns |
| $t_{PZH}$ $t_{PZL}$ | Enable delay time | INH | COM or Yn | 8 | 9.9 | 40 | 5.3 | 45 | 4.4 | 50 | ns |
| $t_{PHZ}$ $t_{PLZ}$ | Disable delay time | INH | COM or Yn | 28.5 | 41.4 | 80 | 28.2 | 90 | 28 | 100 | ns |

### switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 6 V, $C_L$ = 50 pF (unless otherwise noted) (see Figures 9−14)

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $T_A$ = 25°C | | | −40 TO 85°C | | −40 TO 125°C | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | COM or Yn | Yn or COM | 5.5 | 8 | 10.2 | 4.1 | 11 | 3.6 | 12 | ns |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time | Channel Select | COM or Yn | 7.4 | 9.5 | 12.6 | 4.7 | 14.5 | 3.8 | 16.5 | ns |
| $t_{PZH}$ $t_{PZL}$ | Enable delay time | INH | COM or Yn | 6.8 | 8.4 | 39 | 4.8 | 40 | 3.8 | 40 | ns |
| $t_{PHZ}$ $t_{PLZ}$ | Disable delay time | INH | COM or Yn | 14.4 | 38 | 78 | 13.5 | 80 | 13 | 80 | ns |

### operating characteristics, $T_A$ = 25°C (see Figure 15)

| PARAMETER | | $V_{CC}$ | TEST CONDITIONS | TYP | UNIT |
|---|---|---|---|---|---|
| $C_{pd}$ | Power dissipation capacitance | 3.3 V | No load | 48 | pF |
| | | 5 V | | 60 | |

## APPLICATION INFORMATION

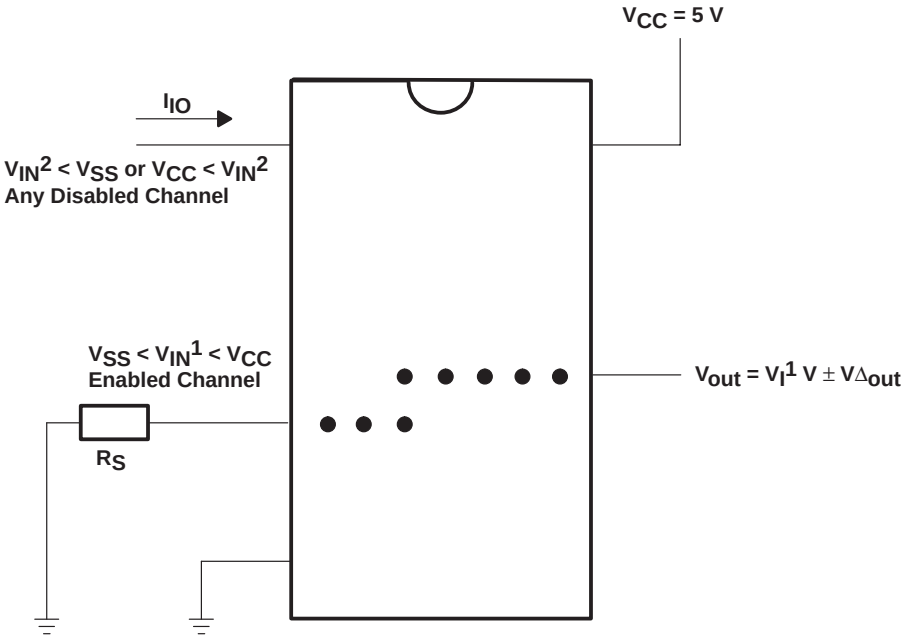



**Figure 1. Injection-Current Coupling Specification**

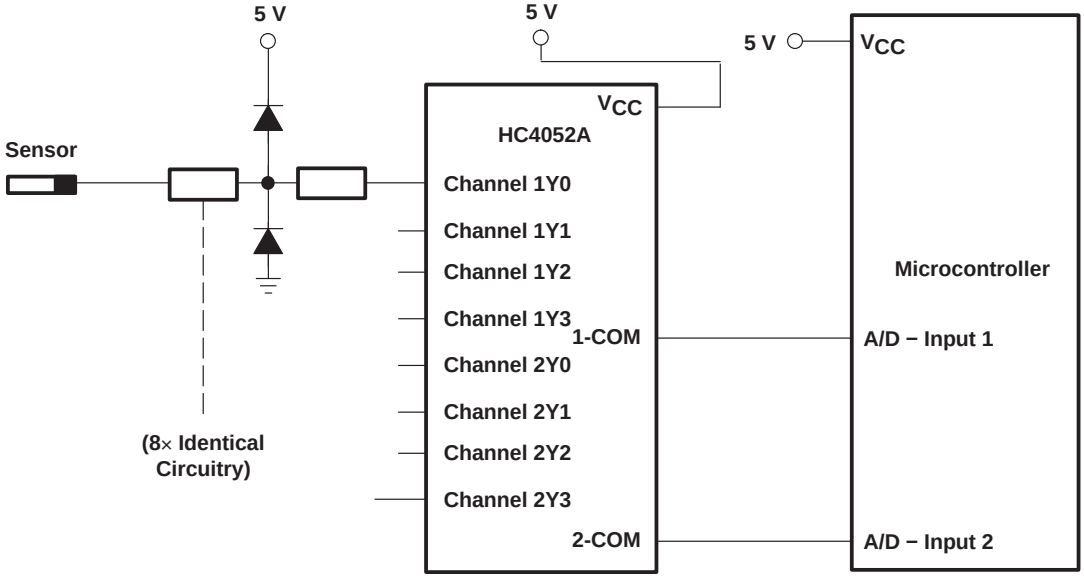



**Figure 2. Actual Technology Requires 32 Passive Components and One Extra 6-V Regulator to Suppress Injection Current Into a Standard HC4052 Multiplexer**

## APPLICATION INFORMATION

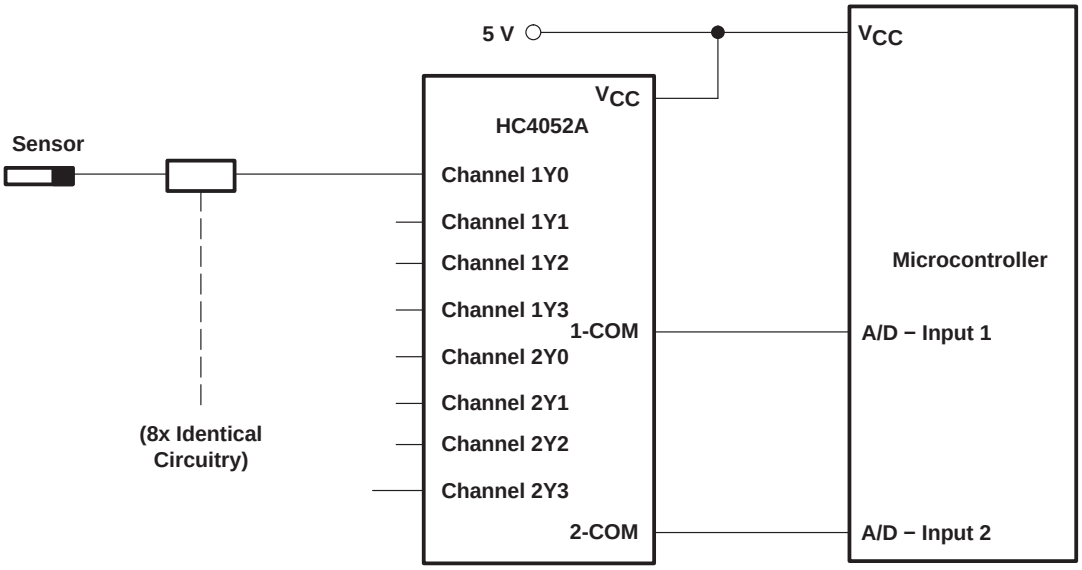



**Figure 3. Solution by Applying the HC4852 Multiplexer**

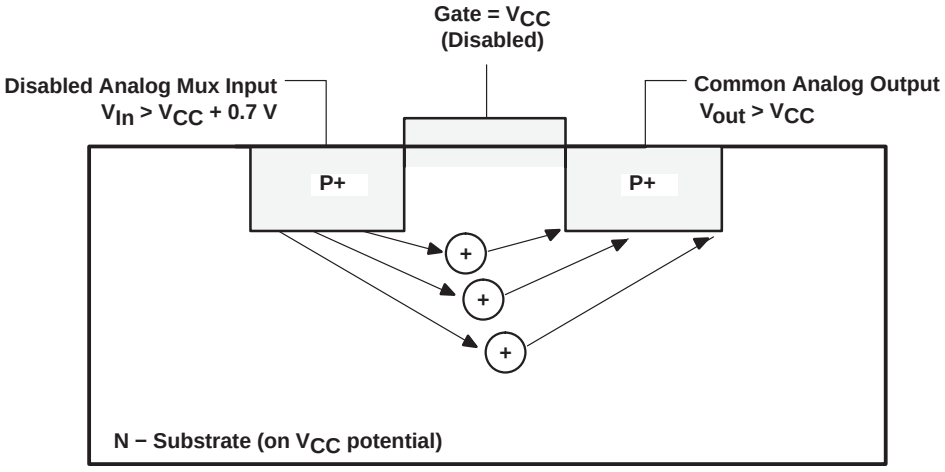



**Figure 4. Diagram of Bipolar Coupling Mechanism
(Appears if $V_{In}$ Exceeds $V_{CC}$, Driving Injection Current Into the Substrate)**

## PARAMETER MEASUREMENT INFORMATION

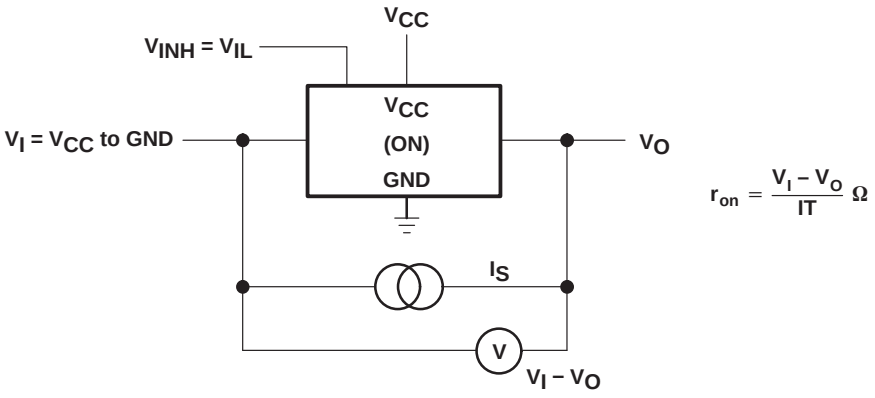



**Figure 5. On-State Resistance Test Circuit**

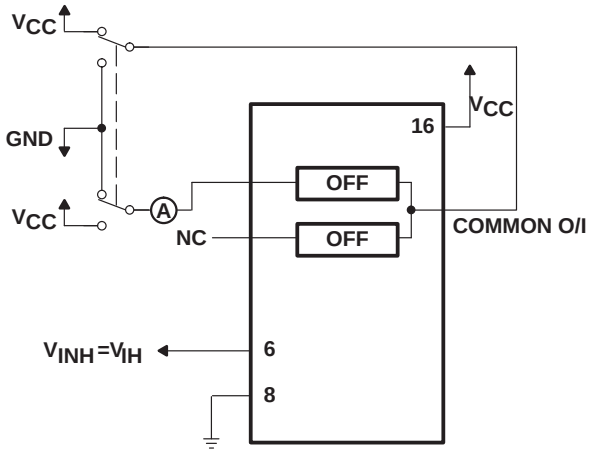



**Figure 6. Maximum Off-Channel Leakage Current, Any One Channel, Test Setup**

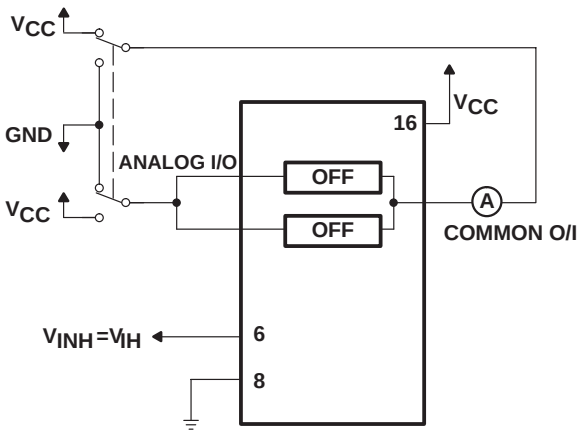



**Figure 7. Maximum Off-Channel Leakage Current, Common Channel, Test Setup**

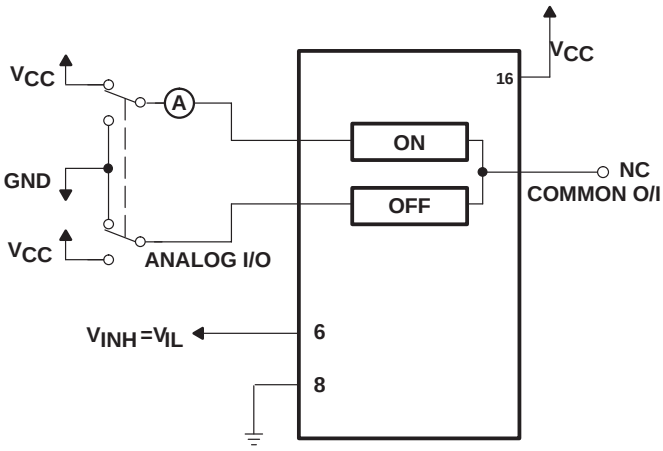



**Figure 8. Maximum On-Channel Leakage Current, Channel to Channel, Test Setup**

## PARAMETER MEASUREMENT INFORMATION

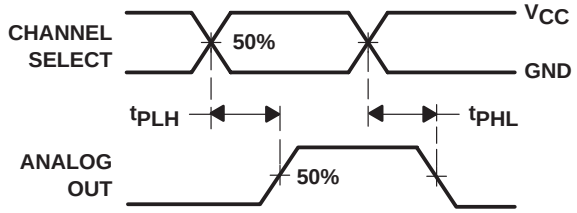
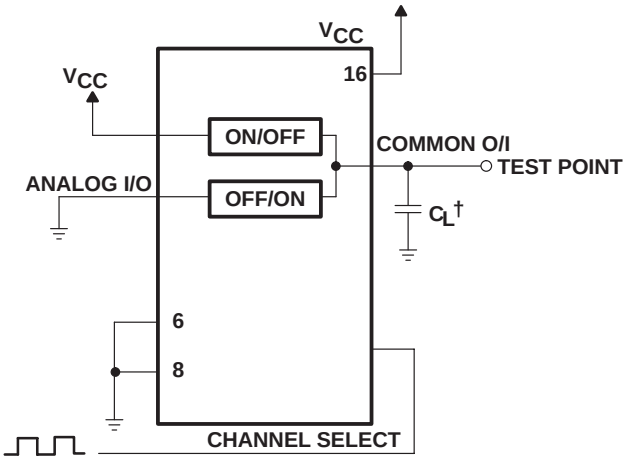



**Figure 9. Propagation Delays, Channel Select to Analog Out**




† Includes all probe and jig capacitance

**Figure 10. Propagation Delay, Channel Select to Analog Out, Test Setup**

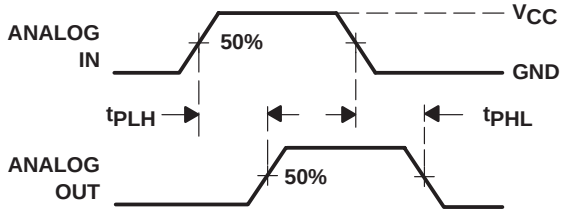
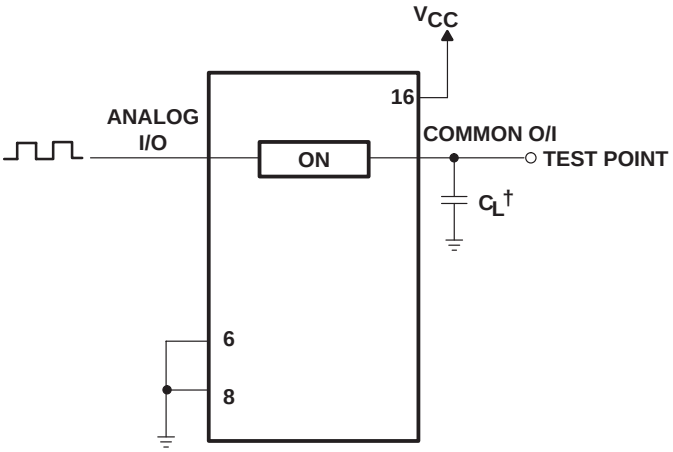



**Figure 11. Propagation Delays, Analog In to Analog Out**




† Includes all probe and jig capacitance

**Figure 12. Propagation Delay, Analog In to Analog Out, Test Setup**

## PARAMETER MEASUREMENT INFORMATION

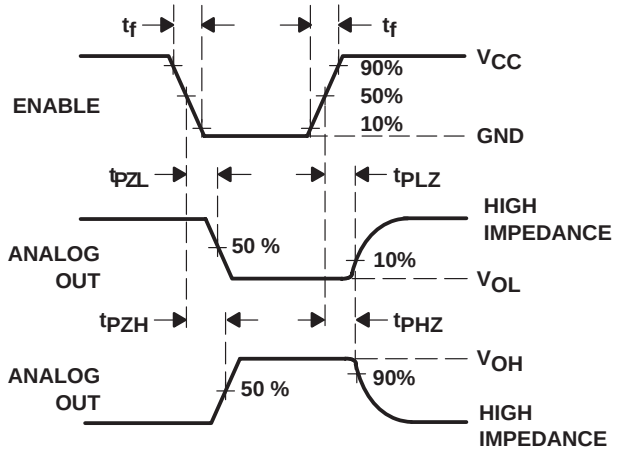



**Figure 13. Propagation Delays, Enable to Analog Out**

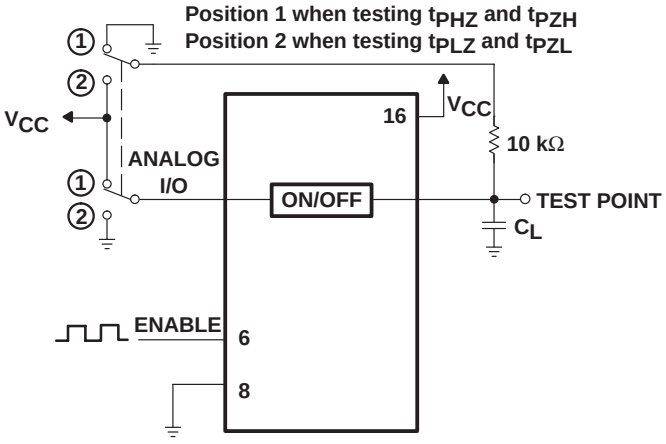



**Figure 14. Propagation Delay, Enable to Analog Out, Test Setup**

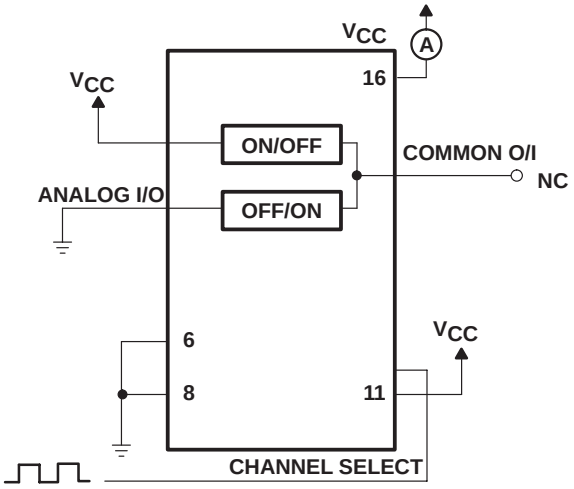
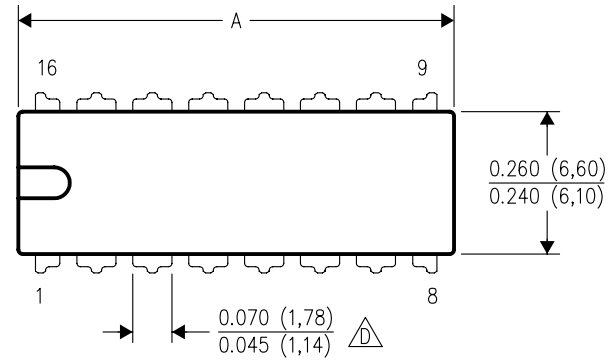



**Figure 15. Power-Dissipation Capacitance, Test Setup**

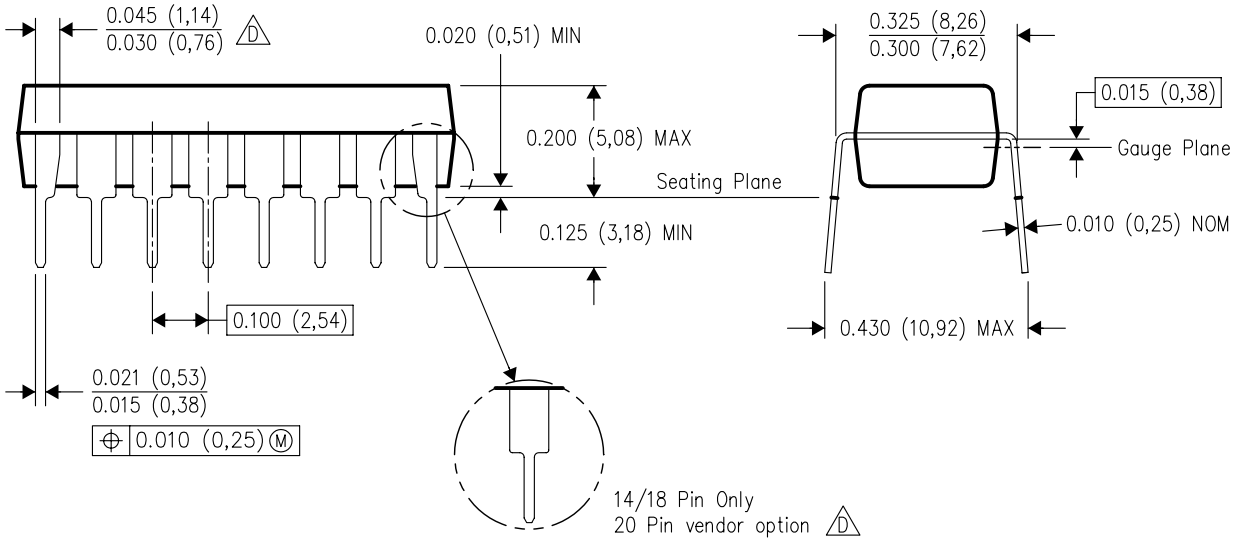
## N (R–PDIP–T**)

## PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN




| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A MAX | 0.775 (19,69) | 0.775 (19,69) | 0.920 (23,37) | 1.060 (26,92) |
| A MIN | 0.745 (18,92) | 0.745 (18,92) | 0.850 (21,59) | 0.940 (23,88) |
| MS–001 VARIATION (C) | AA | BB | AC | AD |



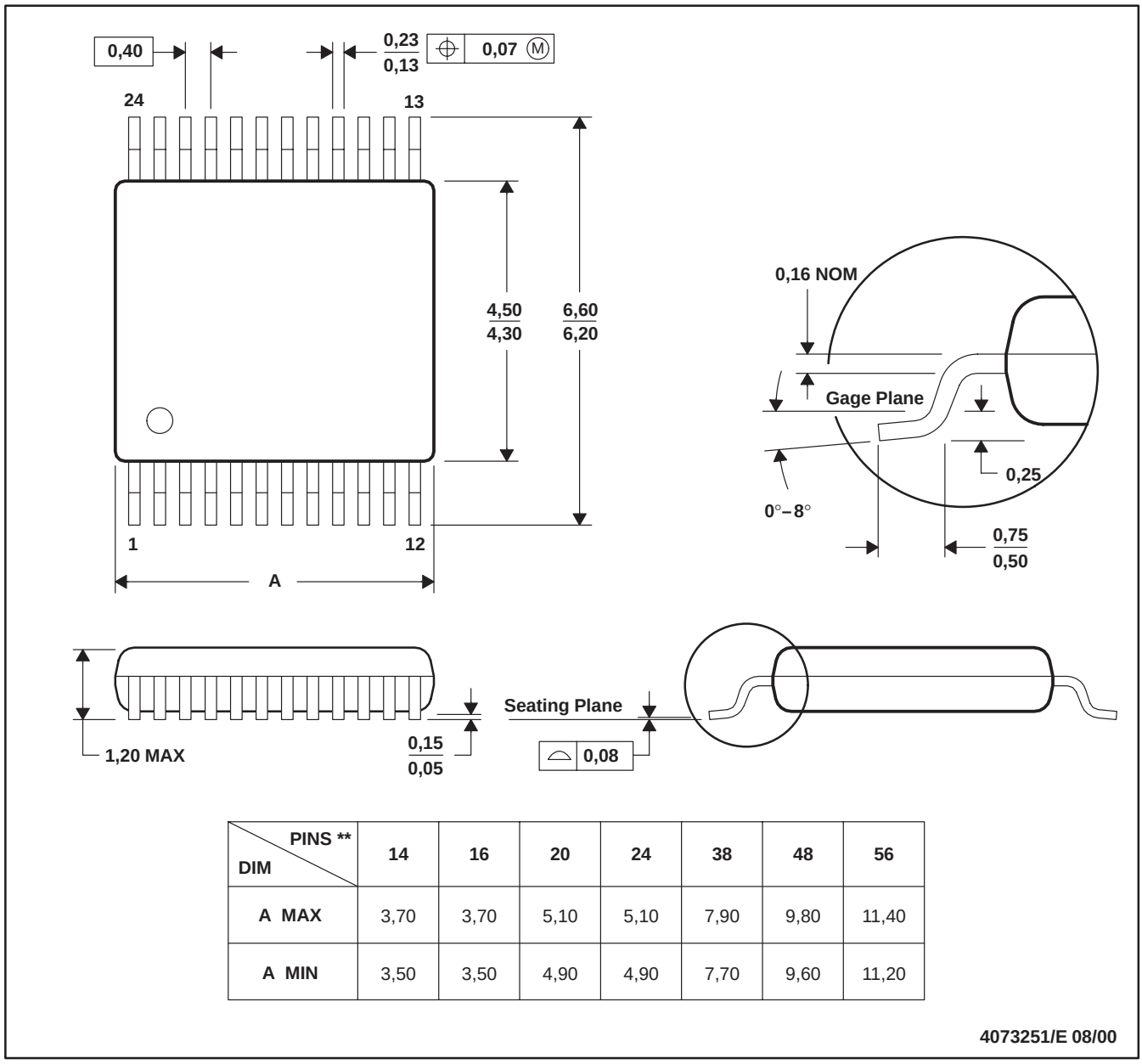

4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

MPDS006C – FEBRUARY 1996 – REVISED AUGUST 2000

**DGV (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE**

**24 PINS SHOWN**

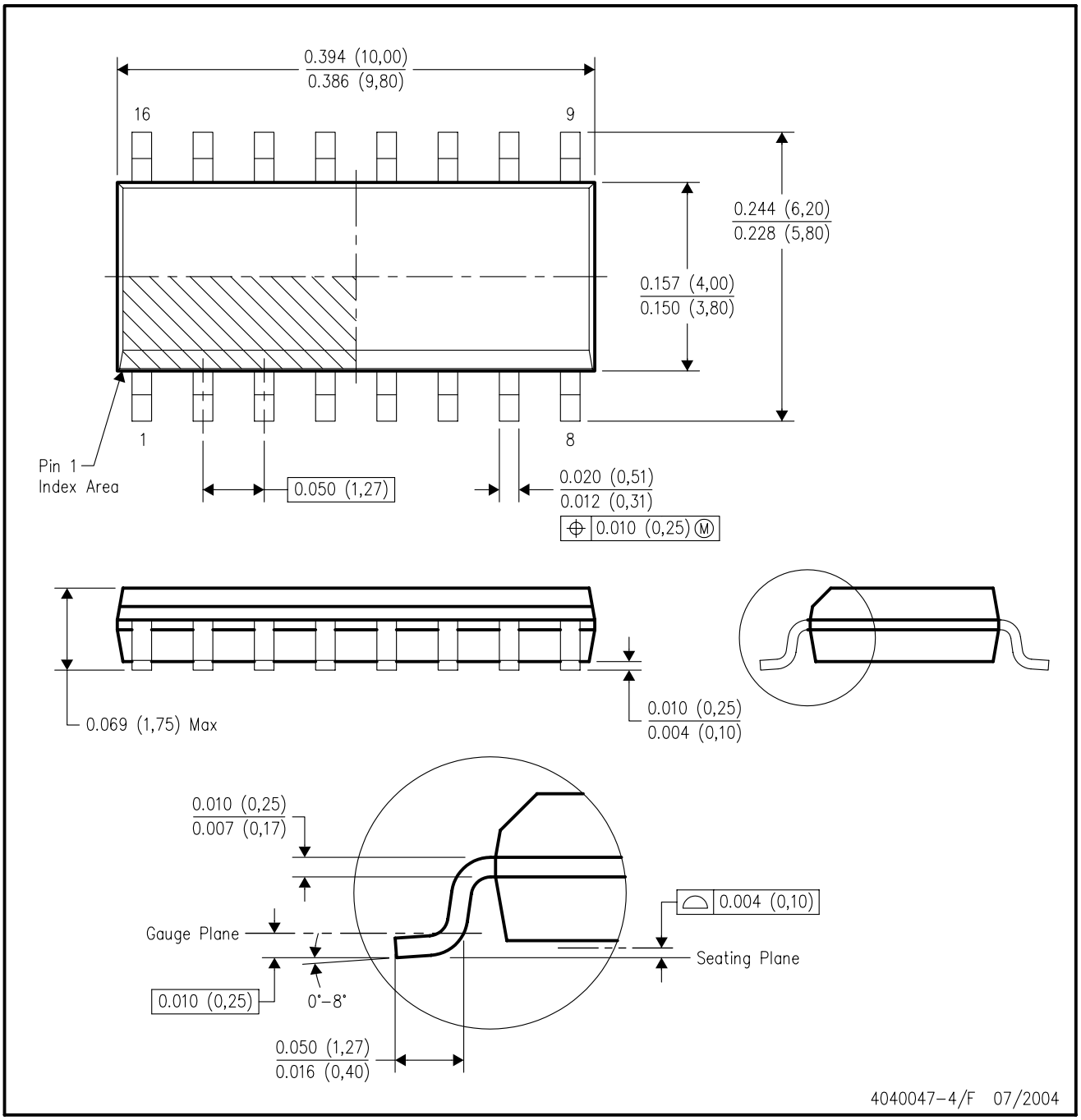



| DIM \ PINS ** | 14 | 16 | 20 | 24 | 38 | 48 | 56 |
|---|---|---|---|---|---|---|---|
| A MAX | 3,70 | 3,70 | 5,10 | 5,10 | 7,90 | 9,80 | 11,40 |
| A MIN | 3,50 | 3,50 | 4,90 | 4,90 | 7,70 | 9,60 | 11,20 |

**4073251/E 08/00**

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
D. Falls within JEDEC: 24/48 Pins – MO-153
14/16/20/56 Pins – MO-194

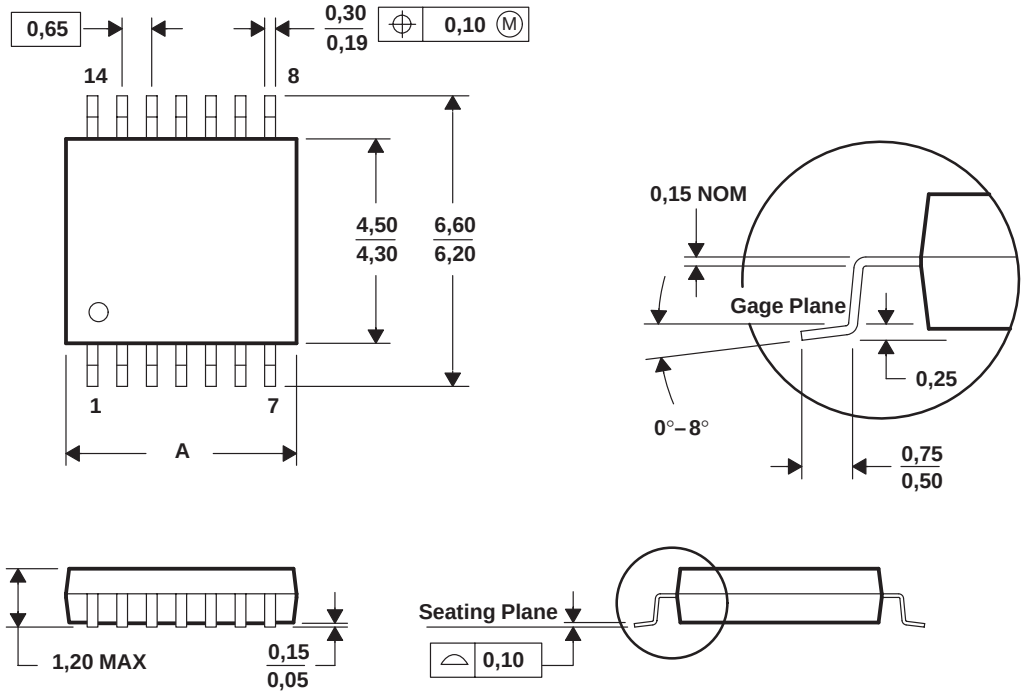
## D (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE




NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AC.

**PW (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE PACKAGE**

**14 PINS SHOWN**




| DIM \ PINS ** | 8 | 14 | 16 | 20 | 24 | 28 |
|---|---|---|---|---|---|---|
| A MAX | 3,10 | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN | 2,90 | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

**4040064/F 01/97**

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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