

SN74LV4051A-EP

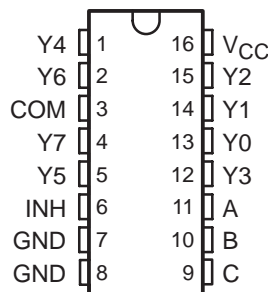
8-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

SCLS501D – MAY 2003 – REVISED MAY 2004

- **Controlled Baseline**
 - One Assembly/Test Site, One Fabrication Site
- **Extended Temperature Performance of –40°C to 105°C**
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree†**
- **2-V to 5.5-V V_{CC} Operation**
- **Supports Mixed-Mode Voltage Operation on All Ports**
- **High On-Off Output-Voltage Ratio**
- **Low Crosstalk Between Switches**
- **Individual Switch Controls**
- **Extremely Low Input Current**
- **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)

† Component qualification in accordance with JEDEC and industry standards to ensure reliable operation over an extended temperature range. This includes, but is not limited to, Highly Accelerated Stress Test (HAST) or biased 85/85, temperature cycle, autoclave or unbiased HAST, electromigration, bond intermetallic life, and mold compound life. Such qualification testing should not be viewed as justifying use of this component beyond specified performance and environmental limits.

D, DW, OR PW PACKAGE
(TOP VIEW)



description/ordering information

This 8-channel CMOS analog multiplexer/demultiplexer is designed for 2-V to 5.5-V V_{CC} operation.

The SN74LV4051A handles both analog and digital signals. Each channel permits signals with amplitudes up to 5.5 V (peak) to be transmitted in either direction.

Applications include signal gating, chopping, modulation or demodulation (modem), and signal multiplexing for analog-to-digital and digital-to-analog conversion systems.

ORDERING INFORMATION

| T_A | PACKAGE‡ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|------------|---------------|-----------------------|------------------|
| –40°C to 105°C | SOIC – D | Tape and reel | SN74LV4051ATDREP | LV4051ATEP |
| | SOIC – DW | Tape and reel | SN74LV4051ATDWREP§ | LV4051ATEP |
| | TSSOP – PW | Tape and reel | SN74LV4051ATPWREP | L4051EP |

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

§ Product Preview.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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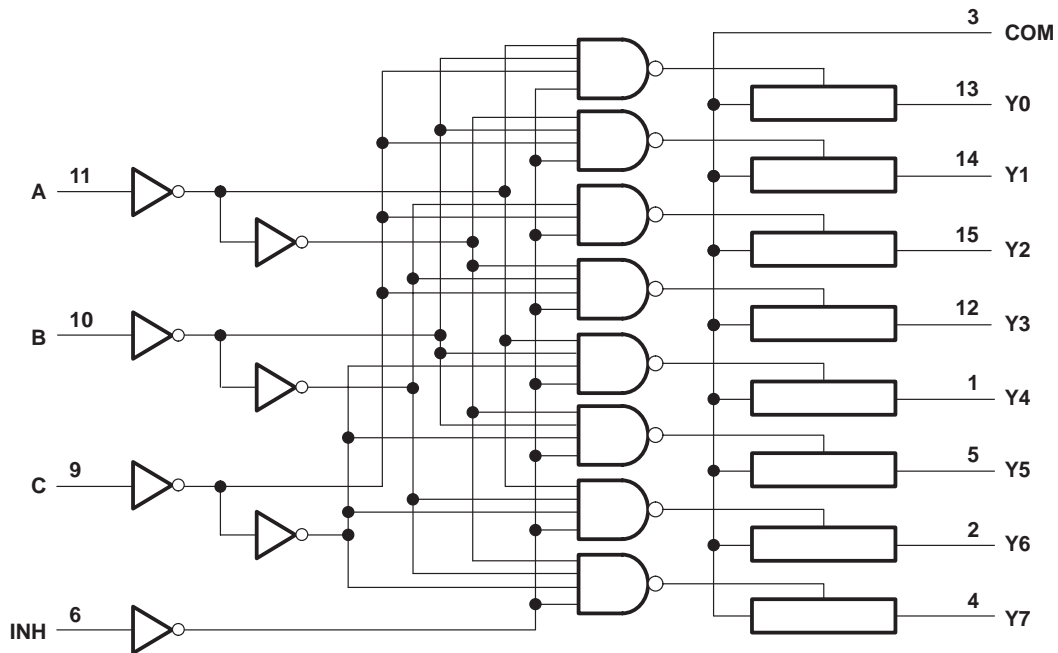
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FUNCTION TABLE

| INPUTS | | | | ON CHANNEL |
|--------|---|---|---|------------|
| INH | C | B | A | |
| L | L | L | L | Y0 |
| L | L | L | H | Y1 |
| L | L | H | L | Y2 |
| L | L | H | H | Y3 |
| L | H | L | L | Y4 |
| L | H | L | H | Y5 |
| L | H | H | L | Y6 |
| L | H | H | H | Y7 |
| H | X | X | X | None |

logic diagram (positive logic)



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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 7.0 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} ($V_I < 0$) | –20 mA |
| I/O diode current, I_{IOK} ($V_{IO} < 0$) | –50 mA |
| Switch through current, I_T ($V_{IO} = 0$ to V_{CC}) | ±25 mA |
| Continuous current through V_{CC} or GND | ±50 mA |
| Package thermal impedance, θ_{JA} (see Note 3): D package | 73°C/W |
| DW package | 57°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 negative-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‡ | 5.5 | V |
| V_{IH} | High-level input voltage, control inputs | $V_{CC} = 2$ V | 1.5 | V |
| | | $V_{CC} = 2.3$ V to 2.7 V | $V_{CC} \times 0.7$ | |
| | | $V_{CC} = 3$ V to 3.6 V | $V_{CC} \times 0.7$ | |
| | | $V_{CC} = 4.5$ V to 5.5 V | $V_{CC} \times 0.7$ | |
| V_{IL} | Low-level input voltage, control inputs | $V_{CC} = 2$ V | 0.5 | V |
| | | $V_{CC} = 2.3$ V to 2.7 V | $V_{CC} \times 0.3$ | |
| | | $V_{CC} = 3$ V to 3.6 V | $V_{CC} \times 0.3$ | |
| | | $V_{CC} = 4.5$ V to 5.5 V | $V_{CC} \times 0.3$ | |
| V_I | Control input voltage | 0 | 5.5 | V |
| V_{IO} | Input/output voltage | 0 | V_{CC} | V |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | $V_{CC} = 2.3$ V to 2.7 V | 200 | ns/V |
| | | $V_{CC} = 3$ V to 3.6 V | 100 | |
| | | $V_{CC} = 4.5$ V to 5.5 V | 20 | |
| T_A | Operating free-air temperature | –40 | 105 | °C |

‡ With supply voltages at or near 2 V, the analog switch on-state resistance becomes very nonlinear. It is recommended that only digital signals be transmitted at these low supply voltages.

NOTE 4: All unused 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.



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

| PARAMETER | TEST CONDITIONS | V _{CC} | T _A = 25°C | | | MIN | MAX | UNIT |
|---------------------|---|-----------------|-----------------------|------|------|-----|-----|------|
| | | | MIN | TYP | MAX | | | |
| r _{on} | On-state switch resistance I _T = 2 mA, V _I = V _{CC} or GND, V _{INH} = V _{IL} , (see Figure 1) | 2.3 V | | 38 | 180 | | 225 | Ω |
| | | 3 V | | 30 | 150 | | 190 | |
| | | 4.5 V | | 22 | 75 | | 100 | |
| r _{on(p)} | Peak on-state resistance I _T = 2 mA, V _I = V _{CC} to GND, V _{INH} = V _{IL} | 2.3 V | | 113 | 500 | | 600 | Ω |
| | | 3 V | | 54 | 180 | | 225 | |
| | | 4.5 V | | 31 | 100 | | 125 | |
| Δr _{on} | Difference in on-state resistance between switches I _T = 2 mA, V _I = V _{CC} to GND, V _{INH} = V _{IL} | 2.3 V | | 2.1 | 30 | | 40 | Ω |
| | | 3 V | | 1.4 | 20 | | 30 | |
| | | 4.5 V | | 1.3 | 15 | | 20 | |
| I _I | Control input current V _I = 5.5 V or GND | 0 to 5.5 V | | | ±0.1 | | ±1 | μA |
| I _{S(off)} | Off-state switch leakage current V _I = V _{CC} and V _O = GND, or V _I = GND and V _O = V _{CC} , V _{INH} = V _{IH} , (see Figure 2) | 5.5 V | | | ±0.1 | | ±1 | μA |
| I _{S(on)} | On-state switch leakage current V _I = V _{CC} or GND, V _{INH} = V _{IL} (see Figure 3) | 5.5 V | | | ±0.1 | | ±1 | μA |
| I _{CC} | Supply current V _I = V _{CC} or GND | 5.5 V | | | | | 20 | μA |
| C _{IC} | Control input capacitance f = 10 MHz | 3.3 V | | 2 | | | | pF |
| C _{IS} | Common terminal capacitance | 3.3 V | | 23.4 | | | | pF |
| C _{OS} | Switch terminal capacitance | 3.3 V | | 5.7 | | | | pF |
| C _F | Feedthrough capacitance | 3.3 V | | 0.5 | | | | pF |

switching characteristics over recommended operating free-air temperature range, V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | T _A = 25°C | | | MIN | MAX | UNIT |
|--------------------------------------|------------------------|-----------------------|-----------------------|---|------|-----|-----|-----|------|
| | | | | MIN | TYP | MAX | | | |
| t _{PLH} t _{PHL} | Propagation delay time | COM or Y _n | Y _n or COM | C _L = 15 pF, (see Figure 4) | 1.9 | 10 | | 16 | ns |
| t _{PZH} t _{PZL} | Enable delay time | INH | COM or Y _n | C _L = 15 pF, (see Figure 5) | 6.6 | 18 | | 23 | ns |
| t _{PHZ} t _{PLZ} | Disable delay time | INH | COM or Y _n | C _L = 15 pF, (see Figure 5) | 7.4 | 18 | | 23 | ns |
| t _{PLH} t _{PHL} | Propagation delay time | COM or Y _n | Y _n or COM | C _L = 50 pF, (see Figure 5) | 3.8 | 12 | | 18 | ns |
| t _{PZH} t _{PZL} | Enable delay time | INH | COM or Y _n | C _L = 50 pF, (see Figure 5) | 7.8 | 28 | | 35 | ns |
| t _{PHZ} t _{PLZ} | Disable delay time | INH | COM or Y _n | C _L = 50 pF, (see Figure 5) | 11.5 | 28 | | 35 | ns |



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**switching characteristics over recommended operating free-air temperature range,
V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted)**

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | T _A = 25°C | | | MIN | MAX | UNIT |
|--------------------------------------|------------------------|-----------------------|-----------------------|--|-----|-----|-----|-----|------|
| | | | | MIN | TYP | MAX | | | |
| t _{PLH} t _{PHL} | Propagation delay time | COM or Y _n | Y _n or COM | C _L = 15 pF, (see Figure 4) | 1.2 | 6 | | 10 | ns |
| t _{PZH} t _{PZL} | Enable delay time | INH | COM or Y _n | C _L = 15 pF, (see Figure 5) | 4.7 | 12 | | 15 | ns |
| t _{PHZ} t _{PLZ} | Disable delay time | INH | COM or Y _n | C _L = 15 pF, (see Figure 5) | 5.7 | 12 | | 15 | ns |
| t _{PLH} t _{PHL} | Propagation delay time | COM or Y _n | Y _n or COM | C _L = 50 pF, (see Figure 4) | 2.5 | 9 | | 12 | ns |
| t _{PZH} t _{PZL} | Enable delay time | INH | COM or Y _n | C _L = 50 pF, (see Figure 5) | 5.5 | 20 | | 25 | ns |
| t _{PHZ} t _{PLZ} | Disable delay time | INH | COM or Y _n | C _L = 50 pF, (see Figure 5) | 8.8 | 20 | | 25 | ns |

**switching characteristics over recommended operating free-air temperature range,
V_{CC} = 5 V ± 0.5 V (unless otherwise noted)**

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | T _A = 25°C | | | MIN | MAX | UNIT |
|--------------------------------------|------------------------|-----------------------|-----------------------|--|-----|-----|-----|-----|------|
| | | | | MIN | TYP | MAX | | | |
| t _{PLH} t _{PHL} | Propagation delay time | COM or Y _n | Y _n or COM | C _L = 15 pF, (see Figure 4) | 0.6 | 4 | | 7 | ns |
| t _{PZH} t _{PZL} | Enable delay time | INH | COM or Y _n | C _L = 15 pF, (see Figure 5) | 3.5 | 8 | | 10 | ns |
| t _{PHZ} t _{PLZ} | Disable delay time | INH | COM or Y _n | C _L = 15 pF, (see Figure 5) | 4.4 | 8 | | 10 | ns |
| t _{PLH} t _{PHL} | Propagation delay time | COM or Y _n | Y _n or COM | C _L = 50 pF, (see Figure 4) | 1.5 | 6 | | 8 | ns |
| t _{PZH} t _{PZL} | Enable delay time | INH | COM or Y _n | C _L = 50 pF, (see Figure 5) | 4 | 14 | | 18 | ns |
| t _{PHZ} t _{PLZ} | Disable delay time | INH | COM or Y _n | C _L = 50 pF, (see Figure 5) | 6.2 | 14 | | 18 | ns |



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analog switch characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | V _{CC} | T _A = 25°C | | | UNIT | |
|--|-----------------------|-----------------------|--|---------------------------------------|-----------------------|-----|-----|------|---|
| | | | | | MIN | TYP | MAX | | |
| Frequency response (switch on) | COM or Y _n | Y _n or COM | C _L = 50 pF, R _L = 600 Ω, f _{in} = 1 MHz (sine wave) (see Note 5 and Figure 6) | 2.3 V | 20 | | | MHz | |
| | | | | 3 V | 25 | | | | |
| | | | | 4.5 V | 35 | | | | |
| Crosstalk (control input to signal output) | INH | COM or Y _n | C _L = 50 pF, R _L = 600 Ω, f _{in} = 1 MHz (square wave) (see Figure 7) | 2.3 V | 20 | | | mV | |
| | | | | 3 V | 35 | | | | |
| | | | | 4.5 V | 60 | | | | |
| Feedthrough attenuation (switch off) | COM or Y _n | Y _n or COM | C _L = 50 pF, R _L = 600 Ω, f _{in} = 1 MHz (see Note 6 and Figure 8) | 2.3 V | -45 | | | dB | |
| | | | | 3 V | -45 | | | | |
| | | | | 4.5 V | -45 | | | | |
| Sine-wave distortion | COM or Y _n | Y _n or COM | C _L = 50 pF, R _L = 10 kΩ, f _{in} = 1 kHz (sine wave) (see Figure 9) | V _I = 2 V _{p-p} | 2.3 V | 0.1 | | | % |
| | | | | V _I = 2.5 V _{p-p} | 3 V | 0.1 | | | |
| | | | | V _I = 4 V _{p-p} | 4.5 V | 0.1 | | | |

NOTES: 5. Adjust f_{in} voltage to obtain 0-dBm output. Increase f_{in} frequency until dB meter reads -3 dB.
6. Adjust f_{in} voltage to obtain 0-dBm input.

operating characteristics, V_{CC} = 3.3 V, T_A = 25°C

| PARAMETER | TEST CONDITIONS | TYP | UNIT |
|---|------------------------------------|-----|------|
| C _{pd} Power dissipation capacitance | C _L = 50 pF, f = 10 MHz | 5.9 | pF |

PARAMETER MEASUREMENT INFORMATION

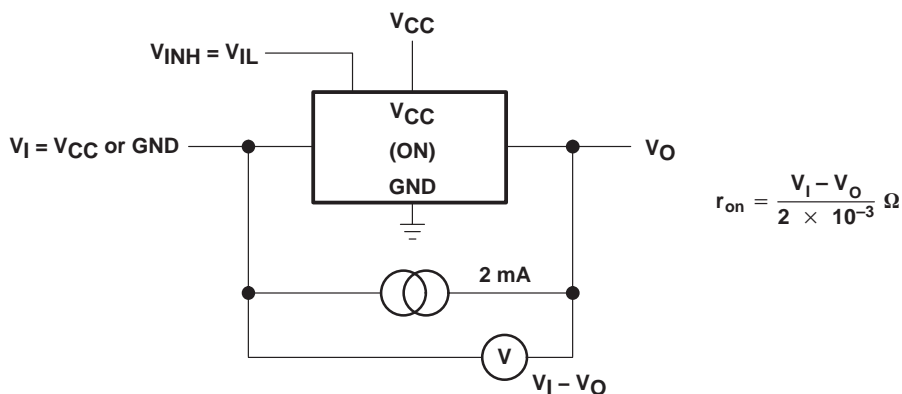
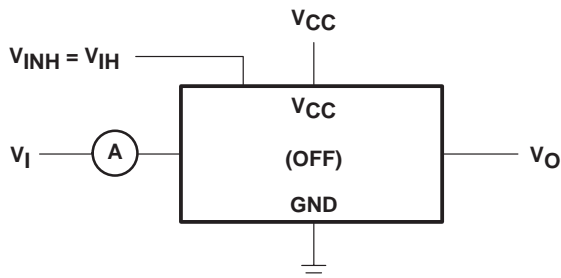


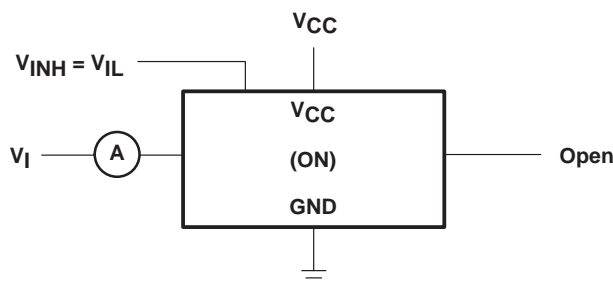
Figure 1. On-State Resistance Test Circuit

PARAMETER MEASUREMENT INFORMATION



Condition 1: $V_I = 0, V_O = V_{CC}$
 Condition 2: $V_I = V_{CC}, V_O = 0$

Figure 2. Off-State Switch Leakage-Current Test Circuit



$V_I = V_{CC} \text{ or } GND$

Figure 3. On-State Switch Leakage-Current Test Circuit

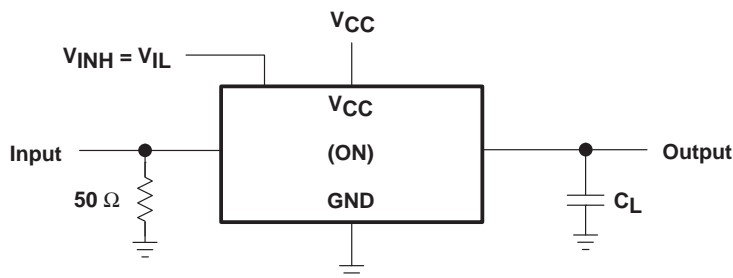
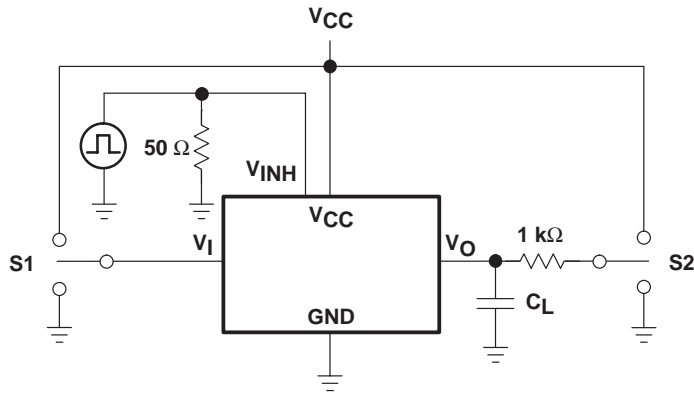


Figure 4. Propagation Delay Time, Signal Input to Signal Output

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PARAMETER MEASUREMENT INFORMATION



| TEST | S1 | S2 |
|-------------------|----------|----------|
| t_{PLZ}/t_{PZL} | GND | V_{CC} |
| t_{PHZ}/t_{PZH} | V_{CC} | GND |

TEST CIRCUIT

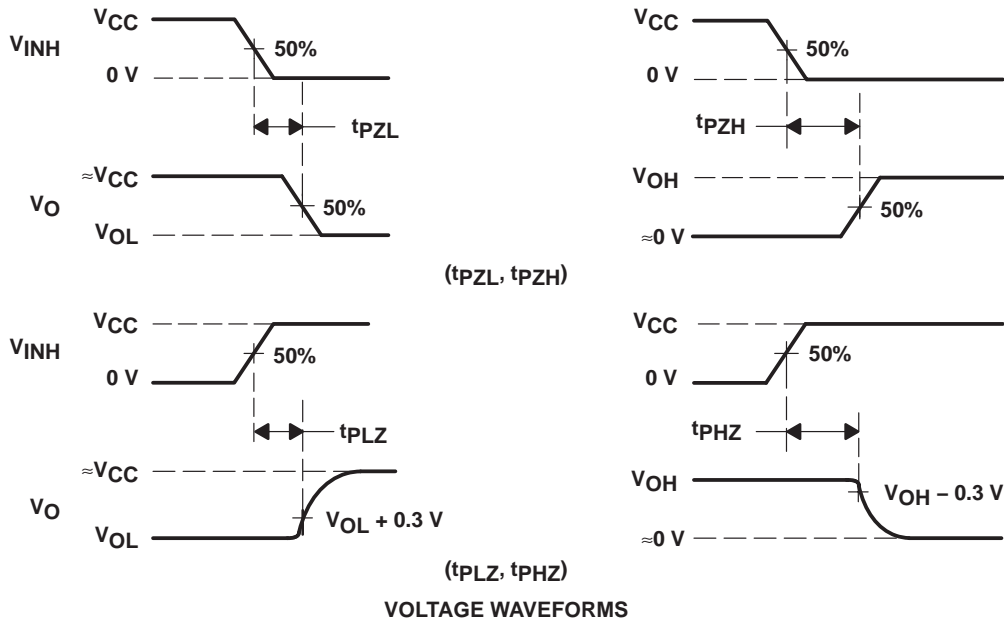
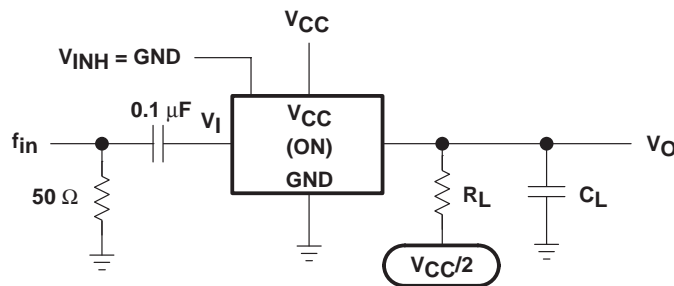


Figure 5. Switching Time (t_{PZL} , t_{PLZ} , t_{PZH} , t_{PHZ}), Control to Signal Output



NOTE A: f_{in} is a sine wave.

Figure 6. Frequency Response (Switch On)

PARAMETER MEASUREMENT INFORMATION

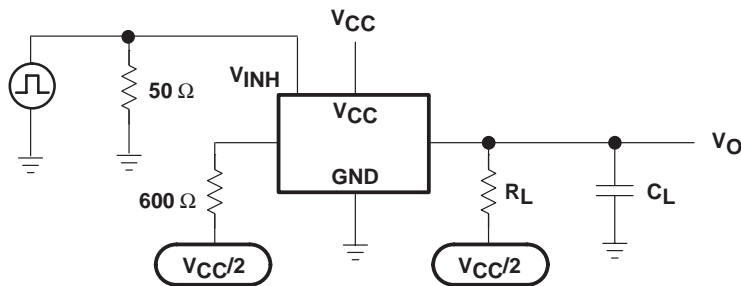


Figure 7. Crosstalk (Control Input, Switch Output)

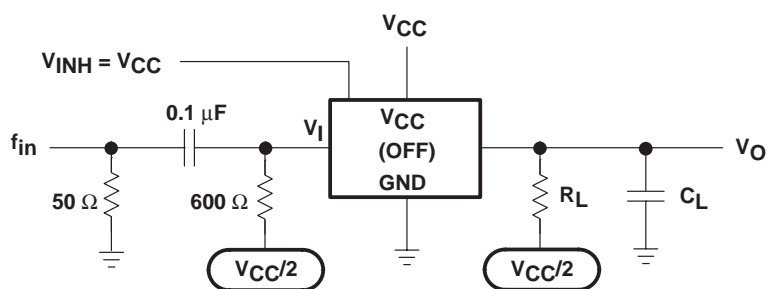


Figure 8. Feedthrough Attenuation (Switch Off)

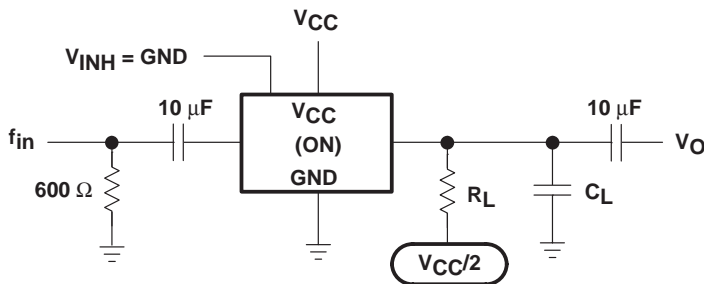


Figure 9. Sine-Wave Distortion

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|-------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| SN74LV4051ATDREP | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74LV4051ATPWREP | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| V62/03664-01XE | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| V62/03664-01YE | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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OTHER QUALIFIED VERSIONS OF SN74LV4051A-EP :

- Catalog: [SN74LV4051A](#)
- Automotive: [SN74LV4051A-Q1](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74LV4051ATDREP | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74LV4051ATDREP | SOIC | D | 16 | 2500 | 333.2 | 345.9 | 28.6 |

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