

# MAX4736

# 0.6Ω, Low-Voltage, Single-Supply, Dual SPDT Analog Switch

## General Description

The MAX4736 is a low on-resistance, low-voltage, dual single-pole/double throw (SPDT) analog switch that operates from a single 1.6V to 4.2V supply. This device has fast switching speeds ( $t_{ON} = 25ns$ ,  $t_{OFF} = 20ns$  max), handles rail-to-rail analog signals, and consumes less than  $4\mu W$  of quiescent power. The MAX4736 has break-before-make switching.

When powered from a 3V supply, the MAX4736 features low  $0.6\Omega$  on-resistance ( $R_{ON}$ ), with  $0.1\Omega$   $R_{ON}$  matching and  $0.05\Omega$   $R_{ON}$  flatness. The digital logic input is 1.8V CMOS compatible when using a single 3V supply.

The MAX4736 has one normally open (NO) switch and one normally closed (NC) switch, and is available in 12-pin TQFN (3mm x 3mm), 10-pin  $\mu$ MAX, and 10-pin  $\mu$ DFN (2mm x 2mm) packages.

## Applications

- Power Routing
- Battery-Powered Systems
- Audio and Video Signal Routing
- Low-Voltage Data-Acquisition Systems
- Communications Circuits
- PCMCIA Cards
- Cellular Phones
- Modems
- Hard Drives

## Benefits and Features

- Low  $R_{ON}$   
 $0.6\Omega$  (3V Supply)  
 $1.5\Omega$  (1.8V Supply)
- $0.1\Omega$  max  $R_{ON}$  Flatness (3V Supply)
- Single-Supply Operation Down to 1.6V
- Available in TQFN,  $\mu$ DFN, and  $\mu$ MAX Packages
- 1.8V CMOS Logic Compatible (3V Supply)
- Fast Switching:  $t_{ON} = 25ns$ ,  $t_{OFF} = 20ns$

## Ordering Information

| PART         | TEMP RANGE     | PIN-PACKAGE                 |
|--------------|----------------|-----------------------------|
| MAX4736EUB+  | -40°C to +85°C | 10 $\mu$ MAX                |
| MAX4736EUB+T | -40°C to +85°C | 10 $\mu$ MAX                |
| MAX4736ETC+  | -40°C to +85°C | 12 TQFN<br>(3mm x 3mm)      |
| MAX4736ETC+T | -40°C to +85°C | 12 TQFN<br>(3mm x 3mm)      |
| MAX4736ELB+  | -40°C to +85°C | 10 $\mu$ DFN<br>(2mm x 2mm) |
| MAX4736ELB+T | -40°C to +85°C | 10 $\mu$ DFN<br>(2mm x 2mm) |

T = Tape and reel.

+Denotes lead(Pb)-free/RoHS-compliant package.

## Pin Configurations/Functional Diagrams/Truth Table

TOP VIEW

TQFN

$\mu$ MAX/ $\mu$ DFN

| MAX4736         |                 |                 |
|-----------------|-----------------|-----------------|
| IN <sub>-</sub> | NO <sub>-</sub> | NC <sub>-</sub> |
| 0               | OFF             | ON              |
| 1               | ON              | OFF             |

SWITCHES SHOWN FOR LOGIC 0 INPUT

NOTE: CONNECT EXPOSED PAD ON TQFN AND  $\mu$ DFN TO GND.

**Absolute Maximum Ratings**

(Voltages referenced to GND.)

V+, IN\_.....-0.3V to +4.6V  
 COM\_, NO\_, NC\_ (Note 1) .....-0.3V to (V+ + 0.3V)  
 Continuous Current COM\_, NO\_, NC\_ .....±300mA  
 Continuous Current (all other pins).....±20mA  
 Peak Current COM\_, NO\_, NC\_ (pulsed at 1ms 10% duty cycle).....±500mA

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

10-Pin μDFN (derate 5.3mW/°C above +70°C).....423.7mW  
 10-Pin μMAX (derate 5.6mW/°C above +70°C).....444mW  
 12-Pin TQFN (derate 14.7mW/°C above +70°C)..... 1176mW  
 Operating Temperature Range.....-40°C to +85°C  
 Maximum Junction Temperature.....+150°C  
 Storage Temperature Range .....-65°C to +150°C  
 Lead Temperature (soldering, 10s).....+300°C  
 Soldering Temperature (reflow).....+260°C

**Note 1:** Signals on COM\_, NO\_, or NC\_ exceeding V+ or GND are clamped by internal diodes. Limit forward current to maximum current rating.

*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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

**Electrical Characteristics—Single 3V Supply**

(V+ = 2.7V to 4.2V, V<sub>IH</sub> = 1.4V, V<sub>IL</sub> = 0.5V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise specified. Typical values are at V+ = 3.0V, T<sub>A</sub> = +25°C.) (Notes 2, 3)

| PARAMETER   | SYMBOL  | CONDITIONS   |                                      | MIN | TYP    | MAX | UNITS |
|---|---|--|--------------------------------------|-----|--------|-----|-------|
| <b>ANALOG SWITCH</b>                              |   |  |                                      |     |        |     |       |
| Analog Signal Range                               | V <sub>COM_</sub> ,<br>V <sub>NO_</sub> ,<br>V <sub>NC_</sub> |  |                                      | 0   |        | V+  | V     |
| On-Resistance (Note 4)                            | R <sub>ON</sub>   | V+ = 2.7V ,<br>I <sub>COM_</sub> = 100mA;<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 1.5V                           | +25°C                                |     | 0.6    | 0.8 | Ω     |
|   |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     |        | 1   |       |
| On-Resistance Match Between Channels (Notes 4, 5) | ΔR <sub>ON</sub>  | V+ = 2.7V ,<br>I <sub>COM_</sub> = 100mA;<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 1.5V                           | +25°C                                |     | 0.1    | 0.2 | Ω     |
|   |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     |        | 0.3 |       |
| On-Resistance Flatness (Note 6)                   | R <sub>FLAT(ON)</sub>   | V+ = 2.7V,<br>I <sub>COM_</sub> = 100mA;<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 1V, 1.5V, 2V                    | +25°C                                |     | 0.05   | 0.1 | Ω     |
|   |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     |        | 0.2 |       |
| NO_ or NC_ Off-Leakage Current (Note 10)          | I <sub>NO_ (OFF)</sub> ,<br>I <sub>NC_ (OFF)</sub>            | V+ = 3.6V ,<br>V <sub>COM_</sub> = 0.3V, 3.3V;<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 3.3V, 0.3V                | +25°C                                | -1  | ±0.002 | +1  | nA    |
|   |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     | -5     |     |       |
| COM_ On-Leakage Current (Note 10)                 | I <sub>COM_(ON)</sub>   | V+ = 3.6V,<br>V <sub>COM_</sub> = 0.3V, 3.3V;<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 0.3V, 3.3V,<br>or floating | +25°C                                | -2  | ±0.002 | +2  | nA    |
|   |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     | -10    |     |       |

**Electrical Characteristics—Single 3V Supply (continued)**

(V+ = 2.7V to 4.2V, V<sub>IH</sub> = 1.4V, V<sub>IL</sub> = 0.5V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise specified. Typical values are at V+ = 3.0V, T<sub>A</sub> = +25°C.) (Notes 2, 3)

| PARAMETER                             | SYMBOL                | CONDITIONS  |                                      | MIN | TYP    | MAX | UNITS |
|---------------------------------------|-----------------------|---|--------------------------------------|-----|--------|-----|-------|
| <b>SWITCH DYNAMIC CHARACTERISTICS</b> |                       |   |                                      |     |        |     |       |
| Turn-On Time                          | t <sub>ON</sub>       | V <sub>NO_</sub> , V <sub>NC_</sub> = 1.5V;<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF,<br>Figure 1   | +25°C                                |     | 20     | 25  | ns    |
|                                       |                       |   | T <sub>MIN</sub> to T <sub>MAX</sub> |     |        | 30  |       |
| Turn-Off Time                         | t <sub>OFF</sub>      | V <sub>NO_</sub> , V <sub>NC_</sub> = 1.5V;<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF,<br>Figure 1   | +25°C                                |     | 15     | 20  | ns    |
|                                       |                       |   | T <sub>MIN</sub> to T <sub>MAX</sub> |     |        | 25  |       |
| Break-Before-Make<br>(Note 7)         | t <sub>BBM</sub>      | V <sub>NO_</sub> , V <sub>NC_</sub> = 1.5V;<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF,<br>Figure 2   | +25°C                                |     | 5      |     | ns    |
|                                       |                       |   | T <sub>MIN</sub> to T <sub>MAX</sub> |     | 1      |     |       |
| Charge Injection                      | Q                     | V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0,<br>C <sub>L</sub> = 1.0nF, Figure 3                           | +25°C                                |     | 60     |     | pC    |
| NO_ or NC_ Off-Capacitance            | C <sub>OFF</sub>      | f = 1MHz, Figure 4  | +25°C                                |     | 33     |     | pF    |
| COM_ Off-Capacitance                  | C <sub>COM(OFF)</sub> | f = 1MHz, Figure 4  | +25°C                                |     | 60     |     | pF    |
| COM_ On-Capacitance                   | C <sub>COM(ON)</sub>  | f = 1MHz, Figure 4  | +25°C                                |     | 85     |     | pF    |
| -3dB On-Channel Bandwidth             | BW                    | Signal = 0, R <sub>IN</sub> = R <sub>OUT</sub> =<br>50Ω, C <sub>L</sub> = 5pF, Figure 5                   |                                      |     | 130    |     | MHz   |
| Off-Isolation (Note 8)                | V <sub>ISO</sub>      | f = 1MHz, V <sub>COM_</sub> = 1V <sub>P-P</sub> ,<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Figure 5 | +25°C                                |     | -52    |     | dB    |
| Crosstalk (Note 9)                    | V <sub>CT</sub>       | f = 1MHz, V <sub>COM_</sub> = 1V <sub>P-P</sub> ,<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Figure 5 | +25°C                                |     | -78    |     | dB    |
| Total Harmonic Distortion             | THD                   | f = 20Hz to 20kHz, V <sub>COM_</sub> =<br>2V <sub>P-P</sub> , R <sub>L</sub> = 32Ω                        | +25°C                                |     | 0.018  |     | %     |
| <b>LOGIC INPUT (A_, IN_)</b>          |                       |   |                                      |     |        |     |       |
| Input Logic High                      | V <sub>IH</sub>       |   |                                      | 1.4 |        |     | V     |
| Input Logic Low                       | V <sub>IL</sub>       |   |                                      |     |        | 0.5 | V     |
| Input Leakage Current                 | I <sub>IN</sub>       | V <sub>IN_</sub> = 0 or 3.6V  |                                      | -1  | +0.005 | +1  | μA    |
| <b>POWER SUPPLY</b>                   |                       |   |                                      |     |        |     |       |
| Power-Supply Range                    | V+                    |   |                                      | 1.6 |        | 3.6 | V     |
| Positive Supply Current               | I+                    | V+ = 3.6V, V <sub>IN_</sub> = 0 or V+,<br>all channels on or off  |                                      |     | 0.006  | 1   | μA    |

**Electrical Characteristics—Single 1.8V Supply**(V+ = 1.8V, V<sub>IH</sub> = 1.0V, V<sub>IL</sub> = 0.4V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise specified. Typical values are at T<sub>A</sub> = +25°C.) (Notes 2, 3)

| PARAMETER                             | SYMBOL  | CONDITIONS   | T <sub>A</sub>                       | MIN | TYP | MAX | UNITS |
|---------------------------------------|---|--|--------------------------------------|-----|-----|-----|-------|
| <b>ANALOG SWITCH</b>                  |   |  |                                      |     |     |     |       |
| Analog Signal Range                   | V <sub>COM_</sub> ,<br>V <sub>NO_</sub> ,<br>V <sub>NC_</sub> |  |                                      | 0   |     | V+  | V     |
| On-Resistance                         | R <sub>ON</sub>   | I <sub>COM_</sub> = 100mA;<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 1V  | +25°C                                | 1.5 | 2   |     | Ω     |
|                                       |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     | 3   |     |       |
| <b>SWITCH DYNAMIC CHARACTERISTICS</b> |   |  |                                      |     |     |     |       |
| Turn-On Time                          | t <sub>ON</sub>   | V <sub>NO_</sub> or V <sub>NC_</sub> = 1V;<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF,<br>Figure 1                         | +25°C                                | 25  | 30  |     | ns    |
|                                       |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     | 35  |     |       |
| Turn-Off Time                         | t <sub>OFF</sub>  | V <sub>NO_</sub> or V <sub>NC_</sub> = 1V;<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF,<br>Figure 1                         | +25°C                                | 18  | 25  |     | ns    |
|                                       |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     | 28  |     |       |
| Break-Before-Make<br>(Note 7)         | t <sub>BBM</sub>  | V <sub>NO_</sub> or V <sub>NC_</sub> = 1V;<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF,<br>Figure 2                         | +25°C                                | 7   |     |     | ns    |
|                                       |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> | 1   |     |     |       |
| Charge Injection                      | Q   | V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0,<br>C <sub>L</sub> = 1nF, Figure 3  | +25°C                                |     | 35  |     | pC    |
| Off-Isolation (Note 8)                | V <sub>ISO</sub>  | f = 1MHz, V <sub>NO_</sub> = V <sub>NC_</sub><br>= 1V <sub>P-P</sub> , R <sub>L</sub> = 50Ω,<br>C <sub>L</sub> = 5pF, Figure 5 | +25°C                                |     | -52 |     | dB    |
| Crosstalk (Note 9)                    | V <sub>CT</sub>   | f = 1MHz, V <sub>COM_</sub> = 1V <sub>P-P</sub> ,<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Figure 5                      | +25°C                                |     | -78 |     | dB    |
| <b>LOGIC INPUT (IN<sub>_</sub>)</b>   |   |  |                                      |     |     |     |       |
| Input Logic High                      | V <sub>IH</sub>   |  |                                      | 1   |     |     | V     |
| Input Logic Low                       | V <sub>IL</sub>   |  |                                      |     |     | 0.4 | V     |
| Input Leakage Current                 | I <sub>IN</sub>   | V <sub>IN_</sub> = 0 or 3.6V   |                                      |     |     | 1   | μA    |

**Note 2:** The algebraic convention, where the most negative value is a minimum and the most positive value is a maximum, is used in this data sheet.

**Note 3:** -40°C specifications are guaranteed by design.

**Note 4:** R<sub>ON</sub> and ΔR<sub>ON</sub> matching specifications for TQFN packaged parts are guaranteed by design.

**Note 5:** ΔR<sub>ON</sub> = R<sub>ON(MAX)</sub> - R<sub>ON(MIN)</sub>.

**Note 6:** Flatness is defined as the difference between the maximum and the minimum value of on-resistance as measured over the specified analog signal ranges.

**Note 7:** Guaranteed by design.

**Note 8:** Off-Isolation = 20log<sub>10</sub>(V<sub>COM\_</sub>/V<sub>NO\_</sub>), V<sub>COM\_</sub> = output, V<sub>NO\_</sub> = input to OFF switch.

**Note 9:** Between two switches.

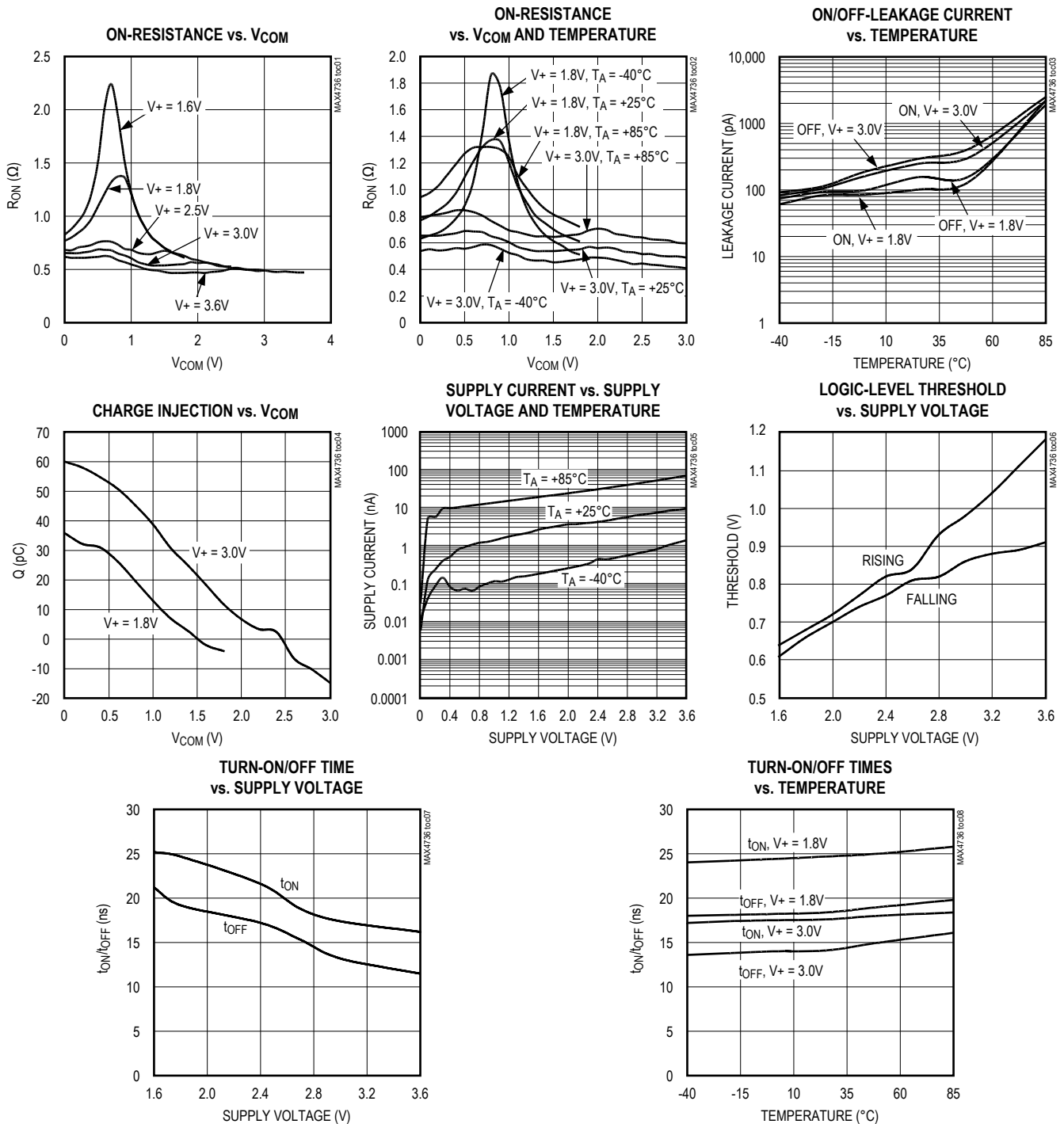
**Note 10:** Leakage parameters are 100% tested at hot temperature and guaranteed by correlation at room.

**Note 11:** Devices are guaranteed to 1 million cycles of operation. (Cycle = switch on → switch off → switch on)

**Note 12:** The minimum load resistance is 8Ω.

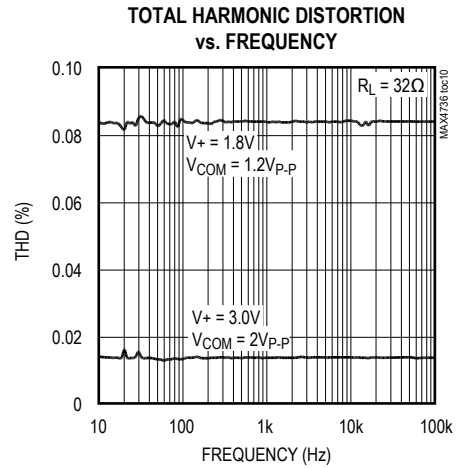
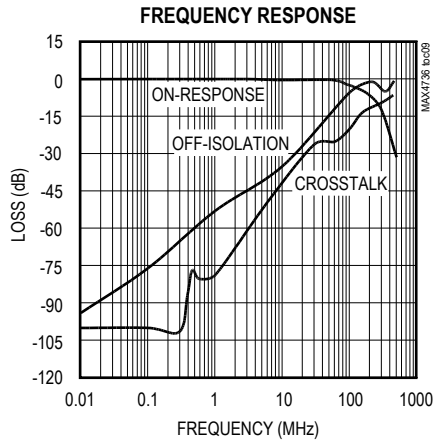
Typical Operating Characteristics

(T<sub>A</sub> = +25°C, unless otherwise noted.)



Typical Operating Characteristics (continued)

(T<sub>A</sub> = +25°C, unless otherwise noted.)



Pin Description

| PIN       |      | NAME | FUNCTION                                 |
|-----------|------|------|--|
| μMAX/μDFN | TQFN |      |  |
| 1         | 12   | IN1  | Digital Control Input Switch 1           |
| 2         | 1    | NO1  | Analog Switch 1—Normally Open Terminal   |
| 3         | 2    | GND  | Ground                                   |
| 4         | 3    | NO2  | Analog Switch 2—Normally Open Terminal   |
| 5         | 4    | IN2  | Digital Control Input Switch 2           |
| 6         | 5    | COM2 | Analog Switch 2—Common Terminal          |
| 7         | 7    | NC2  | Analog Switch 2—Normally Closed Terminal |
| 8         | 8    | V+   | Positive-Supply Voltage Input            |
| 9         | 9    | NC1  | Analog Switch 1—Normally Closed Terminal |
| 10        | 11   | COM1 | Analog Switch 1—Common Terminal          |
| —         | 6,10 | N.C. | No Connection                            |
| —         | EP   | EP   | Exposed Pad. Connect to ground.          |

### Detailed Description

The MAX4736 is a low 0.8Ω max (at V+ = 2.7V) onresistance, low-voltage, dual SPDT analog switch that operates from a 1.6V to 4.2V single supply. CMOS switch construction allows switching analog signals that range from GND to V+.

When powered from a 2.7V supply, the 0.8Ω max R<sub>ON</sub> allows high continuous currents to be switched in a variety of applications.

### Applications Information

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings; stresses beyond the listed ratings can cause permanent damage to the devices. Always sequence V+ on first, followed by NO<sub>-</sub>, NC<sub>-</sub>, or COM<sub>-</sub>.

Although it is not required, power-supply bypassing improves noise margin and prevents switching noise propagation from the V+ supply to other components. A 0.1μF capacitor, connected from V+ to GND, is adequate for most applications.

### Logic Inputs

The MAX4736 logic inputs can be driven up to 3.6V, regardless of the supply voltage. For example, with a 1.8V supply, IN<sub>-</sub> can be driven low to GND and high to 3.6V. Driving IN<sub>-</sub> rail-to-rail minimizes power consumption.

### Analog Signal Levels

Analog signals that range over the entire supply voltage (V+ to GND) can be passed with very little change in onresistance (see *Typical Operating Characteristics*). The switches are bidirectional, so the NO<sub>-</sub>, NC<sub>-</sub>, and COM<sub>-</sub> pins can be used as either inputs or outputs.

### Layout

High-speed switches require proper layout and design procedures for optimum performance. Reduce stray inductance and capacitance by keeping traces short and wide. Ensure that bypass capacitors are as close to the device as possible. Use large ground planes where possible.

### Test Circuits/Timing Diagrams

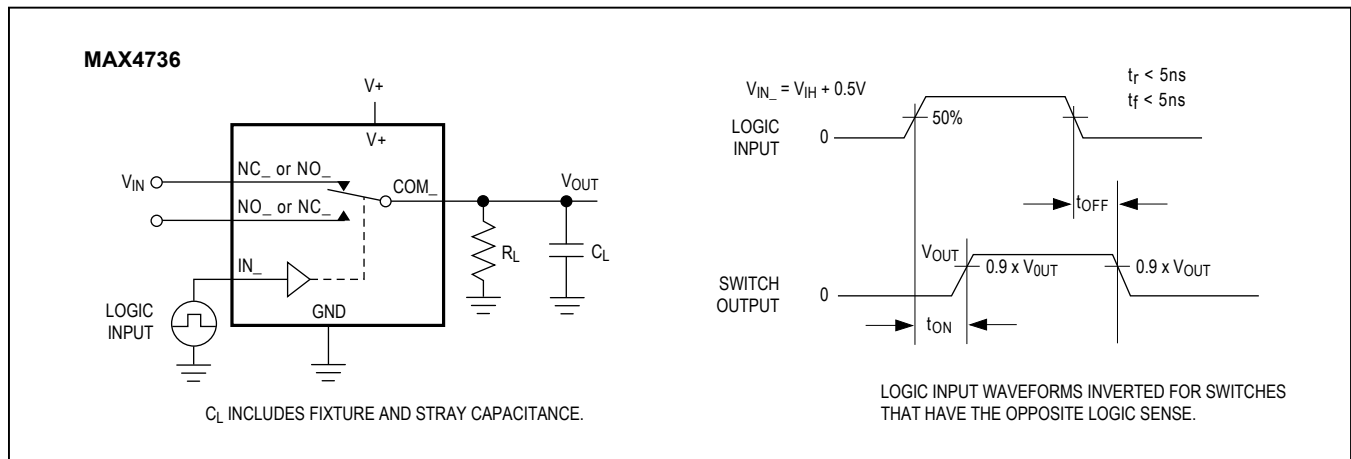


Figure 1. Switching Time

Test Circuits/Timing Diagrams (continued)

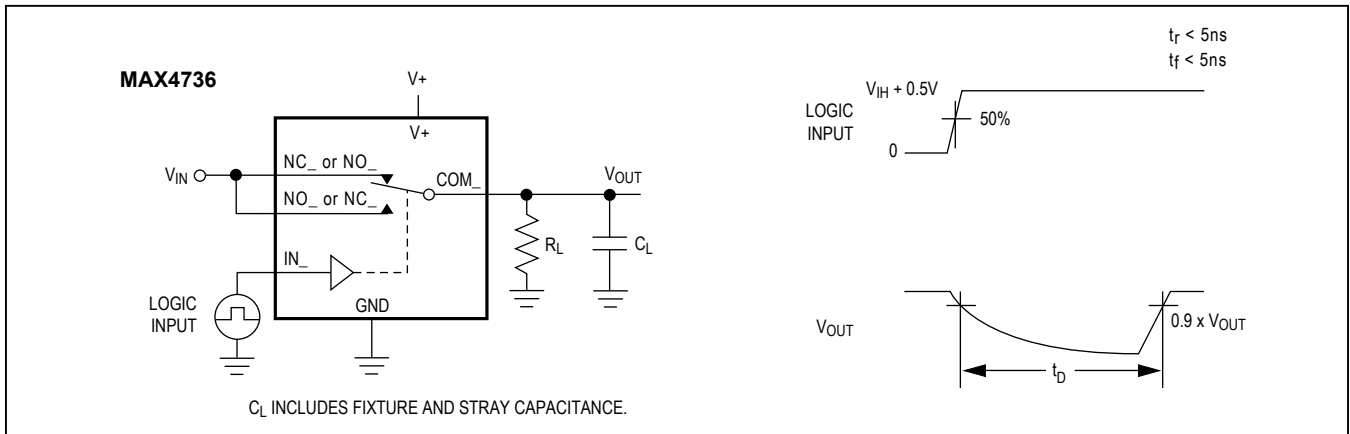


Figure 2. Break-Before-Make Interval

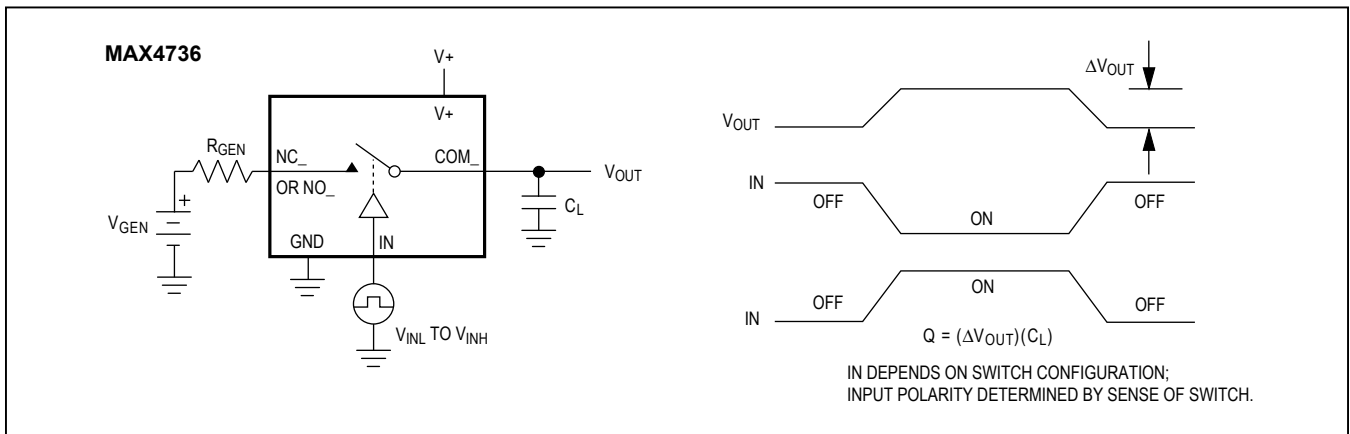


Figure 3. Charge Injection

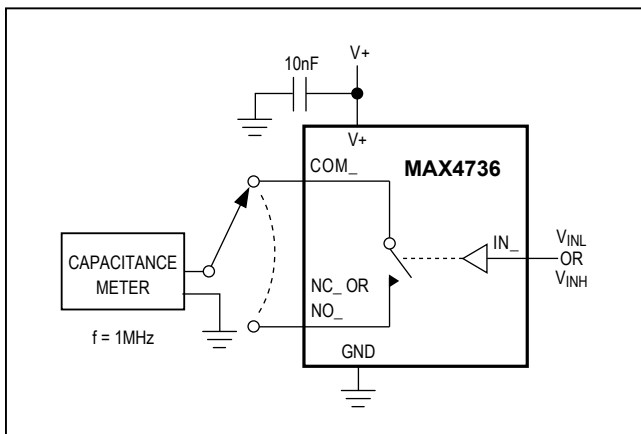


Figure 4. Channel Off/On-Capacitance

Chip Information

TRANSISTOR COUNT: 379

PROCESS: CMOS



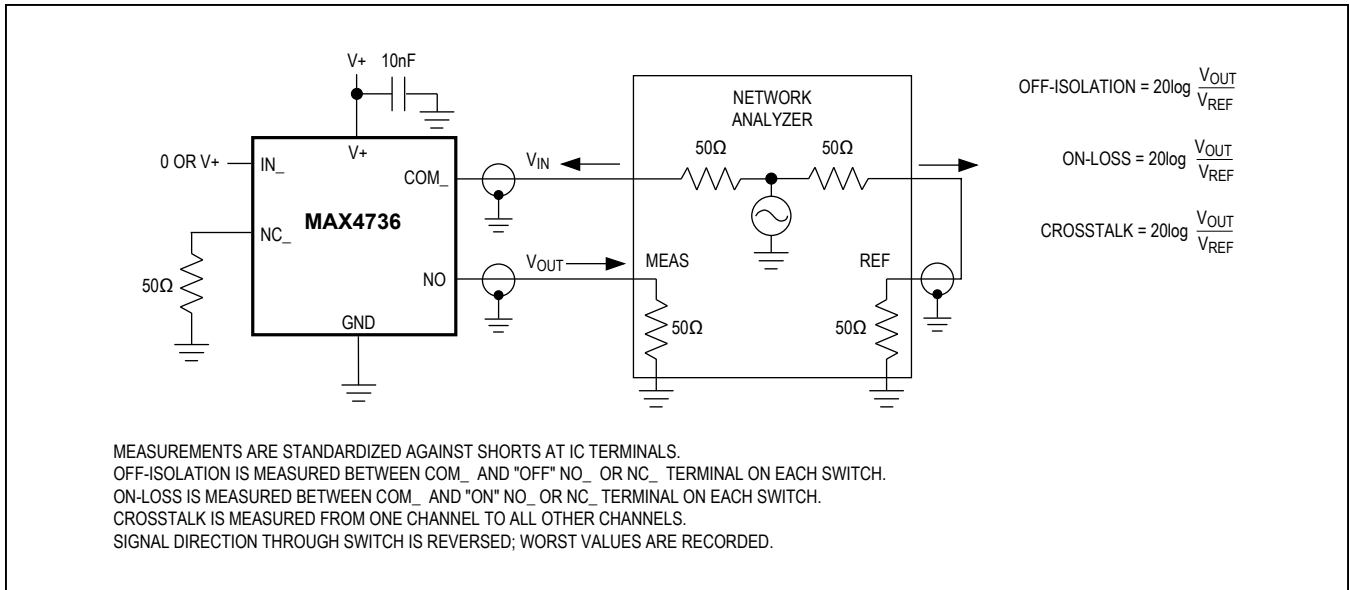


Figure 5. On-Loss, Off-Isolation, and Crosstalk

### Package Information

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | OUTLINE NO.             | LAND PATTERN NO.        |
|--------------|--------------|-------------------------|-------------------------|
| 10 MDFN      | L1022+1      | <a href="#">21-0164</a> | <a href="#">90-0006</a> |
| 10 MMAX      | U10+2        | <a href="#">21-0061</a> | <a href="#">90-0330</a> |
| 12 TQFN      | T1233+1      | <a href="#">21-0136</a> | <a href="#">90-0066</a> |