

Low-Voltage, Dual-Supply, SPDT Analog Switch with Enable

General Description

The MAX4564 is a low-voltage, dual-supply, single-pole/double-throw (SPDT) analog switch designed to operate from dual $\pm 1.8\text{V}$ to $\pm 6\text{V}$ or single $+1.8\text{V}$ to $+12\text{V}$ supplies. The low on-resistance ($R_{ON} = 40\Omega$ at $\pm 5\text{V}$) and low power consumption ($5\mu\text{W}$) make this part ideal for audio, video, and battery-powered applications. This switch offers low leakage currents (1nA max) and fast switching speeds ($t_{ON} = 60\text{ns}$ and $t_{OFF} = 40\text{ns}$ at $\pm 5\text{V}$, max).

The MAX4564 is available in 8-pin SOT23 and $\mu\text{MAX}^{\text{®}}$ packages.

Applications

Battery-Operated Systems
 Audio and Video Switching
 Test Equipment
 Communications Circuits
 Sample-and-Hold Circuits
 Communications Systems

Features

- ◆ **60 Ω max (40 Ω , typ) On-Resistance (R_{ON})**
- ◆ **3 Ω max (0.75 Ω , typ) R_{ON} Matching Between Channels**
- ◆ **10 Ω (max) R_{ON} Flatness**
- ◆ **Low Charge Injection: 3pC (typ)**
- ◆ **Low $\pm 1\text{nA}$ Leakage Current at $+25^{\circ}\text{C}$**
- ◆ **Fast Switching**
 $t_{ON} = 60\text{ns}$ (max)
 $t_{OFF} = 40\text{ns}$ (max)
- ◆ **Guaranteed Break-Before-Make Switching**
- ◆ **TTL/CMOS-Logic Compatible**
- ◆ **Low Crosstalk: -72dB (1MHz)**
- ◆ **High Off-Isolation: -77dB (1MHz)**
- ◆ **Bandwidth -3dB: >450MHz (typ)**
- ◆ **Available in an 8-Pin SOT23 Package**

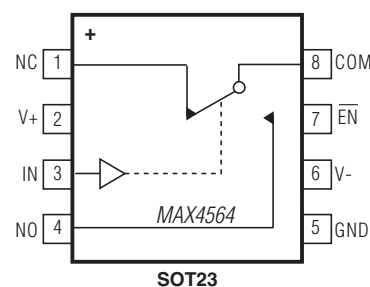
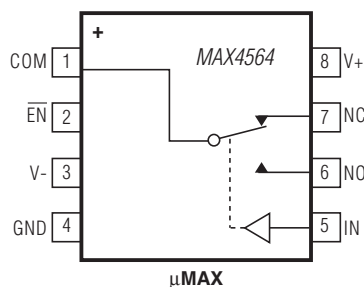
Ordering Information

| PART | TEMP RANGE | PIN PACKAGE | TOP MARK |
|-------------|--|-------------------|----------|
| MAX4564EKA+ | -40 $^{\circ}\text{C}$ to +85 $^{\circ}\text{C}$ | 8 SOT23 | AAEI |
| MAX4564EUA+ | -40 $^{\circ}\text{C}$ to +85 $^{\circ}\text{C}$ | 8 μMAX | — |

+Denotes a lead(Pb)-free/RoHS-compliant package.
 T = Tape and reel.

μMAX is a registered trademark of Maxim Integrated Products, Inc.

Functional Diagrams/Pin Configurations/Truth Table



| $\overline{\text{EN}}$ | IN | NC | NO |
|------------------------|----|-----|-----|
| 0 | 0 | ON | OFF |
| 0 | 1 | OFF | ON |
| 1 | X | OFF | OFF |

X = Don't care

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maximintegrated.com.

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ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)

| | | | |
|-----------------------------------|----------------------------|---|-----------------|
| V+ | -0.3V to +13V | Continuous Power Dissipation (T _A = +70°C) | |
| V- | -13V to +0.3V | SOT23 (derate 5.6mW/°C above +70°C) | 444.4mW |
| V+ to V- | -0.3V to +13V | μMAX (derate 4.5mW/°C above +70°C) | 362mW |
| EN, IN, COM, NC, NO (Note 1) | (V- - 0.3V) to (V+ + 0.3V) | Operating Temperature Range | |
| Continuous Current (any terminal) | ±20mA | MAX4564E_A | -40°C to +85°C |
| Peak Current, COM, NC, NO | | Junction Temperature | +150°C |
| (pulsed at 1ms, 10% duty cycle) | ±30mA | Storage Temperature Range | -65°C to +150°C |
| ESD per Method 3015.7 | >2kV | Lead Temperature (soldering, 10s) | +300°C |
| | | Soldering Temperature (reflow) | +260°C |

Note 1: Signals on NO, NC, COM, IN, or EN exceeding V+ or V- are clamped by internal diodes. Limit forward-diode 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—±5V Supply

(V+ = +4.5V to +6V, V- = -4.5V to -6V, V_{IH} = +2.4V, V_{IL} = +0.8V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---|--|---|----------------|------|------|-----|-------|
| ANALOG SWITCH | | | | | | | |
| Analog Signal Range | V _{COM} , V _{NO} , V _{NC} | | | V- | | V+ | V |
| On-Resistance | R _{ON} | V+ = +4.5V, V- = -4.5V, I _{COM} = 1mA; V _{NO} , V _{NC} = ±3.5V | +25°C | 40 | 60 | | Ω |
| | | | E | | | 100 | |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | V+ = +4.5V, V- = -4.5V, I _{COM} = 1mA; V _{NO} , V _{NC} = ±3.5V | +25°C | 0.75 | 3 | | Ω |
| | | | E | | | 4 | |
| On-Resistance Flatness (Note 5) | R _{FLAT(ON)} | V+ = +4.5V, V- = -4.5V, I _{COM} = 1mA; V _{NO} , V _{NC} = -3.5V, 0, +3.5V | +25°C | 6.5 | 10 | | Ω |
| | | | E | | | 13 | |
| NO or NC Off-Leakage Current | I _{NC(OFF)} or I _{NO(OFF)} | V+ = +5.5V, V- = -5.5V; V _{COM} = +4.5V, -4.5V; V _{NO} , V _{NC} = -4.5, +4.5V | +25°C | -1 | 0.05 | 1 | nA |
| | | | E | -5 | | 5 | |
| COM Off-Leakage Current | I _{COM(OFF)} | V+ = +5.5V, V- = -5.5V; V _{COM} = +4.5V, -4.5V; V _{NO} , V _{NC} = -4.5, +4.5V | +25°C | -1 | 0.05 | 1 | nA |
| | | | E | -5 | | 5 | |
| COM On-Leakage Current | I _{COM(ON)} | V+ = +5.5V, V- = -5.5V, V _{COM} = +4.5V, -4.5V; V _{NO} , V _{NC} = +4.5V, -4.5V, or unconnected | +25°C | -2 | 0.05 | 2 | nA |
| | | | E | -10 | | 10 | |

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ELECTRICAL CHARACTERISTICS—±5V Supply (continued)

(V+ = +4.5V to +6V, V- = -4.5V to -6V, V_{IH} = +2.4V, V_{IL} = +0.8V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---|-----------------------|---|----------------|-----|--------|-----|-------|
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO} , V _{NC} = +3V, -3V, R _L = 1kΩ, C _L = 35pF | +25°C | 40 | 60 | ns | |
| | | | E | 75 | | | |
| Turn-Off Time | t _{OFF} | V _{NO} , V _{NC} = +3V, -3V, R _L = 1kΩ, C _L = 35pF | +25°C | 28 | 40 | ns | |
| | | | E | 50 | | | |
| Transition Time | t _{TRANS} | V _{NC} = +3V, V _{NO} = -3V, V _{NC} = -3V, V _{NO} = +3V, R _L = 1kΩ, C _L = 35pF | +25°C | 50 | 70 | ns | |
| | | | E | 85 | | | |
| Break-Before-Make Time (Note 6) | t _{BBM} | V _{NO} , V _{NC} = +3V, -3V, R _L = 300Ω, C _L = 35pF | +25°C | 5 | 15 | ns | |
| Charge Injection | Q | V _{GEN} = 0, R _{GEN} = 0, C _L = 100pF | +25°C | | 3 | pC | |
| -3dB Bandwidth | f _{-3dB} | R _L = 50Ω, C _L = 10pF, f _{0dB} = 1MHz | +25°C | | 450 | MHz | |
| Off-Isolation (Note 7) | V _{ISO} | R _L = 50Ω, C _L = 10pF, f _{IN} = 1MHz | +25°C | | -77 | dB | |
| Crosstalk (Control Input to Signal Output) | | R _L = 50Ω, C _L = 10pF, V+ = +4.5V, V- = -4.5V, f _{IN} = 1MHz, V _{EN} = V _{IH} | +25°C | | 68 | mV | |
| Crosstalk (Between Switches) | V _{CT} | R _L = 50Ω, C _L = 10pF, f _{IN} = 1MHz | +25°C | | -72 | dB | |
| Total Harmonic Distortion | THD | R _L = 600kΩ, C _L = 50pF, f _{IN} = 20kHz | +25°C | | 0.15 | % | |
| Control Input Capacitance | C _{IN} | | | | 3 | pF | |
| NO or NC Off-Capacitance | C _{OFF} | f _{IN} = 1MHz | +25°C | | 6 | pF | |
| COM Off-Capacitance | C _{COM(OFF)} | f _{IN} = 1MHz | +25°C | | 8 | pF | |
| COM On-Capacitance | C _{COM(ON)} | f _{IN} = 1MHz | +25°C | | 14 | pF | |
| LOGIC INPUT | | | | | | | |
| Input Voltage Low | V _{IL} | | | | | 0.8 | V |
| Input Voltage High | V _{IH} | | | 2.4 | | | V |
| Input Leakage Current | I _L | V+ = +5.5V, V- = -5.5V, V _{IN} = V _{EN} = 0 or +5.5V | +25°C | -1 | 0.0001 | 1 | μA |
| | | | E | -10 | 10 | | |
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | V+ | | | 2 | | 6 | V |
| | V- | | | -2 | | -6 | |
| Positive Supply Current | I+ | V+ = +5.5V, V- = -5.5V, V _{IN} = V _{EN} = 0 or +5.5V | +25°C | -1 | 0.0001 | 1 | μA |
| | | | E | -10 | 10 | | |
| Negative Supply Current | I- | V+ = +5.5V, V- = -5.5V, V _{IN} = V _{EN} = 0 or +5.5V | +25°C | -1 | 0.0001 | 1 | μA |
| | | | E | -10 | 10 | | |

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ELECTRICAL CHARACTERISTICS—Single +5V Supply

(V+ = +4.5V to +6V, V- = 0, V_{IH} = +2.4V, V_{IL} = +0.8V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---|--|---|----------------|-----|--------|-----|-------|
| ANALOG SWITCH | | | | | | | |
| Analog Signal Range | V _{COM} , V _{NO} , V _{NC} | | | 0 | | V+ | V |
| On-Resistance | R _{ON} | V+ = +4.5V, V- = 0, I _{COM} = 1mA; V _{NO} , V _{NC} = +3.5 V | +25°C | | 72 | 100 | Ω |
| | | | E | | | 125 | |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | V+ = +4.5V, V- = 0, I _{COM} = 1mA; V _{NO} , V _{NC} = +3.5 V | +25°C | | 0.75 | 5 | Ω |
| | | | E | | | 7 | |
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO} , V _{NC} = +3V, R _L = 1kΩ, C _L = 35pF | +25°C | | 62 | 90 | ns |
| | | | E | | | 125 | |
| Turn-Off Time | t _{OFF} | V _{NO} , V _{NC} = +3V, R _L = 1kΩ, C _L = 35pF | +25°C | | 22 | 60 | ns |
| | | | E | | | 75 | |
| Transition Time | t _{TRANS} | V _{NC} = +3V, V _{NO} = 0, V _{NC} = 0, V _{NO} = +3V, R _L = 1kΩ, C _L = 35pF | +25°C | | 68 | 100 | ns |
| | | | E | | | 130 | |
| Break-Before-Make Time (Note 6) | t _{BBM} | V _{NO} , V _{NC} = +3V, R _L = 300Ω, C _L = 35pF | E | 10 | 35 | | ns |
| LOGIC INPUT | | | | | | | |
| Input Voltage Low | V _{IL} | | | | | 0.8 | V |
| Input Voltage High | V _{IH} | | | 2.4 | | | V |
| Input Leakage Current | I _L | V+ = +5.5V, V- = 0, V _{IN} = V _{EN} = 0 or +5.5V | +25°C | -1 | 0.0001 | 1 | μA |
| | | | E | -10 | | 10 | |
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | V+ | | | 1.8 | | 12 | V |
| Positive Supply Current | I+ | V+ = +5.5V, V- = 0, V _{IN} = V _{EN} = 0 or +5.5V | +25°C | -1 | 0.0001 | 1 | μA |
| | | | E | -10 | | 10 | |
| Negative Supply Current | I- | V+ = +5.5V, V- = 0, V _{IN} = V _{EN} = 0 or +5.5V | +25°C | -1 | 0.0001 | 1 | μA |
| | | | E | -10 | | 10 | |

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ELECTRICAL CHARACTERISTICS—Single +3V Supply

($V_+ = +2.7V$ to $+3.3V$, $V_- = 0$, $V_{IH} = +2.4V$, $V_{IL} = +0.8V$, $GND = 0$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25^\circ C$.) (Notes 2, 3)

| PARAMETER | SYMBOL | CONDITIONS | T_A | MIN | TYP | MAX | UNITS |
|---|------------------------------------|--|---------------|-----|--------|-------|----------|
| ANALOG SWITCH | | | | | | | |
| Analog Signal Range | V_{COM} , V_{NO} , V_{NC} | | | 0 | | V_+ | V |
| On-Resistance | R_{ON} | $V_+ = +2.7V$, $V_- = 0$, $I_{COM} = 1mA$; V_{NO} , $V_{NC} = +1.5V$ | $+25^\circ C$ | 160 | 275 | | Ω |
| | | | E | | 300 | | |
| On-Resistance Match Between Channels (Note 4) | ΔR_{ON} | $V_+ = +2.7V$, $V_- = 0$, $I_{COM} = 1mA$; V_{NO} , $V_{NC} = +1.5V$ | $+25^\circ C$ | 1.5 | 10 | | Ω |
| | | | E | | 12 | | |
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | | |
| Turn-On Time | t_{ON} | V_{NO} , $V_{NC} = +1.5V$, $R_L = 2k\Omega$, $C_L = 35pF$ | $+25^\circ C$ | 120 | 250 | | ns |
| | | | E | | 275 | | |
| Turn-Off Time | t_{OFF} | V_{NO} , $V_{NC} = +1.5V$, $R_L = 2k\Omega$, $C_L = 35pF$ | $+25^\circ C$ | 40 | 110 | | ns |
| | | | E | | 125 | | |
| Break-Before-Make Time (Note 6) | t_{BBM} | V_{NO} , $V_{NC} = +1.5V$, $R_L = 2k\Omega$, $C_L = 35pF$ | E | 10 | | | ns |
| LOGIC INPUT | | | | | | | |
| Input Voltage Low | V_{IL} | | | | | 0.8 | V |
| Input Voltage High | V_{IH} | | | 2.4 | | | V |
| Input Leakage Current | I_L | $V_+ = +3.3V$, $V_- = 0$, $V_{IN} = V_{\overline{EN}} = 0$ or $+3.3V$ | $+25^\circ C$ | -1 | 0.0001 | 1 | μA |
| | | | E | -10 | | 10 | |

Note 2: The algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.

Note 3: SOT-packaged products are 100% tested at $+25^\circ C$ and guaranteed by design at the full-rated temperature.

Note 4: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.

Note 5: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

Note 6: Guaranteed by design.

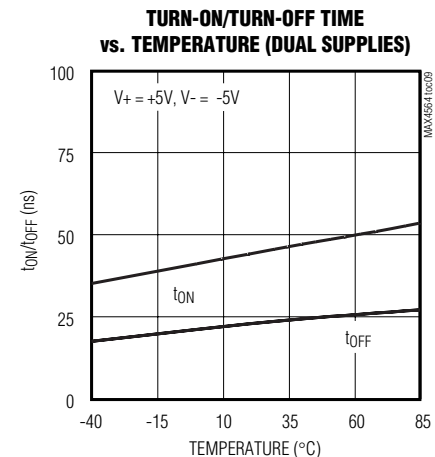
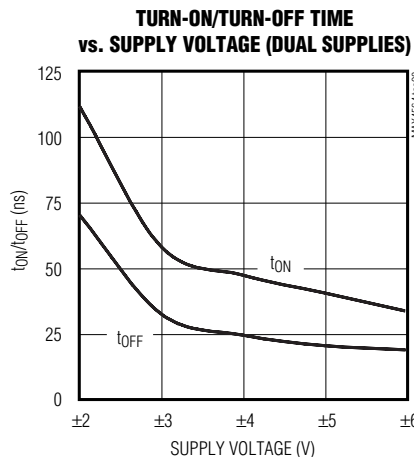
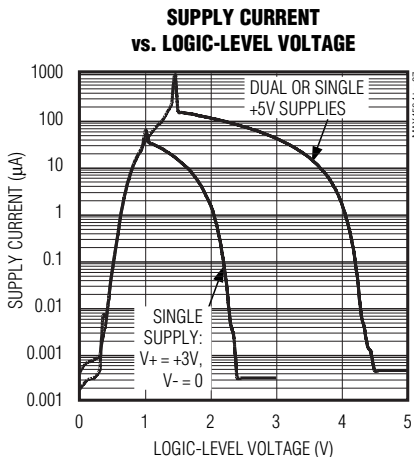
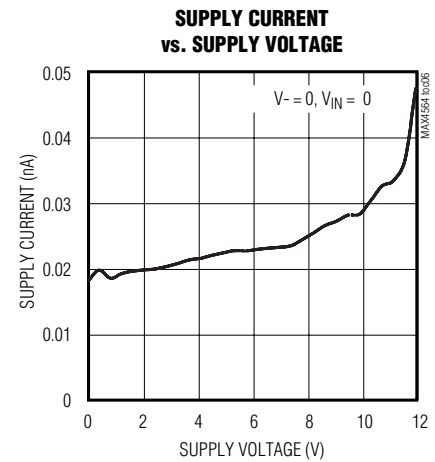
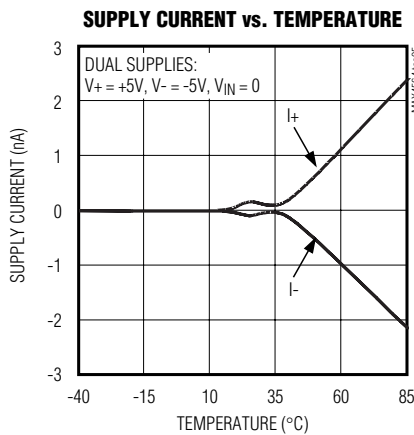
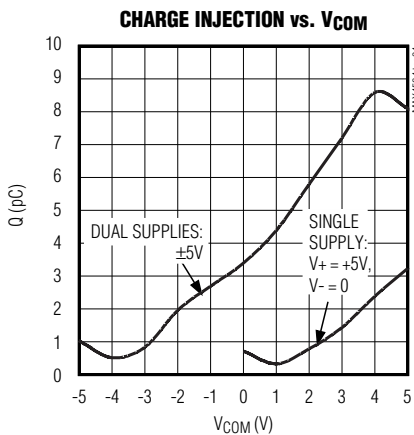
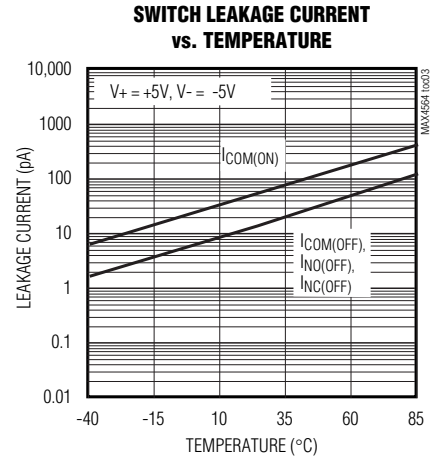
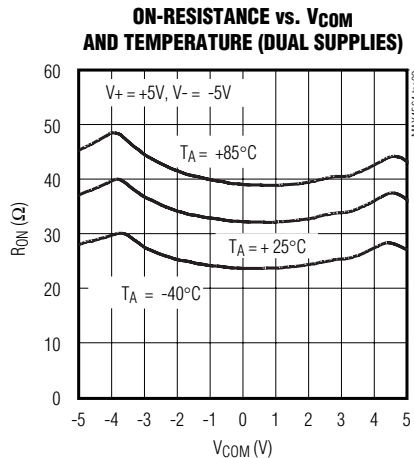
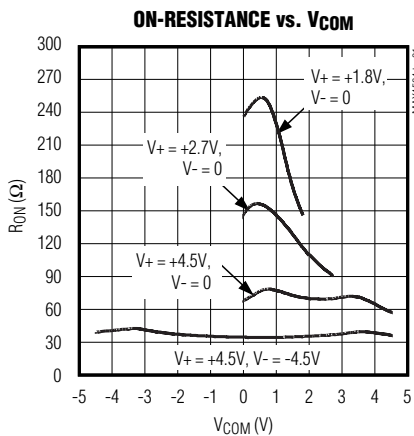
Note 7: Off-Isolation = $20\log_{10}(V_{COM} / V_{NO})$, V_{NO} = input to off switch.

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Typical Operating Characteristics

($T_A = +25^\circ\text{C}$, unless otherwise noted.)

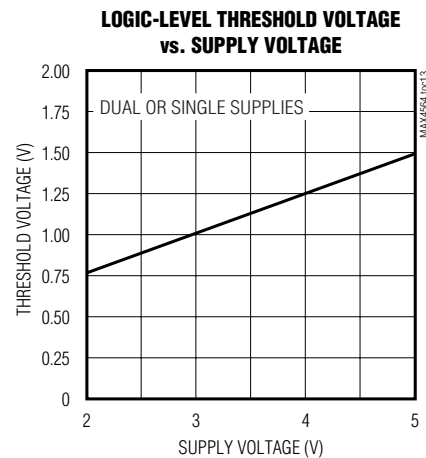
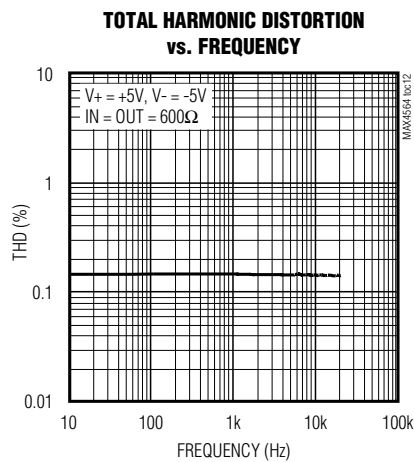
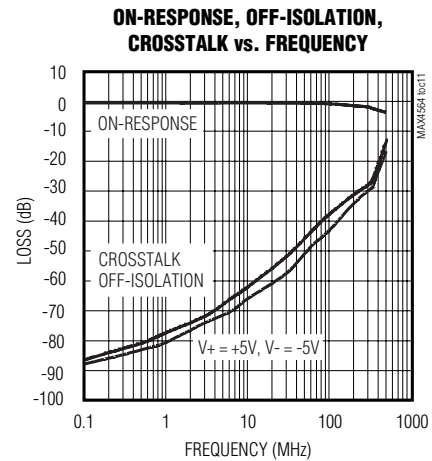
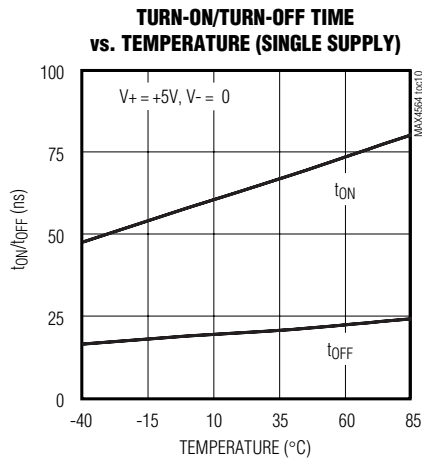


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Typical Operating Characteristics (continued)

($T_A = +25^\circ\text{C}$, unless otherwise noted.)



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Pin Description

| μ MAX | SOT23 | NAME | FUNCTION |
|-----------|-------|------------------------|---|
| 1 | 8 | COM | Analog Switch Common |
| 2 | 7 | $\overline{\text{EN}}$ | Device Enable. Drive $\overline{\text{EN}}$ low for normal SPDT switch operation. If $\overline{\text{EN}}$ is high, both NO and NC are disconnected. |
| 3 | 6 | V- | Negative Supply Voltage |
| 4 | 5 | GND | Ground |
| 5 | 3 | IN | Digital Control Input |
| 6 | 4 | NO | Analog Switch Normally Open |
| 7 | 1 | NC | Analog Switch Normally Closed |
| 8 | 2 | V+ | Positive Supply Voltage |

Detailed Description

The MAX4564 is a dual-supply SPDT CMOS analog switch. The MAX4564 has break-before-make switching. The CMOS switch construction provides Rail-to-Rail[®] signal handling while consuming virtually no power. Each of the two switches is independently controlled by a TTL/CMOS-level-compatible digital input.

Applications Information

Overvoltage Protection

Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the device. Proper power-supply sequencing is recommended for all CMOS devices. Always sequence V+ on first, then V-, followed by the logic inputs NO, NC, or COM. If power-supply sequencing is not possible, add two small-signal diodes (D1, D2) in series with supply pins. Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the device's low switch resistance and low leakage characteristics.

Test Circuits/ Timing Diagrams

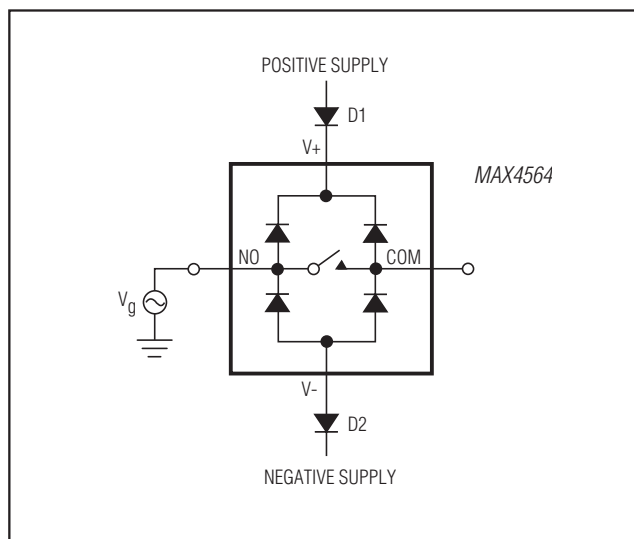


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

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Test Circuits/Timing Diagrams (continued)

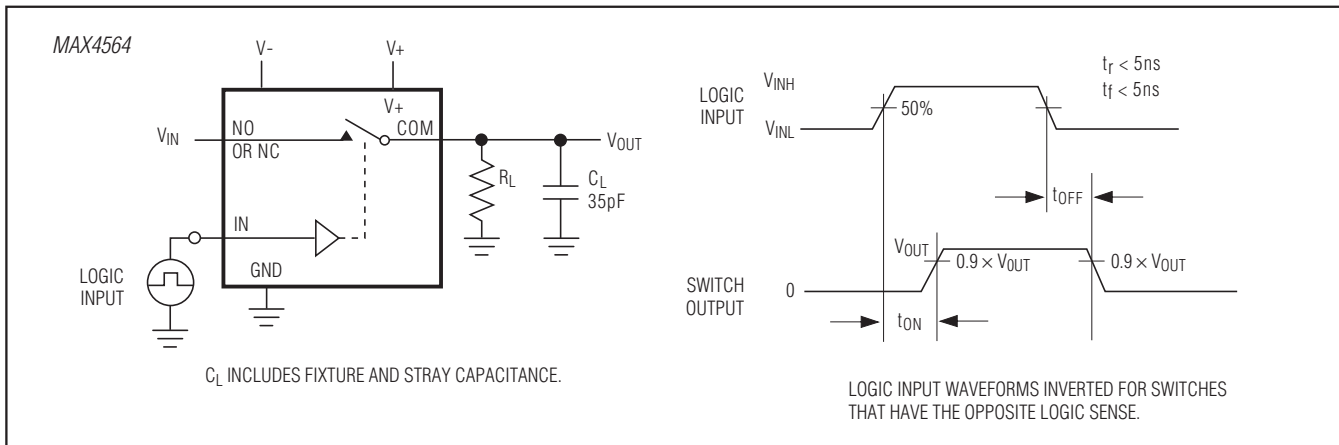


Figure 2. Switching Time

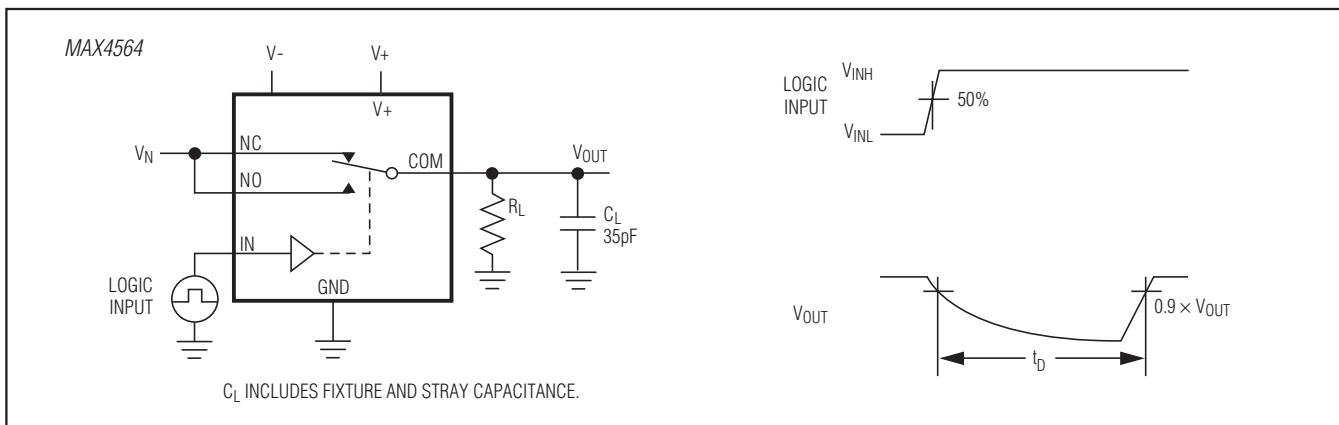


Figure 3. Break-Before-Make Interval

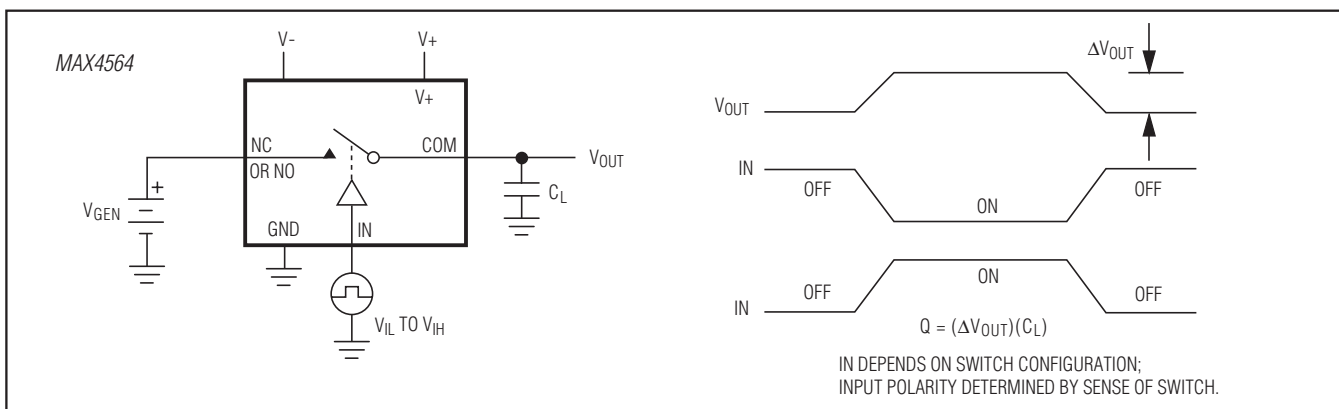


Figure 4. Charge Injection

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Test Circuits/Timing Diagrams (continued)

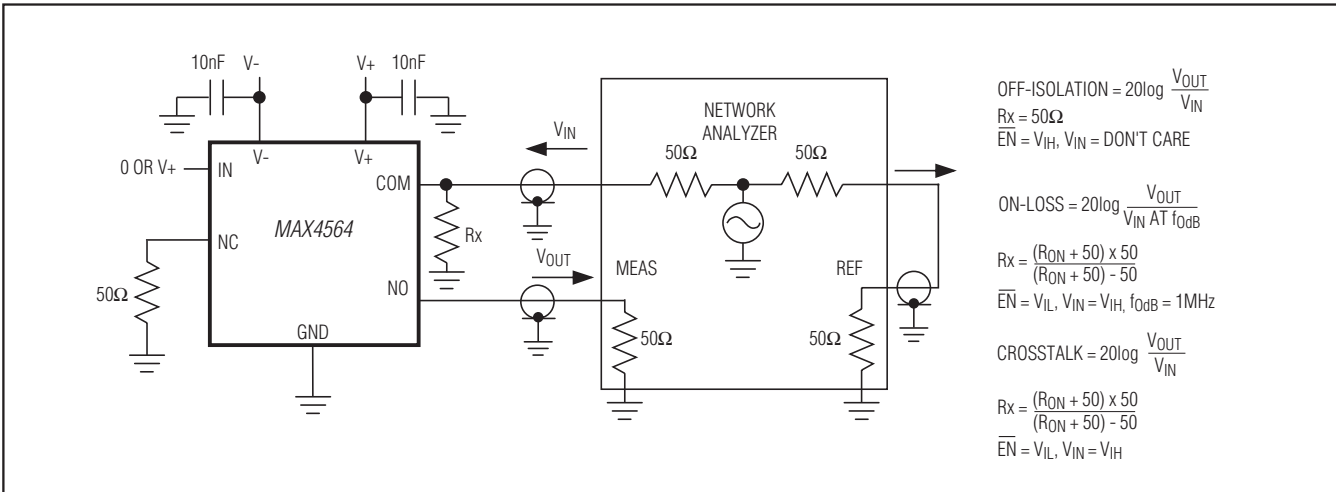


Figure 5. On-Loss, Off-Isolation, and Crosstalk

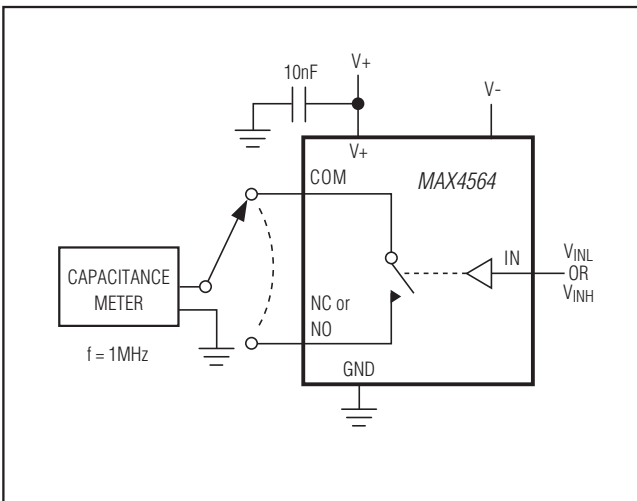


Figure 6. Channel Off/On-Capacitance

Chip Information

PROCESS : CMOS

Package Information

For the latest package outline information and land patterns (footprints), go to 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. |
|--------------|--------------|-------------------------|-------------------------|
| 8 SOT23 | K8SN+1 | 21-0078 | 90-0176 |
| 8 SO | U8+1 | 21-0036 | 90-0092 |

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Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|-----------------|---------------|--|---------------|
| 2 | 10/12 | Added lead-free designation to the part numbers in the <i>Ordering Information</i> | 1 |



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