



**THE DATASHEET OF
MAX4608ESE+T**



MAX4607/MAX4608/ MAX4609

2.5Ω, Dual, SPST, CMOS Analog Switches

General Description

The MAX4607/MAX4608/MAX4609 dual analog switches feature low on-resistance of 2.5Ω max. On-resistance is matched between switches to 0.5Ω max and is flat (0.5Ω max) over the specified signal range. Each switch can handle rail-to-rail analog signals. The off-leakage current is only 2.5nA max at +85°C. These analog switches are ideal in low-distortion applications and are the preferred solution over mechanical relays in automatic test equipment or applications where current switching is required. They have low power requirements, require less board space, and are more reliable than mechanical relays.

The MAX4607 has two normally closed (NC) switches, the MAX4608 has two normally open (NO) switches, and the MAX4609 has one NC and one NO switch.

These switches operate from a single supply of +4.5V to +36V or from dual supplies of ±4.5V to ±20V. All digital inputs have +0.8V and +2.4V logic thresholds, ensuring TTL/CMOS-logic compatibility when using dual ±15V or a single +12V supply.

Applications

| | |
|------------------------|----------------------|
| Reed Relay Replacement | PBX, PABX Systems |
| Test Equipment | Audio-Signal Routing |
| Communication Systems | Avionics |

Features

- ◆ Low On-Resistance (2.5Ω max)
- ◆ Guaranteed R_{ON} Match Between Channels (0.5Ω max)
- ◆ Guaranteed R_{ON} Flatness over Specified Signal Range (0.5Ω max)
- ◆ Rail-to-Rail Signal Handling
- ◆ Guaranteed ESD Protection > 2kV per Method 3015.7
- ◆ Single-Supply Operation: +4.5V to +36V
Dual-Supply Operation: ±4.5V to ±20V
- ◆ TTL/CMOS-Compatible Control Inputs

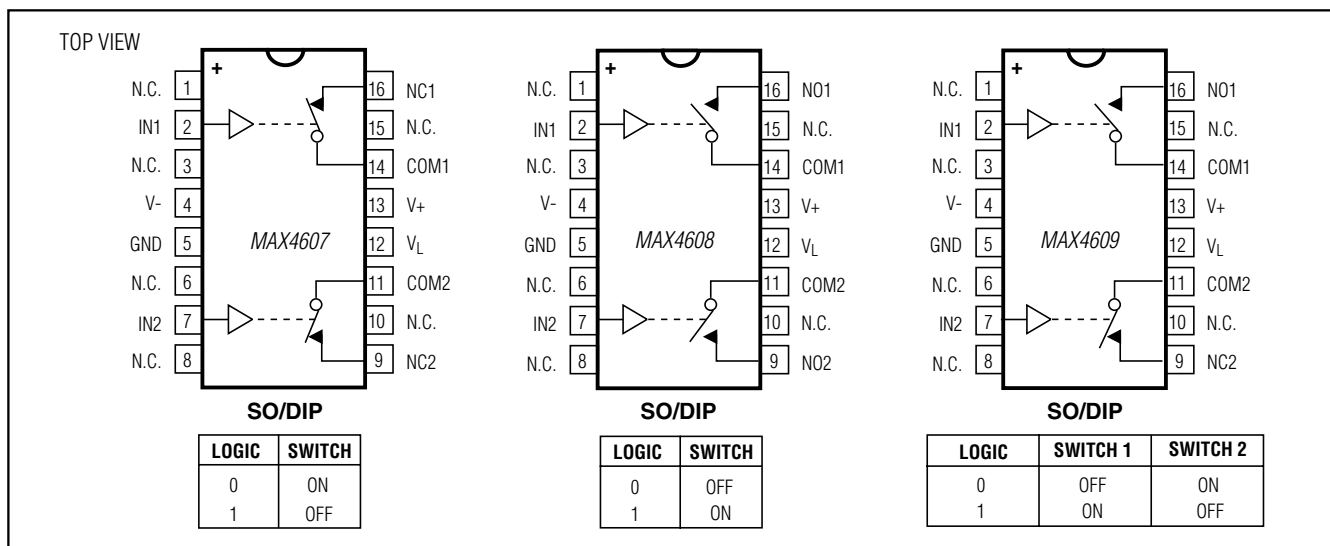
Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|------------|----------------|----------------|
| MAX4607CSE | 0°C to +70°C | 16 Narrow SO |
| MAX4607CPE | 0°C to +70°C | 16 Plastic DIP |
| MAX4607ESE | -40°C to +85°C | 16 Narrow SO |
| MAX4607EPE | -40°C to +85°C | 16 Plastic DIP |

Ordering information continued at end of data sheet.

Devices are also available in a lead(Pb)-free/RoHS-compliant package. Specify lead-free by adding "+" to the part number when ordering.

Pin Configurations/Functional Diagrams/Truth Tables



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

| | |
|---|-----------------------------|
| V+ to GND | -0.3V to +44V |
| V- to GND | +0.3V to -44V |
| V+ to V- | -0.3V to +44V |
| V _L to GND | (GND - 0.3V) to (V+ + 0.3V) |
| All Other Pins to GND (Note 1) | (V- - 0.3V) to (V+ + 0.3V) |
| Continuous Current (COM ₋ , NO ₋ , NC ₋) | ±100mA |
| Peak Current (COM ₋ , NO ₋ , NC ₋) (pulsed at 1ms, 10% duty cycle) | ±300mA |
| Continuous Power Dissipation (T _A = +70°C) | |
| Narrow SO (derate 8.70mW/°C above +70°C) | .696mW |
| Plastic DIP (derate 10.53mW/°C above +70°C) | .842mW |

Operating Temperature Ranges

| | |
|-----------------------------------|-----------------|
| MAX460_C_E | 0°C to +70°C |
| MAX460_E_E | -40°C to +85°C |
| Soldering Temperature (reflow) | |
| Lead(Pb)-Free Packages | +260°C |
| Packages Containing Lead(Pb) | +240°C |
| Storage Temperature Range | -65°C to +160°C |
| Lead Temperature (soldering, 10s) | +300°C |

Note 1: Signals on NC₋, NO₋, COM₋, or IN₋, exceeding V+ or V- will be 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—Dual Supplies

(V+ = +15V, V- = -15V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | | |
|---|--|---|--|--------|--------|-------|------|----|
| ANALOG SWITCH | | | | | | | | |
| Input Voltage Range (Note 3) | V _{COM₋} , V _{NO₋} , V _{NC₋} | | V- | | V+ | V | | |
| COM ₋ to NO ₋ , COM ₋ to NC ₋ On-Resistance | R _{ON} | I _{COM₋} = 10mA, V _{NO₋} or V _{NC₋} = ±10V | T _A = +25°C | | 1.6 | 2.5 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | 3 | | | |
| COM ₋ to NO ₋ , COM ₋ to NC ₋ On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | I _{COM₋} = 10mA, V _{NO₋} or V _{NC₋} = -5V, 0, 5V | T _A = +25°C | | 0.05 | 0.4 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | 0.5 | | | |
| COM ₋ to NO ₋ , COM ₋ to NC ₋ On-Resistance Flatness (Note 5) | R _{FLAT(ON)} | I _{COM₋} = 10mA, V _{NO₋} or V _{NC₋} = ±10V | T _A = +25°C | | 0.1 | 0.4 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | 0.5 | | | |
| Off-Leakage Current (NO ₋ or NC ₋) (Note 6) | I _{NO₋} , I _{NC₋} | V _{COM₋} = ±10V, V _{NO₋} or V _{NC₋} = ±10V | T _A = +25°C | | -0.5 | +0.01 | +0.5 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | -2.5 | +2.5 | | |
| | | | | M | -30 | 30 | | |
| COM ₋ Off-Leakage Current (Note 6) | I _{COM₋(OFF)} | V _{COM₋} = ±10V, V _{NO₋} or V _{NC₋} = ±10V | T _A = +25°C | | -0.5 | +0.01 | 0.5 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | -2.5 | +2.5 | | |
| | | | | M | -30 | 30 | | |
| COM ₋ On-Leakage Current (Note 6) | I _{COM₋(ON)} | V _{COM₋} = ±10V, V _{NO₋} or V _{NC₋} = ±10V or unconnected | T _A = +25°C | | 1 | 0.02 | 1 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | -10 | 10 | | |
| | | | | M | -120 | +120 | | |
| LOGIC INPUT | | | | | | | | |
| Input Current with Input Voltage High | I _{IN_H} | V _{IN₋} = 2.4V, all others = 0.8V | -0.500 | +0.001 | +0.500 | μA | | |
| Input Current with Input Voltage Low | I _{IN_L} | V _{IN₋} = 0.8V, all others = 2.4V | -0.500 | +0.001 | +0.500 | μA | | |

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ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +15V, V- = -15V, VL = +5V, VIN_H = +2.4V, VIN_L = +0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|---------------------------------------|--------|--|-------------------|------|--------|-------|----|
| Logic Input High Voltage | VIN_H | | 2.4 | 1.7 | | V | |
| Logic Input Low Voltage | VIN_L | | | 1.7 | 0.8 | V | |
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | | | ±4.5 | | ±20.0 | V | |
| Positive Supply Current | I+ | VIN = 0 or 5V | TA = +25°C | -0.5 | +0.001 | +0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | +5 | |
| Negative Supply Current | I- | VIN = 0 or 5V | TA = +25°C | -0.5 | +0.001 | +0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | +5 | |
| Logic Supply Current | C | VIN = 0 or 5V | TA = +25°C | -0.5 | +0.001 | +0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | +5 | |
| Ground Current | IGND | VIN = 0 or 5V | TA = +25°C | -0.5 | +0.001 | +0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | +5 | |
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | | |
| Turn-On Time | TON | VCOM_ = ±10V, Figure 2, TA = +25°C | | 110 | | ns | |
| Turn-Off Time | TOFF | VCOM_ = ±10V, Figure 2, TA = +25°C | | 150 | | ns | |
| Charge Injection | Q | CL = 1.0nF, VGEN = 0, RGEN = 0, Figure 3, TA = +25°C | | 45 | | pC | |
| Off-Isolation (Note 7) | VISO | RL = 50Ω, CL = 5pF, f = 1MHz, Figure 4, TA = +25°C | | -60 | | dB | |
| Crosstalk (Note 8) | VCT | RL = 50Ω, CL = 5pF, f = 1MHz, Figure 5, TA = +25°C | | -66 | | dB | |
| NC_ or NO_ Capacitance | COFF | F = 1MHz, Figure 6, TA = +25°C | | 65 | | pF | |
| COM_ Off-Capacitance | CCOM | F = 1MHz, Figure 6, TA = +25°C | | 65 | | pF | |
| On-Capacitance | CCOM | F = 1MHz, Figure 7, TA = +25°C | | 290 | | pF | |

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ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0V, VL = +5V, VIN_H = +2.4V, VIN_L = +0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|--|-------------------|---|-------------------|--------|--------|-------|----|
| ANALOG SWITCH | | | | | | | |
| Input Voltage Range (Note 3) | VCOM_, VNO_, VNC_ | | VGND | | V+ | V | |
| COM_ to NO_, COM_ to NC_ On-Resistance | RON | ICOM_ = 10mA, VNO_ or VNC_ = 10V | TA = +25°C | 3 | 6 | Ω | |
| | | | TA = TMIN to TMAX | | 7 | | |
| COM_ to NO_, COM_ to NC_ On-Resistance Match Between Channels (Note 4) | ΔRON | ICOM_ = 10mA, VNO_ or VNC_ = 10V | TA = +25°C | 0.05 | 0.4 | Ω | |
| | | | TA = TMIN to TMAX | | 0.5 | | |
| COM_ to NO_, COM_ to NC_ On-Resistance Flatness (Note 5) | RFLAT(ON) | ICOM_ = 10mA, VNO_ or VNC_ = 3V, 6V, 0V | TA = +25°C | 0.05 | 1.1 | Ω | |
| | | | TA = TMIN to TMAX | | 1.2 | | |
| Off-Leakage Current (NO_ or NC_) (Notes 6, 9) | INO_ INC_ | VCOM_ = 1V, 10V, VNO_ or VNC_ = 1V, 10V | TA = +25°C | -0.5 | +0.01 | +0.5 | nA |
| | | | TA = TMIN to TMAX | -2.5 | | 2.5 | |
| COM Off-Leakage Current (Notes 6, 9) | ICOM(OFF) | VCOM_ = 10V, 1V, VNO_ or VNC_ = 1V, 10V | TA = +25°C | -0.5 | +0.01 | +0.5 | nA |
| | | | TA = TMIN to TMAX | -2.5 | | +2.5 | |
| COM On-Leakage Current (Notes 6, 9) | ICOM(ON) | VCOM_ = 1V, 10V, VNO_ or VNC_ = 1V, 10V, or unconnected | TA = +25°C | -1 | +0.01 | +1 | nA |
| | | | TA = TMIN to TMAX | -10 | | +10 | |
| LOGIC INPUT | | | | | | | |
| Input Current with Input Voltage High | IIN_H | VIN_ = 2.4V, all others = 0.8V | -0.500 | +0.001 | +0.500 | μA | |
| Input Current with Input Voltage Low | IIN_L | VIN_ = 0.8V, all others = 2.4V | -0.500 | +0.001 | +0.500 | μA | |
| Logic Input High Voltage | VIN_H | | 2.4 | 1.7 | | V | |
| Logic Input Low Voltage | VIN_L | | | 1.7 | 0.8 | V | |

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ELECTRICAL CHARACTERISTICS—Single Supply (continued)

(V₊ = +12V, V₋ = 0V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|---------------------------------------|--------------------|--|---|------|--------|-------|----|
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | | | +4.5 | | +36.0 | V | |
| Positive Supply Current | I ₊ | V _{IN} = 0V or 5V | T _A = +25°C | -0.5 | +0.001 | +0.5 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | +5 | |
| Logic Supply Current | I _L | V _{IN} = 0V or 5V | T _A = +25°C | -0.5 | +0.001 | +0.5 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | +5 | |
| Ground Current | I _{GND} | V _{IN} = 0V or 5V | T _A = +25°C | -0.5 | +0.001 | +0.5 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | +5 | |
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | | |
| Turn-On Time | t _{ON} | V _{COM_} = 10V, Figure 2, T _A = +25°C | | 110 | | ns | |
| Turn-Off Time | t _{OFF} | V _{COM_} = 10V, Figure 2, T _A = +25°C | | 130 | | ns | |
| Charge Injection | Q | C _L = 1.0nF, V _{GEN} = 0V, R _{GEN} = 0Ω, Figure 3, T _A = +25°C | | 50 | | pC | |
| Crosstalk (Note 8) | V _{CT} | R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 5, T _A = +25°C | | 66 | | dB | |
| NC or NO Capacitance | C _(OFF) | f = 1MHz, Figure 6, T _A = +25°C | | 105 | | pF | |
| COM Off-Capacitance | C _(COM) | f = 1MHz, Figure 6, T _A = +25°C | | 105 | | pF | |
| On-Capacitance | C _(COM) | f = 1MHz, Figure 7, T _A = +25°C | | 185 | | pF | |

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

Note 3: Guaranteed by design.

Note 4: ΔRON = RON(MAX) - RON(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 range.

Note 6: Leakage parameters are 100% tested at maximum-rated hot temperature and guaranteed by correlation at +25°C.

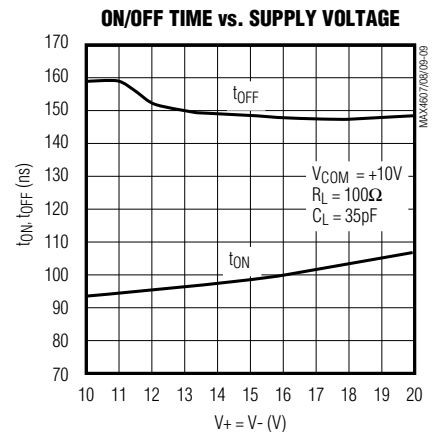
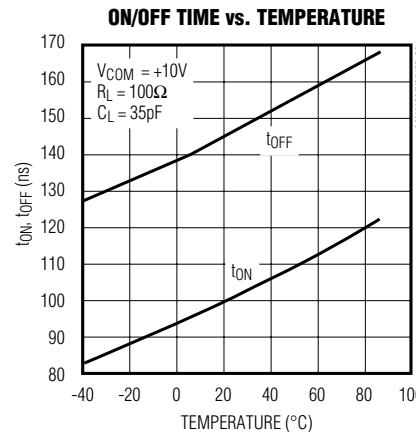
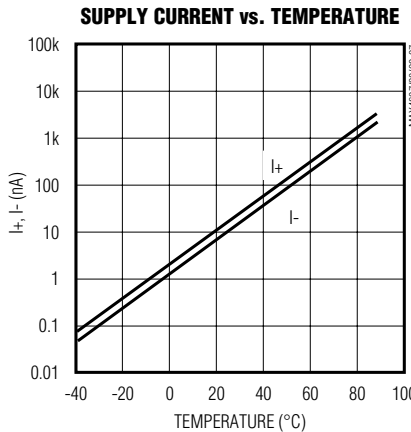
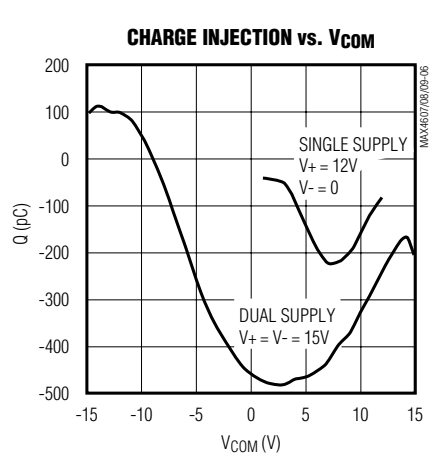
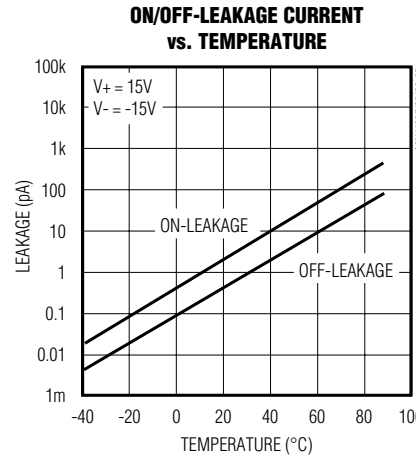
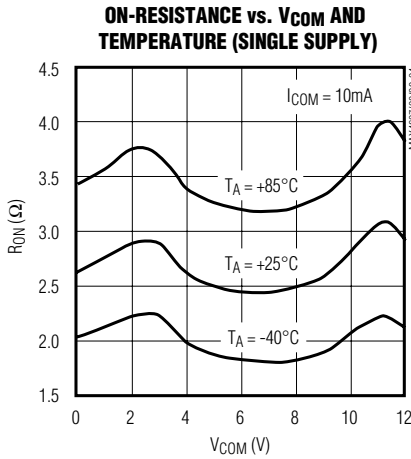
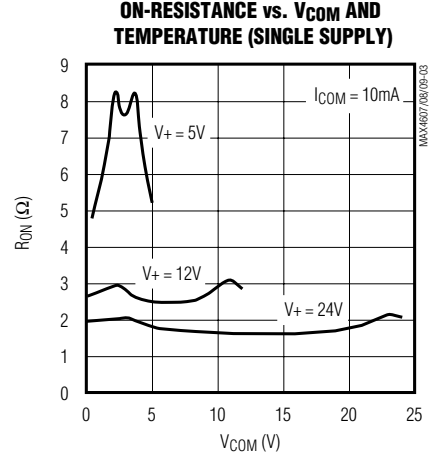
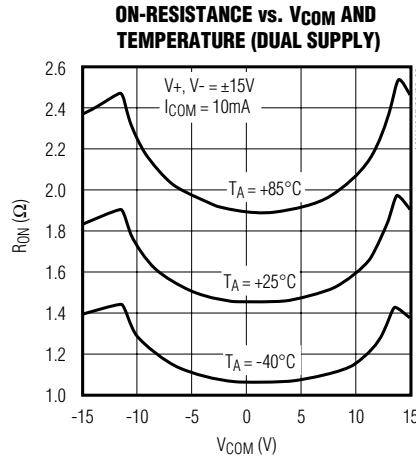
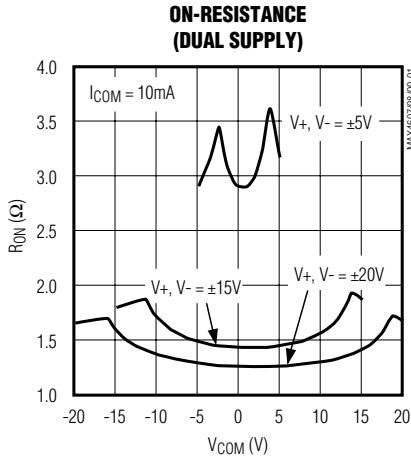
Note 7: Off-isolation = 20log₁₀ [V_{COM} / (V_{NC} or V_{NO})], V_{COM} = output, V_{NC} or V_{NO} = input to off switch.

Note 8: Between any two switchesΩ.

Note 9: Leakage testing at single supply is guaranteed by testing with dual supplies.

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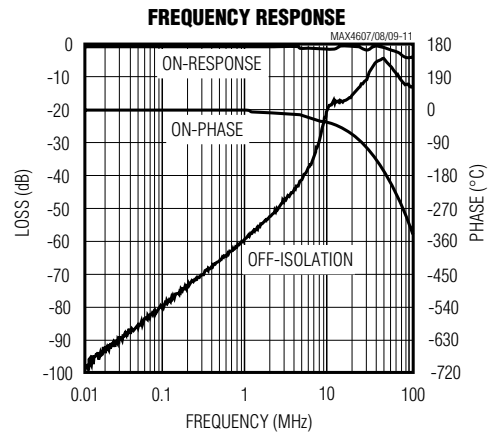
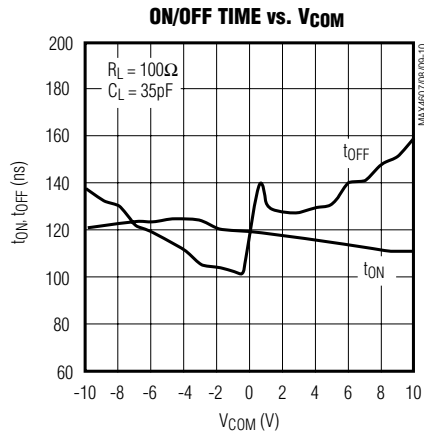


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Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)



Pin Description

| PIN | | | NAME | FUNCTION |
|--------------------|--------------------|--------------------|----------------|---|
| MAX4607 | MAX4608 | MAX4609 | | |
| 2, 7 | 2, 7 | 2, 7 | IN2, IN2 | Logic-Control Digital Inputs |
| 14, 11 | 14, 11 | 14, 11 | COM1, COM2 | Analog Switch, Common Terminals |
| 16, 9 | — | — | NC1, NC2 | Analog Switch, Normally Closed Terminals |
| — | 16, 9 | — | NO1, NO2 | Analog Switch, Normally Open Terminals |
| — | — | 9 | NC1 | Analog Switch, Normally Closed Terminal |
| — | — | 16 | NO1 | Analog Switch, Normally Open Terminal |
| 4 | 4 | 4 | V- | Negative Analog Supply-Voltage Input. Connect to DGND for single-supply operation. |
| 5 | 5 | 5 | GND | Ground |
| 1, 3, 6, 8, 10, 15 | 1, 3, 6, 8, 10, 15 | 1, 3, 6, 8, 10, 15 | N.C. | No Connection. Not internally connected. Connect to GND as low impedance to improve on/off-isolation. |
| 12 | 12 | 12 | V _L | Logic-Supply Input |
| 13 | 13 | 13 | V+ | Positive Analog-Supply Input |

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Applications Information

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings can cause permanent damage to the devices. Always sequence V+ on first, then V-, followed by the logic inputs, NO, or COM. If power-supply sequencing is not possible, add two small signal diodes (D1, D2) in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V. These protection diodes are not recommended when using a single supply.

Off-Isolation at High Frequencies

With the N.C. pins connected to GND, the high-frequency on-response of these parts extends from DC to above 100MHz with a typical loss of -2dB. When the switch is turned off, however, it behaves like a capacitor, and off-isolation decreases with increasing frequency. (Above 300MHz, the switch actually passes more signal turned off than turned on.) This effect is more pronounced with higher source and load impedances.

Above 5MHz, circuit-board layout becomes critical, and it becomes difficult to characterize the response of the switch independent of the circuit. The graphs shown in the *Typical Operating Characteristics* were taken using a 50Ω source and load connected with BNC connectors to a circuit board deemed "average;" that is, designed with isolation in mind, but not using strip-line or other special RF circuit techniques. For critical applications above 5MHz, use the MAX440, MAX441, and MAX442, which are fully characterized up to 160MHz.

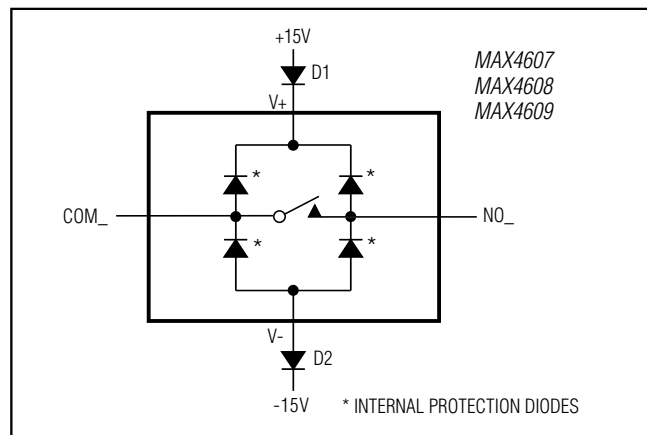


Figure 1. Overvoltage Protection Using External Blocking Diodes

Test Circuits/Timing Diagrams

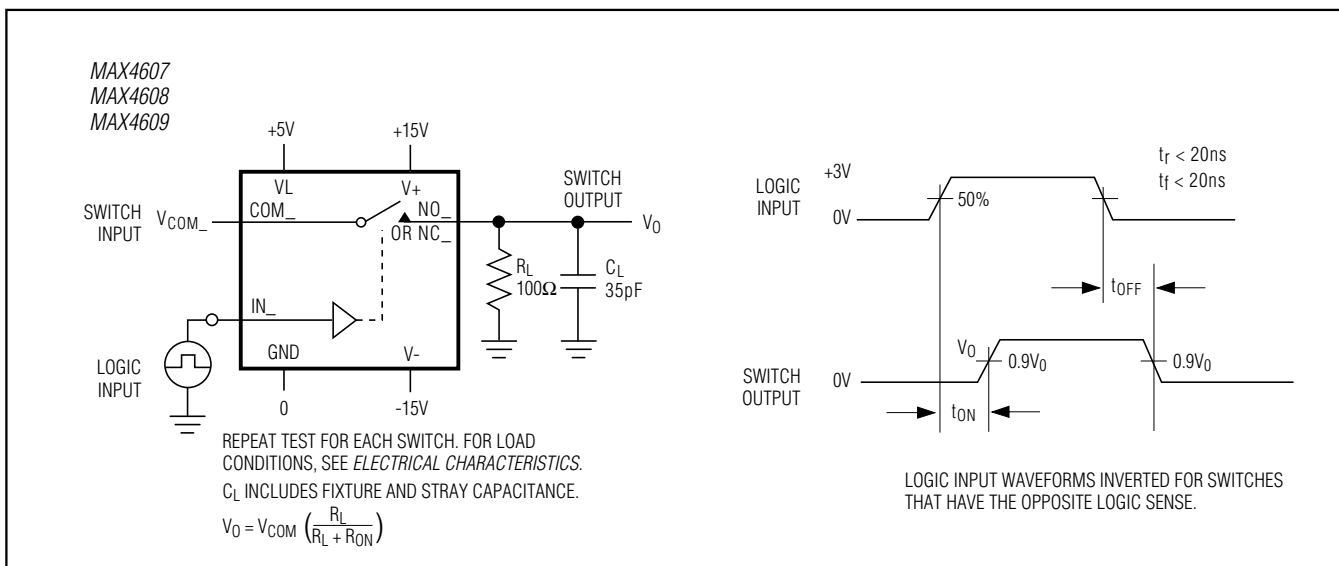


Figure 2. Switching-Time Test Circuit

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Test Circuits/Timing Diagrams (continued)

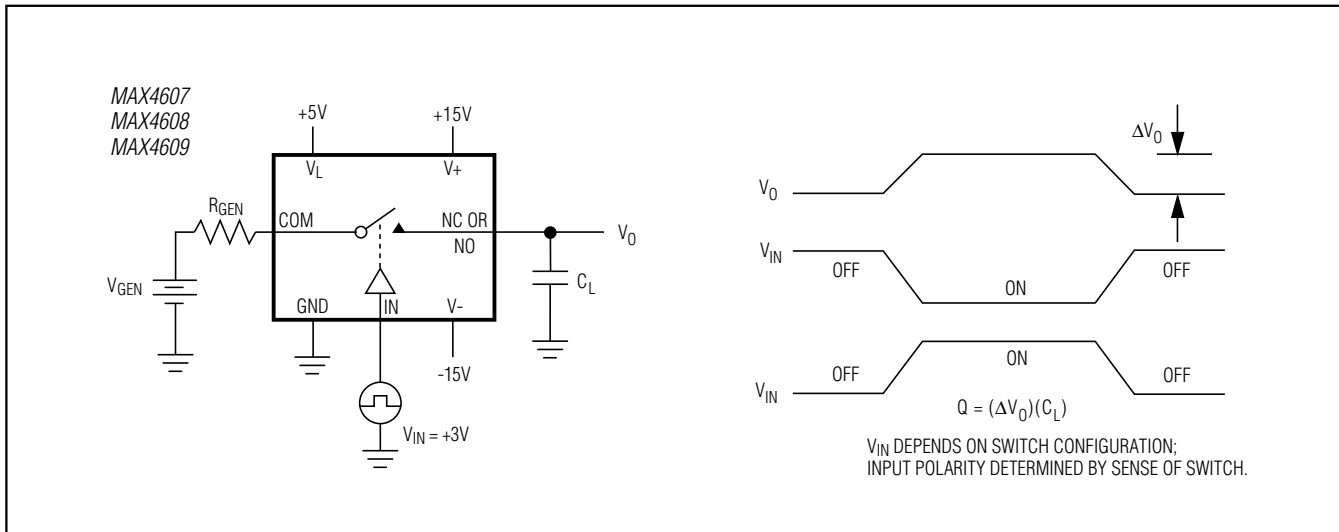


Figure 3. Charge-Injection Test Circuit

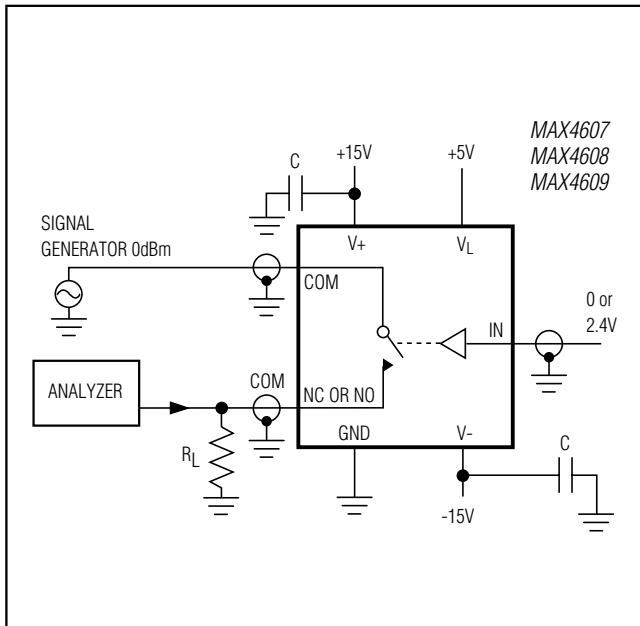


Figure 4. Off-Isolation Test Circuit

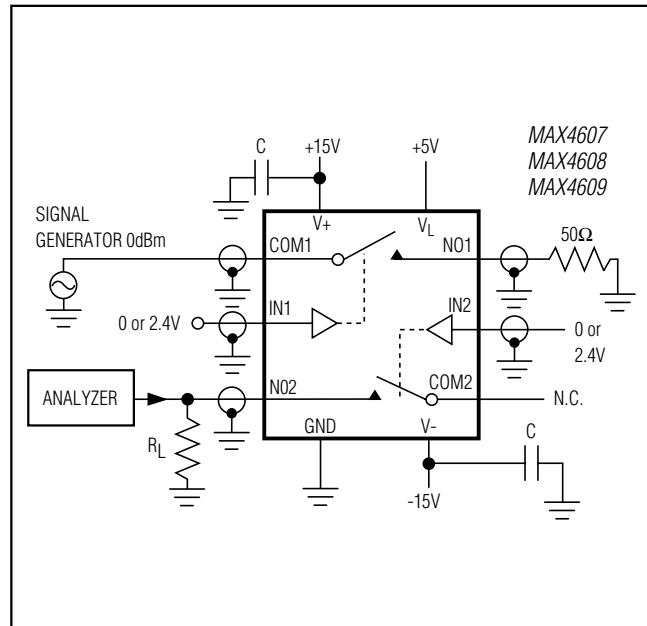


Figure 5. Crosstalk Test Circuit

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Test Circuits/Timing Diagrams (continued)

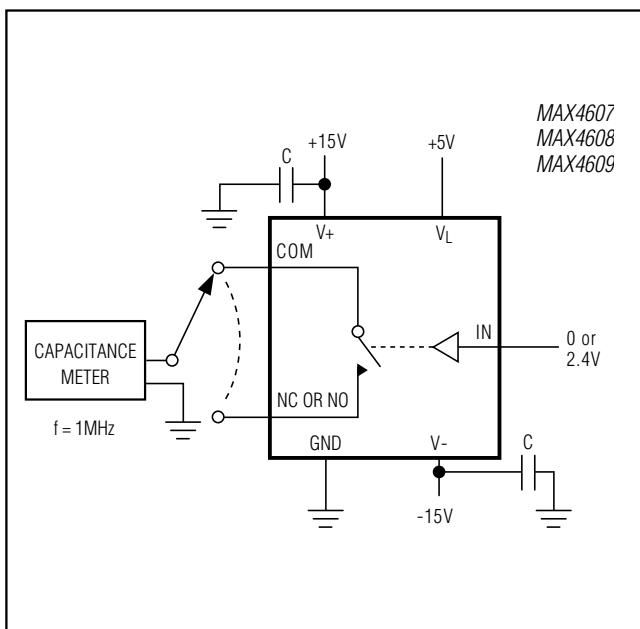


Figure 6. Switch Off-Capacitance Test Circuit

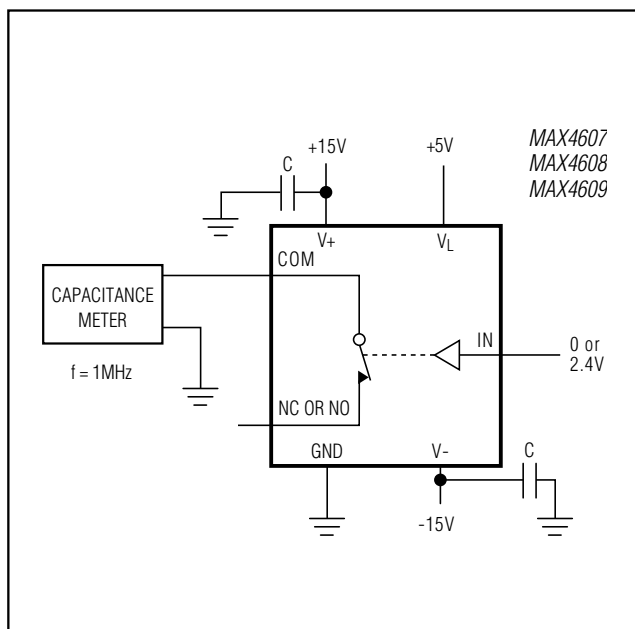


Figure 7. Switch On-Capacitance Test Circuit

Ordering Information (continued)

| PART | TEMP RANGE | PIN-PACKAGE |
|--------------------|-----------------|----------------|
| MAX4608 CSE | -0°C to +70°C | 16 Narrow SO |
| MAX4608CPE | 0°C to +70°C | 16 Plastic DIP |
| MAX4608ESE | -40°C to +85°C | 16 Narrow SO |
| MAX4608EPE | -40°C to +85°C | 16 Plastic DIP |
| MAX4608MSE/PR3 | -55°C to +125°C | 16 Narrow SO |
| MAX4609 CSE | -0°C to +70°C | 16 Narrow SO |
| MAX4609CPE | -0°C to +70°C | 16 Plastic DIP |
| MAX4609ESE | -40°C to +85°C | 16 Narrow SO |
| MAX4609EPE | -40°C to +85°C | 16 Plastic DIP |

Devices are also available in a lead(Pb)-free/RoHS-compliant package. Specify lead-free by adding "+" to the part number when ordering.

Chip Information

PROCESS: BiCMOS

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. |
|--------------|--------------|-------------------------|-------------------------|
| 16 PDIP | P16-4 | 21-0043 | — |
| 16 SO | S16-8 | 21-0041 | 90-0097 |

MAX4607/MAX4608/MAX4609

2.5Ω, Dual, SPST, CMOS Analog Switches

Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|-----------------|---------------|--|----------------|
| 2 | 3/10 | Updated the maximum limits of the COM_ to NO_, COM_ to NC_ On-Resistance Flatness parameter in the <i>Electrical Characteristics—Single Supply</i> table. | 4 |
| 3 | 9/12 | Added MAX4608MSE/PR3 part, lead-free information, and updated on- and off-leakage current conditions, and updated power supply minimum values, and updated package codes | 1, 2, 3, 5, 10 |





Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time. The parametric values (min and max limits) shown in the Electrical Characteristics table are guaranteed. Other parametric values quoted in this data sheet are provided for guidance.

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