



**THE DATASHEET OF
MAX4701ETE+**





Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

MAX4699/MAX4701/MAX4702

General Description

The MAX4699/MAX4701/MAX4702 are low-voltage, single-supply CMOS analog switches. The MAX4699/MAX4701 are dual double-pole/double-throw (DPDT) switches with two control inputs that control two single-pole/double-throw (SPDT) switches each. The MAX4702 is a quad SPDT switch with one control input and one low-voltage digital logic power supply.

These devices operate from a single +1.8V to +5.5V power supply. When powered from a +2.7V supply the MAX4699/MAX4701/MAX4702 offer a 75Ω on-resistance (R_{ON}), with 12Ω max R_{ON} flatness and 4Ω max matching between channels. Each switch has rail-to-rail signal handling, fast switching speeds of t_{ON} = 35ns, t_{OFF} = 20ns, and a maximum 1nA of leakage current.

The MAX4699/MAX4701 digital inputs are 1.8V-logic compatible when operated from a +3V supply. The MAX4702's digital inputs feature a 1.0V threshold when powered with a 1.5V logic supply.

The MAX4699 is available in a space-saving 16-lead 4mm x 4mm TQFN package. The MAX4701/MAX4702 are available in space-saving 16-lead 3mm x 3mm TQFN 16-pin TSSOP packages.

Applications

- Audio and Video Signal Routing
- Cellular Phones
- Battery-Operated Equipment
- Communications Circuits
- Modems

Features

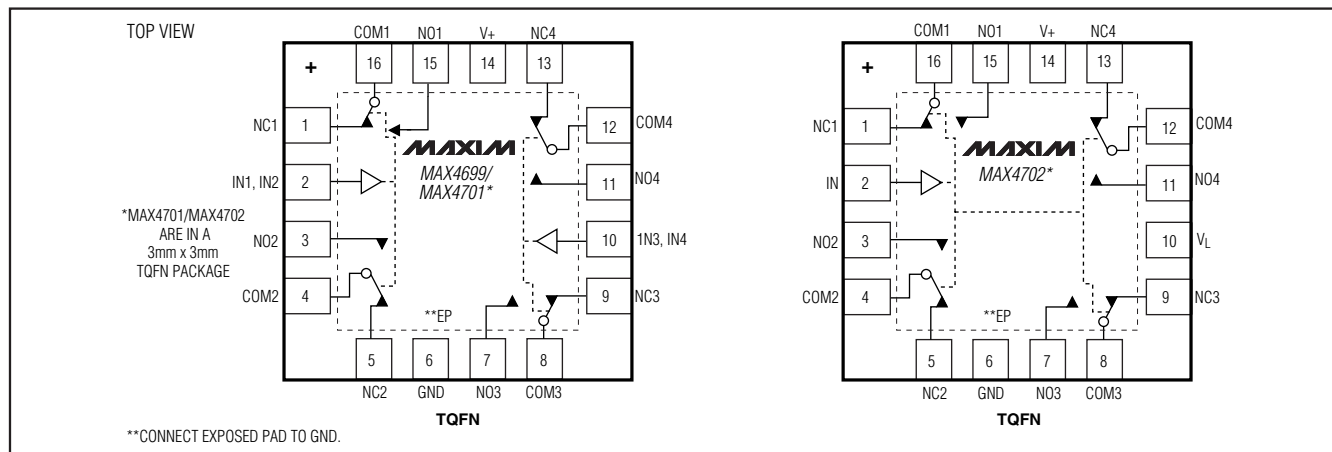
- ◆ 3mm x 3mm and 4mm x 4mm 16-Pin TQFN Packages
- ◆ Guaranteed On-Resistance:
75Ω (max) (+3V Supply)
40Ω (max) (+5V Supply)
- ◆ Guaranteed Match Between Channels:
4Ω max
- ◆ Guaranteed Flatness Over Signal Range:
12Ω max
- ◆ Low Leakage Currents Over Temperature:
1nA Max at +85°C
- ◆ Fast Switching: t_{ON} = 35ns, t_{OFF} = 20ns
- ◆ Guaranteed Break-Before-Make
- ◆ Single-Supply Operation from +1.8V to +5.5V
- ◆ Rail-to-Rail Signal Handling
- ◆ -3dB Bandwidth: 250MHz
- ◆ Low Crosstalk: -79dB (1MHz)
- ◆ High Off-Isolation: -76dB (1MHz)

Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|-------------|----------------|-------------------------|
| MAX4699ETE+ | -40°C to +85°C | 16 TQFN-EP* (4mm x 4mm) |
| MAX4701EUE+ | -40°C to +85°C | 16 TSSOP |
| MAX4701ETE+ | -40°C to +85°C | 16 TQFN-EP* (3mm x 3mm) |
| MAX4702EUE+ | -40°C to +85°C | 16 TSSOP |
| MAX4702ETE+ | -40°C to +85°C | 16 TQFN-EP* (3mm x 3mm) |

+Denotes a lead(Pb)-free/RoHS-compliant package.
*EP = Exposed pad.

Pin Configurations



Pin Configurations continued at end of data sheet.



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

Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)

| | |
|--|----------------------|
| V+ | -0.3V to +6V |
| V _L , IN ₋ , COM ₋ , NO ₋ , NC ₋ (Note 1) | -0.3V to (V+ + 0.3V) |
| Continuous Current COM ₋ , NO ₋ , NC ₋ | ±20mA |
| Peak Current COM ₋ , NO ₋ , NC ₋ (pulsed at 1ms, 10% duty cycle) | ±40mA |

Continuous Power Dissipation (T_A = +70°C)

| | |
|--|-----------------|
| TSSOP (derate 9.4mW/°C above +70°C) | 754.7mW |
| 16-Pin TQFN (derate 20.8mW/°C above +70°C) | 1666.7mW |
| 16-Pin Thin QFN (derate 25mW/°C above +70°C) | 2000mW |
| Operating Temperature Range | -40°C to +85°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (soldering, 10s) | +300°C |
| Soldering Temperature (reflow) | +260°C |

Note 1: Signals on IN₋, COM₋, NO₋, and NC₋ exceeding 0 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—Single +3V Supply

(V+ = +2.7V to +3.3V, V_{GND} = 0V, V_{IH} = +1.4V, V_{IL} = +0.5V, (V_L = +1.5V, V_{IH} = +1.0V, V_{IL} = +0.4V for MAX4702 only), T_A = -40°C to +85°C. Typical values are at V+ = +3V and T_A = +25°C, unless otherwise noted.) (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, I _{COM-} = 10mA; V _{NO-} or V _{NC-} = +1.5V | +25°C T _{MIN} to T _{MAX} | | 60 75 | 75 85 | Ω |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | V+ = +2.7V, I _{COM-} = 10mA; V _{NO-} or V _{NC-} = +1.5V | +25°C T _{MIN} to T _{MAX} | | 2 | 4 5 | Ω |
| On-Resistance Flatness (Note 5) | R _{FLAT} (ON) | V+ = +2.7V, I _{COM-} = 10mA; V _{NO-} or V _{NC-} = +1V, +1.5V, +2V | +25°C T _{MIN} to T _{MAX} | | 8 | 12 14 | Ω |
| NO ₋ , NC ₋ Off-Leakage Current (Note 6) | I _{NO-(OFF)} , I _{NC-(OFF)} | V+ = +3.3V, V _{COM-} = +1V, +3V; V _{NO-} or V _{NC-} = +3V, +1V | +25°C T _{MIN} to T _{MAX} | -0.5 -1 | | +0.5 1 | nA |
| COM ₋ On-Leakage Current (Note 6) | I _{COM-} (ON) | V+ = +3.3V, V _{COM-} = +1V, +3V; V _{NO-} or V _{NC-} = +1V, +3V, or unconnected | +25°C T _{MIN} to T _{MAX} | -0.5 -1 | | +0.5 1 | nA |
| DYNAMIC | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO-} or V _{NC-} = +2V; R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C T _{MIN} to T _{MAX} | | 27 | 35 45 | ns |
| Turn-Off Time | t _{OFF} | V _{NO-} or V _{NC-} = +2V; R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C T _{MIN} to T _{MAX} | | 15 | 20 25 | ns |
| Break-Before-Make (Note 6) | t _{BBM} | V _{NO-} or V _{NC-} = +2V; R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C T _{MIN} to T _{MAX} | | 15 | 1 | ns |
| On-Channel -3dB Bandwidth | BW | Signal = 0dBm, 50Ω in and out, Figure 5 | | | 250 | | MHz |
| Off-Isolation (Note 7) | V _{ISO} | f = 1MHz, R _L = 50Ω, C _L = 5pF, Figure 5 | +25°C | | -76 | | dB |

Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

MAX4699/MAX4701/MAX4702

ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = +2.7V to +3.3V, V_{GND} = 0V, V_{IH} = +1.4V, V_{IL} = +0.5V, (V_L = +1.5V, V_{IH} = +1.0V, V_{IL} = +0.4V for MAX4702 only), T_A = -40°C to +85°C. Typical values are at V+ = +3V and T_A = +25°C, unless otherwise noted.) (Notes 2, 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---|---|--|--------------------------------------|-----|------|-----|-------|
| Crosstalk (Note 8) | V _{CT} | f = 1MHz, R _L = 50Ω, C _L = 5pF, Figure 5 | +25°C | | -79 | | dB |
| Charge Injection | Q | V _{GEN} = 0V, R _{GEN} = 0Ω, C _L = 1.0nF, Figure 4 | +25°C | | 0.5 | | pC |
| NO ₋ , NC ₋ , Off-Capacitance | C _{NO_(OFF)} , C _{NC_(OFF)} | f = 1MHz, V _{NO_-} , V _{NC_-} = GND, Figure 6 | +25°C | | 8 | | pF |
| Switch On-Capacitance | C _(ON) | f = 1MHz, Figure 6 | +25°C | | 20 | | pF |
| Total Harmonic Distortion | THD | f = 20Hz to 20kHz, 2.5Vp-p, R _L = 600Ω | +25°C | | 0.02 | | % |
| DIGITAL I/O | | | | | | | |
| Input Logic High | V _{IH} | MAX4699/MAX4701 | | 1.4 | | | V |
| | | MAX4702 (V _L = +1.5V) | | 1.0 | | | |
| Input Logic Low | V _{IL} | MAX4699/MAX4701 | | | | 0.8 | V |
| | | MAX4702 (V _L = +1.5V) | | 0.4 | | | |
| Input Leakage Current | I _{IH} , I _{IL} | V _{IN} = 0 to V+ | | -1 | | 1 | μA |
| SUPPLY | | | | | | | |
| Power-Supply Range | V+ | | | 1.8 | | 5.5 | V |
| Logic Power-Supply Input | V _L | | | 1.5 | | V+ | V |
| Positive Supply Current | I+ | V+ = +3.3V, V _{IN} = 0 or V+ | T _{MIN} to T _{MAX} | -1 | | 1 | μA |

ELECTRICAL CHARACTERISTICS—Single +5V Supply

(V+ = +5V ±10%, V_{GND} = 0V, V_{IH} = +2.4V, V_{IL} = +0.8V, (V_L = +1.5V, V_{IH} = +1.0V, V_{IL} = +0.4V for MAX4702 only), T_A = -40°C to +85°C. Typical values are at V+ = +5V and T_A = +25°C, unless otherwise noted.) (Notes 2, 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---|--|--|--------------------------------------|-----|-----|-----|-------|
| Analog Signal Range | V _{COM_-} , V _{NO_-} , V _{NC_-} | | | 0 | | V+ | V |
| On-Resistance | R _{ON} | V+ = +4.5V, I _{COM_-} = 10mA; V _{NO_-} or V _{NC_-} = +3.5V | +25°C | | 30 | 40 | Ω |
| | | | T _{MIN} to T _{MAX} | | | 50 | |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | V+ = +4.5V, I _{COM_-} = 10mA; V _{NO_-} or V _{NC_-} = +3.5V | +25°C | | 1 | 3 | Ω |
| | | | T _{MIN} to T _{MAX} | | | 5 | |
| On-Resistance Flatness (Note 5) | R _{FLAT (ON)} | V+ = +4.5V, I _{COM_-} = 10mA; V _{NO_-} or V _{NC_-} = +2.0V, +2.25V, +3.5V | +25°C | | 5 | 8 | Ω |
| | | | T _{MIN} to T _{MAX} | | | 10 | |
| DYNAMIC | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO_-} or V _{NC_-} = +3V; R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C | | 15 | 18 | ns |
| | | | T _{MIN} to T _{MAX} | | | 20 | |

Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

($V_+ = +5V \pm 10\%$, $V_{GND} = 0V$, $V_{IH} = +2.4V$, $V_{IL} = +0.8V$, ($V_L = +1.5V$, $V_{IH} = +1.0V$, $V_{IL} = +0.4V$ for MAX4702 only), $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$. Typical values are at $V_+ = +5V$ and $T_A = +25^\circ\text{C}$, unless otherwise noted.) (Notes 2, 3)

| PARAMETER | SYMBOL | CONDITIONS | T_A | MIN | TYP | MAX | UNITS |
|----------------------------|---------------------|---|------------------------|-----|-----|-----|---------------|
| Turn-Off Time | t_{OFF} | $V_{NO_}$ or $V_{NC_} = +3V$; $R_L = 300\Omega$, $C_L = 35\text{pF}$, Figure 2 | $+25^\circ\text{C}$ | | 7 | 12 | ns |
| | | | T_{MIN} to T_{MAX} | | | 15 | |
| Break-Before-Make (Note 6) | t_{BBM} | $V_{NO_}$ or $V_{NC_} = +3V$; $R_L = 300\Omega$, $C_L = 35\text{pF}$, Figure 2 | $+25^\circ\text{C}$ | | 10 | | ns |
| | | | T_{MIN} to T_{MAX} | | 2 | | |
| Charge Injection | Q | $V_{GEN} = 0V$, $R_{GEN} = 0\Omega$, $C_L = 1.0\text{nF}$, Figure 4 | $+25^\circ\text{C}$ | | 0.5 | | pC |
| DIGITAL I/O | | | | | | | |
| Input Logic High | V_{IH} | MAX4699/MAX4701 | | | 2.4 | | V |
| | | MAX4702 ($V_L = +1.5V$) | | | 1.0 | | |
| Input Logic Low | V_{IL} | MAX4699/MAX4701 | | | | 0.8 | V |
| | | MAX4702 ($V_L = +1.5V$) | | | | 0.4 | |
| Logic Input Current | I_{IH} , I_{IL} | $V_{IN} = 0$ to V_+ | | | -1 | 1 | μA |

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: -40°C specifications are guaranteed by design.

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 = $20\log_{10}(V_{COM_} / V_{NO_})$, $V_{COM_}$ = output, $V_{NO_}$ = input to off switch.

Note 8: Between any two switches.

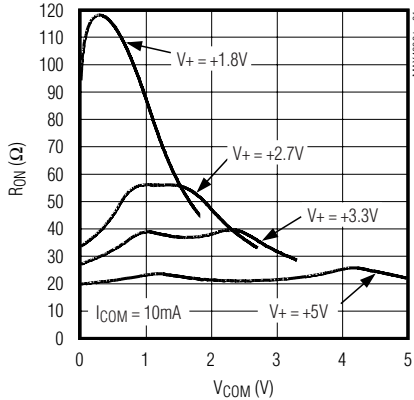
Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

Typical Operating Characteristics

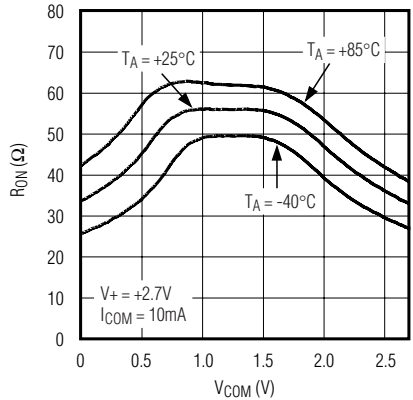
($T_A = +25^\circ\text{C}$, unless otherwise noted. $V_L = +1.5\text{V}$ for MAX4702 only.)

MAX4699/MAX4701/MAX4702

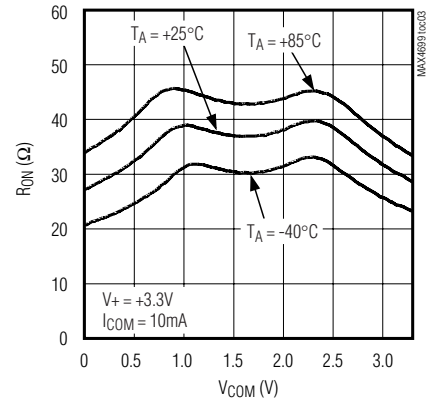
ON-RESISTANCE vs. COM VOLTAGE OVER SUPPLY VOLTAGE



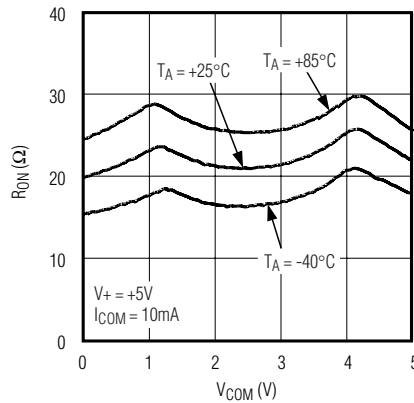
ON-RESISTANCE vs. COM VOLTAGE OVER TEMPERATURE ($V_+ = +2.7\text{V}$)



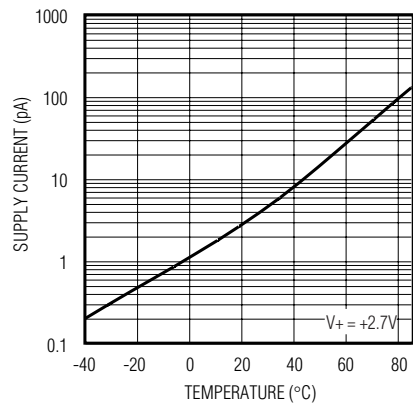
ON-RESISTANCE vs. COM VOLTAGE OVER TEMPERATURE ($V_+ = +3.3\text{V}$)



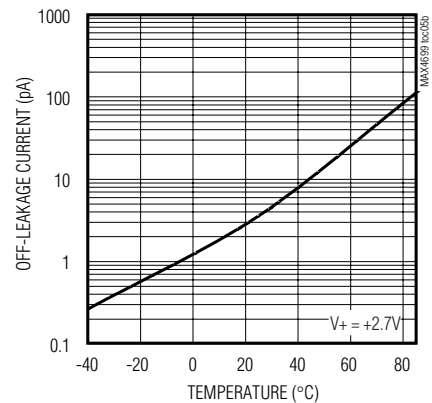
ON-RESISTANCE vs. COM VOLTAGE OVER TEMPERATURE ($V_+ = +5\text{V}$)



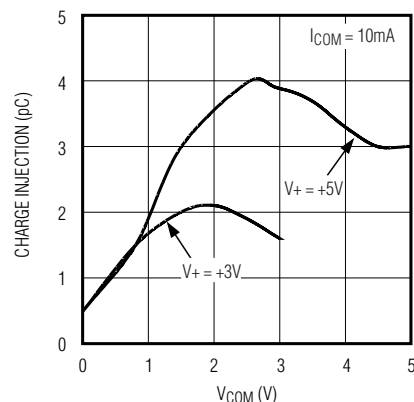
ON-LEAKAGE CURRENT vs. TEMPERATURE



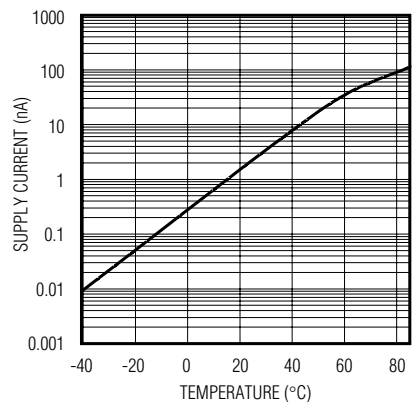
OFF-LEAKAGE CURRENT vs. TEMPERATURE



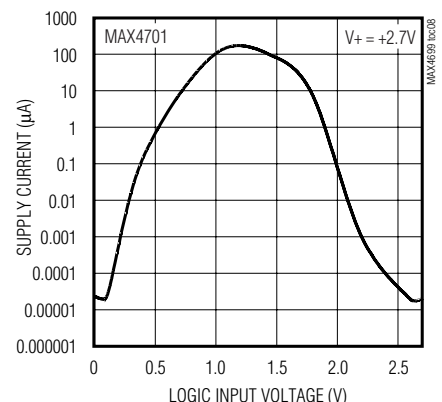
CHARGE INJECTION vs. COM VOLTAGE OVER SUPPLY VOLTAGE



SUPPLY CURRENT vs. TEMPERATURE



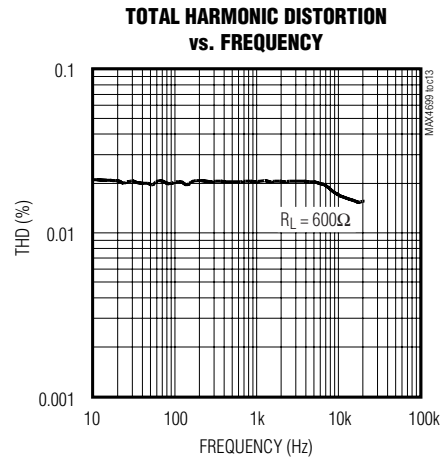
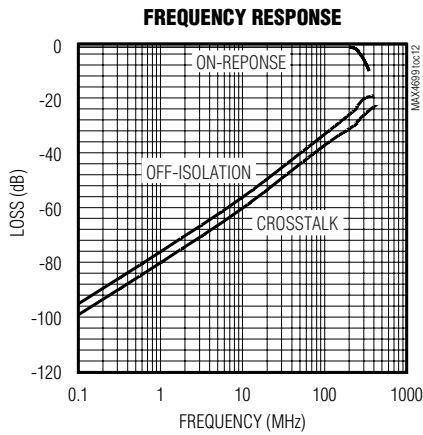
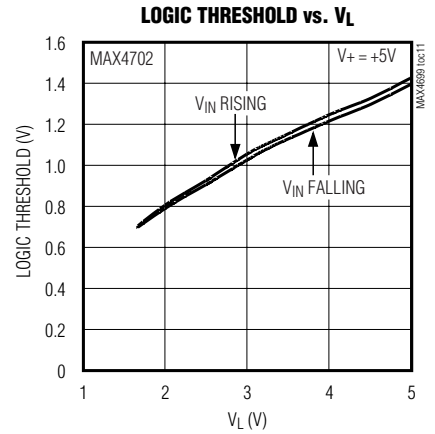
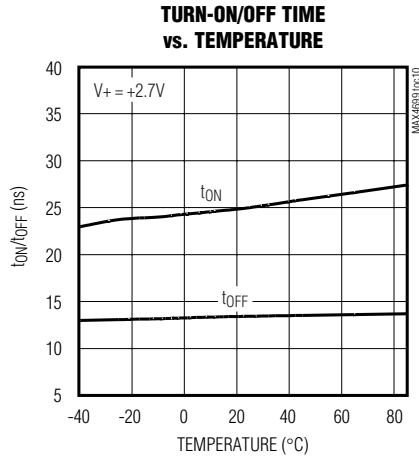
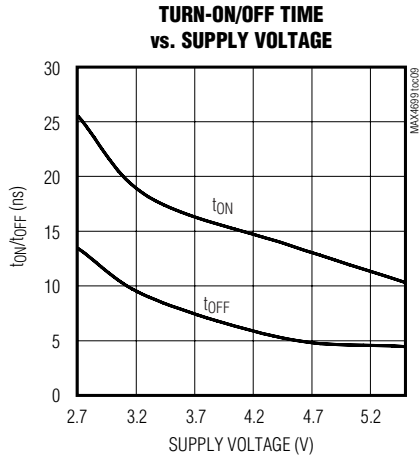
SUPPLY CURRENT vs. LOGIC INPUT VOLTAGE



Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

Typical Operating Characteristics (continued)

($T_A = +25^\circ\text{C}$, unless otherwise noted. $V_L = +1.5\text{V}$ for MAX4702 only.)



Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

Pin Description

| TQFN-EP PIN | | TSSOP PIN | | NAME | FUNCTION |
|---------------------|---------|-----------|---------|----------------|---|
| MAX4699/ MAX4701 | MAX4702 | MAX4701 | MAX4702 | | |
| 1 | 1 | 3 | 3 | NC1 | Analog Switch 1—Normally Closed Terminal |
| — | 2 | — | 4 | IN | Digital Control Input Switch 1, 2, 3, and 4 |
| 2 | — | 4 | — | IN1, IN2 | Digital Control Input Switch 1 and 2 |
| 3 | 3 | 5 | 5 | NO2 | Analog Switch 2—Normally Open Terminal |
| 4 | 4 | 6 | 6 | COM2 | Analog Switch 2—Common Terminal |
| 5 | 5 | 7 | 7 | NC2 | Analog Switch 2—Normally Closed Terminal |
| 6 | 6 | 8 | 8 | GND | Ground |
| 7 | 7 | 9 | 9 | NO3 | Analog Switch 3—Normally Open Terminal |
| 8 | 8 | 10 | 10 | COM3 | Analog Switch 3—Common Terminal |
| 9 | 9 | 11 | 11 | NC3 | Analog Switch 3—Normally Closed Terminal |
| — | 10 | — | 12 | V _L | Logic Power-Supply Input |
| 10 | — | 12 | — | IN3, IN4 | Digital Control Input Switch 3 and 4 |
| 11 | 11 | 13 | 13 | NO4 | Analog Switch 4—Normally Open Terminal |
| 12 | 12 | 14 | 14 | COM4 | Analog Switch 4—Common Terminal |
| 13 | 13 | 15 | 15 | NC4 | Analog Switch 4—Normally Closed Terminal |
| 14 | 14 | 16 | 16 | V ₊ | Positive Supply Voltage Input |
| 15 | 15 | 1 | 1 | NO1 | Analog Switch 1—Normally Open Terminal |
| 16 | 16 | 2 | 2 | COM1 | Analog Switch 1—Common Terminal |
| — | — | — | — | EP | Exposed Pad (TQFN Only). Connect EP to GND. |

MAX4699/MAX4701/MAX4702

Detailed Description

The MAX4699/MAX4701 are low-voltage CMOS analog switches that operate from a single +1.8V to +5.5V power supply. The MAX4702 requires an additional logic supply that allows for setting lower logic thresholds. The MAX4699/MAX4701 are double-pole/double-throw (DPDT) devices. The MAX4702 is a quad single-pole/double-throw (SPDT) device. These devices feature a break-before-make switching, fast switching speeds (with V₊ = 5V: t_{ON} = 18ns max, t_{OFF} = 9ns max and with V₊ = 3V: t_{ON} = 35ns, t_{OFF} = 20) and rail-to-rail signal handling. A logic input on the MAX4702 allows for logic thresholds as low as 1.0V.

Applications Information

Analog Signal Levels

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

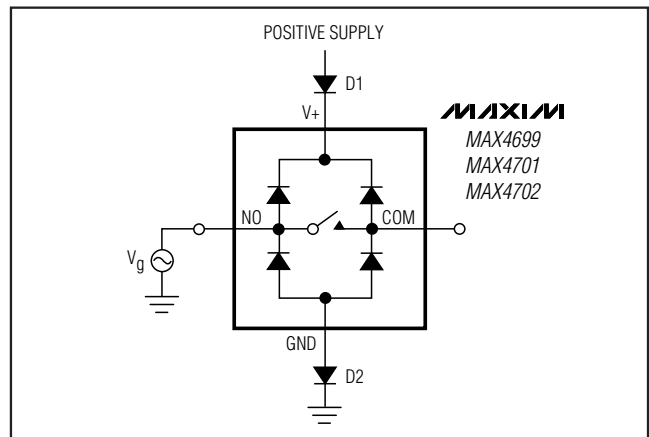


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

Power-Supply Sequencing and Overvoltage Protection

Caution: Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the devices.

Proper power-supply sequencing is recommended for all CMOS devices. Always apply V+ before applying analog signals, especially if the analog signal is not current limited. If this sequencing is not possible, and if the analog inputs are not current limited to <20mA, add a small-signal diode (D1) as shown in Figure 1. If the analog signal can dip below GND, add D2. Adding protection diodes reduces the analog range to a diode drop (about 0.7V) below V+ (for D1), and a diode drop above ground (for D2). On-resistance increases slightly at low supply voltages. Maximum supply voltage (V+) must not exceed +6V.

Adding protection diode D2 causes the logic threshold to be shifted relative to GND. TTL compatibility is not guaranteed when D2 is added.

Protection diodes D1 and D2 also protect against some overvoltage situations. With Figure 1's circuit, if the supply voltage is below the absolute maximum rating, and if a fault voltage up to the absolute maximum rating is applied to an analog signal pin, no damage will result.

V_L Logic Input (MAX4702)

The MAX4702 features a V_L logic input that allows for lower logic input thresholds down to 1.0V min for V_{IH} in the quad SPDT configuration. Power-up V_L after V+ has been powered with a minimum of 1.5V to ensure proper operation of the device.

Test Circuits/Timing Diagrams

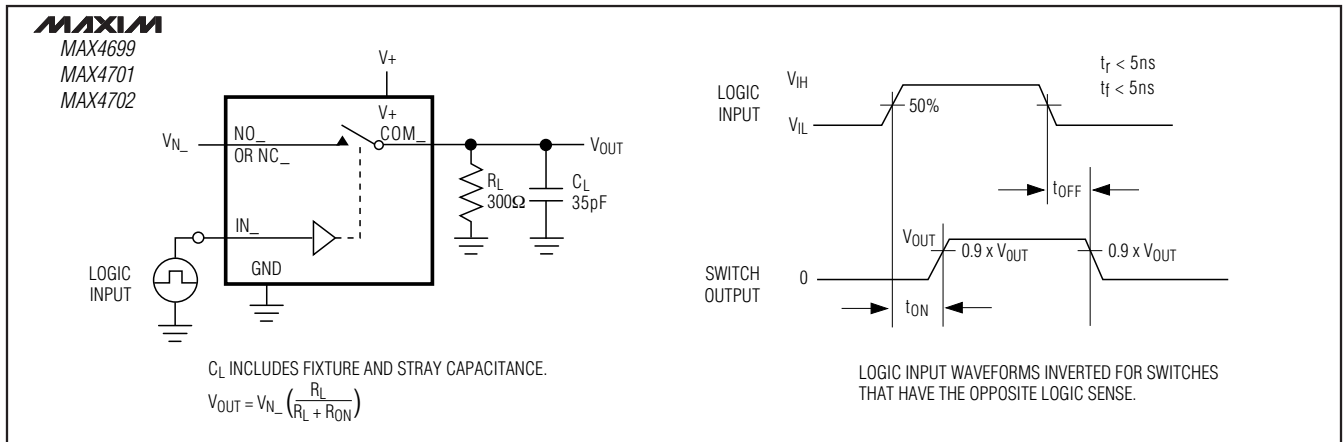


Figure 2. Switching Time

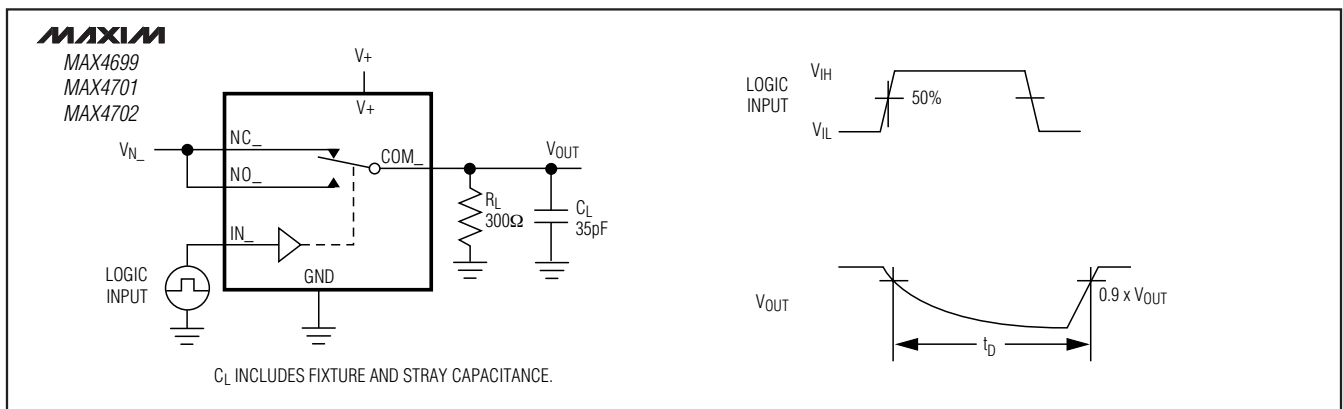


Figure 3. Break-Before-Make Interval

Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

Test Circuits/Timing Diagrams (continued)

MAX4699/MAX4701/MAX4702

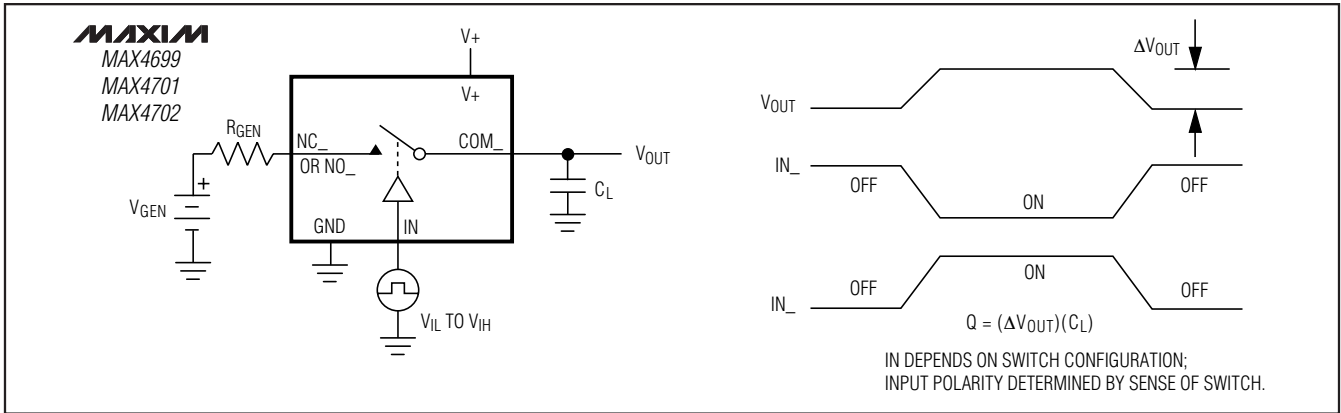


Figure 4. Charge Injection

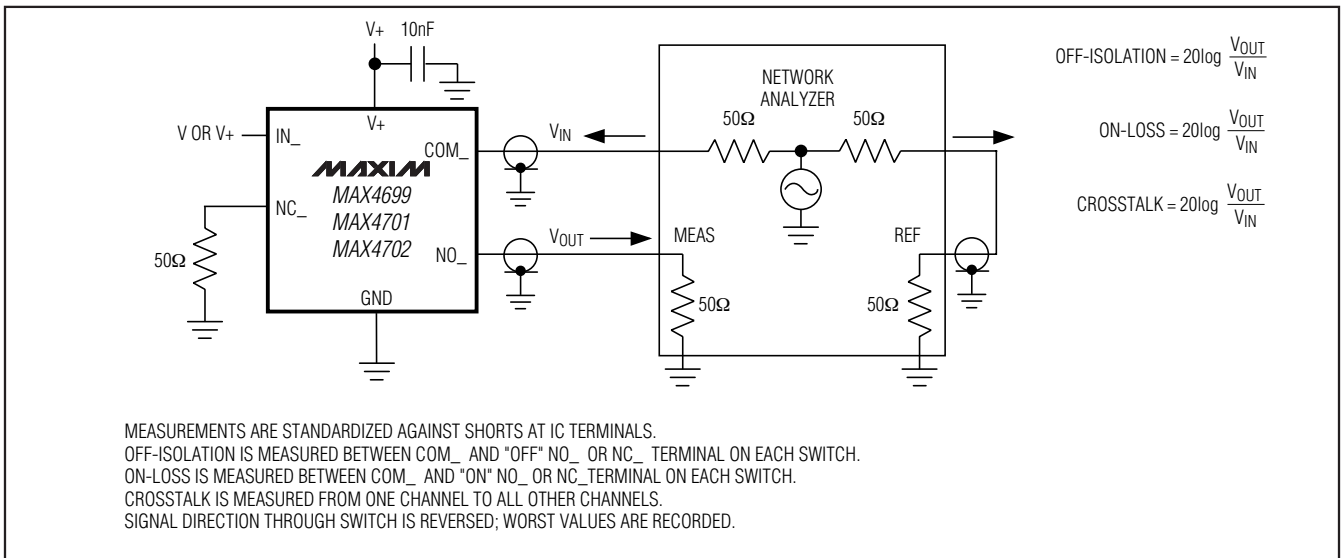


Figure 5. On-Loss, Off-Isolation, and Crosstalk

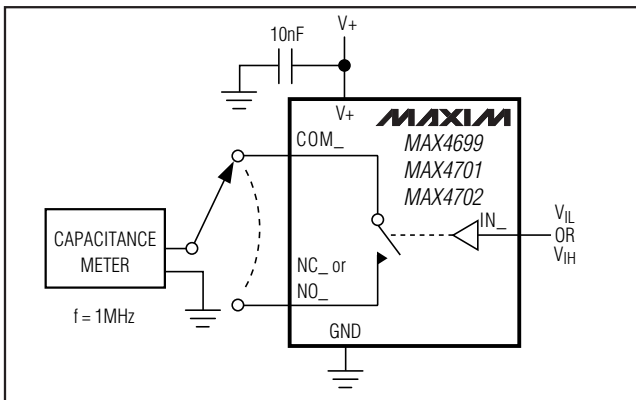


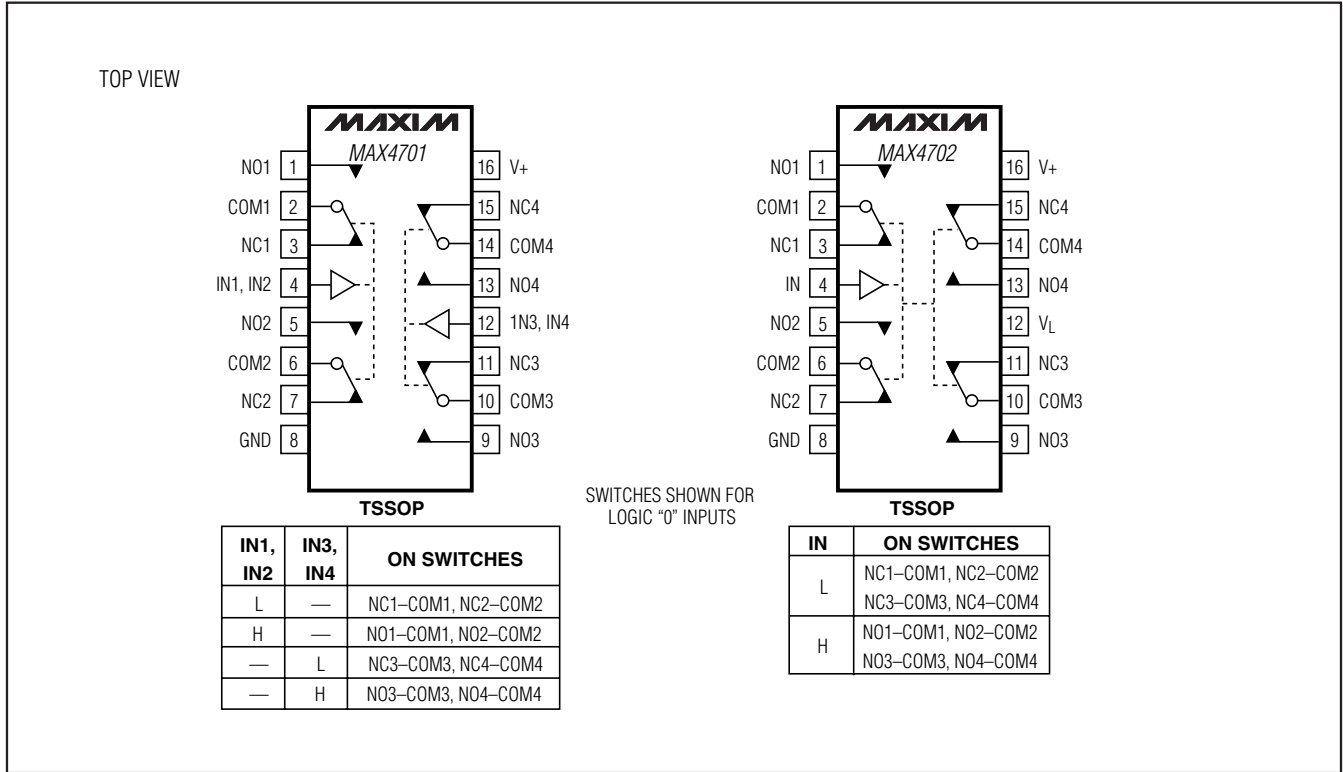
Figure 6. Channel Off/On-Capacitance

Chip Information

SUBSTRATE CONNECTED TO GND

Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

Pin Configurations (continued)



Package Information

For the latest package outline information and land patterns (footprints), go to www.maxim-ic.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 TQFN-EP (4mm x 4mm) | T1644+4 | 21-0139 | 90-0070 |
| 16 TQFN-EP (3mm x 3mm) | T1633+4 | 21-0136 | 90-0031 |
| 16 TSSOP | U16+2 | 21-0066 | 90-0117 |

Low-Voltage, Dual DPDT/Quad SPDT Analog Switches in QFN

Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|-----------------|---------------|---|---------------|
| 2 | 10/09 | Added "Exposed pad" reference to the <i>Ordering Information</i> table, <i>Pin Configurations</i> , and <i>Pin Description</i> table. | 1, 7 |
| 3 | 4/11 | Corrected part numbers in <i>Ordering Information</i> ; updated <i>Absolute Maximum Ratings</i> . | 1, 2 |



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