



Low-Voltage, 60Ω Dual SPDT Analog Switch in Thin QFN

MAX4695

General Description

The MAX4695 is a low-voltage, dual single-pole/double-throw (SPDT) analog switch that operates from a single +1.8V to +5.5V supply. The MAX4695 features break-before-make switching action with a $t_{ON} = 30ns$ and $t_{OFF} = 18ns$ at +3V.

When powered from a +2.7V supply, the device has a 60Ω (max) on-resistance (R_{ON}), with 3Ω (max) R_{ON} matching and 10Ω (max) R_{ON} flatness. The digital logic inputs are 1.8V-logic compatible from a +2.7V to +3.3V supply. The MAX4695 is available in both a space-saving 3mm x 3mm 12-pin TQFN package and a 10-pin μ MAX® package.

Applications

- MP3 Players
- Battery-Operated Equipment
- Relay Replacement
- Audio and Video Signal Routing
- Low-Voltage Data-Acquisition Systems
- Communications Circuits
- PCMCIA Cards
- Cellular Phones
- Modems

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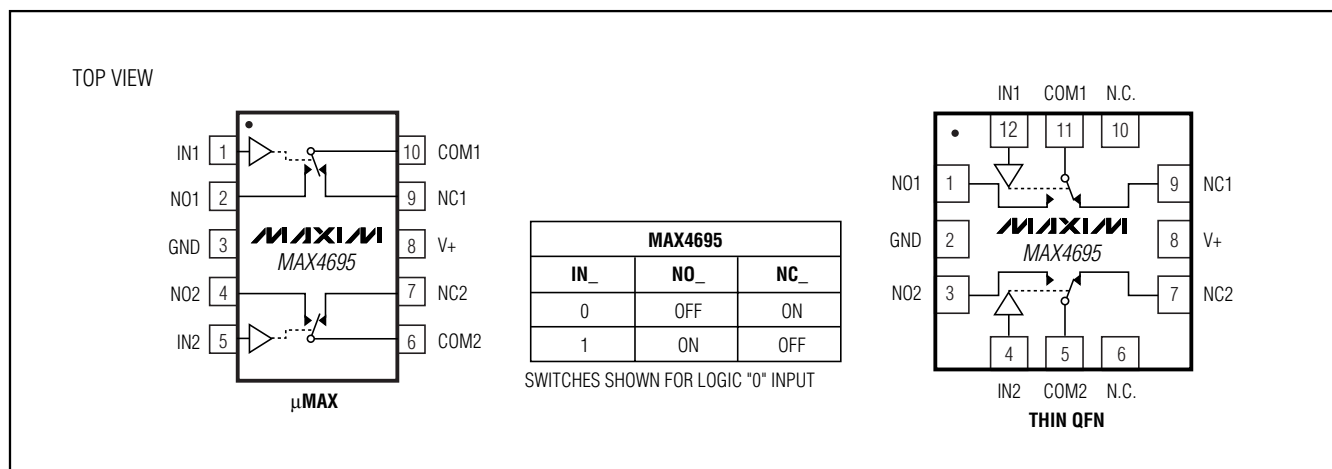
Features

- ◆ 3mm x 3mm 12-Pin Thin QFN Package
- ◆ **Guaranteed On-Resistance:**
60Ω (max) (+2.7V supply)
25Ω (typ) (+5V supply)
- ◆ **Guaranteed Match Between Channels:** 3Ω (max)
- ◆ **Guaranteed Flatness Over Signal Range:**
10Ω (max)
- ◆ **Guaranteed Low Leakage Currents:**
100pA (max) at +25°C
- ◆ **Switching Time:** $t_{ON} = 30ns$, $t_{OFF} = 18ns$
- ◆ +1.8V to +5.5V Single-Supply Operation
- ◆ Rail-to-Rail Signal Handling
- ◆ -3dB Bandwidth: >300MHz
- ◆ **Low Crosstalk:** -82dB (1MHz)
- ◆ **High Off-Isolation:** -75dB (1MHz)
- ◆ **Low 4pC Charge Injection**
- ◆ **THD: 0.03%**
- ◆ +1.8V CMOS-Logic Compatible

Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|------------|---------------|--------------|
| MAX4695ETC | -40°C to 85°C | 12 TQFN |
| MAX4695EUB | -40°C to 85°C | 10 μ MAX |

Pin Configurations



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

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ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)

| | |
|--|----------------------|
| V+ | -0.3V to +6V |
| All Other Pins (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 |
| ESD per Method 3015.7 | ±2kV |

Continuous Power Dissipation (T_A = +70°C)

| | |
|--|-----------------|
| 10-Pin μMAX (derate 4.7mW/°C above +70°C) | 330mW |
| 12-Pin Thin QFN (derate 16.7mW/°C above +70°C) | 1333.3mW |
| Operating Temperature Range | -40°C to +85°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (soldering, 10s) | +300°C |

Note 1: Signals on IN₋, COM₋, NO₋, and NC₋ exceeding V+ or GND 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_{IH} = +1.4V, V_{IL} = +0.5V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +3V and T_A = +25°C.) (Notes 2, 9)

| 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-} = 1mA, V _{NO-} or V _{NC-} = +1.4V | +25°C T _{MIN} to T _{MAX} | | 40 60 | 70 | Ω |
| On-Resistance Match Between Channels (Note 3) | ΔR _{ON} | V+ = +2.7V, I _{COM-} = 1mA, V _{NO-} or V _{NC-} = +1.4V | +25°C T _{MIN} to T _{MAX} | | 0.5 | 3 | Ω |
| On-Resistance Flatness (Note 4) | R _{FLAT (ON)} | V+ = +2.7V, I _{COM-} = 1mA, V _{NO-} or V _{NC-} = +1V, +1.4V, +1.8V | +25°C T _{MIN} to T _{MAX} | | 6 | 10 | Ω |
| NO ₋ , NC ₋ Off-Leakage Current (Note 5) | I _{NO-(OFF)} , I _{NC-(OFF)} | V+ = +3.3V, V _{COM-} = +0.3V, +3V V _{NO-} or V _{NC-} = +3V, +0.3V | +25°C T _{MIN} to T _{MAX} | -0.1 -1 | ±0.01 | +0.1 +1 | nA |
| COM ₋ On-Leakage Current (Note 5) | I _{COM-(ON)} | V+ = +3.3V, V _{COM-} = +0.3V, +3V V _{NO-} or V _{NC-} = +0.3V, +3V, or floating | +25°C T _{MIN} to T _{MAX} | -0.2 -2 | ±0.01 | +0.2 +2 | nA |
| DYNAMIC | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO} or V _{NC-} = +1.5V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C T _{MIN} to T _{MAX} | | 24 | 30 | ns |
| Turn-Off Time | t _{OFF} | V _{NO} or V _{NC-} = +1.5V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C T _{MIN} to T _{MAX} | | 12 | 18 | ns |
| Break-Before-Make Time (Note 6) | t _{BBM} | V _{NO} or V _{NC-} = +1.5V, R _L = 300Ω, C _L = 35pF, Figure 3 | +25°C T _{MIN} to T _{MAX} | | 12 | | ns |
| Charge Injection | Q | V _{GEN} = 0, R _{GEN} = 0, C _L = 1.0nF, Figure 4 | | | 4 | | pC |
| On-Channel -3dB Bandwidth | BW | Signal = 0dBm, 50Ω in and out, Figure 5 | | | 300 | | MHz |
| Off-Isolation (Note 7) | V _{ISO} | f = 1MHz, R _L = 50Ω, C _L = 5pF, Figure 5 | | | -75 | | dB |

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ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = +2.7V to +3.3V, V_{IH} = +1.4V, V_{IL} = +0.5V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +3V and T_A = +25°C.) (Notes 2, 9)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---|--|--|----------------|-----|------|-----|-------|
| Crosstalk (Note 8) | V _{CT} | f = 1MHz, R _L = 50Ω, C _L = 5pF, Figure 5 | | | -82 | | dB |
| Total Harmonic Distortion | THD | f = 20Hz to 20kHz, 2Vp-p, R _L = 600Ω | | | 0.03 | | % |
| NO ₋ , NC ₋ Off-Capacitance | C _{NO_(OFF)} , C _{NC_(OFF)} | f = 1MHz, V _{NO_-} or V _{NC_-} = GND, Figure 6 | | | 7 | | pF |
| COM ₋ On-Capacitance | C _{COM_(ON)} | f = 1MHz, V _{NO_-} or V _{NC_-} = GND, Figure 6 | | | 19 | | pF |
| DIGITAL I/O | | | | | | | |
| Input Logic High | V _{IH} | | | 1.4 | | | V |
| Input Logic Low | V _{IL} | | | | | 0.5 | V |
| Input Leakage Current | I _{IH} , I _{IL} | V _{IN} = 0 or V+ | | -1 | | +1 | μA |
| SUPPLY | | | | | | | |
| Power-Supply Range | V+ | | | 1.8 | | 5.5 | V |
| Power-Supply Current | I+ | V+ = +5.5V, V _{IN} = 0 or V+ | | | | 1 | μA |

ELECTRICAL CHARACTERISTICS—Single +5V Supply

(V+ = +4.5V to +5.5V, V_{IH} = +2.0V, V_{IL} = +0.8V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +5V and T_A = +25°C.) (Notes 2, 9)

| 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, I _{COM_-} = 1mA, V _{NO_-} or V _{NC_-} = +3.5V | +25°C | | 25 | 35 | Ω |
| | | | T _{MIN} to T _{MAX} | | | 40 | |
| On-Resistance Match Between Channels (Note 3) | ΔR _{ON} | V+ = +4.5V, I _{COM_-} = 1mA, V _{NO_-} or V _{NC_-} = +3.5V | +25°C | | 0.5 | 2 | Ω |
| | | | T _{MIN} to T _{MAX} | | | 3 | |
| On-Resistance Flatness (Note 4) | R _{FLAT (ON)} | V+ = +4.5V, I _{COM_-} = 1mA, V _{NO_-} or V _{NC_-} = +1V, +2.5V, +3.5V | +25°C | | 4 | 8 | Ω |
| | | | T _{MIN} to T _{MAX} | | | 10 | |
| NO ₋ , NC ₋ Off-Leakage Current (Note 5) | I _{NO_(OFF)} , I _{NC_(OFF)} | V+ = +5.5V, V _{COM_-} = +1V, +4.5V, V _{NO_-} or V _{NC_-} = +4.5V, +1V | +25°C | -0.1 | ±0.01 | +0.1 | nA |
| | | | T _{MIN} to T _{MAX} | -1 | | +1 | |
| COM ₋ On-Leakage Current (Note 5) | I _{COM_(ON)} | V+ = +5.5V, V _{COM_-} = +1V, +4.5V, V _{NO_-} or V _{NC_-} = +1V, +4.5V, or floating | +25°C | -0.2 | ±0.01 | +0.2 | nA |
| | | | T _{MIN} to T _{MAX} | -2 | | +2 | |
| DYNAMIC | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO_-} , V _{NC_-} = +3V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C | | 17 | 25 | ns |
| | | | T _{MIN} to T _{MAX} | | | 30 | |
| Turn-Off Time | t _{OFF} | V _{NO_-} , V _{NC_-} = +3V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C | | 8 | 15 | ns |
| | | | T _{MIN} to T _{MAX} | | | 20 | |

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ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = +4.5V to +5.5V, V_{IH} = +2.0V, V_{IL} = +0.8V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +5V and T_A = +25°C.) (Notes 2, 9)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---------------------------------|-----------------------------------|---|--------------------------------------|------|-----|-----|-------|
| Break-Before-Make Time (Note 6) | t _{BBM} | V _{NO_} , V _{NC_} = +3V, R _L = 300Ω, C _L = 35pF, Figure 3 | +25°C | 9 | | | ns |
| | | | T _{MIN} to T _{MAX} | 2 | | | |
| Charge Injection | Q | V _{GEN} = 0, R _{GEN} = 0, C _L = 1.0nF, Figure 4 | | 8 | | | pC |
| On-Channel -3dB Bandwidth | BW | Signal = 0dBm, 50Ω in and out, Figure 5 | | 300 | | | MHz |
| Off-Isolation (Note 7) | V _{ISO} | f = 1MHz, R _L = 50Ω, C _L = 5pF, Figure 5 | | -75 | | | dB |
| Crosstalk (Note 8) | V _{CT} | f = 1MHz, R _L = 50Ω, C _L = 5pF, Figure 5 | | -82 | | | dB |
| Total Harmonic Distortion | THD | f = 20Hz to 20kHz, 2Vp-p, R _L = 600Ω | | 0.02 | | | % |
| DIGITAL I/O | | | | | | | |
| Input Logic High | V _{IH} | | | 2.0 | | | V |
| Input Logic Low | V _{IL} | | | | | 0.8 | V |
| Input Leakage Current | I _{IH} , I _{IL} | V _{IN_} = 0 or V+ | | -1 | +1 | | μA |
| SUPPLY | | | | | | | |
| Power-Supply Range | V+ | | | 1.8 | 5.5 | | V |
| Positive Supply Current | I+ | V+ = +5.5V, V _{IN} = 0 or V+ | | | | 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: ΔRON = RON(MAX) - RON(MIN).

Note 4: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

Note 5: Leakage currents are 100% tested at T_A = +85°C. Limits across the full temperature range are guaranteed by correlation.

Note 6: Guaranteed by design.

Note 7: Off-Isolation = 20log₁₀(V_{COM_} / V_{NO_}), V_{COM_} = output, V_{NO_} = input to off switch.

Note 8: Between any two switches.

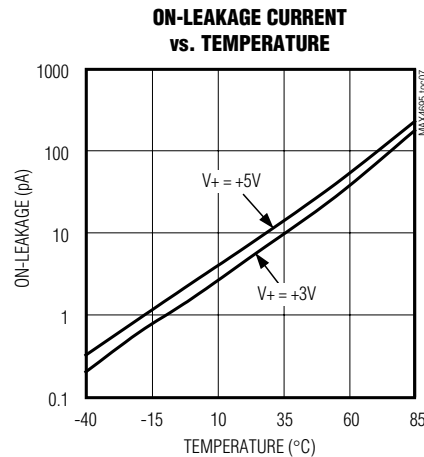
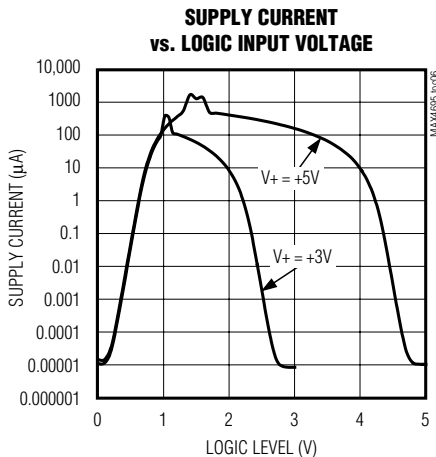
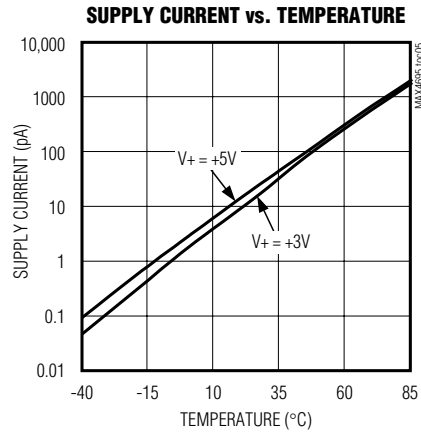
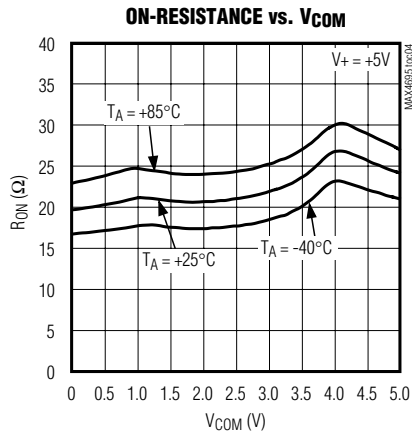
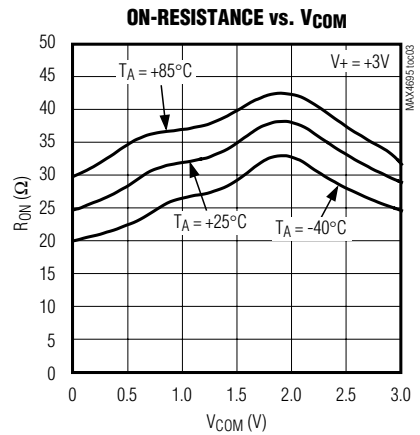
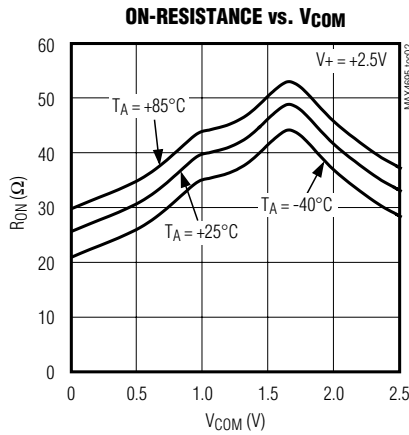
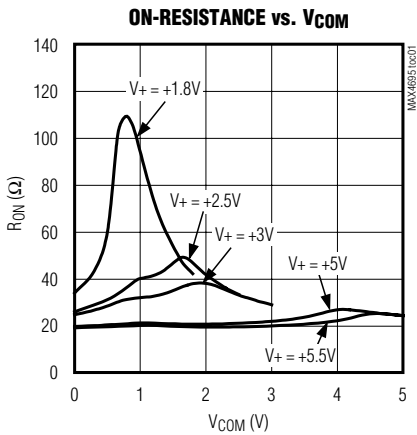
Note 9: -40°C specifications are guaranteed by design.

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Typical Operating Characteristics

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

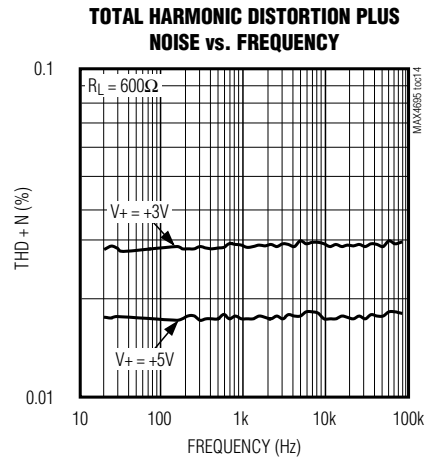
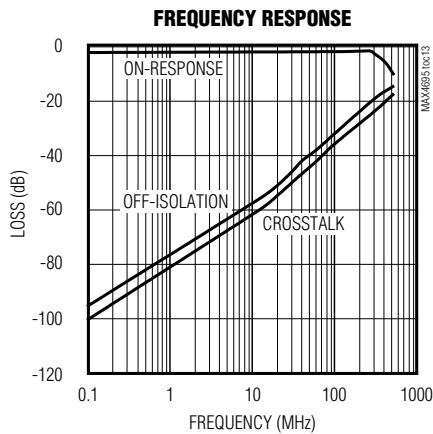
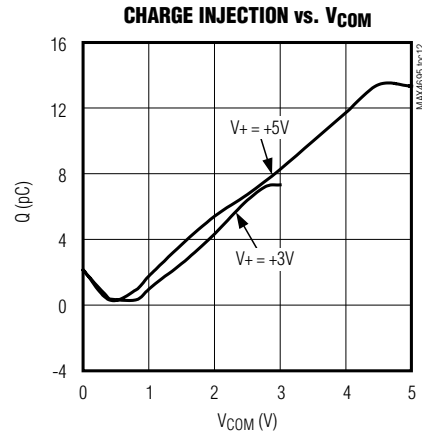
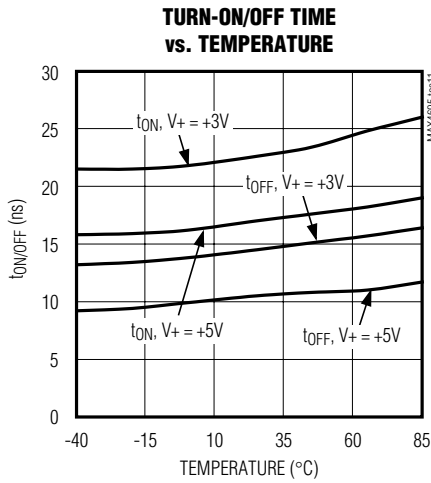
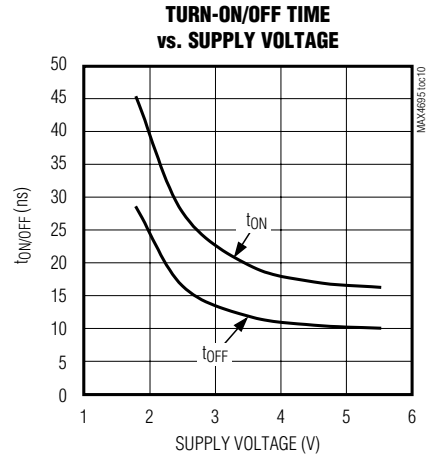
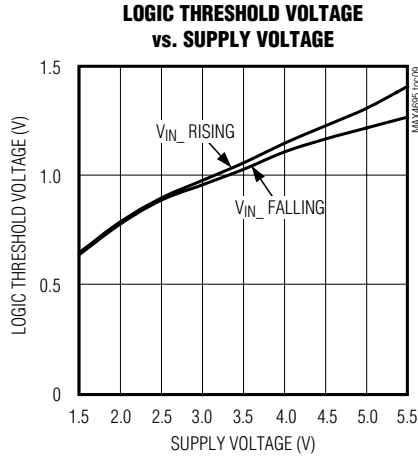
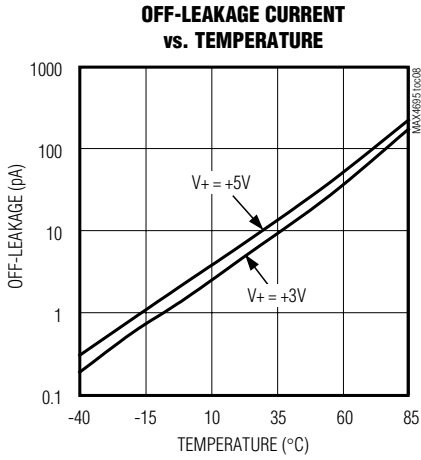
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Typical Operating Characteristics (continued)

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



Low-Voltage, 60Ω Dual SPDT Analog Switch in Thin QFN

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Pin Description

| PIN | | NAME | FUNCTION |
|------|-------|------|--|
| μMAX | 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 |
| — | 6, 10 | N.C. | No Connection. Not internally connected. |
| 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 Common Switch 1 |

Detailed Description

The MAX4695 is a low-voltage, dual single-pole/double-throw (SPDT) analog switch that operates from a single +1.8V to +5.5V supply. When powered from a +2.7V supply, the device has a 60Ω (max) on-resistance (R_{ON}), with 3Ω (max) R_{ON} matching and 10Ω (max) R_{ON} flatness. The digital logic inputs are 1.8V-logic compatible from a +2.7V to +3.3V supply.

Applications Information

Digital Control Inputs

The MAX4695 logic inputs are 1.8V CMOS logic compatible for 3V operation and TTL compatible for 5V operation of V+. Driving IN_ rail-to-rail minimizes power consumption.

Analog Signal Levels

Analog signals that range over the entire supply voltage (V+ to GND) are 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 either inputs or outputs.

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 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. In the circuit in Figure 1, 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.

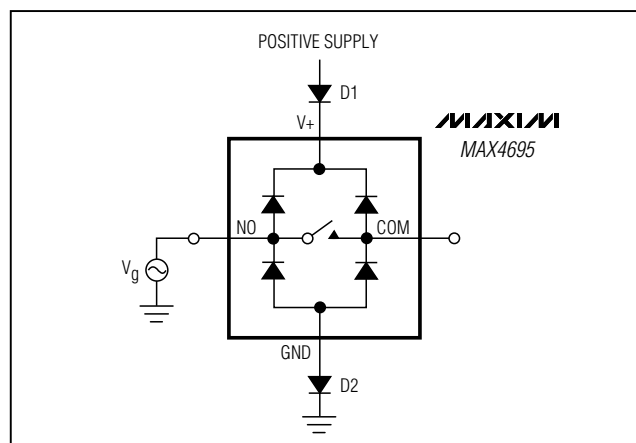


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

Low-Voltage, 60Ω Dual SPDT Analog Switch in Thin QFN

Test Circuits/Timing Diagrams

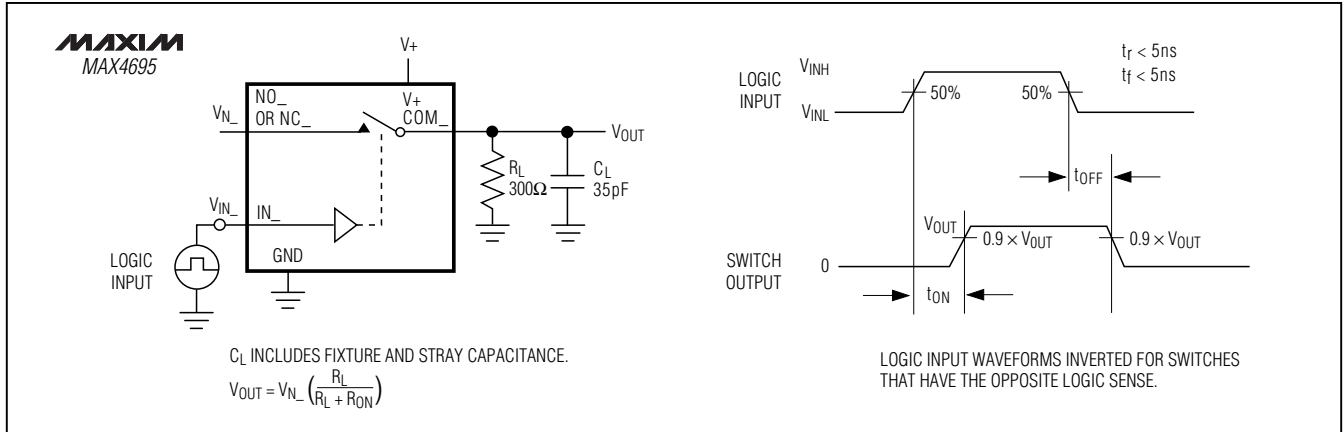


Figure 2. Switching Time

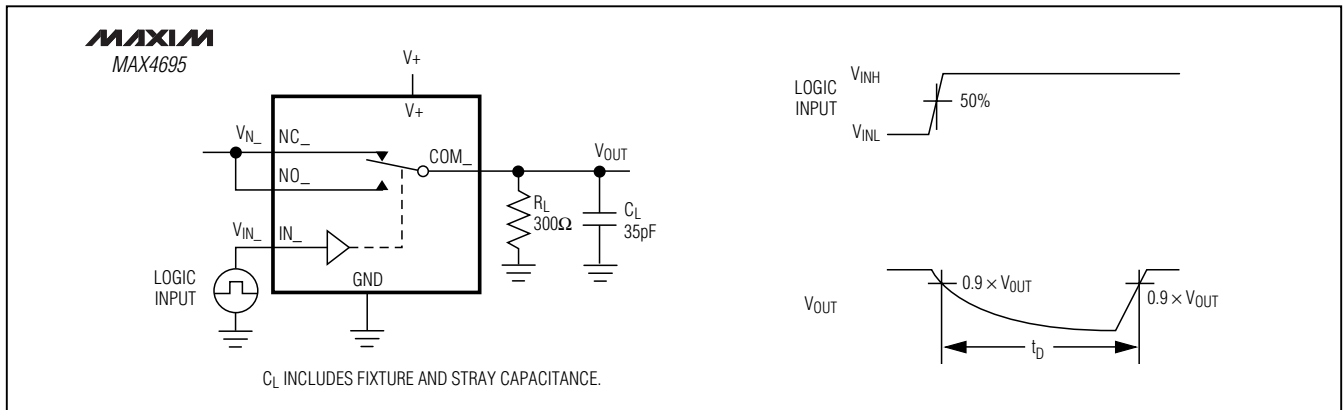


Figure 3. Break-Before-Make Interval

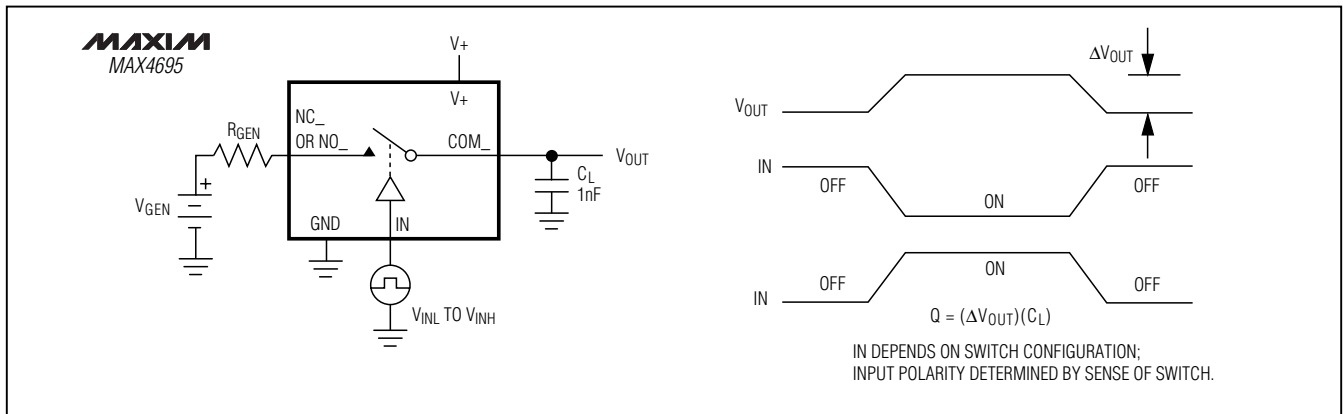


Figure 4. Charge Injection

Low-Voltage, 60Ω Dual SPDT Analog Switch in Thin QFN

Test Circuits/Timing Diagrams (continued)

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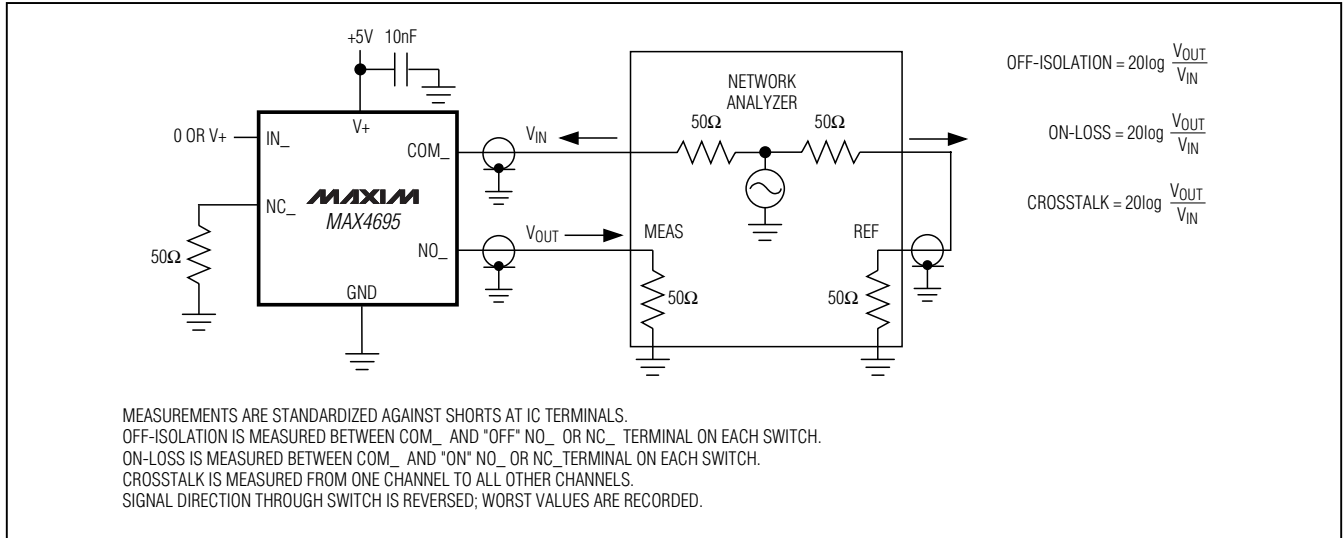


Figure 5. Off-Isolation/On-Channel Bandwidth, Crosstalk

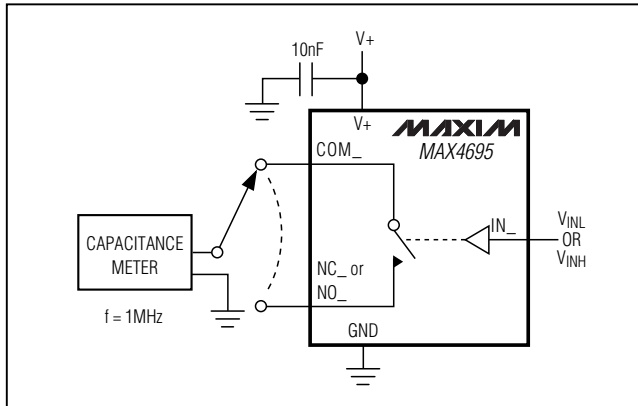


Figure 6. Channel Off/On-Capacitance

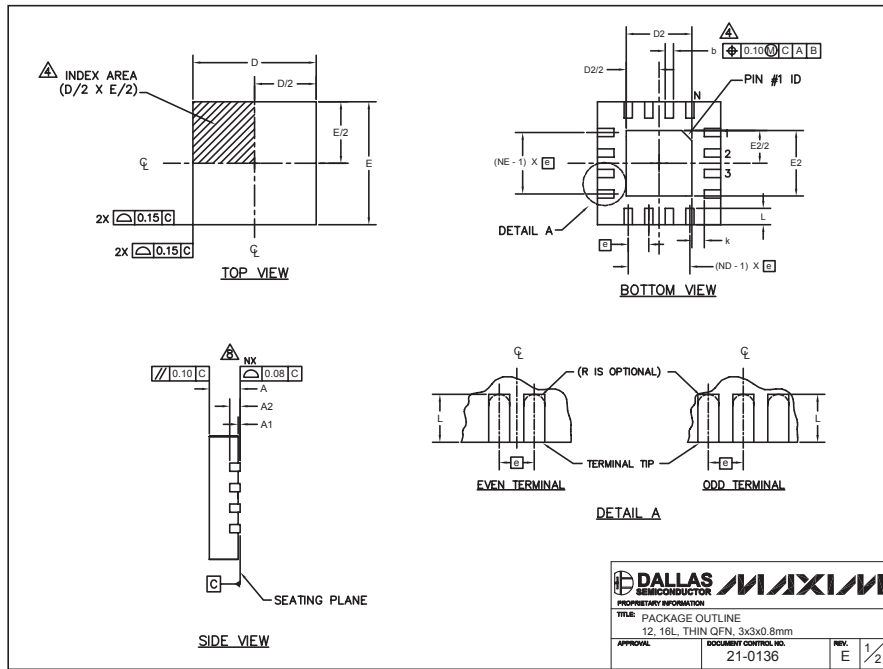
Chip Information

TRANSISTOR COUNT: 130

Low-Voltage, 60Ω Dual SPDT Analog Switch in Thin QFN

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)



12x16L QFN THIN EPS

| PKG REF. | 12L 3x3 | | | 16L 3x3 | | |
|----------|-----------|------|------|----------|------|------|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.70 | 0.75 | 0.80 | 0.70 | 0.75 | 0.80 |
| b | 0.20 | 0.25 | 0.30 | 0.20 | 0.25 | 0.30 |
| D | 2.90 | 3.00 | 3.10 | 2.90 | 3.00 | 3.10 |
| E | 2.90 | 3.00 | 3.10 | 2.90 | 3.00 | 3.10 |
| e | 0.50 BSC. | | | | | |
| L | 0.45 | 0.55 | 0.65 | 0.30 | 0.40 | 0.50 |
| N | 12 | | | | | |
| ND | 3 | | | 4 | | |
| NE | 3 | | | 4 | | |
| A1 | 0 | 0.02 | 0.05 | 0 | 0.02 | 0.05 |
| A2 | 0.20 REF | | | 0.20 REF | | |
| k | 0.25 | - | - | 0.25 | - | - |

| PKG CODES | D2 | | | E2 | | | PIN ID | JEDEC | DOWN BONDS ALLOWED |
|-----------|------|------|------|------|------|------|-------------|--------|--------------------|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | | | |
| T1233-1 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-1 | NO |
| T1233-3 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-1 | YES |
| T1633-1 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-2 | NO |
| T1633-2 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-2 | YES |
| T1633F-3 | 0.65 | 0.80 | 0.95 | 0.65 | 0.80 | 0.95 | 0.225 x 45° | WEED-2 | N/A |
| T1633-4 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-2 | NO |

NOTES:

- DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
- ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
- N IS THE TOTAL NUMBER OF TERMINALS.
- THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
- DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.20 mm AND 0.25 mm FROM TERMINAL TIP.
- ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
- DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
- COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
- DRAWING CONFORMS TO JEDEC MO220 REVISION C.

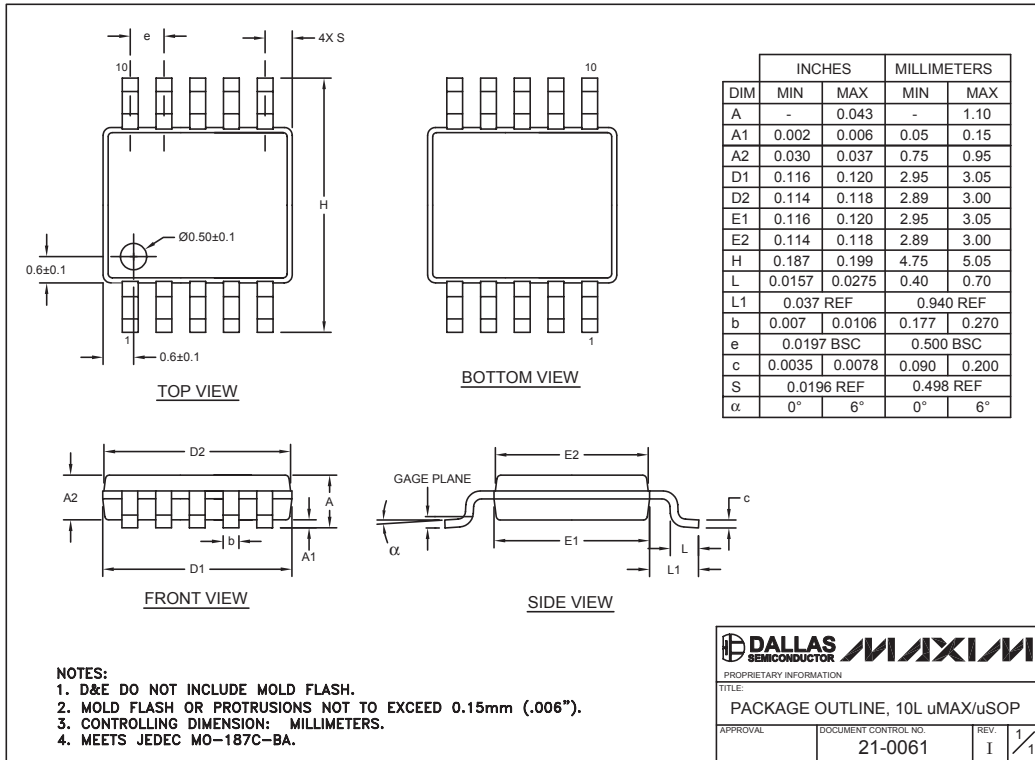
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|----------|----------------------|-------|
| APPROVAL | DOCUMENT CONTROL NO. | REV. |
| | 21-0136 | E 2/2 |

Low-Voltage, 60Ω Dual SPDT Analog Switch in Thin QFN

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)

MAX4695



10LUMAX EP5

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