



Precision, 8-Channel/Dual 4-Channel, High-Performance, CMOS Analog Multiplexers

MAX308/MAX309

General Description

The MAX308/MAX309 precision, monolithic, CMOS analog multiplexers (muxes) offer low on-resistance (less than 100Ω), which is matched to within 5Ω between channels and remains flat over the specified analog signal range (7Ω max). They also offer low leakage over temperature (NO-off leakage current less than 5nA at +85°C) and fast switching speeds (transition time less than 250ns). The MAX308 is a single-ended 1-of-8 device, and the MAX309 is a differential 2-of-4 device.

The MAX308/MAX309 are fabricated with Maxim's improved 44V silicon-gate process. Design improvements yield extremely low charge injection (less than 10pC) and guarantee electrostatic discharge protection greater than 2000V.

These muxes operate with a single +5V to +30V supply or bipolar ±5V to ±20V supplies, while retaining TTL/CMOS-logic input compatibility and fast switching. CMOS inputs provide reduced input loading. These improved parts are plug-in upgrades for the industry-standard DG408, DG409, DG508A, and DG509A.

Applications

- Sample-and-Hold Circuits
- Automatic Test Equipment
- Heads-Up Displays
- Guidance and Control Systems
- Military Radios
- Communications Systems
- Battery-Operated Systems
- PBX, PABX
- Audio Signal Routing

Features

- ◆ Guaranteed On-Resistance Match Between Channels, <5Ω Max
- ◆ Low On-Resistance, <100Ω Max
- ◆ Guaranteed Flat On-Resistance over Specified Signal Range, 7Ω Max
- ◆ Guaranteed Low Charge Injection, <10pC
- ◆ NO-Off Leakage Current <5nA at +85°C
- ◆ COM-Off Leakage Current <20nA at +85°C
- ◆ ESD Protection >2000V
- ◆ Plug-In Upgrade for Industry-Standard DG408/DG409/DG508A/DG509A
- ◆ Single-Supply Operation (+5V to +30V) Bipolar-Supply Operation (±5V to ±20V)
- ◆ Low Power Consumption, <300μW
- ◆ Rail-to-Rail Signal Handling
- ◆ TTL/CMOS-Logic Compatible

Ordering Information

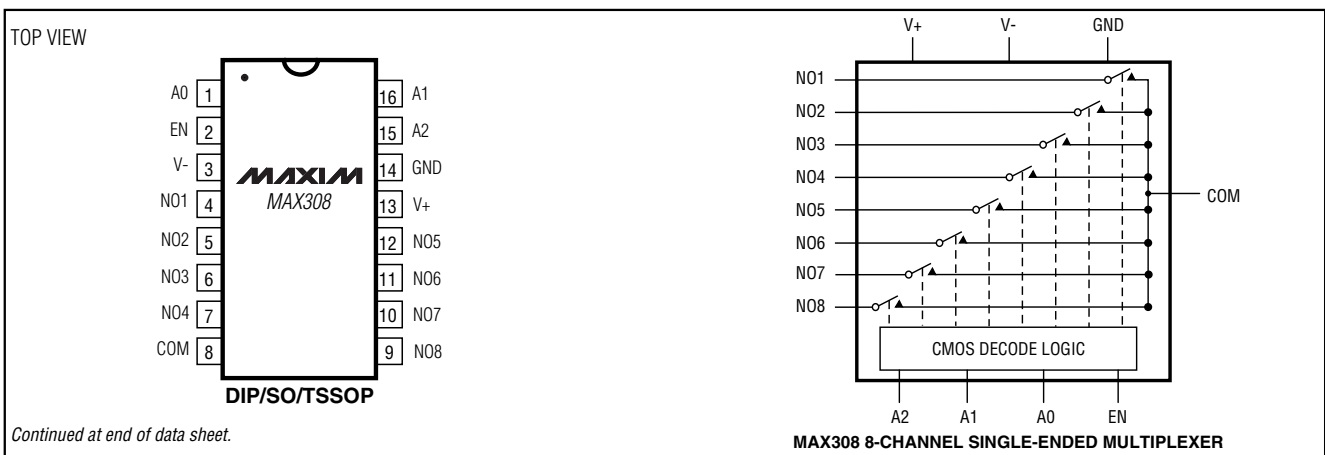
| PART | TEMP RANGE | PIN-PACKAGE |
|-----------|-----------------|----------------|
| MAX308CPE | 0°C to +70°C | 16 Plastic DIP |
| MAX308CSE | 0°C to +70°C | 16 Narrow SO |
| MAX308C/D | 0°C to +70°C | Dice* |
| MAX308CUE | 0°C to +70°C | 16 TSSOP |
| MAX308EPE | -40°C to +85°C | 16 Plastic DIP |
| MAX308ESE | -40°C to +85°C | 16 Narrow SO |
| MAX308EJE | -40°C to +85°C | 16 CERDIP |
| MAX308EUE | -40°C to +85°C | 16 TSSOP |
| MAX308MJE | -55°C to +125°C | 16 CERDIP** |

Ordering Information continued at end of data sheet.

*Contact factory for dice specifications.

**Contact factory for availability.

Pin Configurations/Functional Diagrams/Truth Tables



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.

Precision, 8-Channel/Dual 4-Channel, High-Performance, CMOS Analog Multiplexers

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-

V+-0.3V, 44V
 GND-0.3V, 25V

Digital Inputs, NO, COM (Note 1).....(V- - 2V) to (V+ + 2V) or 30mA, (whichever occurs first)

Continuous Current (any terminal).....30mA

Peak Current, NO or COM (pulsed at 1ms, 10% duty cycle max)100mA

Continuous Power Dissipation (TA = +70°C)

Plastic DIP (derate 10.53mW/°C above +70°C)842mW

Narrow SO (derate 8.70mW/°C above +70°C)696mW

CERDIP (derate 10.00mW/°C above +70°C)800mW

TSSOP (derate 6.7mW/°C above +70°C)457mW

Operating Temperature Ranges

MAX30_C_ _0°C to +70°C

MAX30_E_ _-40°C to +85°C

MAX30_MJE-55°C to +125°C

Storage Temperature Range-65°C to +150°C

Lead Temperature (soldering, 10sec)+300°C

Note 1: Signals on NO, COM, EN, A0, A1, or A2 exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current ratings.

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, GND = 0V, VAH = +2.4V, VAL = +0.8V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP (Note 2) | MAX | UNITS | | |
|---|-----------|--|-------------------|-------------------|--------------|-------|-------|------|-----|
| SWITCH | | | | | | | | | |
| Analog Signal Range | VNO, VCOM | (Note 3) | | -15 | | 15 | V | | |
| On-Resistance | RON | INO = -1.0mA, VCOM = ±10V | TA = +25°C | | 60 | 100 | Ω | | |
| | | | TA = TMIN to TMAX | | | 125 | | | |
| On-Resistance Matching Between Channels | ΔRON | INO = -1.0mA, VCOM = ±10V (Note 4) | TA = +25°C | | 1.5 | 5 | Ω | | |
| | | | TA = TMIN to TMAX | | | 8 | | | |
| On-Resistance Flatness | RFLAT | INO = -1.0mA, VCOM = ±5V or 0V | TA = +25°C | | 1.8 | 7 | Ω | | |
| | | | TA = TMIN to TMAX | | | 10 | | | |
| NO-Off Leakage Current (Note 5) | INO(OFF) | VCOM = +10V, VNO = ±10V, VEN = 0V | TA = +25°C | | -0.5 | 0.01 | 0.5 | nA | |
| | | | TA = TMIN to TMAX | C, E | | -2.5 | | | 2.5 |
| | | | | M | | -5.0 | | | 5.0 |
| COM-Off Leakage Current (Note 5) | ICOM(OFF) | VNO = ±10V, VCOM = +10V, VEN = 0V | MAX308 | TA = +25°C | | -0.75 | 0.02 | 0.75 | nA |
| | | | | TA = TMIN to TMAX | C, E | | -10 | | |
| | | | M | | | -20 | | 20 | |
| | | MAX309 | TA = +25°C | | -0.75 | 0.02 | 0.75 | | |
| | | | TA = TMIN to TMAX | C, E | | -5 | | 5 | |
| | | | | M | | -10 | | 10 | |
| COM-On Leakage Current (Note 5) | ICOM(ON) | VCOM = ±10V, VNO = ±10V, sequence each switch on | MAX308 | TA = +25°C | | -0.75 | 0.02 | 0.75 | nA |
| | | | | TA = TMIN to TMAX | C, E | | -10 | | |
| | | | M | | | -20 | | 20 | |
| | | MAX309 | TA = +25°C | | -0.75 | 0.02 | 0.75 | | |
| | | | TA = TMIN to TMAX | C, E | | -5 | | 5 | |
| | | | | M | | -10 | | 10 | |

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MAX308/MAX309

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V₊ = +15V, V₋ = -15V, GND = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP (Note 2) | MAX | UNITS |
|---------------------------------------|-----------------------|---|---|------------------------|-----------------|-----|-------|
| INPUT | | | | | | | |
| Input Current with Input Voltage High | I _{AH} | V _A = 2.4V or 15V | | -1.0 | | 1.0 | μA |
| Input Current with Input Voltage Low | I _{AL} | V _{EN} = 0V or 2.4V, V _A = 0V | | -1.0 | | 1.0 | μA |
| SUPPLY | | | | | | | |
| Power-Supply Range | | | | ±5 | | ±20 | V |
| Positive Supply Current | I ₊ | V _{EN} = V _A = 0V or 4.5V | T _A = +25°C | | 16 | 30 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | | | 75 | |
| | | V _{EN} = 2.4V, V _{A(ALL)} = 0V or 2.4V | T _A = +25°C | | 0.075 | 0.5 | mA |
| | | | T _A = T _{MIN} to T _{MAX} | | | | |
| Negative Supply Current | I ₋ | V _{EN} = 2.4V, V _{A(ALL)} = 0V or 2.4V | T _A = +25°C | | -1 | 1 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | | | -10 | |
| DYNAMIC | | | | | | | |
| Transistion Time | t _{TRANS} | Figure 2 | T _A = +25°C | | 85 | 175 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | | |
| Break-Before-Make Interval | t _{OPEN} | Figure 4 | T _A = +25°C | 10 | 40 | | ns |
| Enable Turn-On Time | t _{ON(EN)} | Figure 3 | T _A = +25°C | | 85 | 150 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | | |
| Enable Turn-Off Time | t _{OFF(EN)} | Figure 3 | T _A = +25°C | | | 150 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | | |
| Charge Injection (Note 3) | Q | C _L = 1.0nF, V _{NO} = 0V, R _S = 0Ω, Figure 5 | T _A = T _{MIN} to T _{MAX} | | | | pC |
| | | | T _A = +25°C | | 2 | 10 | |
| Off Isolation (Note 6) | V _{ISO} | V _{EN} = 0V, R _L = 1kΩ, f = 100kHz, Figure 6 | T _A = +25°C | | -75 | | dB |
| Crosstalk Between Channels | V _{CT} | V _{EN} = 2.4V, f = 100kHz, V _{GEN} = 1V _{P-P} , R _L = 1kΩ, Figure 7 | T _A = +25°C | | -92 | | dB |
| Logic Input Capacitance | C _{IN} | f = 1MHz | T _A = +25°C | | 8 | | pF |
| NO-Off Capacitance | C _{NO(OFF)} | f = 1MHz, V _{EN} = V _{NO} = 0V, Figure 8 | T _A = +25°C | | 3 | | pF |
| COM-Off Capacitance | C _{COM(OFF)} | f = 1MHz, V _{EN} = 0.8V, V _{COM} = 0V, Figure 8 | MAX308 | T _A = +25°C | | 26 | pF |
| | | | MAX309 | | | 14 | |
| COM-On Capacitance | C _{COM(ON)} | f = 1MHz, V _{EN} = 2.4V, V _{COM} = 0V, Figure 8 | MAX308 | T _A = +25°C | | 37 | pF |
| | | | MAX309 | | | 25 | |

Precision, 8-Channel/Dual 4-Channel, High-Performance, CMOS Analog Multiplexers

ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0V, GND = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP (Note 2) | MAX | UNITS |
|----------------------------------|---------------------------------------|--|------------------------|-----|-----------------|-----|-------|
| SWITCH | | | | | | | |
| Analog Signal Range | V _{NO} , V _{COM} | (Note 3) | | 0 | | 12 | V |
| On-Resistance | R _{ON} | I _{NO} = -1.0mA V _{COM} = 3V or 10V | T _A = +25°C | | 120 | 175 | Ω |
| DYNAMIC | | | | | | | |
| Transition Time (Note 3) | t _{TRANS} | V _{NO1} = 8V, V _{NO8} = 0V, V _{IN} = 2.4V, Figure 2 | T _A = +25°C | | 115 | 450 | ns |
| Enable Turn-On Time (Note 3) | t _{ON(EN)} | V _{INH} = 2.4V, V _{INL} = 0V, V _{NO1} = 5V, Figure 3 | T _A = +25°C | | 100 | 600 | ns |
| Enable Turn-Off Time (Note 3) | t _{OFF(EN)} | V _{INH} = 2.4V, V _{INL} = 0V, V _{NO1} = 5V, Figure 3 | T _A = +25°C | | 75 | 300 | ns |
| Charge Injection (Note 3) | Q | C _L = 1.0nF, V _{NO} = 0V, R _S = 0Ω | T _A = +25°C | | 2 | 10 | pC |

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: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$. On-resistance match between channels and flatness are guaranteed only with specified voltages. Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured at the extremes of the specified analog signal range.

Note 5: Leakage parameters are 100% tested at the maximum rated hot temperature and guaranteed by correlation at +25°C.

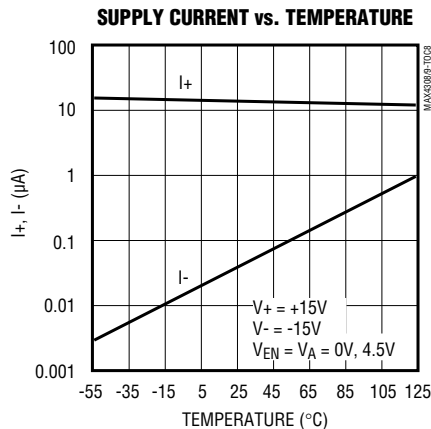
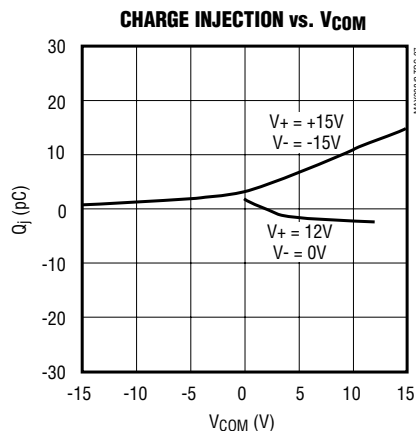
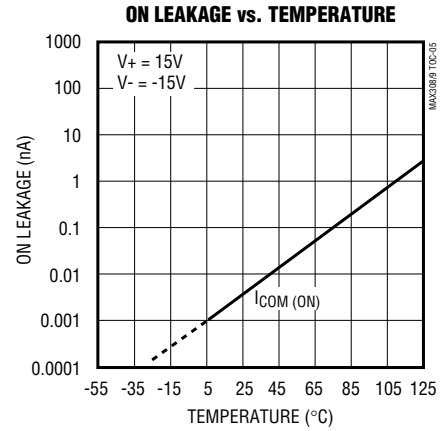
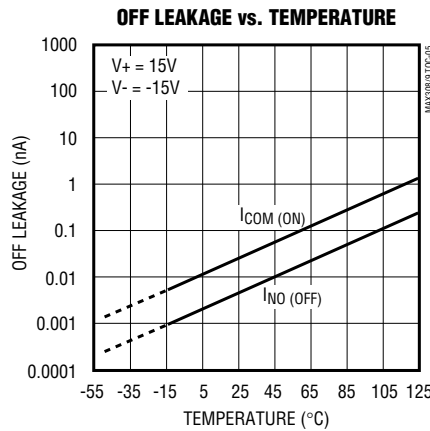
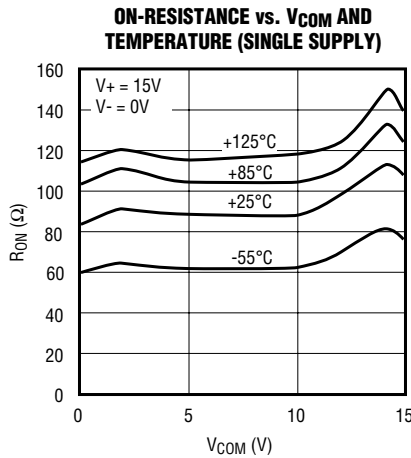
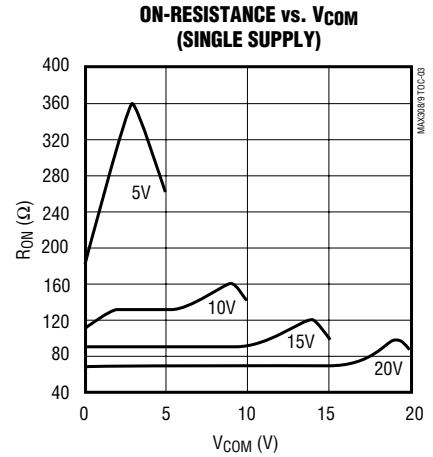
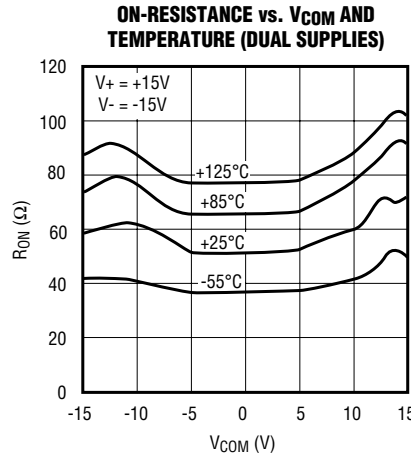
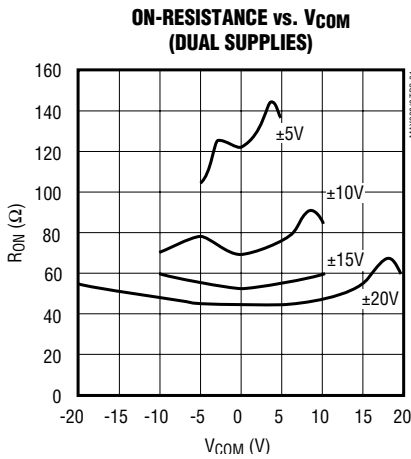
Note 6: Off isolation = $20\log V_{COM}/V_{NO}$, where V_{COM} = output and V_{NO} = input to off switch.

Precision, 8-Channel/Dual 4-Channel, High-Performance, CMOS Analog Multiplexers

Typical Operating Characteristics

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

MAX308/MAX309



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Pin Description

| PIN | | NAME | FUNCTION |
|-----------|--------|------------|-------------------------------|
| MAX308 | MAX309 | | |
| 1, 15, 16 | — | A0, A2, A1 | Address Inputs |
| — | 1, 16 | A0, A1 | Address Inputs |
| 2 | 2 | EN | Enable Input |
| 3 | 3 | V- | Negative Supply Voltage Input |
| 4–7 | — | NO1–NO4 | Analog Inputs—Bidirectional |
| — | 4–7 | NO1A–NO4A | Analog Inputs—Bidirectional |
| 8 | — | COM | Analog Output—Bidirectional |
| — | 8, 9 | COMA, COMB | Analog Outputs—Bidirectional |
| 9–12 | — | NO8–NO5 | Analog Inputs—Bidirectional |
| — | 10–13 | NO4B–NO1B | Analog Inputs—Bidirectional |
| 13 | 14 | V+ | Positive Supply Voltage Input |
| 14 | 15 | GND | Ground |

Applications Information

Operation with Supply Voltages Other than 15V

Using supply voltages less than $\pm 15\text{V}$ will reduce the analog signal range. The MAX308/MAX309 switches operate with $\pm 5\text{V}$ to $\pm 20\text{V}$ bipolar supplies or with a $+5\text{V}$ to $+30\text{V}$ single supply. Connect V- to GND when operating with a single supply. Both device types can also operate with unbalanced supplies, such as $+24\text{V}$ and -5V . The *Typical Operating Characteristics* graphs show typical on-resistance with 20V, 15V, 10V, and 5V supplies. (Switching times increase by a factor of two or more for operation at 5V.)

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 may 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 in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to 1V below V+ and 1V 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 $+44\text{V}$.

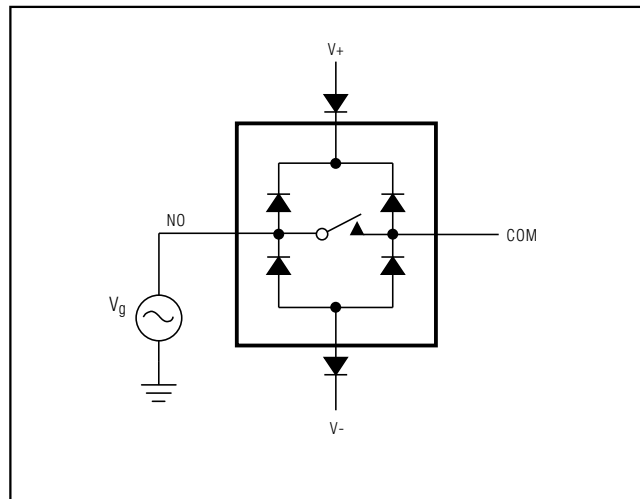


Figure 1. Overvoltage Protection Using External Blocking Diodes

Precision, 8-Channel/Dual 4-Channel, High-Performance, CMOS Analog Multiplexers

Test Circuits/Timing Diagrams

MAX308/MAX309

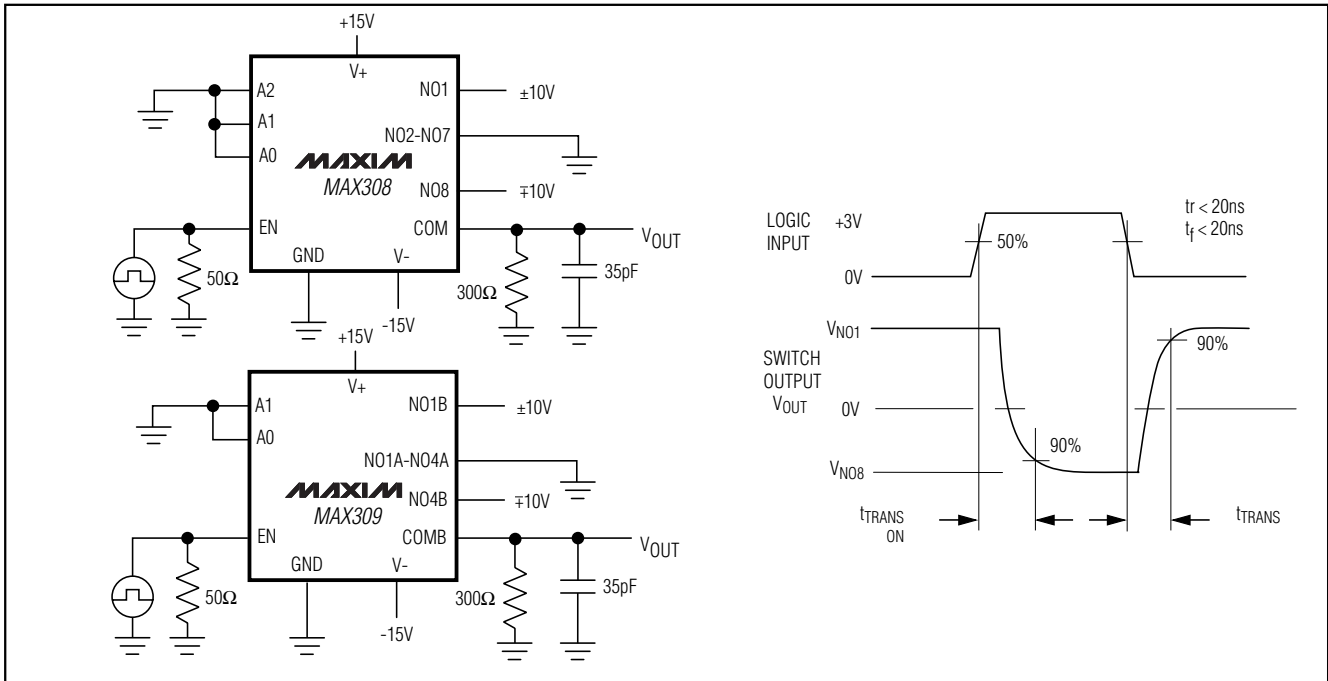


Figure 2. Transition Time

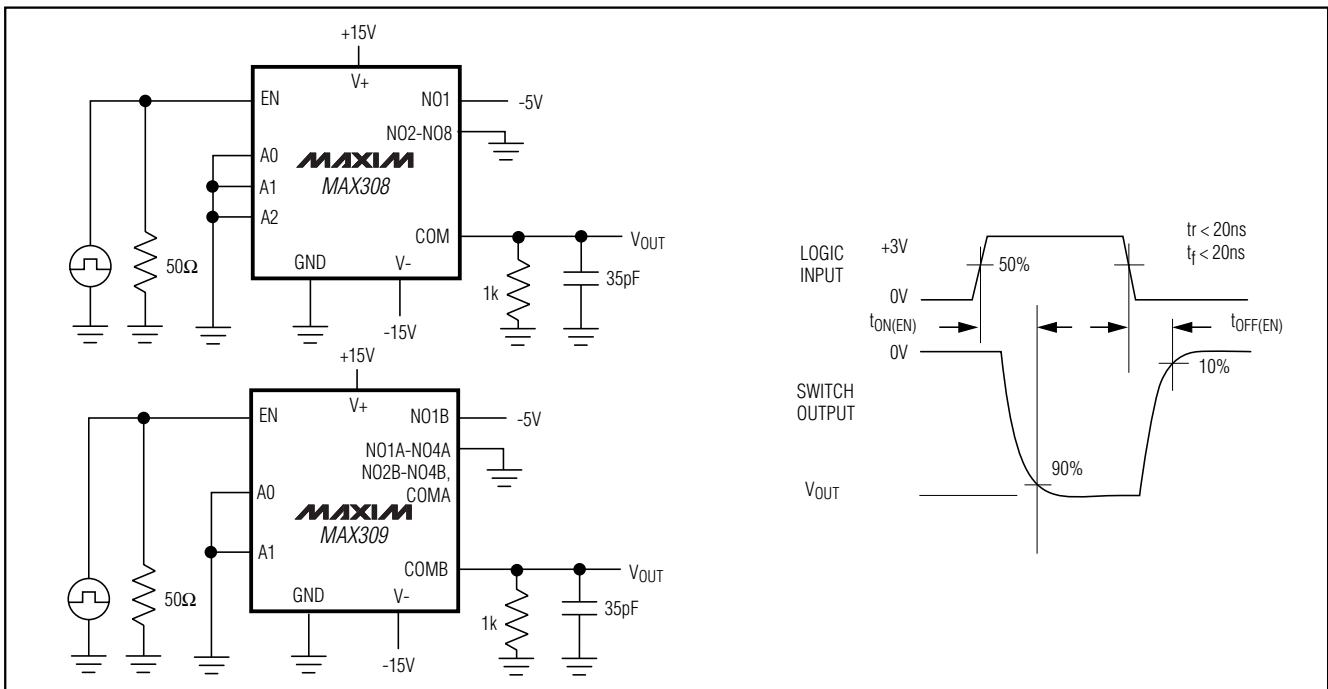


Figure 3. Enable Switching Time

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Test Circuits/Timing Diagrams (continued)

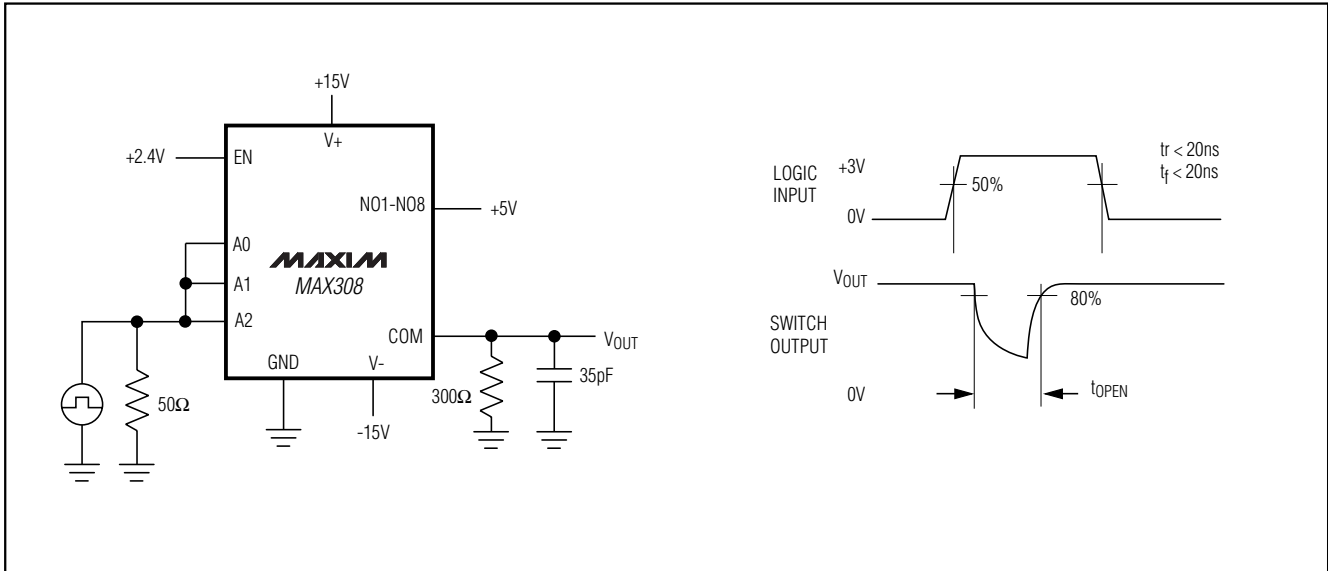


Figure 4. Break-Before-Make Interval

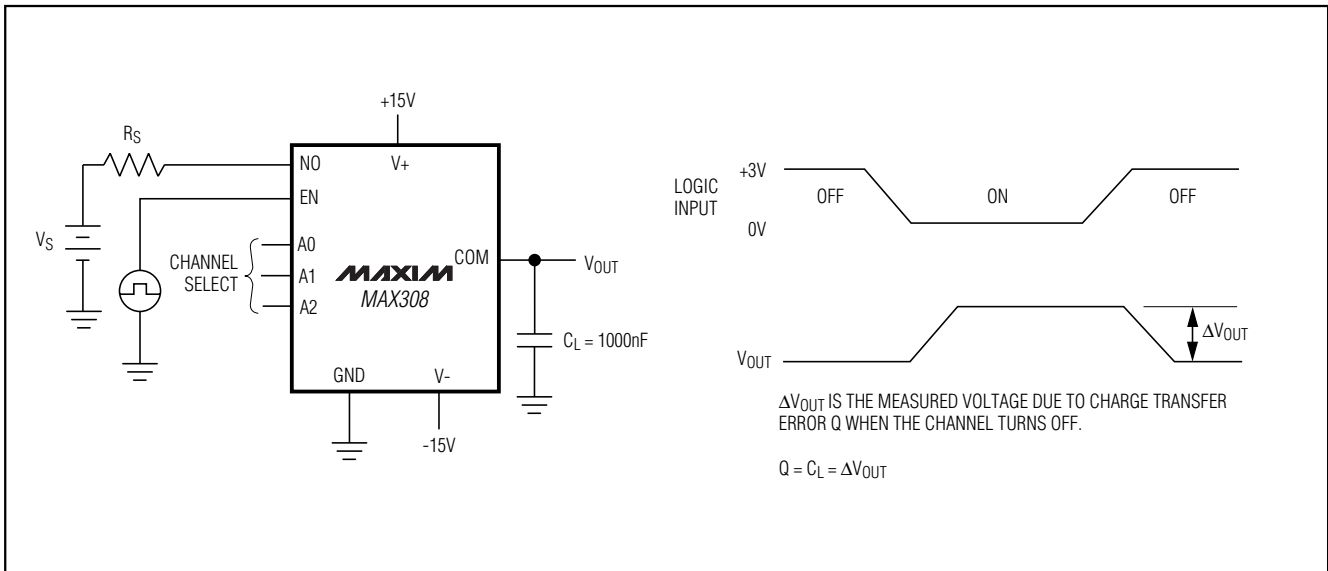


Figure 5. Charge Injection

Precision, 8-Channel/Dual 4-Channel, High-Performance, CMOS Analog Multiplexers

Test Circuits/Timing Diagrams (continued)

MAX308/MAX309

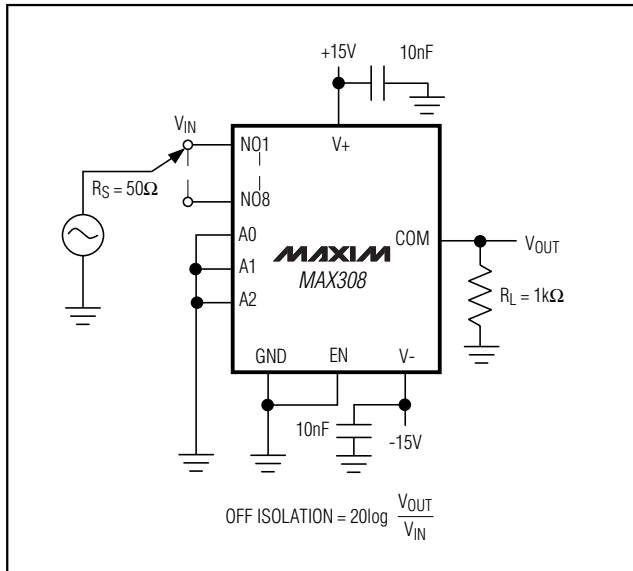


Figure 6. Off Isolation

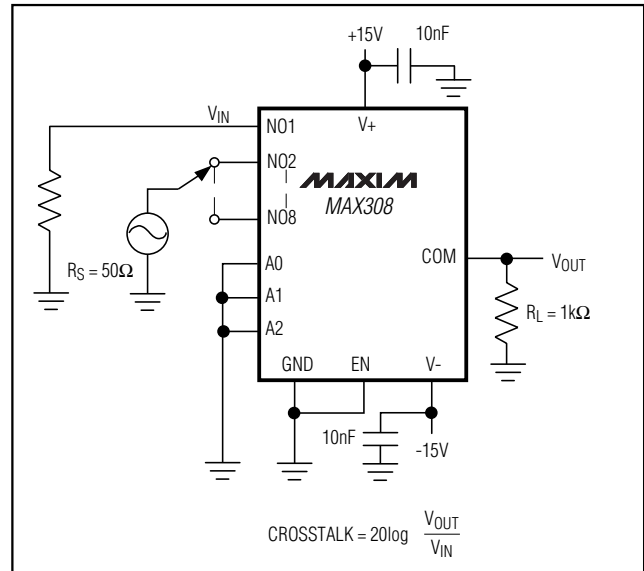


Figure 7. Crosstalk

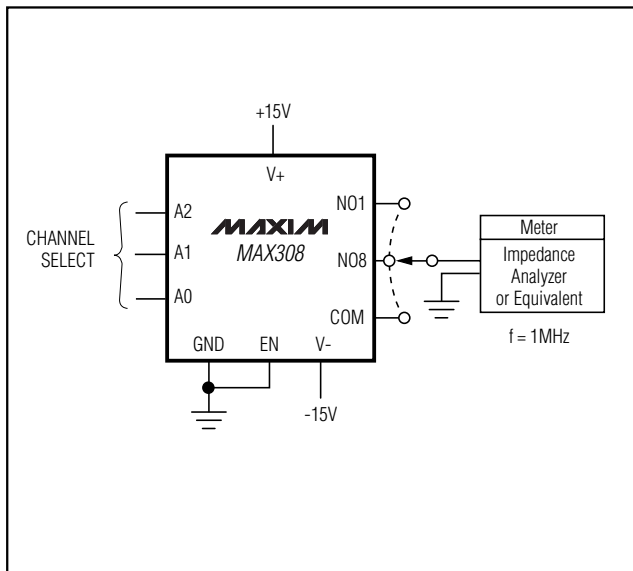
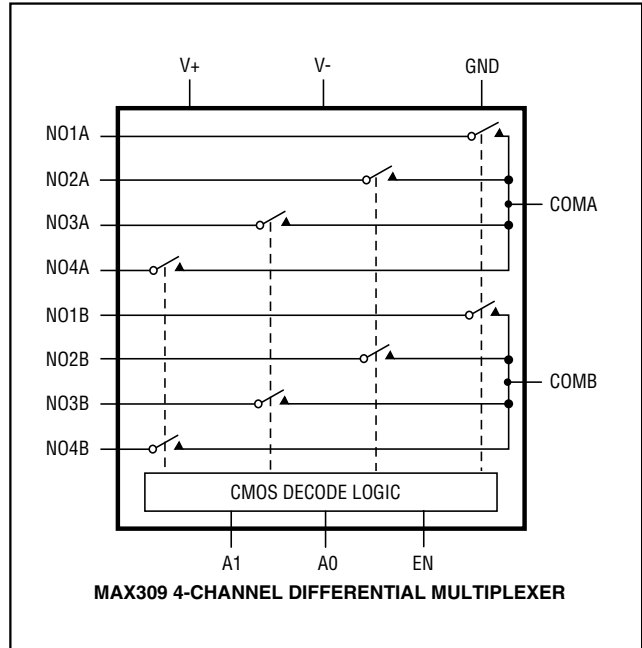
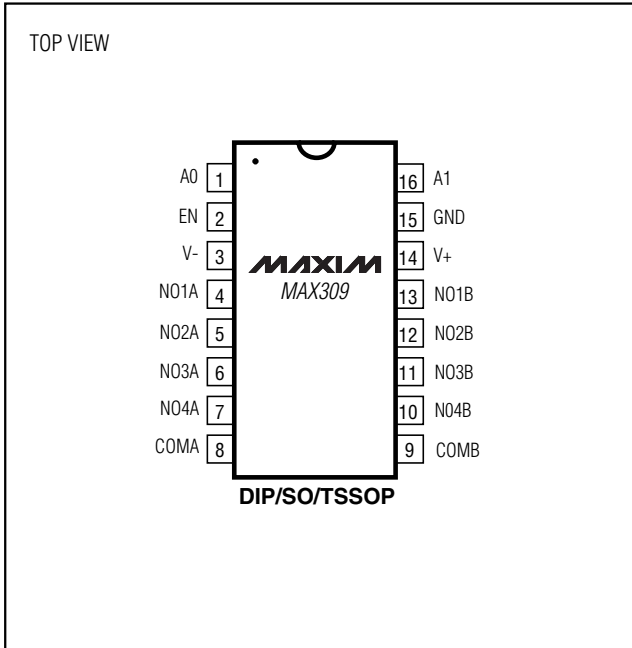


Figure 8. NO/COM Capacitance

Precision, 8-Channel/Dual 4-Channel, High-Performance, CMOS Analog Multiplexers

Pin Configurations/Functional Diagrams/Truth Tables (continued)



| A2 | A1 | A0 | EN | ON SWITCH |
|----|----|----|----|-----------|
| X | X | X | 0 | None |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 2 |
| 0 | 1 | 0 | 1 | 3 |
| 0 | 1 | 1 | 1 | 4 |
| 1 | 0 | 0 | 1 | 5 |
| 1 | 0 | 1 | 1 | 6 |
| 1 | 1 | 0 | 1 | 7 |
| 1 | 1 | 1 | 1 | 8 |

MAX308

LOGIC "0" $V_{AL} \leq 0.8V$, LOGIC "1" $V_{AH} \geq 2.4V$

| A1 | A0 | EN | ON SWITCH |
|----|----|----|-----------|
| X | X | 0 | None |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 2 |
| 1 | 0 | 1 | 3 |
| 1 | 1 | 1 | 4 |

MAX309

LOGIC "0" $V_{AL} \leq 0.8V$, LOGIC "1" $V_{AH} \geq 2.4V$

Precision, 8-Channel/Dual 4-Channel, High-Performance, CMOS Analog Multiplexers

MAX308/MAX309

Ordering Information (continued)

| PART | TEMP RANGE | PIN-PACKAGE |
|------------------|-------------------|--------------------|
| MAX309CPE | 0°C to +70°C | 16 Plastic DIP |
| MAX309CSE | 0°C to +70°C | 16 Narrow SO |
| MAX309CUE | 0°C to +70°C | 16 TSSOP |
| MAX309C/D | 0°C to +70°C | Dice* |
| MAX309EPE | -40°C to +85°C | 16 Plastic DIP |
| MAX309ESE | -40°C to +85°C | 16 Narrow SO |
| MAX309EJE | -40°C to +85°C | 16 CERDIP |
| MAX309EUE | -40°C to +85°C | 16 TSSOP |
| MAX309MJE | -55°C to +125°C | 16 CERDIP** |

*Contact factory for dice specifications.

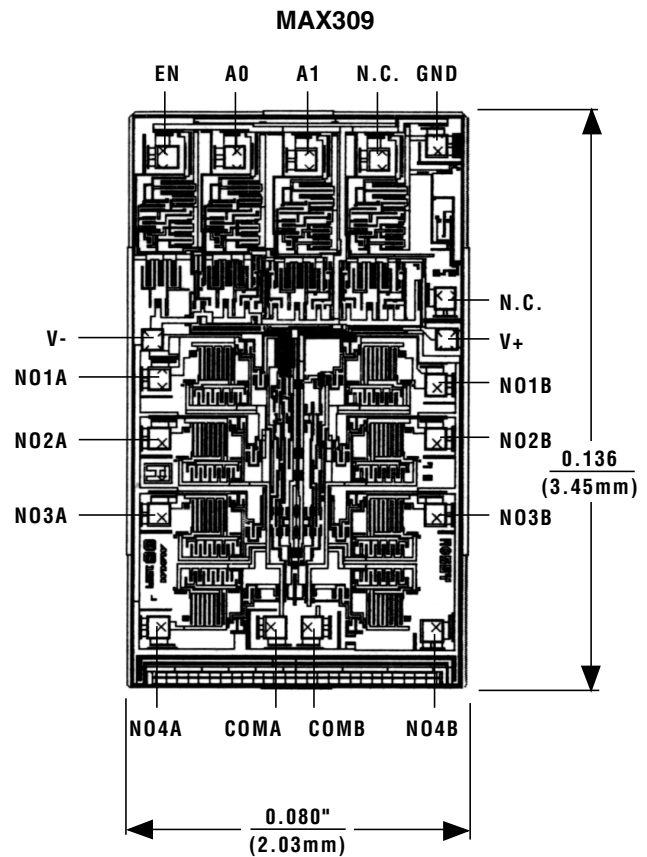
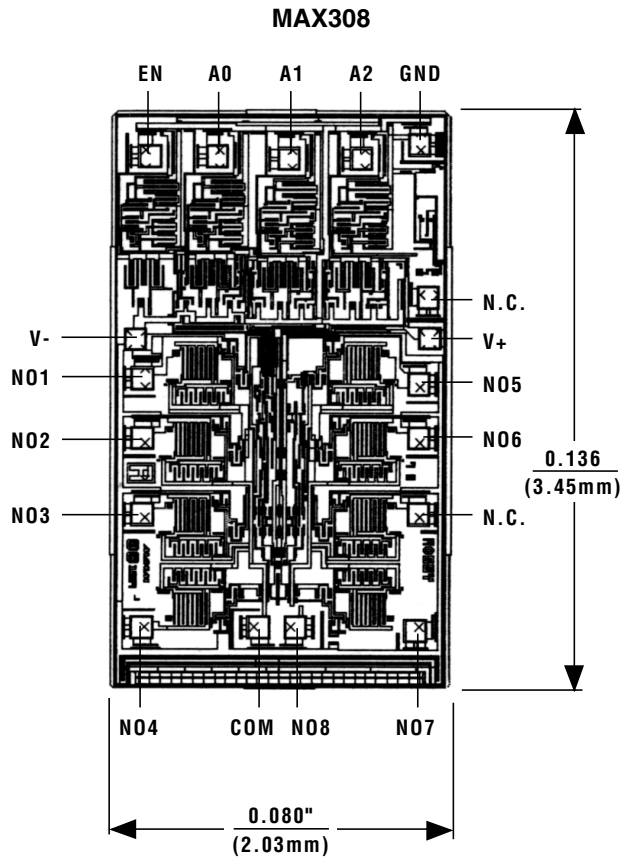
**Contact factory for availability.

Package Information

For the latest package outline information, go to
www.maxim-ic.com/packages.

Precision, 8-Channel/Dual 4-Channel, High-Performance, CMOS Analog Multiplexers

Chip Topographies



N.C. = NO INTERNAL CONNECTION

TRANSISTOR COUNT: 122
SUBSTRATE CONNECTED TO V+

TRANSISTOR COUNT: 122
SUBSTRATE CONNECTED TO V+

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