



## Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

### General Description

The MAX306/MAX307 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 ( $I_{NO(OFF)}$  less than 2.5nA at +85°C) and fast switching speeds ( $t_{TRANS}$  less than 250ns). The MAX306 is a single-ended 1-of-16 device, and the MAX307 is a differential 2-of-8 device.

The MAX306/MAX307 are fabricated with Maxim's improved 44V silicon-gate process. Design improvements yield extremely low charge injection (less than 10pC) and guarantee electrostatic discharge (ESD) protection greater than 2000V.

These muxes operate with a single +4.5V to +30V supply, or bipolar ±4.5V 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 DG406, DG407, DG506A, and DG507A.

### Applications

Sample-and-Hold Circuits  
 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 Charge Injection, <10pC
- ♦  $I_{NO(OFF)}$  Leakage <2.5nA at +85°C
- ♦  $I_{COM(OFF)}$  Leakage <20nA at +85°C
- ♦ ESD Protection >2000V
- ♦ Plug-In Upgrade for Industry-Standard DG406/DG407/DG506A/DG507A
- ♦ Single-Supply Operation (+4.5V to +30V)  
Bipolar-Supply Operation (±4.5V to ±20V)
- ♦ Low Power Consumption, <1.25mW
- ♦ Rail-to-Rail Signal Handling
- ♦ TTL/CMOS-Logic Compatible

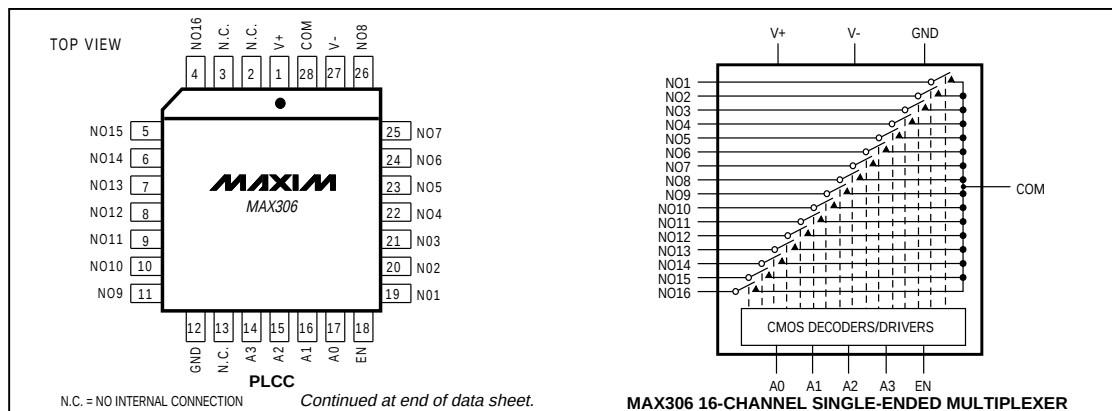
### Ordering Information

| PART      | TEMP. RANGE     | PIN-PACKAGE    |
|-----------|-----------------|----------------|
| MAX306CPI | 0°C to +70°C    | 28 Plastic DIP |
| MAX306CWI | 0°C to +70°C    | 28 Wide SO     |
| MAX306C/D | 0°C to +70°C    | Dice*          |
| MAX306EPI | -40°C to +85°C  | 28 Plastic DIP |
| MAX306EWI | -40°C to +85°C  | 28 Wide SO     |
| MAX306EQI | -40°C to +85°C  | 28 PLCC        |
| MAX306MJI | -55°C to +125°C | 28 CERDIP      |

Ordering Information continued at end of data sheet.

\* Contact factory for dice specifications.

### Pin Configurations/Functional Diagrams/Truth Tables





# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

## ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +15V, V- = -15V, GND = 0V, V<sub>AH</sub> = +2.4V, V<sub>AL</sub> = +0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

| PARAMETER                             | SYMBOL                | CONDITIONS                                                                                                |                                                       | MIN  | TYP<br>(Note 2) | MAX | UNITS |
|---------------------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------|------|-----------------|-----|-------|
| INPUT                                 |                       |                                                                                                           |                                                       |      |                 |     |       |
| Input Current with Input Voltage High | I <sub>AH</sub>       | V <sub>A</sub> = 2.4V or 15V                                                                              |                                                       | -1.0 |                 | 1.0 | μA    |
| Input Current with Input Voltage Low  | I <sub>AL</sub>       | V <sub>EN</sub> = 0V or 2.4V, V <sub>A</sub> = 0V                                                         |                                                       | -1.0 |                 | 1.0 | μA    |
| SUPPLY                                |                       |                                                                                                           |                                                       |      |                 |     |       |
| Power-Supply Range                    |                       |                                                                                                           |                                                       | ±4.5 |                 | ±20 | V     |
| Positive Supply Current               | I <sup>+</sup>        | V <sub>EN</sub> = V <sub>A</sub> = 0V or 4.5V                                                             | T <sub>A</sub> = +25°C                                |      | 16              | 30  | μA    |
|                                       |                       |                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      |                 | 75  |       |
|                                       |                       | V <sub>EN</sub> = 2.4V, V <sub>A(ALL)</sub> = 0V or 2.4V                                                  | T <sub>A</sub> = +25°C                                |      | 0.075           | 0.5 | mA    |
|                                       |                       |                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      |                 | 1   |       |
| Negative Supply Current               | I <sup>-</sup>        | V <sub>EN</sub> = 2.4V, V <sub>A(ALL)</sub> = 0V or 2.4V                                                  | T <sub>A</sub> = +25°C                                | -1   |                 | 1   | μA    |
|                                       |                       |                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | -10  |                 | 10  |       |
| DYNAMIC                               |                       |                                                                                                           |                                                       |      |                 |     |       |
| Transistion Time                      | t <sub>TRANS</sub>    | Figure 2                                                                                                  | T <sub>A</sub> = +25°C                                |      | 110             | 300 | ns    |
|                                       |                       |                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      |                 | 400 |       |
| Break-Before-Make Interval            | t <sub>OPEN</sub>     | Figure 4                                                                                                  | T <sub>A</sub> = +25°C                                | 10   | 40              |     | ns    |
| Enable Turn-On Time                   | t <sub>ON(EN)</sub>   | Figure 3                                                                                                  | T <sub>A</sub> = +25°C                                |      | 130             | 200 | ns    |
|                                       |                       |                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      |                 | 400 |       |
| Enable Turn-Off Time                  | t <sub>OFF(EN)</sub>  | Figure 3                                                                                                  | T <sub>A</sub> = +25°C                                |      | 55              | 150 | ns    |
|                                       |                       |                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      |                 | 300 |       |
| Charge Injection (Note 3)             | Q                     | C <sub>L</sub> = 1.0nF, V <sub>NO</sub> = 0V, R <sub>S</sub> = 0Ω, Figure 5                               | T <sub>A</sub> = +25°C                                |      | 2               | 10  | pC    |
| Off Isolation (Note 6)                | V <sub>ISO</sub>      | V <sub>EN</sub> = 0V, R <sub>L</sub> = 1kΩ, f = 100kHz, Figure 6                                          | T <sub>A</sub> = +25°C                                |      | -69             |     | dB    |
| Crosstalk Between Channels            | V <sub>CT</sub>       | V <sub>EN</sub> = 2.4V, f = 100kHz, V <sub>GEN</sub> = 1V <sub>P-P</sub> , R <sub>L</sub> = 1kΩ, Figure 7 | T <sub>A</sub> = +25°C                                |      | -92             |     | dB    |
| Logic Input Capacitance               | C <sub>IN</sub>       | f = 1MHz                                                                                                  | T <sub>A</sub> = +25°C                                |      | 8               |     | pF    |
| NO-Off Capacitance                    | C <sub>NO(OFF)</sub>  | f = 1MHz, V <sub>EN</sub> = V <sub>NO</sub> = 0V, Figure 8                                                | T <sub>A</sub> = +25°C                                |      | 8               |     | pF    |
| COM-Off Capacitance                   | C <sub>COM(OFF)</sub> | f = 1MHz, V <sub>EN</sub> = 0.8V, V <sub>COM</sub> = 0V, Figure 8                                         | T <sub>A</sub> = +25°C                                |      | 130             |     | pF    |
|                                       |                       |                                                                                                           |                                                       |      | 65              |     |       |
| COM-On Capacitance                    | C <sub>COM(ON)</sub>  | f = 1MHz, V <sub>EN</sub> = 2.4V, V <sub>COM</sub> = 0V, Figure 8                                         | T <sub>A</sub> = +25°C                                |      | 140             |     | pF    |
|                                       |                       |                                                                                                           |                                                       |      | 70              |     |       |

MAX306/MAX307

## Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

### ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0V, GND = 0V, V<sub>AH</sub> = +2.4V, V<sub>AL</sub> = +0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

| PARAMETER                        | SYMBOL                                | CONDITIONS                                                                               |                        | MIN | TYP<br>(Note 2) | MAX | UNITS |
|----------------------------------|---------------------------------------|------------------------------------------------------------------------------------------|------------------------|-----|-----------------|-----|-------|
| SWITCH                           |                                       |                                                                                          |                        |     |                 |     |       |
| Analog Signal Range              | V <sub>NO</sub> ,<br>V <sub>COM</sub> | (Note 3)                                                                                 |                        | 0   |                 | 12  | V     |
| On-Resistance                    | R <sub>ON</sub>                       | I <sub>NO</sub> = -1.0mA<br>V <sub>COM</sub> = 3V or 10V                                 | T <sub>A</sub> = +25°C |     | 120             | 175 | Ω     |
| DYNAMIC                          |                                       |                                                                                          |                        |     |                 |     |       |
| Transition Time<br>(Note 3)      | t <sub>TRANS</sub>                    | V <sub>NO1</sub> = 8V,<br>V <sub>NO8</sub> = 0V,<br>V <sub>IN</sub> = 2.4V,<br>Figure 1  | T <sub>A</sub> = +25°C |     | 130             | 450 | ns    |
| Enable Turn-On Time<br>(Note 3)  | t <sub>ON(EN)</sub>                   | V <sub>INH</sub> = 2.4V,<br>V <sub>INL</sub> = 0V,<br>V <sub>NO1</sub> = 5V,<br>Figure 3 | T <sub>A</sub> = +25°C |     | 105             | 600 | ns    |
| Enable Turn-Off Time<br>(Note 3) | t <sub>OFF(EN)</sub>                  | V <sub>INH</sub> = 2.4V,<br>V <sub>INL</sub> = 0V,<br>V <sub>NO1</sub> = 5V,<br>Figure 3 | T <sub>A</sub> = +25°C |     | 80              | 300 | ns    |
| Charge Injection<br>(Note 3)     | Q                                     | C <sub>L</sub> = 1.0nF,<br>V <sub>NO</sub> = 0V,<br>R <sub>S</sub> = 0Ω                  | T <sub>A</sub> = +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:** ΔR<sub>ON</sub> = R<sub>ON(MAX)</sub> - R<sub>ON(MIN)</sub>. 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.

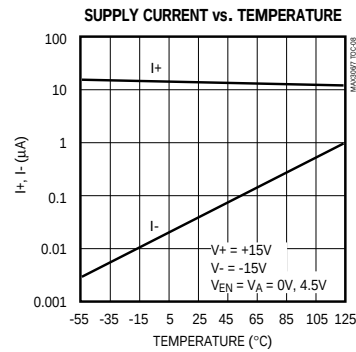
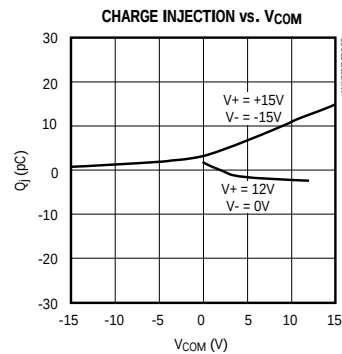
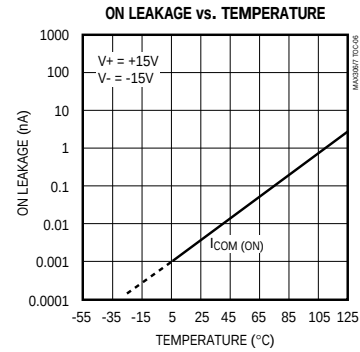
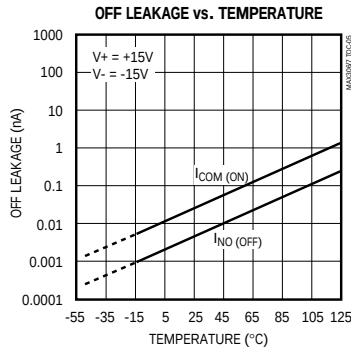
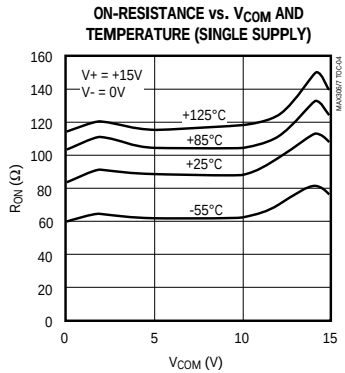
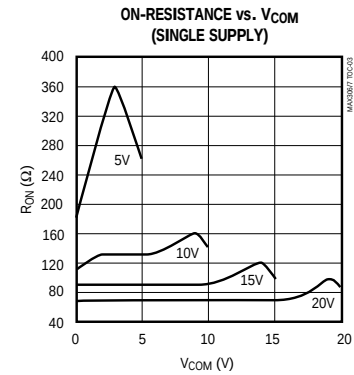
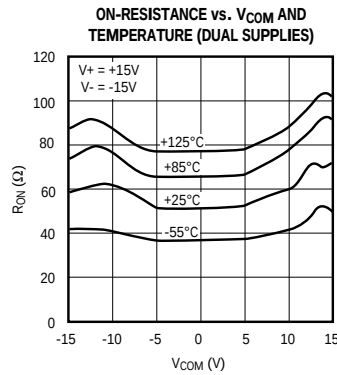
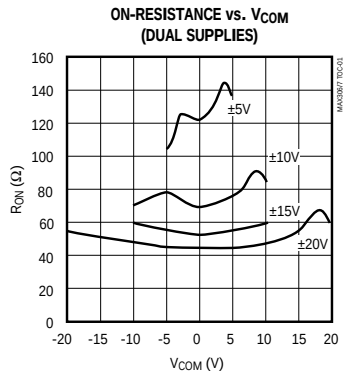
**Note 6:** Off isolation = 20log V<sub>COM</sub>/V<sub>NO</sub>, where V<sub>COM</sub> = output and V<sub>NO</sub> = input to off switch.

# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

## Typical Operating Characteristics

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

MAX306/MAX307



# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

## Pin Descriptions

| MAX306 PIN | NAME     | FUNCTION                      |
|------------|----------|-------------------------------|
| 1          | V+       | Positive Supply Voltage Input |
| 2, 3, 13   | N.C.     | No Internal Connections       |
| 4–11       | NO16–NO9 | Analog Inputs–bidirectional   |
| 12         | GND      | Ground                        |
| 14–17      | A3–A0    | Address Inputs                |
| 18         | EN       | Enable Inputs                 |
| 19–26      | NO1–NO8  | Analog Inputs–bidirectional   |
| 27         | V-       | Negative Supply Voltage Input |
| 28         | COM      | Output–bidirectional          |

| MAX307 PIN | NAME       | FUNCTION                      |
|------------|------------|-------------------------------|
| 1          | V+         | Positive Supply Voltage Input |
| 2          | COMB       | Output B–bidirectional        |
| 3, 13, 14  | N.C.       | No Internal Connection        |
| 4–11       | NO8B–NO1B  | Analog Inputs–bidirectional   |
| 12         | GND        | Ground                        |
| 15, 16, 17 | A2, A1, A0 | Address Inputs                |
| 18         | EN         | Enable Input                  |
| 19–26      | NO1A–NO8A  | Analog Inputs–bidirectional   |
| 27         | V-         | Negative Supply Voltage Input |
| 28         | COMA       | Output A–bidirectional        |

## Applications Information

### Operation with Supply Voltages Other than $\pm 15\text{V}$

Using supply voltages other than  $\pm 15\text{V}$  will reduce the analog signal range. The MAX306/MAX307 switches operate with  $\pm 4.5\text{V}$  to  $\pm 20\text{V}$  bipolar supplies or with a  $+4.5\text{V}$  to  $+30\text{V}$  single supply; connect V- to GND when operating with a single supply. Also, both device types can operate with unbalanced supplies such as  $+24\text{V}$  and  $-5\text{V}$ . 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 either 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 above V+ and 1V below V-, but low switch resistance and low leakage characteristics are unaffected. Device operation is unchanged, and the difference between V+ and V- should not exceed  $+44\text{V}$ .

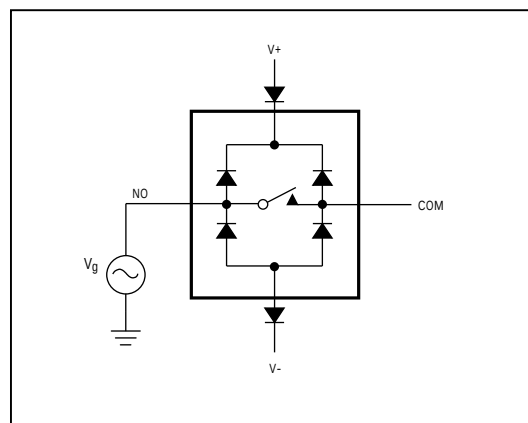


Figure 1. Overvoltage Protection Using External Blocking Diodes

# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

## Test Circuits/Timing Diagrams

MAX306/MAX307

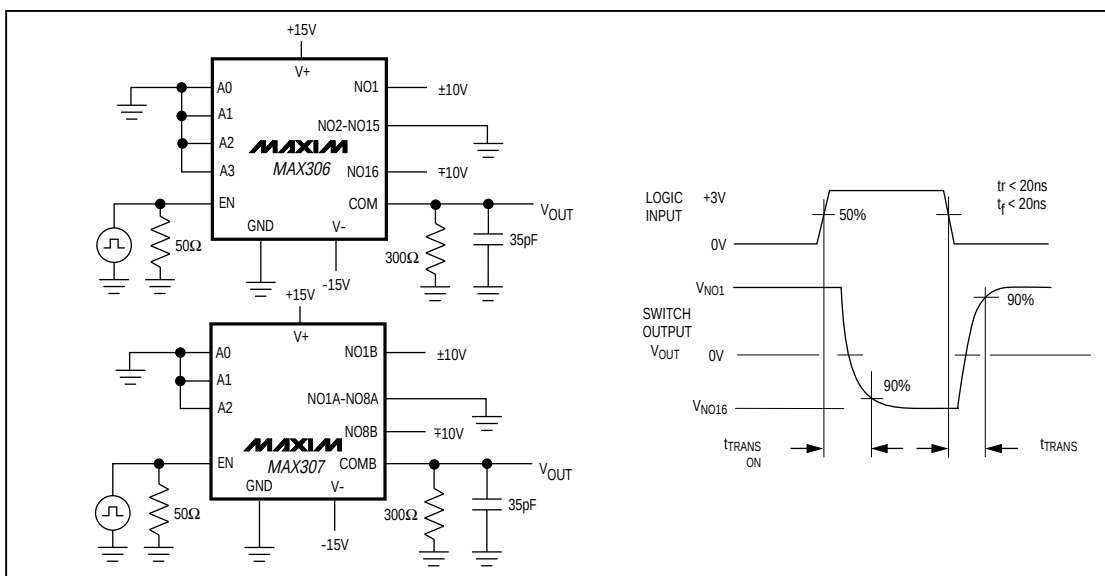


Figure 2. Transition Time

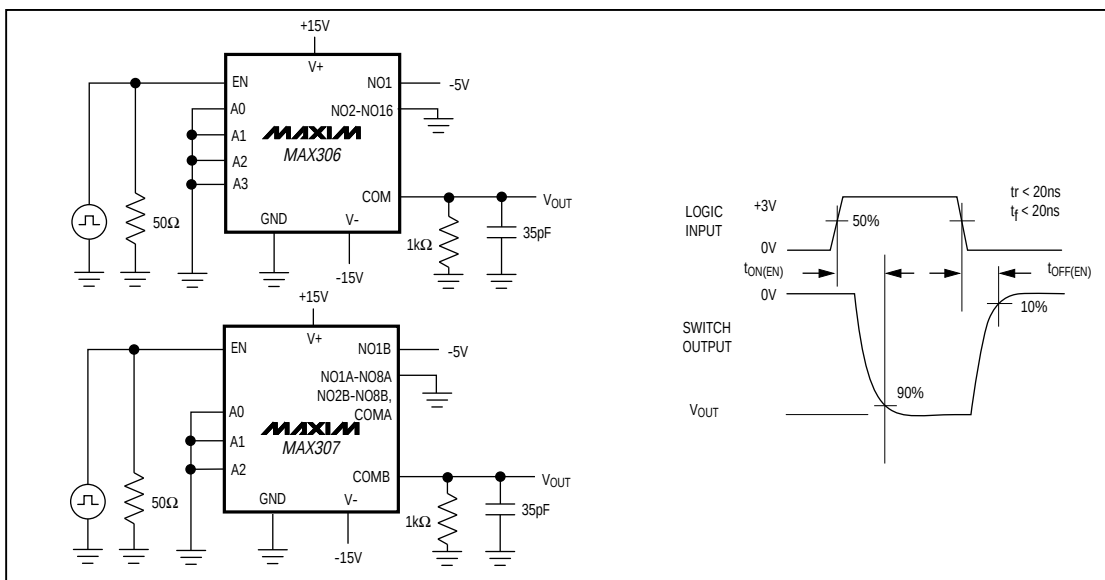


Figure 3. Enable Switching Time

# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

## Test Circuits/Timing Diagrams (continued)

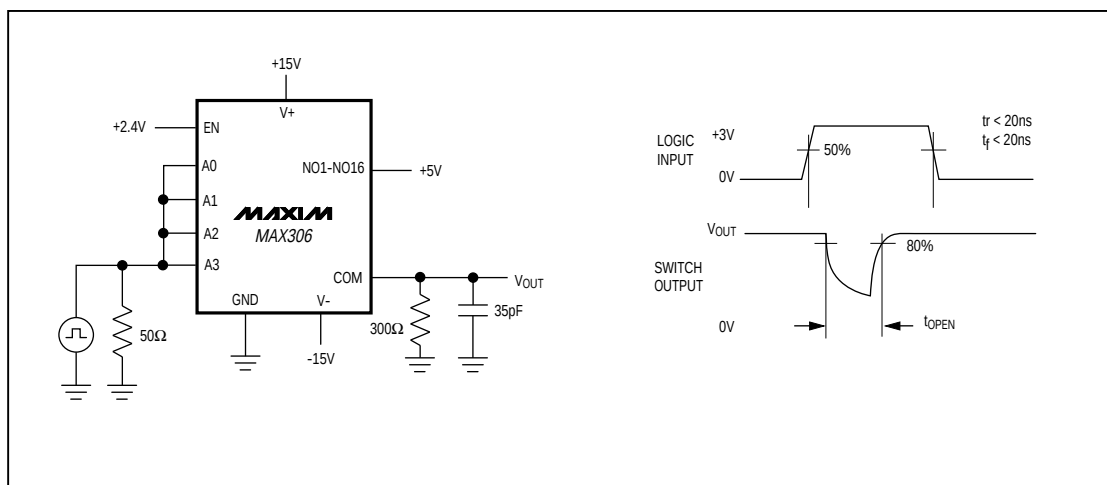


Figure 4. Break-Before-Make Interval

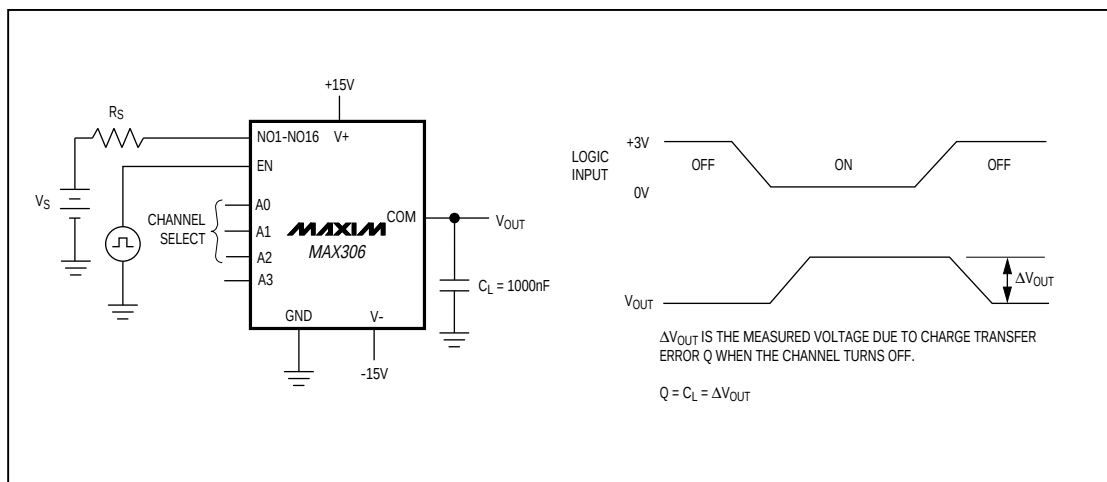


Figure 5. Charge Injection



# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

## Test Circuits/Timing Diagrams (continued)

MAX306/MAX307

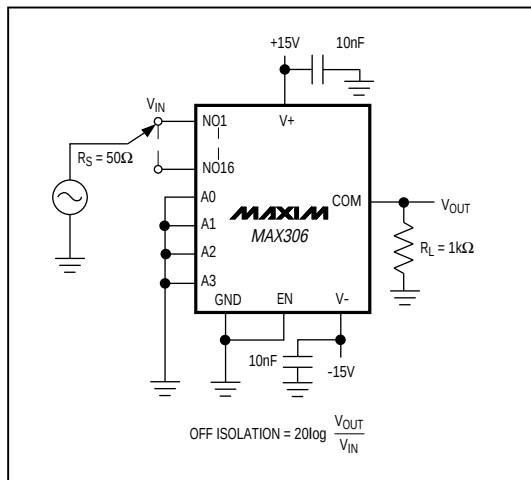


Figure 6. Off Isolation

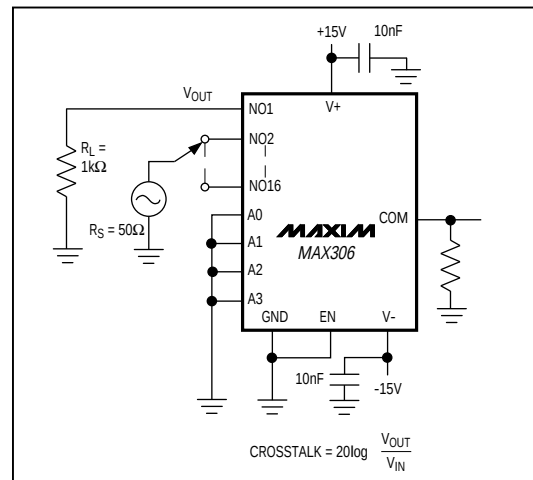


Figure 7. Crosstalk

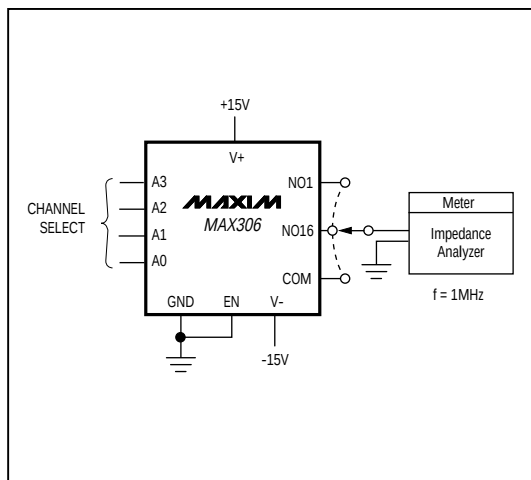
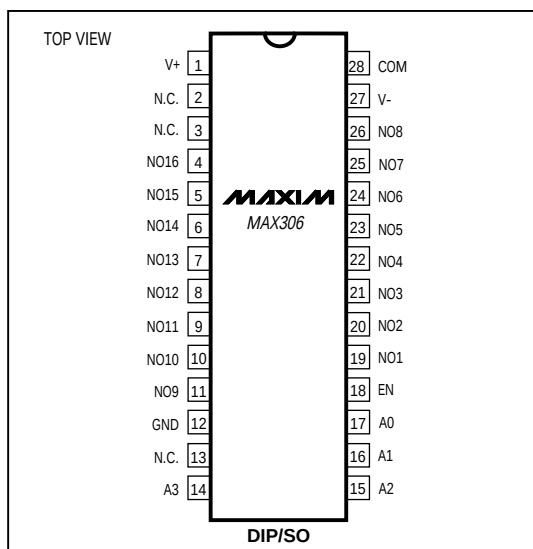


Figure 8. NO/COM Capacitance

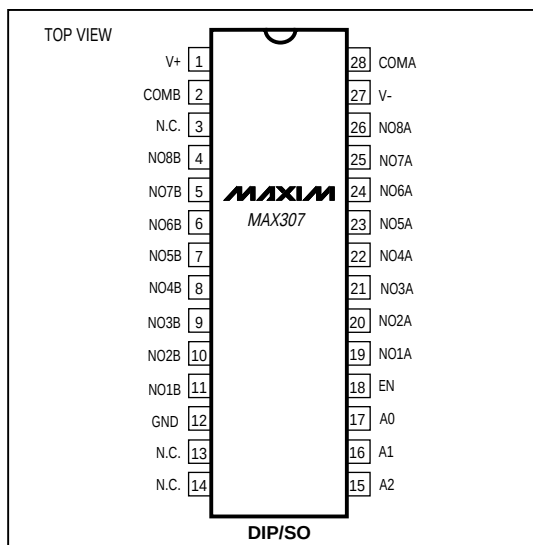
# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

## Pin Configurations/Functional Diagrams/Truth Tables (continued)



| A3 | A2 | A1 | A0 | EN | ON Switch |
|----|----|----|----|----|-----------|
| X  | X  | X  | X  | 0  | None      |
| 0  | 0  | 0  | 0  | 1  | 1         |
| 0  | 0  | 0  | 1  | 1  | 2         |
| 0  | 0  | 1  | 0  | 1  | 3         |
| 0  | 0  | 1  | 1  | 1  | 4         |
| 0  | 1  | 0  | 0  | 1  | 5         |
| 0  | 1  | 0  | 1  | 1  | 6         |
| 0  | 1  | 1  | 0  | 1  | 7         |
| 0  | 1  | 1  | 1  | 1  | 8         |
| 1  | 0  | 0  | 0  | 1  | 9         |
| 1  | 0  | 0  | 1  | 1  | 10        |
| 1  | 0  | 1  | 0  | 1  | 11        |
| 1  | 0  | 1  | 1  | 1  | 12        |
| 1  | 1  | 0  | 0  | 1  | 13        |
| 1  | 1  | 0  | 1  | 1  | 14        |
| 1  | 1  | 1  | 0  | 1  | 15        |
| 1  | 1  | 1  | 1  | 1  | 16        |

MAX306

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

| 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         |

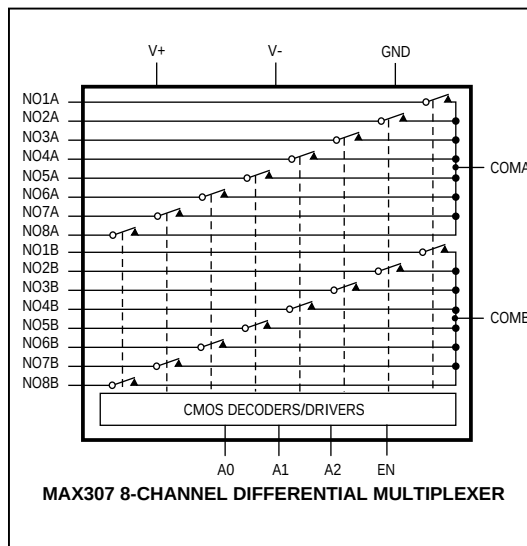
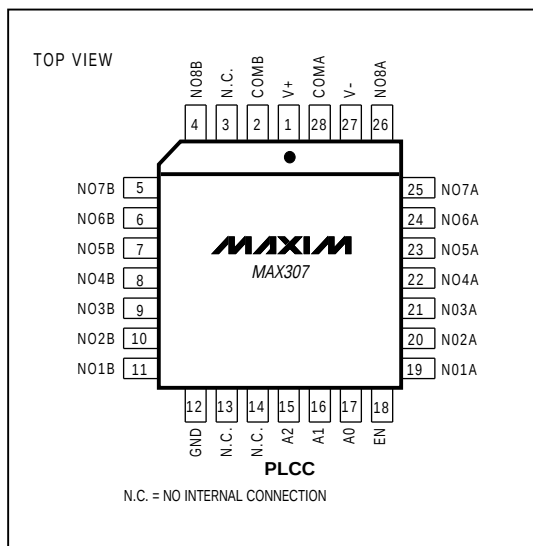
MAX307

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

# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

**Pin Configurations/Functional Diagrams/Truth Tables (continued)**

**MAX306/MAX307**



## **Ordering Information (continued)**

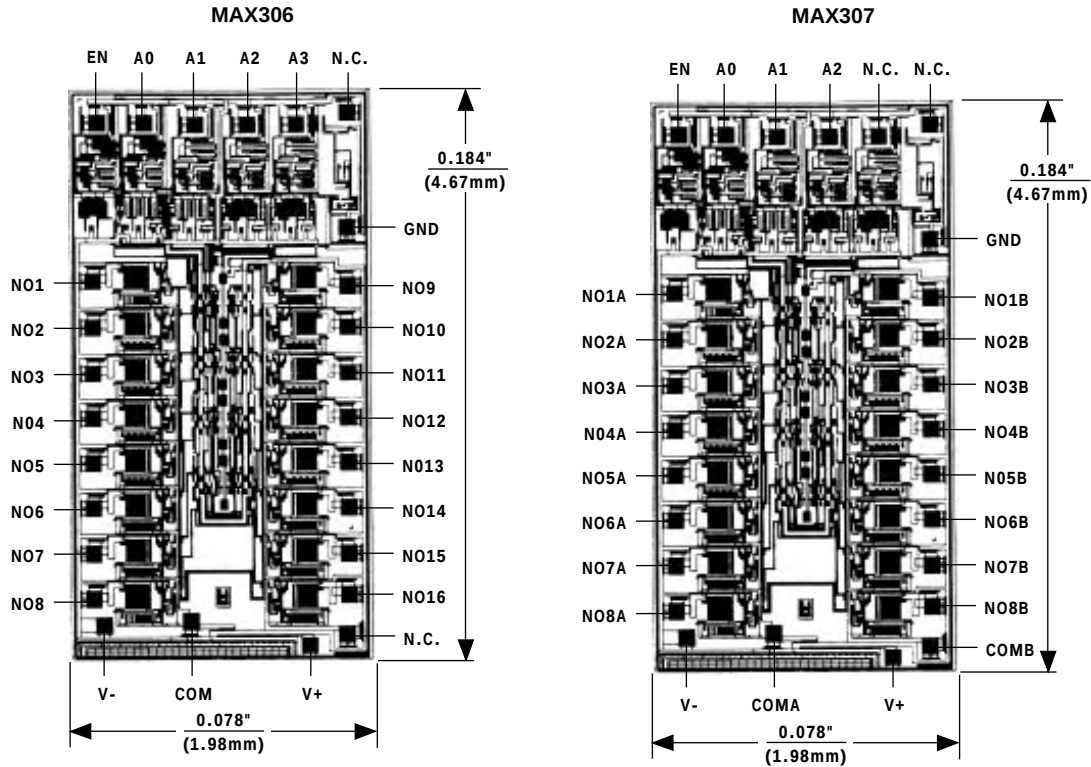
| PART      | TEMP. RANGE     | PIN-PACKAGE    |
|-----------|-----------------|----------------|
| MAX307CPI | 0°C to +70°C    | 28 Plastic DIP |
| MAX307CWI | 0°C to +70°C    | 28 Wide SO     |
| MAX307C/D | 0°C to +70°C    | Dice*          |
| MAX307EPI | -40°C to +85°C  | 28 Plastic DIP |
| MAX307EWI | -40°C to +85°C  | 28 Wide SO     |
| MAX307EQI | -40°C to +85°C  | 28 PLCC        |
| MAX307MJI | -55°C to +125°C | 28 CERDIP      |

\* Contact factory for dice specifications.

## Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

MAX306/MAX307

### Chip Topographies



N.C. = NO INTERNAL CONNECTION

TRANSISTOR COUNT: 269

SUBSTRATE IS INTERNALLY CONNECTED TO V+

TRANSISTOR COUNT: 269

SUBSTRATE IS INTERNALLY CONNECTED TO V+

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