



**THE DATASHEET OF  
MAX397CWI+**



# MAX396/MAX397

# Precision, 16-Channel/Dual 8-Channel, Low-Voltage, CMOS Analog Multiplexers

## General Description

The MAX396/MAX397 low-voltage, CMOS analog multiplexers (muxes) offer low on-resistance (100Ω max), which is matched to within 6Ω between switches and remains flat over the specified signal range (10Ω max). They also offer low leakage over temperature (input off-leakage current less than 1nA at +85°C) and fast switching speeds (transition time less than 250ns). The MAX396 is a 16-channel device, and the MAX397 is a dual, 8-channel device.

The MAX396/MAX397 are fabricated with Maxim's low-voltage silicon-gate process. Design improvements yield extremely low charge injection (5pC max) and guarantee electrostatic-discharge (ESD) protection greater than 2000V per Method 3015.7

These muxes operate with a single +2.7V to +16V supply or with ±2.7V to ±8V dual supplies, while retaining CMOS-logic input compatibility and fast switching. The MAX396/MAX397 are pin compatible with the industry standard MAX306/MAX307, DG406/DG407, and DG506A/DG507A.

## Benefits and Features

- Pin-Compatible with MAX306/MAX307, DG406/DG407, DG506A/DG507A
- Single-Supply Operation (+2.7V to +16V)  
Dual-Supply Operation (±2.7V to ±8V)
- Low On-Resistance (100Ω max)
- Guaranteed  $R_{ON}$  Match Between Channels (6Ω max)
- Guaranteed  $R_{ON}$  Flatness over Specified Signal Range (10Ω max)
- Guaranteed Low Charge Injection (5pC max)
- Input Off-Leakage Current < 1nA at +85°C
- Output Off-Leakage Current < 2.5nA at +85°C
- Low Power Consumption < 10μW
- TTL/CMOS Compatible

## Applications

- Sample-and-Hold Circuits
- Avionics
- Battery-Operated Equipment
- Low-Voltage Data Acquisition Systems
- Automatic Test Equipment
- Communications Systems
- Audio Signal Routing
- Industrial Process Control Systems

## Functional Diagrams/Truth Tables

MAX396 16-CHANNEL SINGLE-ENDED MULTIPLEXER

| MAX396 |    |    |    |    |           |
|--------|----|----|----|----|-----------|
| 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        |

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

*Continued at end of data sheet.*

**Absolute Maximum Ratings**

(Voltage referenced to GND, unless otherwise noted.)  
 V+ .....-0.3V to +17V  
 V- .....+0.3V to -17V  
 V+ to V- .....-0.3V to +17V  
 Voltage into Any Terminal (Note 1)..... (V- - 2V) to (V+ + 2V)  
 or 30mA (whichever occurs first)  
 Current into Any Terminal..... ±30mA  
 Peak Current into Any Terminal..... ±50mA  
 Continuous Power Dissipation (T<sub>A</sub> = +70°C)  
 Plastic DIP (derate 14.29mW/°C above +70°C)..... 1143mW  
 Wide SO (derate 12.50mW/°C above +70°C)..... 1000mW

SSOP (derate 9.52mW/°C above +70°C) .....762mW  
 PLCC (derate 10.53mW/°C above +70°C).....842mW  
 CERDIP (derate 16.67mW/°C above +70°C)..... 1333mW  
 Operating Temperature Ranges  
 MAX39\_C\_I .....0°C to +70°C  
 MAX39\_E\_I ..... -40°C to +85°C  
 MAX39\_MJI ..... -55°C to +125°C  
 Storage Temperature Range ..... -65°C to +150°C  
 Lead Temperature (soldering, 10sec) ..... +300°C

**Note 1:** Signals on any terminal exceeding V+ or V- are clamped by internal diodes. Limit forward 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+ = +5V ±10%, V- = -5V ±10%, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = 2.4V, V<sub>AL</sub> = V<sub>ENL</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 |     |
|--|------------------------------------|--|--------|---|-----------------|------|-------|-----|
| <b>SWITCH</b>                                    |                                    |  |        |   |                 |      |       |     |
| Analog Signal Range                              | V <sub>COM</sub> , V <sub>NO</sub> | (Note 3)   |        | V-  |                 | V+   | V     |     |
| Channel On-Resistance                            | R <sub>ON</sub>                    | I <sub>NO</sub> = 1mA, V <sub>COM</sub> = ±3.5V                          |        | T <sub>A</sub> = +25°C                                | 60              | 100  | Ω     |     |
|  |                                    |  |        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                 | 125  |       |     |
| On-Resistance Matching Between Channels (Note 4) | ΔR <sub>ON</sub>                   | I <sub>NO</sub> = 1mA, V <sub>COM</sub> = ±3.5V, V+ = 5V, V- = -5V       |        | T <sub>A</sub> = +25°C                                | 1.8             | 6    | Ω     |     |
|  |                                    |  |        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                 | 8    |       |     |
| On-Resistance Flatness (Note 5)                  | R <sub>FLAT(ON)</sub>              | I <sub>NO</sub> = 1mA, V <sub>COM</sub> = ±3V, V+ = 5V, V- = -5V         |        | T <sub>A</sub> = +25°C                                | 5               | 10   | Ω     |     |
|  |                                    |  |        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                 | 13   |       |     |
| NO Off-Leakage Current (Note 6)                  | I <sub>NO(OFF)</sub>               | V <sub>NO</sub> = ±4.5V, V <sub>COM</sub> = ∓4.5V, V+ = 5.5V, V- = -5.5V |        | T <sub>A</sub> = +25°C                                | -0.1            | 0.03 | nA    |     |
|  |                                    |  |        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | C, E            | -1.0 |       | 1.0 |
|  |                                    |  |        |   | M               | -10  |       | 10  |
| COM Off-Leakage Current (Note 6)                 | I <sub>COM(OFF)</sub>              | V <sub>COM</sub> = ±4.5V, V <sub>NO</sub> = ∓4.5V, V+ = 5.5V, V- = -5.5V | MAX396 | T <sub>A</sub> = +25°C                                | -0.2            | 0.05 | nA    |     |
|  |                                    |  |        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | C, E            | -2.5 |       | 2.5 |
|  |                                    |  |        |   | M               | -40  |       | 40  |
|  |                                    | V <sub>COM</sub> = ±4.5V, V <sub>NO</sub> = ∓4.5V, V+ = 5.5V, V- = -5.5V | MAX397 | T <sub>A</sub> = +25°C                                | -0.1            | 0.03 | nA    |     |
|  |                                    |  |        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | C, E            | -2.5 |       | 2.5 |
|  |                                    |  |        |   | M               | -20  |       | 20  |
| COM On-Leakage Current (Note 6)                  | I <sub>COM(ON)</sub>               | V <sub>COM</sub> = ±4.5V, V <sub>NO</sub> = 4.5V,                        | MAX396 | T <sub>A</sub> = +25°C                                | -0.4            | 0.09 | nA    |     |
|  |                                    |  |        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | C, E            | -5   |       | 5   |
|  |                                    |  |        |   | M               | -60  |       | 60  |
|  |                                    | V <sub>COM</sub> = ±4.5V, V <sub>NO</sub> = 4.5V,                        | MAX397 | T <sub>A</sub> = +25°C                                | -0.2            | 0.05 | nA    |     |
|  |                                    |  |        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | C, E            | -2.5 |       | 2.5 |
|  |                                    |  |        |   | M               | -30  |       | 30  |

**Electrical Characteristics —Dual Supplies (continued)**(V+ = +5V ±10%, V- = -5V ±10%, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = 2.4V, V<sub>AL</sub> = V<sub>ENL</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 |
|---------------------------------------|------------------------------------|---|---|------------------------|-----------------|-----|-------|
| <b>DIGITAL LOGIC INPUT</b>            |                                    |   |   |                        |                 |     |       |
| Logic High Input Voltage              | V <sub>AH</sub> , V <sub>ENH</sub> |   |   | 2.4                    |                 |     | V     |
| Logic Low Input Voltage               | V <sub>AL</sub> , V <sub>ENL</sub> |   |   |                        |                 | 0.8 | V     |
| Input Current with Input Voltage High | I <sub>AH</sub> , I <sub>ENH</sub> | V <sub>A</sub> = V <sub>EN</sub> = 2.4V   |   | -0.1                   |                 | 0.1 | μA    |
| Input Current with Input Voltage Low  | I <sub>AL</sub> , I <sub>ENL</sub> | V <sub>A</sub> = V <sub>EN</sub> = 0.8V   |   | -0.1                   |                 | 0.1 | μA    |
| <b>SUPPLY</b>                         |                                    |   |   |                        |                 |     |       |
| Power-Supply Range                    |                                    |   |   | ±3                     |                 | ±8  | V     |
| Positive Supply Current               | I+                                 | V <sub>EN</sub> = V <sub>A</sub> = 0V/V+, V+ = 5.5V, V- = -5.5V                             | T <sub>A</sub> = +25°C                                | -1                     |                 | 1   | μA    |
| Negative Supply Current               | I-                                 | V <sub>EN</sub> = V <sub>A</sub> = 0V/V+, V+ = 5.5V, V- = -5.5V                             |   | -1                     |                 | 1   | μA    |
| Ground Current                        | I <sub>GND</sub>                   | V <sub>EN</sub> = V <sub>A</sub> = 0V/V+, V+ = 5.5V, V- = -5.5V                             | T <sub>A</sub> = +25°C                                | -1                     |                 | 1   | μA    |
|                                       |                                    |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | -1                     |                 | 1   |       |
| <b>DYNAMIC</b>                        |                                    |   |   |                        |                 |     |       |
| Transition Time                       | t <sub>TRANS</sub>                 | Figure 2  | T <sub>A</sub> = +25°C                                | 95                     | 150             |     | ns    |
|                                       |                                    |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                        | 250             |     |       |
| Break-Before-Make Interval            | t <sub>OPEN</sub>                  | Figure 4  | T <sub>A</sub> = +25°C                                | 5                      | 70              |     | ns    |
| Enable Turn-On Time                   | t <sub>ON(EN)</sub>                | Figure 3  | T <sub>A</sub> = +25°C                                | 100                    | 150             |     | ns    |
|                                       |                                    |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                        | 250             |     |       |
| 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> |                        | 200             |     |       |
| Charge Injection (Note 3)             | V <sub>CTE</sub>                   | C <sub>L</sub> = 100pF, V <sub>NO</sub> = 0V, Figure 5                                      | T <sub>A</sub> = +25°C                                | 2                      | 5               |     | pC    |
| Off-Isolation (Note 7)                | V <sub>ISO</sub>                   | V <sub>EN</sub> = 0V, R <sub>L</sub> = 1kΩ, f = 100kHz                                      | T <sub>A</sub> = +25°C                                | -75                    |                 |     | dB    |
| Crosstalk Between Channels            | V <sub>CT</sub>                    | V <sub>EN</sub> = 2.4V, f = 100kHz, V <sub>NO</sub> = 1Vp-p, 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>COM</sub> = 0V   | T <sub>A</sub> = +25°C                                | 11                     |                 |     | pF    |
| COM Off-Capacitance                   | C <sub>COM(OFF)</sub>              | f = 1MHz, V <sub>EN</sub> = V <sub>COM</sub> = 0V   | MAX396  | T <sub>A</sub> = +25°C | 80              |     | pF    |
|                                       |                                    |   | MAX397  |                        | 40              |     |       |
| COM On-Capacitance                    | C <sub>COM(ON)</sub>               | f = 1MHz, V <sub>EN</sub> = V <sub>COM</sub> = 0V   | MAX396  | T <sub>A</sub> = +25°C | 90              |     | pF    |
|                                       |                                    |   | MAX397  |                        | 68              |     |       |

**Electrical Characteristics—Single +5V Supply**

(V+ = +5V ±10%, V- = 0V, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = 2.4V, V<sub>AL</sub> = V<sub>ENL</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 |     |    |
|--|------------------------------------|--|---|--|-----------------|------|-------|-----|----|
| <b>SWITCH</b>  |                                    |  |   |  |                 |      |       |     |    |
| Analog Signal Range                                      | V <sub>COM</sub> , V <sub>NO</sub> | (Note 3)   |   | V-   |                 | V+   | V     |     |    |
| On-Resistance  | R <sub>ON</sub>                    | I <sub>NO</sub> = 1mA, V <sub>COM</sub> = 3.5V,<br>V+ = 4.5V         |   | T <sub>A</sub> = +25°C                                   |                 | 120  | 225   | Ω   |    |
|  |                                    |  |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |                 |      | 280   |     |    |
| On-Resistance Matching Between Channels (Note 4)         | ΔR <sub>ON</sub>                   | I <sub>NO</sub> = 1mA, V <sub>COM</sub> = 3.5V,<br>V+ = 4.5V         |   | T <sub>A</sub> = +25°C                                   |                 | 2    | 10    | Ω   |    |
|  |                                    |  |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |                 |      | 12    |     |    |
| On-Resistance Flatness                                   | R <sub>FLAT</sub>                  | I <sub>NO</sub> = 1mA, V <sub>COM</sub> = 3V, 2V, 1V;<br>V+ = 5V     |   | T <sub>A</sub> = +25°C                                   |                 | 5    | 16    | Ω   |    |
|  |                                    |  |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |                 |      | 20    |     |    |
| NO Off-Leakage Current (Note 8)                          | I <sub>NO(OFF)</sub>               | V <sub>NO</sub> = 4.5V, V <sub>COM</sub> = 0V,<br>V+ = 5.5V          |   | T <sub>A</sub> = +25°C                                   |                 | -0.1 | 0.03  | 0.1 | nA |
|  |                                    |  |   | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E            | -1.0 |       | 1.0 |    |
|  |                                    |  |   |  | M               |      | -10   |     |    |
| COM Off-Leakage Current (Note 8)                         | I <sub>COM(OFF)</sub>              | V <sub>COM</sub> = 4.5V,<br>V <sub>NO</sub> = 0V,<br>V+ = 5.5V       | MAX396  | T <sub>A</sub> = +25°C                                   |                 | -0.2 | 0.05  | 0.2 | nA |
|  |                                    |  |   | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E            | -2.5 |       | 2.5 |    |
|  |                                    | M  |   |  | -40             |      | 40    |     |    |
|  |                                    | V <sub>COM</sub> = 4.5V,<br>V <sub>NO</sub> = 0V,<br>V+ = 5.5V       | MAX397  | T <sub>A</sub> = +25°C                                   |                 | -0.2 | 0.02  | 0.2 |    |
| T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E                               |  |   | -2.5   |                 | 2.5  |       |     |    |
|  | M                                  |  | -20   |  | 20              |      |       |     |    |
| COM On-Leakage Current (Note 6)                          | I <sub>COM(ON)</sub>               | V <sub>COM</sub> = 4.5V,<br>V <sub>NO</sub> = 4.5V,<br>V+ = 5.5V     | MAX396  | T <sub>A</sub> = +25°C                                   |                 | -0.4 | 0.09  | 0.4 | nA |
|  |                                    |  |   | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E            | -5   |       | 5   |    |
|  |                                    | M  |   |  | -60             |      | 60    |     |    |
|  |                                    | MAX397   | T <sub>A</sub> = +25°C                                |  | -0.2            | 0.04 | 0.2   |     |    |
| T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E                               |  | -2.5  |  | 2.5             |      |       |     |    |
|  | M                                  |  | -30   |  | 30              |      |       |     |    |
| <b>DIGITAL LOGIC INPUT</b>                               |                                    |  |   |  |                 |      |       |     |    |
| Logic High Input Voltage                                 | V <sub>AH</sub> , V <sub>ENH</sub> |  |   | 2.4  |                 |      | V     |     |    |
| Logic Low Input Voltage                                  | V <sub>AL</sub> , V <sub>ENL</sub> |  |   |  |                 | 0.8  | V     |     |    |
| Input Current with Input Voltage High                    | I <sub>AH</sub> , I <sub>ENH</sub> | V <sub>A</sub> = V <sub>EN</sub> = 2.4V                              |   | -0.1   | 0.001           | 0.1  | μA    |     |    |
| Input Current with Input Voltage Low                     | I <sub>AL</sub> , I <sub>ENL</sub> | V <sub>A</sub> = 0V, V <sub>EN</sub> = 0.8V                          |   | -0.1   | 0.001           | 0.1  | μA    |     |    |
| <b>SUPPLY</b>  |                                    |  |   |  |                 |      |       |     |    |
| Power-Supply Range                                       |                                    |  |   | 2.7  |                 | 15   | V     |     |    |
| Positive Supply Current                                  | I+                                 | V <sub>EN</sub> = V <sub>A</sub> = 0V, V+; V+ = 5.5V; V- = 0V        |   | -1.0   | 0.06            | 1.0  | μA    |     |    |
| Negative Supply Current                                  | I-                                 | V <sub>EN</sub> = V <sub>A</sub> = 0V, V+; V+ = 5.5V; V- = 0V        |   | -1.0   | 0.08            | 1.0  | μA    |     |    |
| Ground Current   | I <sub>GND</sub>                   | V <sub>EN</sub> = V+, 0V; V <sub>A</sub> = 0V;<br>V+ = 5.5V; V- = 0V | T <sub>A</sub> = +25°C                                |  | -1.0            | 0.08 | 1.0   | μA  |    |
|  |                                    |  | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |  | -1.0            |      | 1.0   |     |    |

**Electrical Characteristics—Single +5V Supply (continued)**(V+ = +5V ±10%, V- = 0V, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = 2.4V, V<sub>AL</sub> = V<sub>ENL</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 |
|----------------------------------|----------------------|---|---|-----------------|-----|-------|
| <b>DYNAMIC</b>                   |                      |   |   |                 |     |       |
| Transition Time (Note 3)         | t <sub>TRANS</sub>   | V <sub>NO</sub> = 3V, Figure 2                            | T <sub>A</sub> = +25°C                                | 105             | 245 | ns    |
|                                  |                      |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                 | 350 |       |
| Break-Before-Make Interval       | t <sub>OPEN</sub>    | (Note 3)  | T <sub>A</sub> = +25°C                                | 10              | 65  | ns    |
| Enable Turn-On Time<br>(Note 3)  | t <sub>ON(EN)</sub>  |   | T <sub>A</sub> = +25°C                                | 125             | 200 | ns    |
|                                  |                      |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                 | 275 |       |
| Enable Turn-Off Time<br>(Note 3) | t <sub>OFF(EN)</sub> |   | T <sub>A</sub> = +25°C                                | 100             | 125 | ns    |
|                                  |                      |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                 | 200 |       |
| Charge Injection (Note 3)        | V <sub>CTE</sub>     | C <sub>L</sub> = 100pF, V <sub>NO</sub> = 0V,<br>Figure 5 | T <sub>A</sub> = +25°C                                | 1.5             | 5   | pC    |

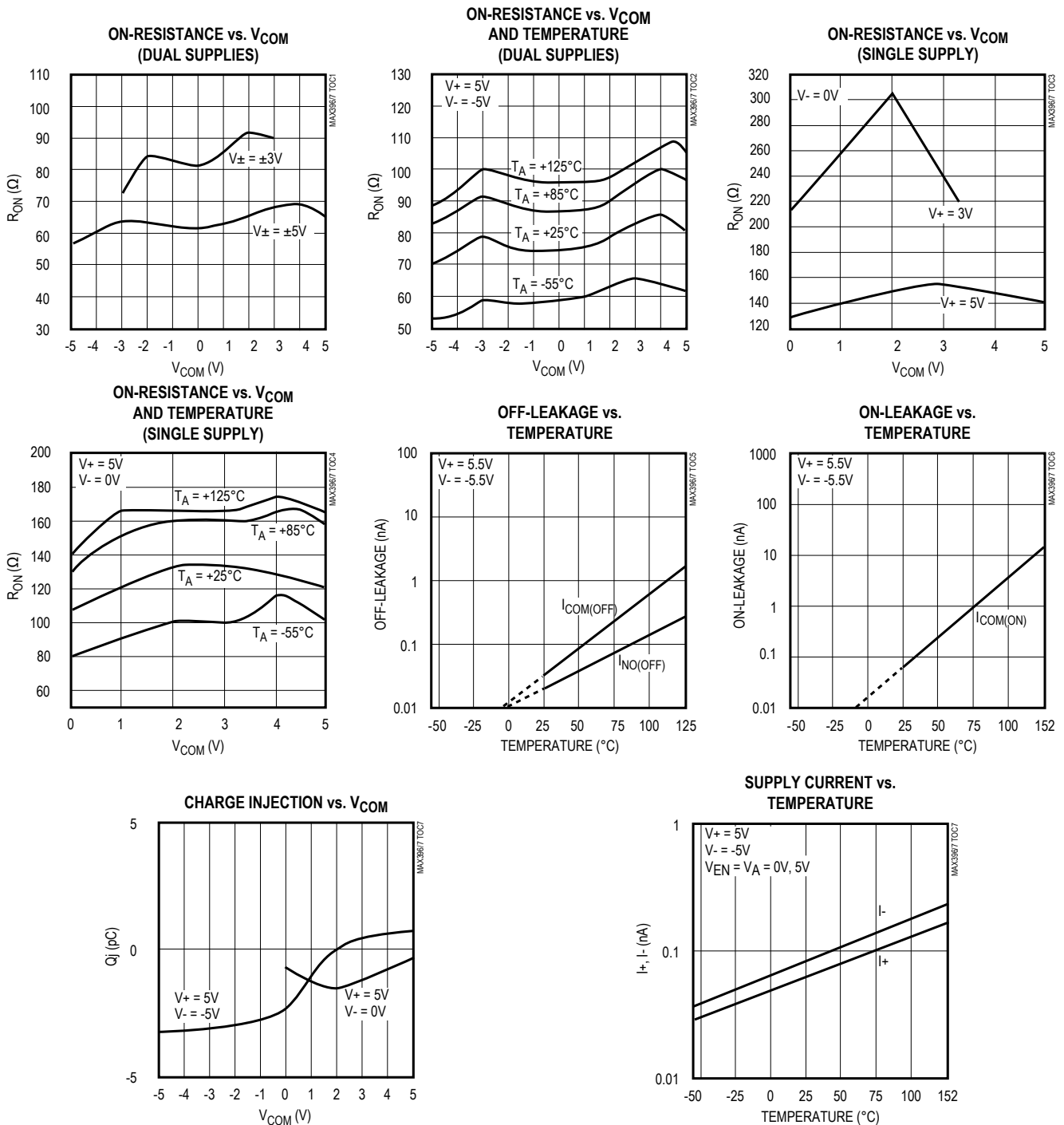
**Electrical Characteristics—Single +3V Supply**(V+ = +3V ±10%, V- = 0V, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = 2.4V, V<sub>AL</sub> = V<sub>ENL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

| PARAMETER                        | SYMBOL               | CONDITIONS   | MIN   | TYP<br>(Note 2) | MAX | UNITS |
|----------------------------------|----------------------|--|---|-----------------|-----|-------|
| <b>SWITCH</b>                    |                      |  |   |                 |     |       |
| Analog Signal Range              | V <sub>ANALOG</sub>  | (Note 3)   | V-  |                 | V+  | V     |
| On-Resistance                    | R <sub>ON</sub>      | I <sub>NO</sub> = 1mA, V <sub>COM</sub> = 1.5V,<br>V+ = 3V                           | T <sub>A</sub> = +25°C                                | 315             | 550 | Ω     |
|                                  |                      |  | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                 | 650 |       |
| <b>DYNAMIC</b>                   |                      |  |   |                 |     |       |
| Transition Time (Note 3)         | t <sub>TRANS</sub>   | Figure 2, V <sub>IN</sub> = 2.4V,<br>V <sub>N01</sub> = 1.5V, V <sub>N08</sub> = 0V  | T <sub>A</sub> = +25°C                                | 230             | 575 | ns    |
|                                  |                      |  | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |                 | 750 |       |
| Enable Turn-On Time<br>(Note 3)  | t <sub>ON(EN)</sub>  | Figure 3, V <sub>INH</sub> = 2.4V,<br>V <sub>INL</sub> = 0V, V <sub>N01</sub> = 1.5V | T <sub>A</sub> = +25°C                                | 260             | 500 | ns    |
| Enable Turn-Off Time<br>(Note 3) | t <sub>OFF(EN)</sub> | Figure 3, V <sub>INH</sub> = 2.4V,<br>V <sub>INL</sub> = 0V, V <sub>N01</sub> = 1.5V | T <sub>A</sub> = +25°C                                | 135             | 400 | ns    |
| Charge Injection (Note 3)        | V <sub>CTE</sub>     | C <sub>L</sub> = 100pF, V <sub>NO</sub> = 0V,<br>Figure 5                            | T <sub>A</sub> = +25°C                                | 1               | 5   | pC    |

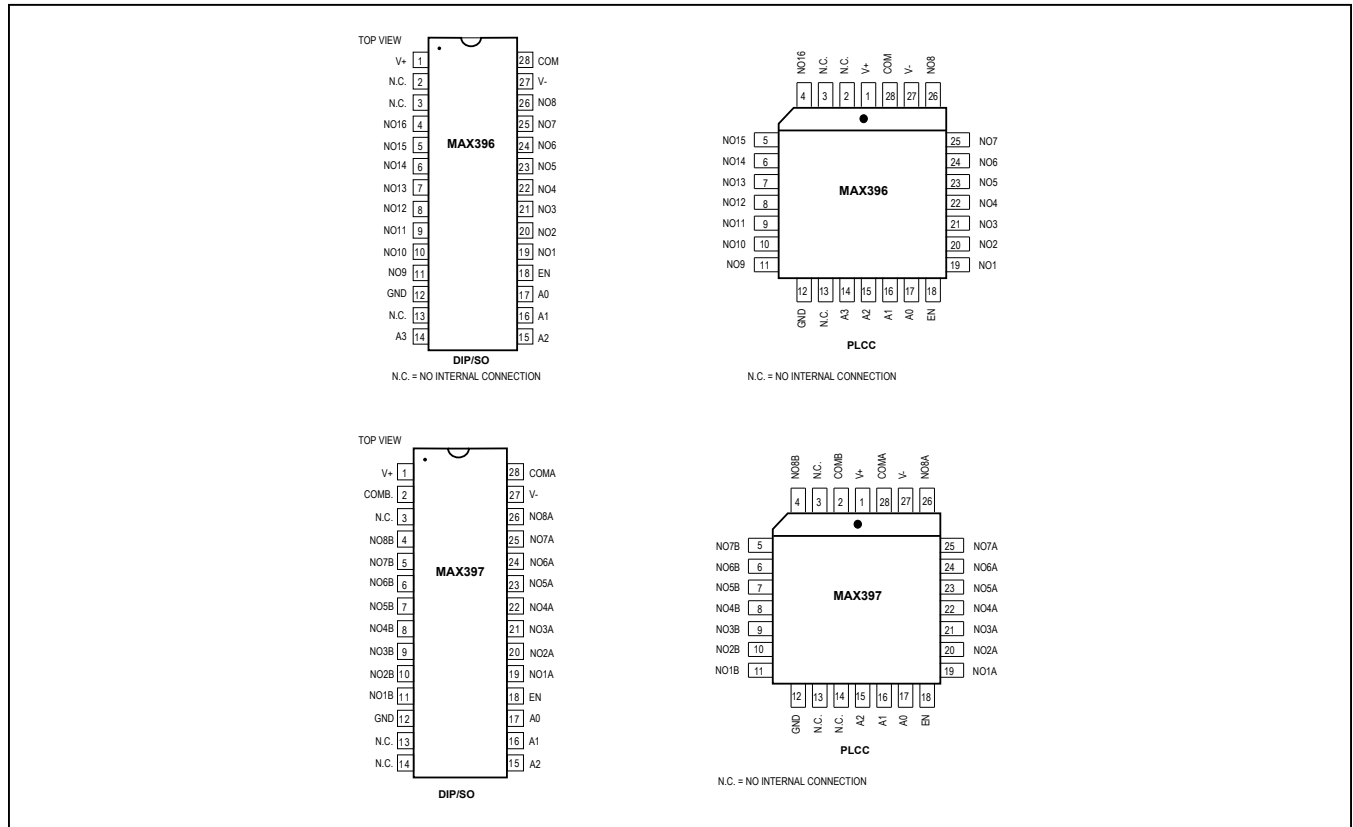
**Note 2:** The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.**Note 3:** Guaranteed by design.**Note 4:** ΔR<sub>ON</sub> = R<sub>ON(MAX)</sub> - R<sub>ON(MIN)</sub>.**Note 5:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges, i.e., V<sub>NO</sub> = 3V to 0V and 0V to -3V.**Note 6:** Leakage parameters are 100% tested at maximum rated hot operating temperature, and guaranteed by correlation at +25°C.**Note 7:** Worst-case isolation is on channel 4 because of its proximity to the COM pin. Off-isolation = 20log V<sub>COM</sub>/V<sub>NO</sub>. V<sub>COM</sub> = output, V<sub>NO</sub> = input to off switch.**Note 8:** Leakage testing at single supply is guaranteed by correlation testing with dual supplies.

Typical Operating Characteristics

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



Pin Configurations



Pin Description

| PIN      |            | NAME       | FUNCTION                                |
|----------|------------|------------|---|
| MAX396   | MAX397     |            |   |
| 1        | 1          | V+         | Positive Supply-Voltage Input           |
| 2, 3, 13 | —          | N.C.       | No Internal Connection                  |
| —        | 2          | COMB       | Analog Signal B Output* (bidirectional) |
| —        | 3, 13, 14  | N.C.       | No Internal Connection                  |
| 4–11     | —          | NO16–NO9   | Analog Signal Inputs* (bidirectional)   |
| —        | 4–11       | NO8B–NO1B  | Analog Signal B Inputs* (bidirectional) |
| 12       | 12         | GND        | Logic Ground                            |
| 14–17    | —          | A3–A0      | Logic Address Inputs                    |
| —        | 15, 16, 17 | A2, A1, A0 | Logic Address Inputs                    |
| 18       | 18         | EN         | Logic Enable Input                      |
| 19–26    | —          | NO1–NO8    | Analog Signal Inputs* (bidirectional)   |
| —        | 19–26      | NO1A–NO8A  | Analog Signal A Inputs* (bidirectional) |
| 27       | 27         | V-         | Negative Supply-Voltage Input           |
| 28       | —          | COM        | Analog Signal Output* (bidirectional)   |
| —        | 28         | COMA       | Analog Signal A Output* (bidirectional) |

\*Analog signal inputs and outputs are names of convenience only; they are identical and interchangeable.

**Applications Information**

**Operation with Supply Voltages Other than  $\pm 5V$**

Using supply voltages less than  $\pm 5V$  reduces the analog signal range. The MAX396/MAX397 multiplexers (muxes) operate with  $\pm 3V$  to  $\pm 8V$  bipolar supplies or with a  $+3V$  to  $+15V$  single supply. Connect  $V-$  to GND when operating with a single supply. Both devices can also operate with unbalanced supplies, such as  $+10V$  and  $-5V$ . The *Typical Operating Characteristics* graphs show typical on-resistance with  $\pm 3V$ ,  $\pm 5V$ ,  $+3V$ , and  $+5V$  supplies.

These muxes operate with a single supply as low as  $1V$ , although on-resistance and switching times become extremely high. Performance is not guaranteed below  $2.7V$ . This is useful information only because it assures proper switch state while power supplies ramp up or down slowly.

**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  $17V$ . These protection diodes are not recommended when using a single supply.

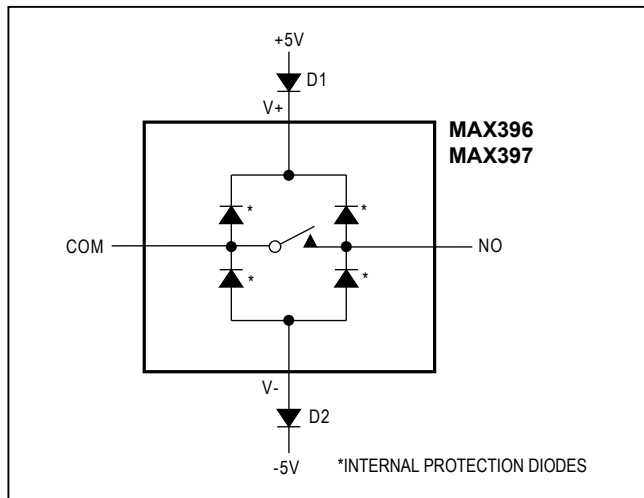


Figure 1. Overvoltage Protection Using External Blocking Diodes

Test Circuits/Timing Diagrams

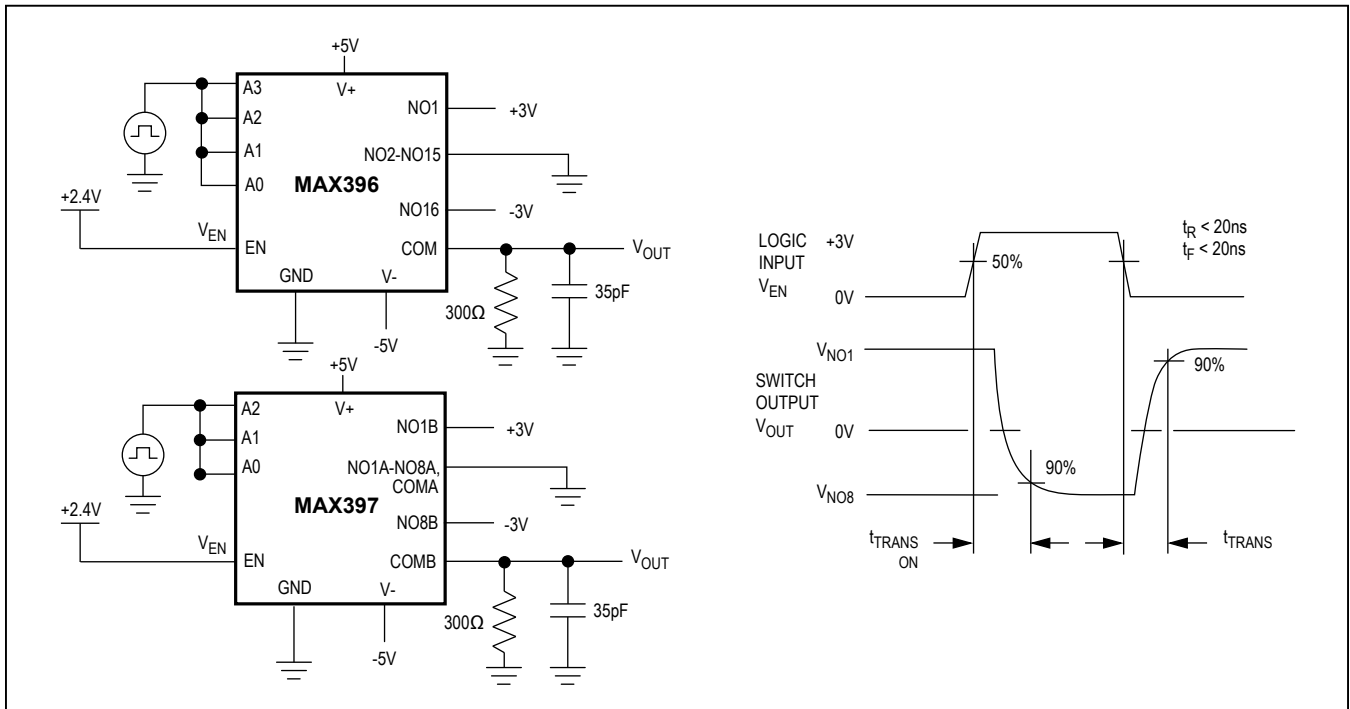


Figure 2. Transition Time

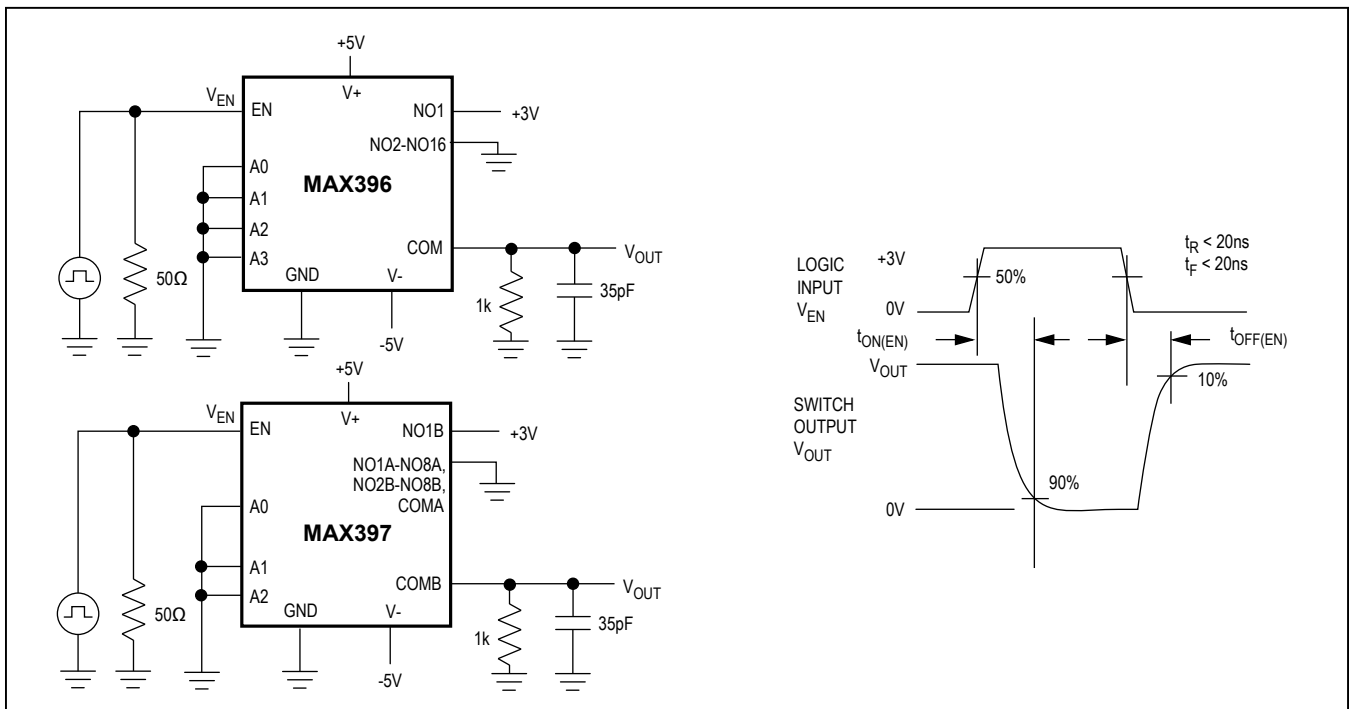


Figure 3. Enable Switching Time

Test Circuits/Timing Diagrams (continued)

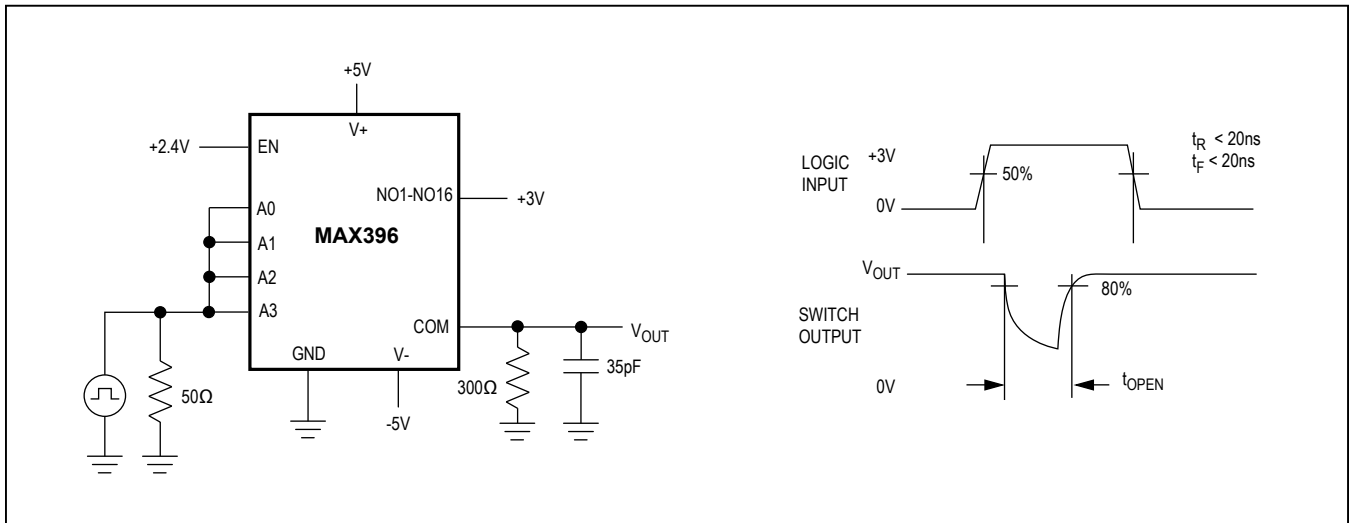


Figure 4. Break-Before-Make Interval

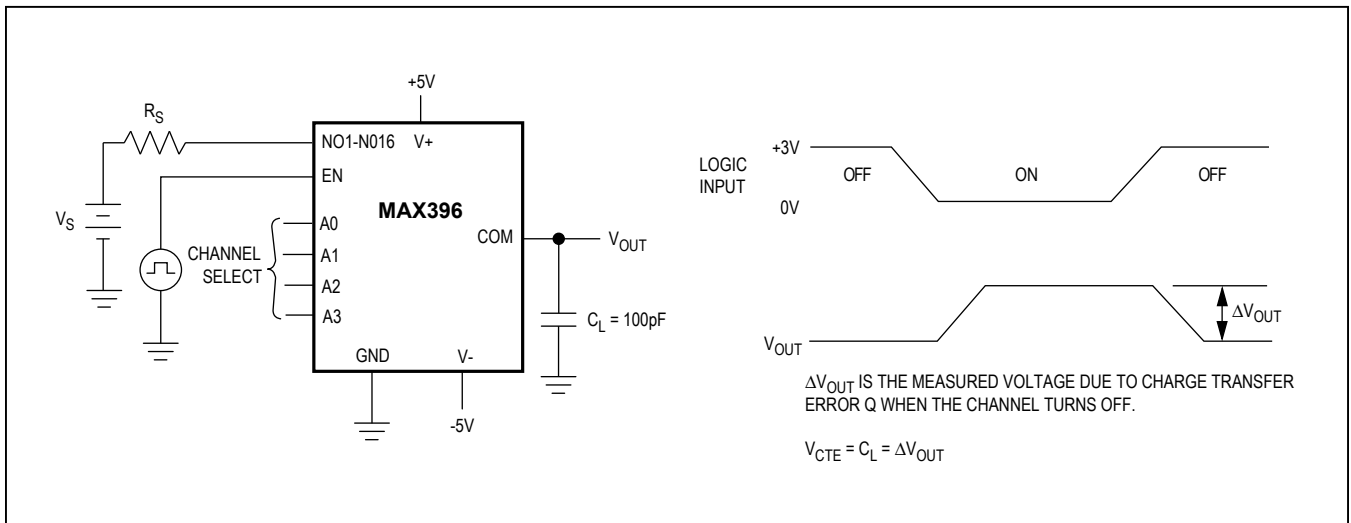


Figure 5. Charge Injection ( $V_{CTE}$ )

Test Circuits/Timing Diagrams (continued)

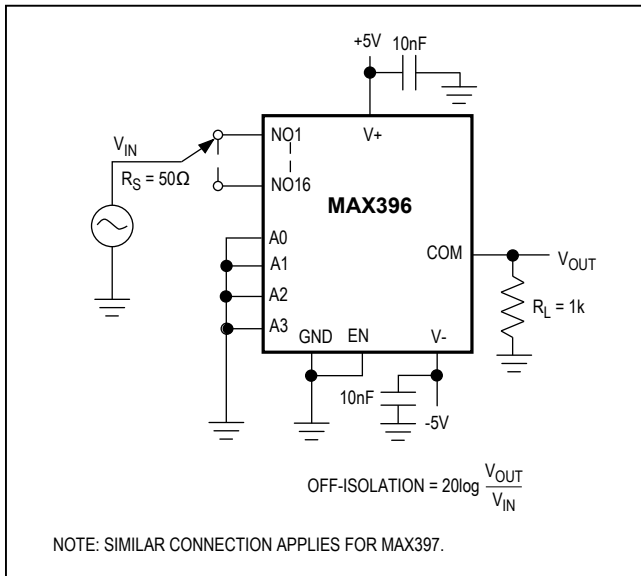


Figure 6. Off-Isolation ( $V_{ISO}$ )

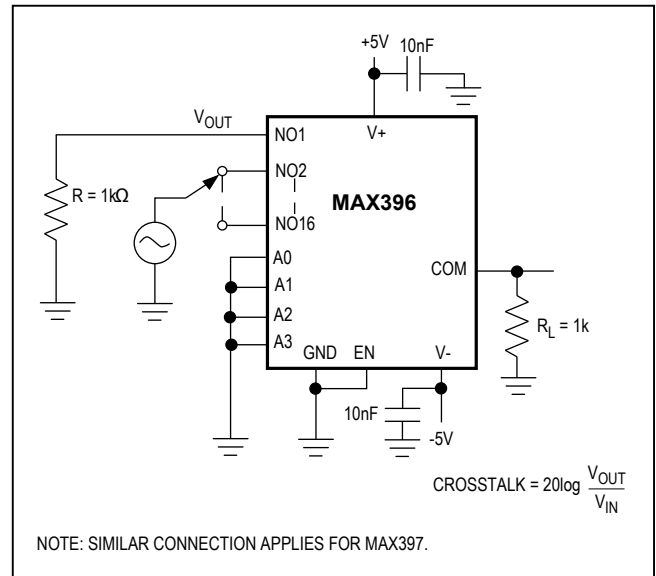


Figure 7. Crosstalk ( $V_{CT}$ )

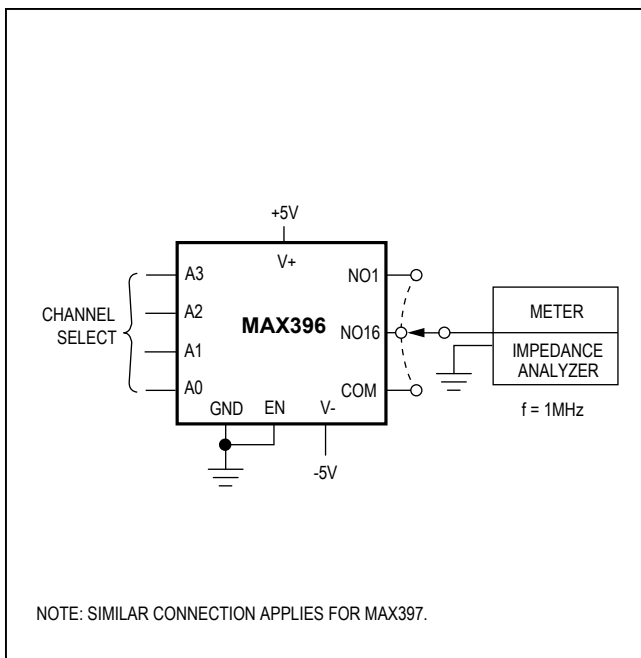
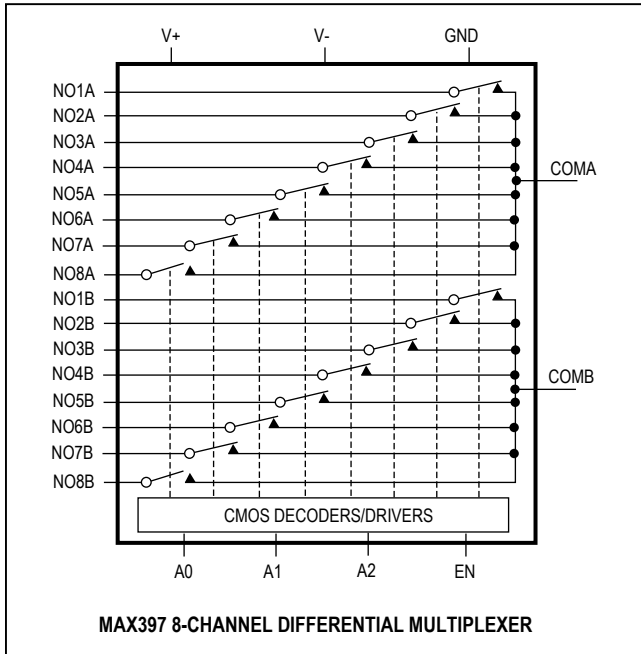


Figure 8. NO/COM Capacitance

# MAX396/MAX397

# Precision, 16-Channel/Dual 8-Channel, Low-Voltage, CMOS Analog Multiplexers

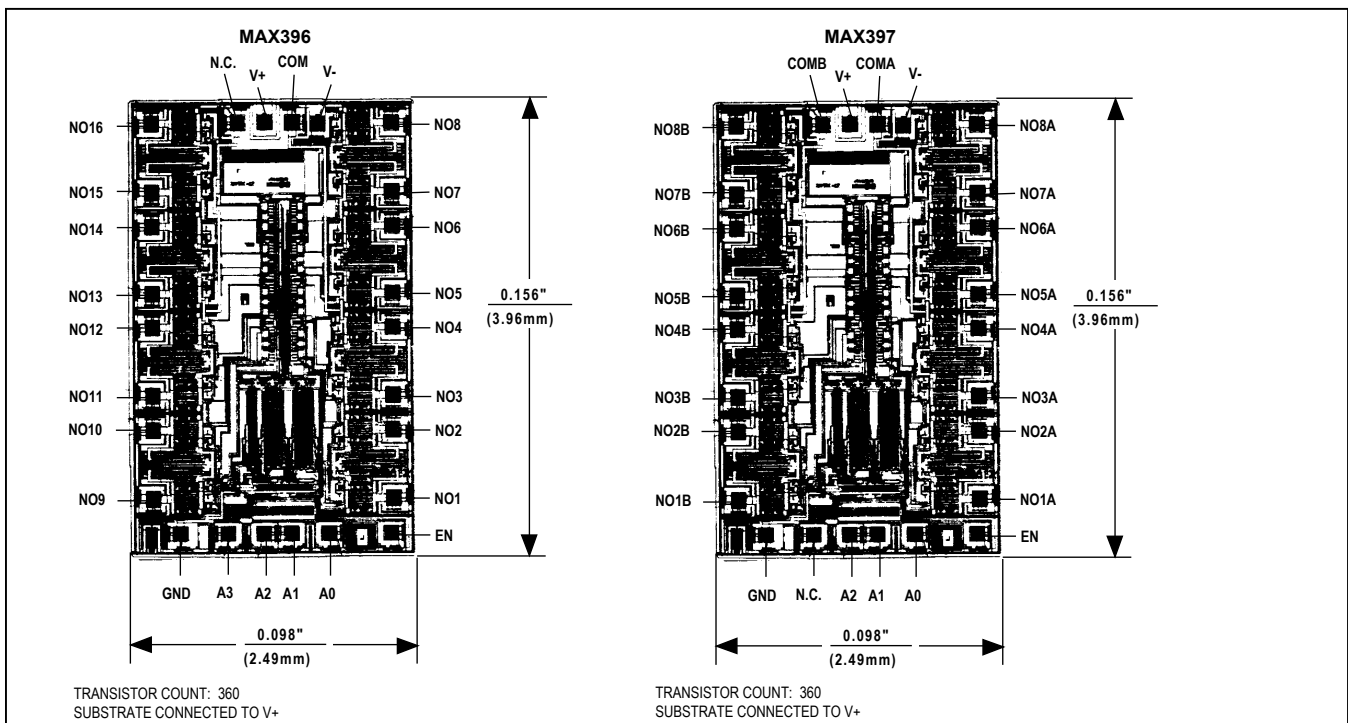
## Functional Diagrams/Truth Tables (continued)



| MAX397 |    |    |    |           |
|--------|----|----|----|-----------|
| 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         |

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

## Chip Topographies



## Ordering Information

| PART             | TEMP. RANGE     | PIN-PACKAGE    |
|------------------|-----------------|----------------|
| <b>MAX396CPI</b> | 0°C to +70°C    | 28 Plastic DIP |
| MAX396CWI        | 0°C to +70°C    | 28 Wide SO     |
| MAX396CAI        | 0°C to +70°C    | 28 SSOP        |
| MAX396CQI        | 0°C to +70°C    | 28 PLCC**      |
| MAX396C/D        | 0°C to +70°C    | Dice*          |
| MAX396EPI        | -40°C to +85°C  | 28 Plastic DIP |
| MAX396EWI        | -40°C to +85°C  | 28 Wide SO     |
| MAX396EQI        | -40°C to +85°C  | 28 PLCC**      |
| MAX396MJI        | -55°C to +125°C | 28 CERDIP**    |
| <b>MAX397CPI</b> | 0°C to +70°C    | 28 Plastic DIP |
| MAX397CWI        | 0°C to +70°C    | 28 Wide SO     |
| MAX397CAI        | 0°C to +70°C    | 28 SSOP        |
| MAX397CQI        | 0°C to +70°C    | 28 PLCC**      |
| MAX397C/D        | 0°C to +70°C    | Dice*          |
| MAX397EPI        | -40°C to +85°C  | 28 Plastic DIP |
| MAX397EWI        | -40°C to +85°C  | 28 Wide SO     |
| MAX397EQI        | -40°C to +85°C  | 28 PLCC**      |
| MAX397MJI        | -55°C to +125°C | 28 CERDIP**    |

\*Contact factory for dice specifications.

\*\*Contact factory for package availability.

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION                   | PAGES CHANGED |
|-----------------|---------------|-------------------------------|---------------|
| 2               | 1/16          | Fixed typos, updated template | 1–14          |

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