

## Precision, Quad, SPST Analog Switches

### General Description

The MAX391/MAX392/MAX393 are precision, quad, single-pole/single-throw (SPST) analog switches designed to operate at +3V, +5V, or ±5V. The MAX391 has four normally closed (NC) switches, and the MAX392 has four normally open (NO) switches. The MAX393 has two NO and two NC switches. All three devices offer low leakage (100pA max) and fast switching speeds ( $t_{ON} \leq 130\text{ns}$ ,  $t_{OFF} \leq 75\text{ns}$ ). Power consumption is just 1μW—ideal for battery-operated equipment. All devices operate from a single +3V to +15V supply or from dual ±3.0V to ±8V supplies.

With ±5V supplies, the MAX391/MAX392/MAX393 offer guaranteed 2Ω max channel-to-channel matching, 30Ω max on-resistance ( $R_{ON}$ ), and 4Ω max  $R_{ON}$  flatness over the specified range.

These switches are also fully specified for single +5V operation, with 2Ω max  $R_{ON}$  match, 60Ω max  $R_{ON}$ , and 6Ω max flatness.

These low-voltage switches also offer 5pC max charge injection, and ESD protection is greater than 2000V, per method 3015.7.

### Applications

|                           |                              |
|---------------------------|------------------------------|
| Battery-Operated Systems  | Sample-and-Hold Circuits     |
| Heads-Up Displays         | Guidance and Control Systems |
| Audio and Video Switching | Military Radios              |
| Test Equipment            | Communications Systems       |
| ±5V DACs and ADCs         | PBX, PABX                    |

### Features

- ◆ Low On-Resistance, 20Ω Typical
- ◆ Guaranteed On-Resistance Match Between Channels, < 2Ω
- ◆ Guaranteed On-Resistance Flatness Over Signal Range, 4Ω Max
- ◆ Guaranteed Charge Injection, < 5pC
- ◆ Improved Leakage Over Temperature, < 2.5nA at +85°C
- ◆ Electrostatic Discharge > 2000V per Method 3015.7
- ◆ Single-Supply Operation (+3V to +15V)  
Bipolar-Supply Operation (±3V to ±8V)
- ◆ Low Power Consumption, < 1μW
- ◆ TTL/CMOS-Logic Compatible

### Ordering Information

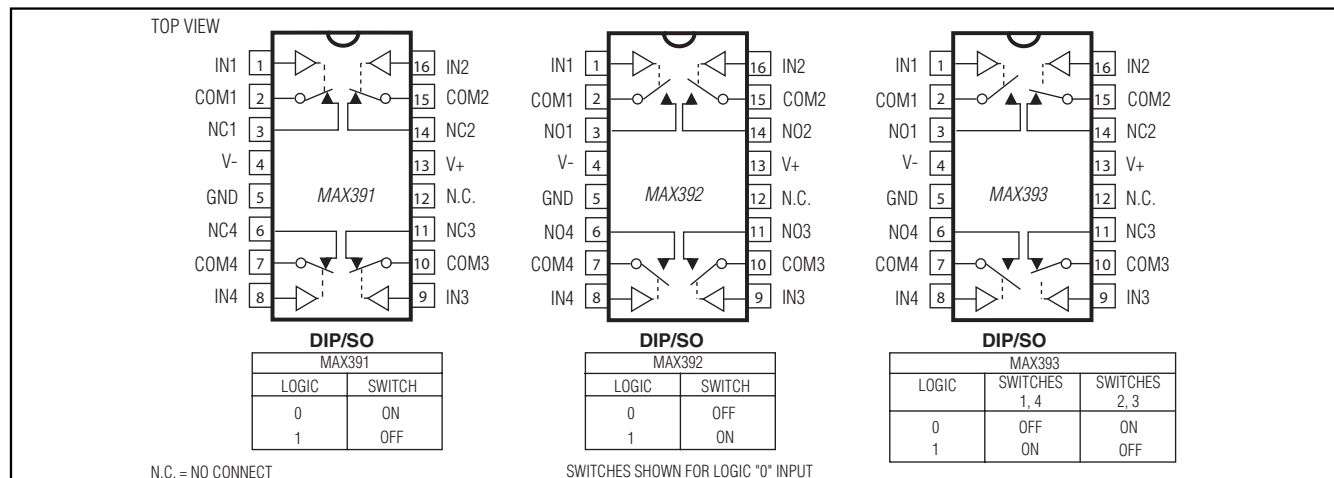
| PART      | TEMP RANGE     | PIN-PACKAGE    | PKG CODE |
|-----------|----------------|----------------|----------|
| MAX391CPE | 0°C to +70°C   | 16 Plastic DIP | P16-1    |
| MAX391CSE | 0°C to +70°C   | 16 Narrow SO   | S16-2    |
| MAX391CUE | 0°C to +70°C   | 16 TSSOP       | U16-2    |
| MAX391CGE | 0°C to +70°C   | 16 QFN-EP†     | G1644-1  |
| MAX391C/D | 0°C to +70°C   | Dice*          | —        |
| MAX391EPE | -40°C to +85°C | 16 Plastic DIP | P16-1    |

Ordering Information continued on last page.

\*Contact factory for dice specifications.

†EP = Exposed pad.

### Pin Configurations/Functional Diagrams/Truth Tables



# MAX391/MAX392/MAX393

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### ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-

|                                                                        |                      |
|------------------------------------------------------------------------|----------------------|
| V+ .....                                                               | -0.3V to +17V        |
| GND .....                                                              | -0.3V to +17V        |
| GND .....                                                              | -0.3V to (V+ + 0.3V) |
| VIN_, VCOM_, VNC_, VNO_ (Note 1) .....                                 | V- to V+             |
| Current (any terminal) .....                                           | 30mA                 |
| Peak Current, COM_, NO_, NC_ (pulsed at 1ms, 10% duty cycle max) ..... | 100mA                |
| ESD per Method 3015.7 .....                                            | > 2000V              |
| 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           |
| TSSOP (derate 6.7mW/°C above +70°C) .....      | 457mW           |
| CERDIP (derate 10.00mW/°C above +70°C) .....   | 800mW           |
| QFN (derate 18.5mW/°C above +70°C) .....       | 1481mW          |
| Operating Temperature Ranges .....             |                 |
| MAX39_C_ .....                                 | 0°C to +70°C    |
| MAX39_E_ .....                                 | -40°C to +85°C  |
| MAX39_M_ .....                                 | -55°C to +125°C |
| Storage Temperature Range .....                | -65°C to +150°C |
| Lead Temperature (soldering, 10s) .....        | +300°C          |

**Note 1:** Signals on NC\_, NO\_, COM\_, or IN\_ exceeding V+ or V- are clamped by internal diodes. Limit forward diode current to maximum current rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### ELECTRICAL CHARACTERISTICS—Dual Supplies

(V+ = +5V ±10%, V- = -5V ±10%, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER                                     | SYMBOL                                                        | CONDITIONS                                                                                               |                                                          |      | MIN      TYP      MAX<br>(Note 2) |       |      | UNITS |
|-----------------------------------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------|------|-----------------------------------|-------|------|-------|
| ANALOG SWITCH                                 |                                                               |                                                                                                          |                                                          |      |                                   |       |      |       |
| Analog Signal Range                           | V <sub>COM_</sub> ,<br>V <sub>NO_</sub> ,<br>V <sub>NC_</sub> | (Note 3)                                                                                                 |                                                          |      | V-                      V+        |       | V    |       |
| On-Resistance                                 | R <sub>ON</sub>                                               | V+ = 4.5V,<br>V- = -4.5V,<br>I <sub>COM_</sub> = -10mA,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = ±3.5V  | T <sub>A</sub> =<br>+25°C                                | C, E | 20                                | 35    | Ω    |       |
|                                               |                                                               |                                                                                                          |                                                          | M    | 20                                | 30    |      |       |
|                                               |                                                               |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |      | 45                                |       |      |       |
| On-Resistance Match Between Channels (Note 4) | ΔR <sub>ON</sub>                                              | V+ = 5V, V- = -5V,<br>I <sub>COM_</sub> = -10mA,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = ±3V           | T <sub>A</sub> = +25°C                                   |      | 0.3                               | 2     | Ω    |       |
|                                               |                                                               |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |      | 4                                 |       |      |       |
| On-Resistance Flatness (Note 5)               | R <sub>FLAT(ON)</sub>                                         | V+ = 5V, V- = -5V,<br>I <sub>COM_</sub> = -10mA,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = ±3V           | T <sub>A</sub> = +25°C                                   |      | 1                                 | 4     | Ω    |       |
|                                               |                                                               |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |      | 6                                 |       |      |       |
| NO or NC Off-Leakage Current (Note 6)         | I <sub>NO(OFF)</sub><br>or<br>I <sub>NC(OFF)</sub>            | V+ = 5.5V,<br>V- = -5.5V,<br>V <sub>COM_</sub> = ±4.5V,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = ∓ 4.5V | T <sub>A</sub> = +25°C                                   |      | -0.1                              | ±0.01 | +0.1 | nA    |
|                                               |                                                               |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E | -2.5                              | +2.5  |      |       |
|                                               |                                                               |                                                                                                          |                                                          | M    | -5                                | +5    |      |       |
| COM Off-Leakage Current (Note 6)              | I <sub>COM(OFF)</sub>                                         | V+ = 5.5V,<br>V- = -5.5V,<br>V <sub>COM_</sub> = ±4.5V,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = ∓ 4.5V | T <sub>A</sub> = +25°C                                   |      | -0.1                              | ±0.01 | +0.1 | nA    |
|                                               |                                                               |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E | -2.5                              | +2.5  |      |       |
|                                               |                                                               |                                                                                                          |                                                          | M    | -5                                | +5    |      |       |
| COM On-Leakage Current (Note 6)               | I <sub>COM(ON)</sub>                                          | V+ = 5.5V,<br>V- = -5.5V,<br>V <sub>COM_</sub> = ±4.5V,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = ±4.5V  | T <sub>A</sub> = +25°C                                   |      | -0.2                              | ±0.01 | +0.2 | nA    |
|                                               |                                                               |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E | -5.0                              | +5.0  |      |       |
|                                               |                                                               |                                                                                                          |                                                          | M    | -20                               | +20   |      |       |

# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +5V ±10%, V- = -5V ±10%, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER                             | SYMBOL                | CONDITIONS                                                                                                     |                                                       | MIN  | TYP<br>(Note 2) | MAX  | UNITS |
|---------------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|------|-----------------|------|-------|
| LOGIC INPUT                           |                       |                                                                                                                |                                                       |      |                 |      |       |
| Input Current with Input-Voltage High | I <sub>INH</sub>      | I <sub>N</sub> = 2.4V, all others = 0.8V                                                                       |                                                       | -0.5 | ±0.005          | +0.5 | μA    |
| Input Current with Input-Voltage Low  | I <sub>INL</sub>      | I <sub>N</sub> = 0.8V, all others = 2.4V                                                                       |                                                       | -0.5 | ±0.005          | +0.5 | μA    |
| DYNAMIC                               |                       |                                                                                                                |                                                       |      |                 |      |       |
| Turn-On Time                          | t <sub>ON</sub>       | V <sub>COM_</sub> = ±3V, Figure 2                                                                              | T <sub>A</sub> = +25°C                                | 65   | 130             | ns   |       |
|                                       |                       |                                                                                                                | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 175  |                 |      |       |
| Turn-Off Time                         | t <sub>OFF</sub>      | V <sub>COM_</sub> = ±3V, Figure 2                                                                              | T <sub>A</sub> = +25°C                                | 35   | 75              | ns   |       |
|                                       |                       |                                                                                                                | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 100  |                 |      |       |
| Break-Before-Make Time Delay (Note 3) | t <sub>D</sub>        | MAX393 only, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, Figure 3                                            |                                                       | 5    | 10              | ns   |       |
| Charge Injection (Note 3)             | Q                     | C <sub>L</sub> = 1.0nF, V <sub>GEN</sub> = 0V, R <sub>GEN</sub> = 0Ω, Figure 4                                 | T <sub>A</sub> = +25°C                                | 2    | 5               | pC   |       |
| Off-Isolation (Note 7)                | OIRR                  | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz, Figure 5                                                 | T <sub>A</sub> = +25°C                                | 72   |                 | dB   |       |
| Crosstalk (Note 8)                    |                       | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz, Figure 6                                                 | T <sub>A</sub> = +25°C                                | 85   |                 | dB   |       |
| NC or NO Capacitance                  | C <sub>(OFF)</sub>    | f = 1MHz, Figure 7                                                                                             | T <sub>A</sub> = +25°C                                | 9    |                 | pF   |       |
| COM Off-Capacitance                   | C <sub>COM(OFF)</sub> | f = 1MHz, Figure 7                                                                                             | T <sub>A</sub> = +25°C                                | 9    |                 | pF   |       |
| COM On-Capacitance                    | C <sub>COM(ON)</sub>  | f = 1MHz, Figure 8                                                                                             | T <sub>A</sub> = +25°C                                | 22   |                 | pF   |       |
| SUPPLY                                |                       |                                                                                                                |                                                       |      |                 |      |       |
| Power-Supply Range                    |                       |                                                                                                                |                                                       | -8.0 | +8.0            | V    |       |
| Positive Supply Current               | I <sub>+</sub>        | V <sub>+</sub> = 5.5V, V <sub>-</sub> = -5.5V, V <sub>IN</sub> = 0V or V <sub>+</sub> , all channels on or off | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | -1   | +1              | μA   |       |
| Negative Supply Current               | I <sub>-</sub>        | V <sub>+</sub> = 5.5V, V <sub>-</sub> = -5.5V, V <sub>IN</sub> = 0V or V <sub>+</sub> , all channels on or off | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | -1   | +1              | μA   |       |

# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### ELECTRICAL CHARACTERISTICS—Single +5V Supply

(V+ = +5V ±10%, V- = 0V ±10%, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER                                        | SYMBOL                                                        | CONDITIONS                                                                               |                                                          |      | MIN   | TYP<br>(Note 2) | MAX   | UNITS |
|--------------------------------------------------|---------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------------------------|------|-------|-----------------|-------|-------|
| ANALOG SWITCH                                    |                                                               |                                                                                          |                                                          |      |       |                 |       |       |
| Analog Signal Range                              | V <sub>COM_</sub> ,<br>V <sub>NO_</sub> ,<br>V <sub>NC_</sub> | (Note 3)                                                                                 |                                                          |      | 0     |                 | V+    | V     |
| On-Resistance                                    | R <sub>ON</sub>                                               | V+ = 4.5V,<br>I <sub>COM_</sub> = -10mA,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 3.5V  | T <sub>A</sub> = +25°C                                   |      | 30    |                 | 60    | Ω     |
|                                                  |                                                               |                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |      |       |                 | 75    |       |
| On-Resistance Match<br>Between Channels (Note 4) | ΔR <sub>ON</sub>                                              | V+ = 5V,<br>I <sub>COM_</sub> = -1.0mA,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 3V     | T <sub>A</sub> = +25°C                                   |      | 0.8   |                 | 2     | Ω     |
|                                                  |                                                               |                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |      |       |                 | 4     |       |
| On-Resistance Flatness<br>(Notes 3, 5)           | R <sub>FLAT(ON)</sub>                                         | V+ = 5V,<br>I <sub>COM_</sub> = -1.0mA,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 1V, 3V | T <sub>A</sub> = +25°C                                   |      | 2     |                 | 6     | Ω     |
|                                                  |                                                               |                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |      |       |                 | 8     |       |
| NO or NC Off-Leakage<br>Current (Note 9)         | I <sub>NO(OFF)</sub><br>or<br>I <sub>NC(OFF)</sub>            | V+ = 5.5V,<br>V <sub>COM_</sub> = 0V,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 4.5V     | T <sub>A</sub> = +25°C                                   |      | -0.25 | ±0.01           | +0.25 | nA    |
|                                                  |                                                               |                                                                                          | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E | -0.1  |                 | +0.1  |       |
|                                                  |                                                               |                                                                                          |                                                          | M    | -2.5  |                 | +2.5  |       |
| COM Off-Leakage Current<br>(Note 9)              | I <sub>COM(OFF)</sub>                                         | V+ = 5.5V,<br>V <sub>COM_</sub> = 0V,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 4.5V     | T <sub>A</sub> = +25°C                                   |      | -0.1  |                 | +0.1  | nA    |
|                                                  |                                                               |                                                                                          | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E | -2.5  |                 | +2.5  |       |
|                                                  |                                                               |                                                                                          |                                                          | M    | -5.0  |                 | +5.0  |       |
| COM On-Leakage Current<br>(Note 9)               | I <sub>COM(ON)</sub>                                          | V+ = 5.5V,<br>V <sub>COM_</sub> = 5V,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 4.5V     | T <sub>A</sub> = +25°C                                   |      | -0.2  |                 | +0.2  | nA    |
|                                                  |                                                               |                                                                                          | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E | -5.0  |                 | +5.0  |       |
|                                                  |                                                               |                                                                                          |                                                          | M    | -20   |                 | +20   |       |
| DYNAMIC                                          |                                                               |                                                                                          |                                                          |      |       |                 |       |       |
| Turn-On Time                                     | t <sub>ON</sub>                                               | V <sub>NO_</sub> or V <sub>NC_</sub> = 3V                                                | T <sub>A</sub> = +25°C                                   |      | 85    |                 | 170   | ns    |
|                                                  |                                                               |                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |      |       |                 | 240   |       |
| Turn-Off Time                                    | t <sub>OFF</sub>                                              | V <sub>NO_</sub> or V <sub>NC_</sub> = 3V                                                | T <sub>A</sub> = +25°C                                   |      | 25    |                 | 50    | ns    |
|                                                  |                                                               |                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>    |      |       |                 | 100   |       |
| Break-Before-Make Time<br>Delay (Note 3)         | t <sub>D</sub>                                                | MAX393 only, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF                                |                                                          |      | 10    |                 |       | ns    |
| Charge Injection<br>(Note 3)                     | Q                                                             | C <sub>L</sub> = 1.0nF, V <sub>GEN</sub> = 0V,<br>R <sub>GEN</sub> = 0V, Figure 4        | T <sub>A</sub> = +25°C                                   |      | 1     |                 | 5     | pC    |
| SUPPLY                                           |                                                               |                                                                                          |                                                          |      |       |                 |       |       |
| Positive Supply Current                          | I+                                                            | V+ = 5.5V, V <sub>IN</sub> = 0V or V+, all channels on or off                            |                                                          |      | -1    |                 | +1    | μA    |
| Negative Supply Current                          | I-                                                            | V+ = 5.5V, V <sub>IN</sub> = 0V or V+, all channels on or off                            |                                                          |      | -1    |                 | +1    | μA    |

# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### ELECTRICAL CHARACTERISTICS—Single +3.3V Supply

(V+ = +3.0V to +3.6V, GND = 0V, V<sub>INH</sub> = 2.4V, V<sub>INL</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 |
|---------------------------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------|-----|-----------------|-----|-------|
| ANALOG SWITCH                         |                                                               |                                                                                        |                                                       |     |                 |     |       |
| Analog Signal Range                   | V <sub>COM_</sub> ,<br>V <sub>NO_</sub> ,<br>V <sub>NC_</sub> | (Note 3)                                                                               |                                                       | 0   |                 | V+  | V     |
| Channel On-Resistance                 | R <sub>ON</sub>                                               | V+ = 3V,<br>I <sub>COM_</sub> = -1.0mA,<br>V <sub>NO_</sub> or V <sub>NC_</sub> = 1.5V | T <sub>A</sub> = +25°C                                | 83  | 175             | Ω   |       |
|                                       |                                                               |                                                                                        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 275 |                 |     |       |
| DYNAMIC                               |                                                               |                                                                                        |                                                       |     |                 |     |       |
| Turn-On Time (Note 3)                 | t <sub>ON</sub>                                               | V <sub>NO_</sub> or V <sub>NC_</sub> = 1.5V                                            | T <sub>A</sub> = +25°C                                | 160 | 400             | ns  |       |
|                                       |                                                               |                                                                                        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 500 |                 |     |       |
| Turn-Off Time (Note 3)                | t <sub>OFF</sub>                                              | V <sub>NO_</sub> or V <sub>NC_</sub> = 1.5V                                            | T <sub>A</sub> = +25°C                                | 40  | 125             | ns  |       |
|                                       |                                                               |                                                                                        | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 175 |                 |     |       |
| Break-Before-Make Time Delay (Note 3) | t <sub>D</sub>                                                | MAX393 only,<br>R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF                           | T <sub>A</sub> = +25°C                                | 20  |                 | ns  |       |
| Charge Injection (Note 3)             | Q                                                             | C <sub>L</sub> = 1.0nF,<br>V <sub>GEN</sub> = 0V, R <sub>GEN</sub> = 0V                | T <sub>A</sub> = +25°C                                | 1   | 5               | pC  |       |
| SUPPLY                                |                                                               |                                                                                        |                                                       |     |                 |     |       |
| Positive Supply Current               | I+                                                            | V+ = 3.6V, V <sub>IN</sub> = 0V or V+, all channels on or off                          |                                                       | -1  | +1              | μA  |       |
| Negative Supply Current               | I-                                                            | V+ = 3.6V, V <sub>IN</sub> = 0V or V+, all channels on or off                          |                                                       | -1  | +1              | μA  |       |

**Note 2:** The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.

**Note 3:** Guaranteed by design.

**Note 4:** ΔR<sub>ON</sub> = ΔR<sub>ON</sub> max - ΔR<sub>ON</sub> min.

**Note 5:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.

**Note 6:** Leakage parameters are 100% tested at maximum rated hot temperature and guaranteed by correlation at +25°C.

**Note 7:** Off-isolation = 20 log<sub>10</sub> [ V<sub>COM\_</sub> / (V<sub>NC\_</sub> or V<sub>NO\_</sub>) ], V<sub>COM\_</sub> = output, V<sub>NC\_</sub> or V<sub>NO\_</sub> = input to off switch.

**Note 8:** Between any two switches.

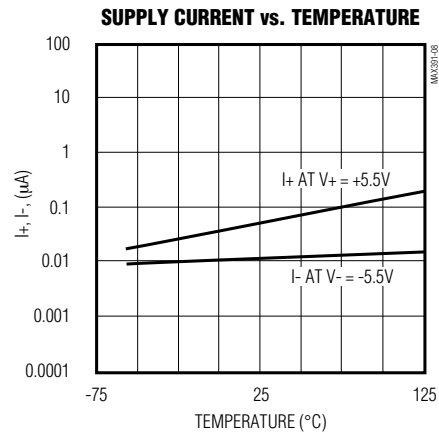
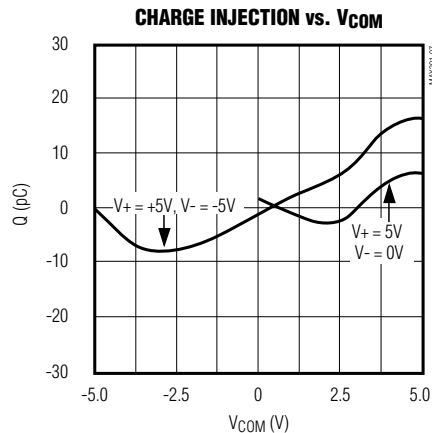
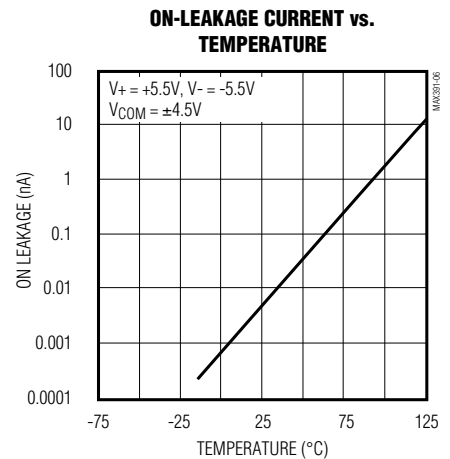
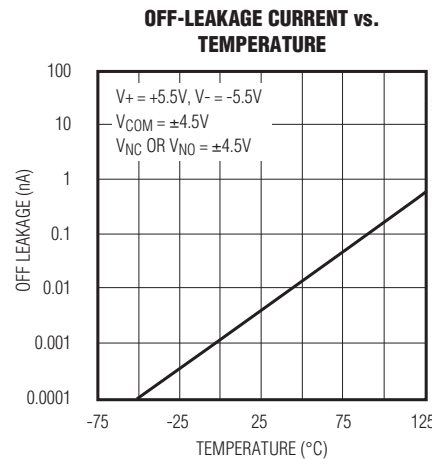
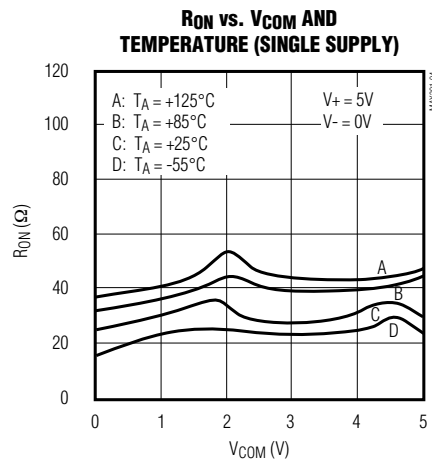
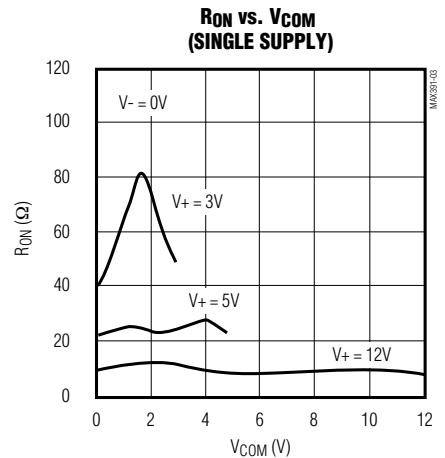
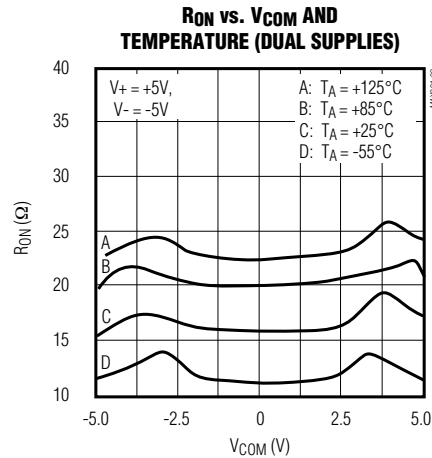
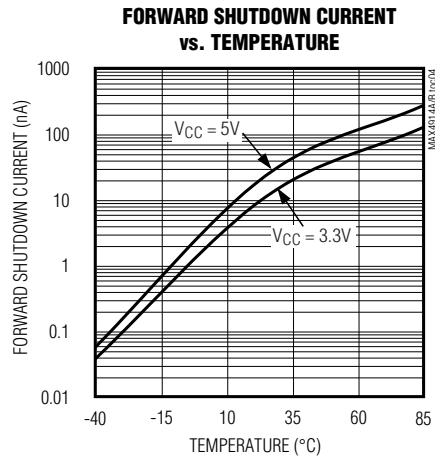
**Note 9:** Leakage testing at single supply is guaranteed by testing with dual singles.

# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### Typical Operating Characteristics

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



# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### Pin Description

| PIN          |              | NAME                     | FUNCTION                                             |
|--------------|--------------|--------------------------|------------------------------------------------------|
| DIP/SO/TSSOP | QFN          |                          |                                                      |
| 1, 16, 9, 8  | 15, 14, 7, 6 | IN1–IN4                  | Inputs                                               |
| 2, 15, 10, 7 | 16, 13, 8, 5 | COM1–COM                 | Analog Switch Common Terminal                        |
| 3, 14, 11, 6 | 1, 12, 9, 4  | NO1–NO4<br>or<br>NC1–NC4 | Switch Inputs                                        |
| 4            | 2            | V-                       | Negative-Supply Voltage Input                        |
| 5            | 3            | GND                      | Ground                                               |
| 12           | 10           | N.C.                     | No Connection. Not internally connected              |
| 13           | 11           | V+                       | Positive-Supply Voltage Input—connected to substrate |
| —            | EP           | EP                       | Exposed Pad. Connect to V+.                          |

### Applications Information

#### 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, followed by V-, and then logic inputs. 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 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 17V.

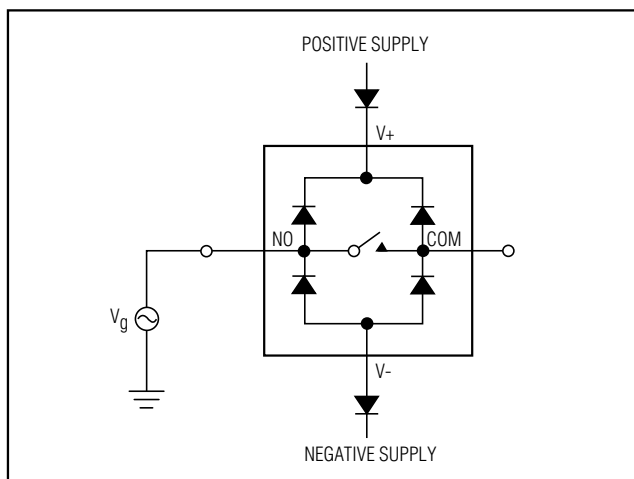


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### Test Circuits/Timing Diagrams

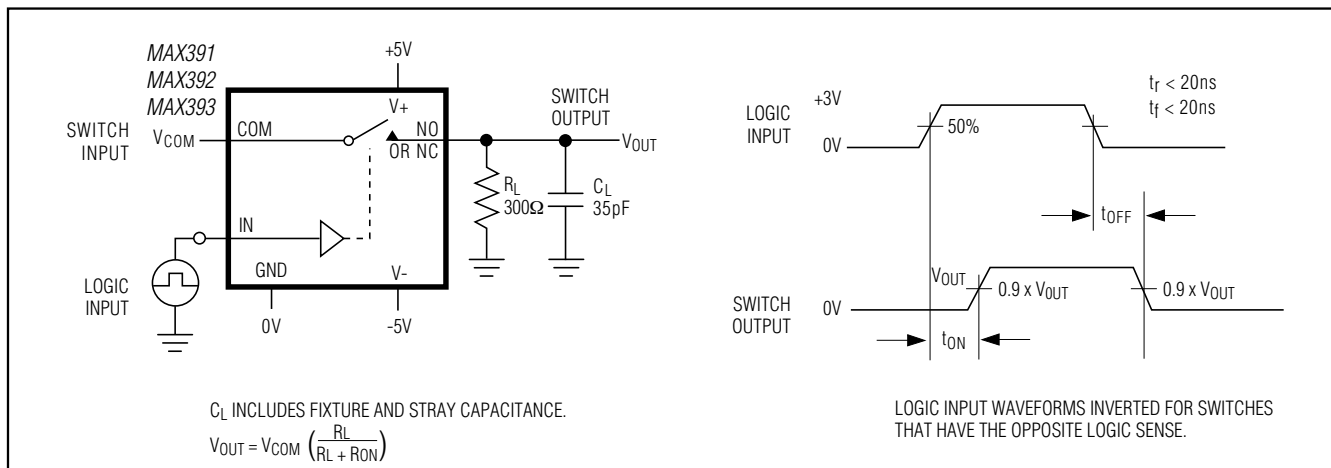


Figure 2. Switching Time

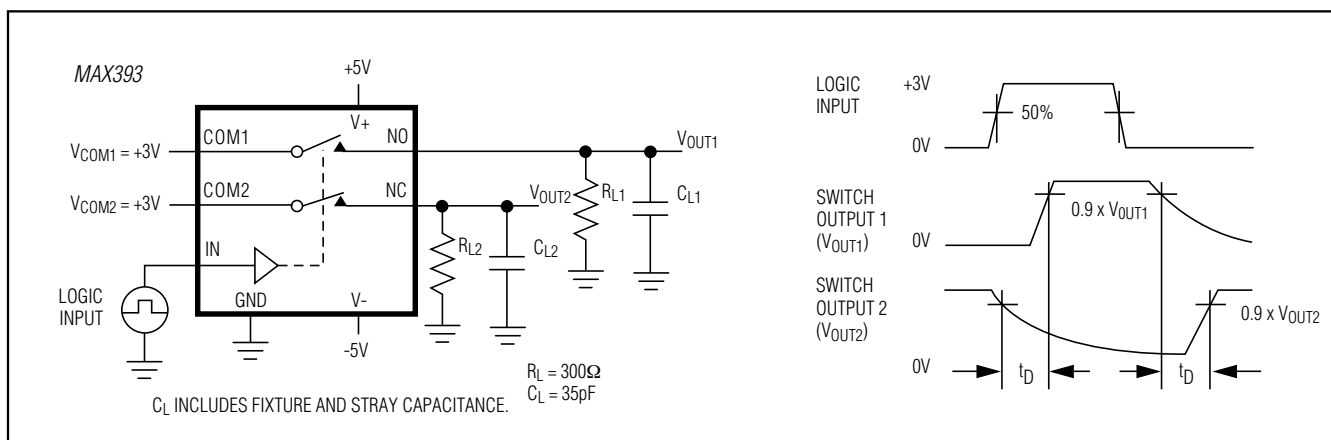


Figure 3. Break-Before-Make Interval (MAX393 only)

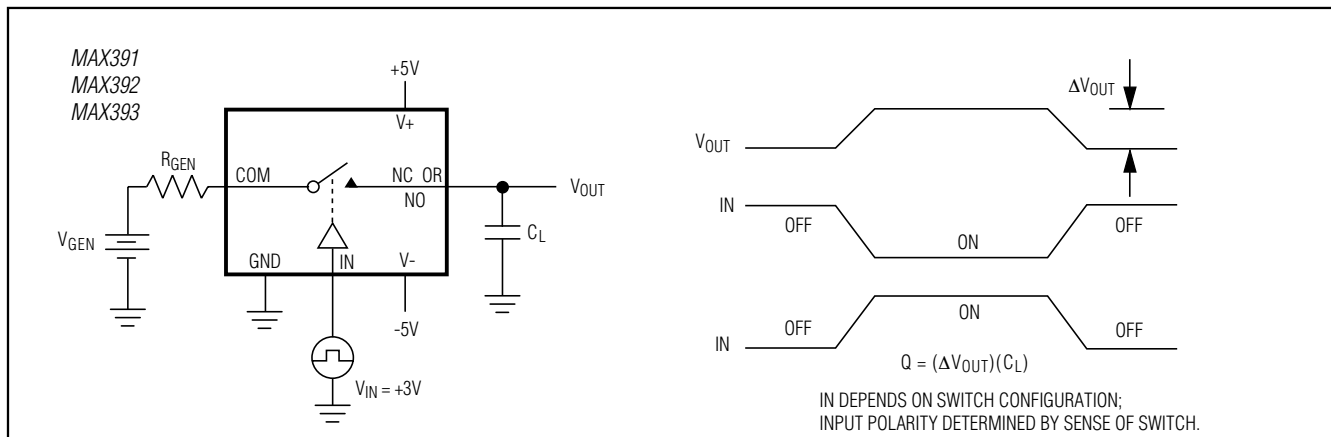


Figure 4. Charge Injection

# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### Test Circuits/Timing Diagrams (continued)

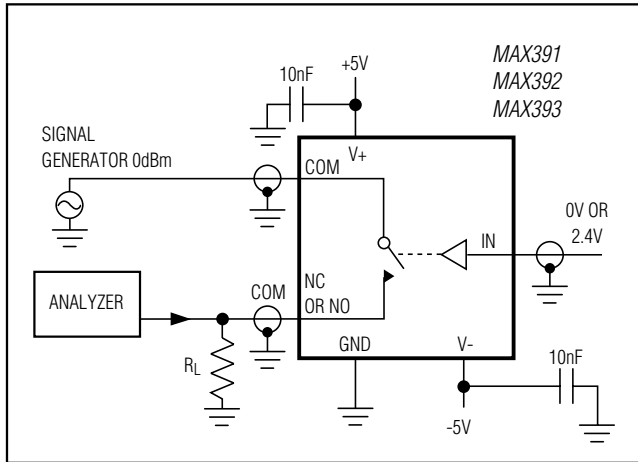


Figure 5. Off-Isolation

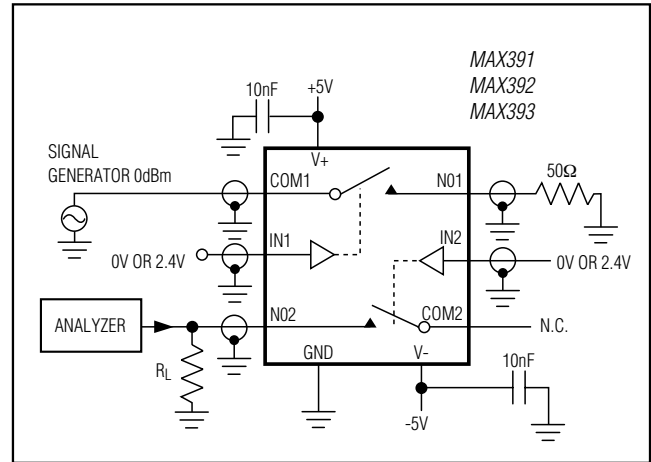


Figure 6. Crosstalk

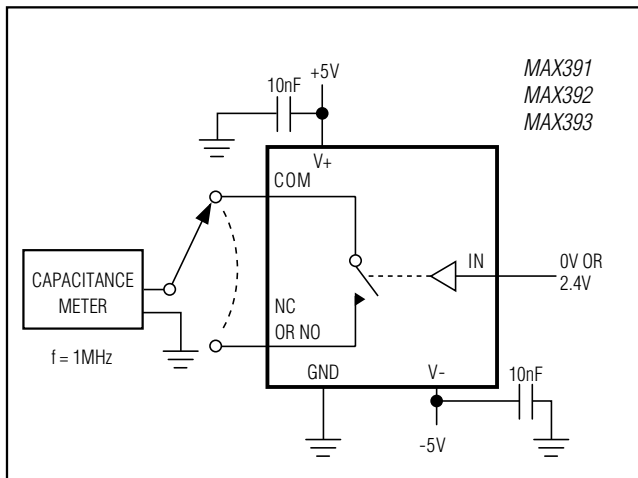


Figure 7. Channel Off-Capacitance

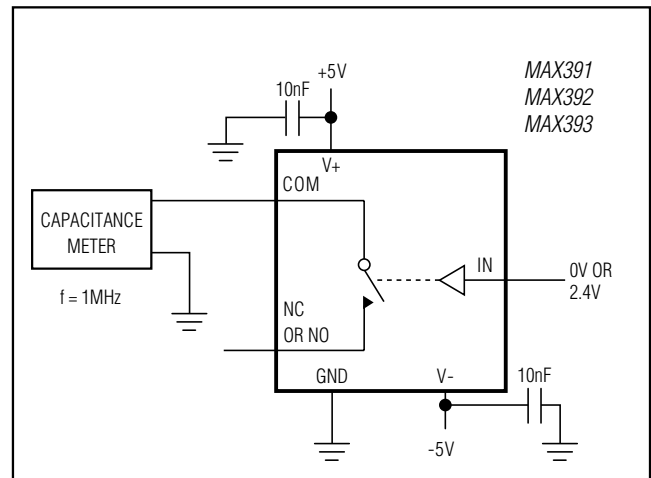


Figure 8. Channel On-Capacitance

# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### Ordering Information (continued)

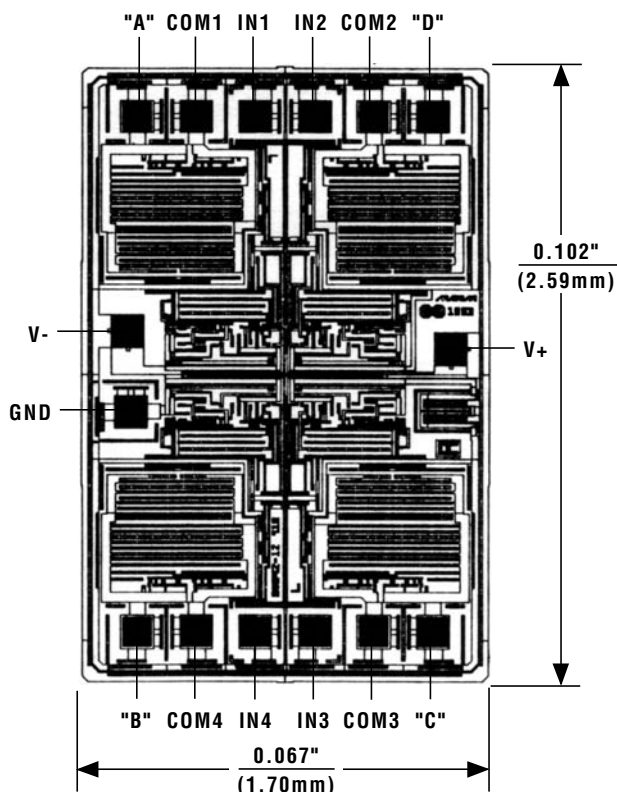
| PART             | TEMP RANGE      | PIN-<br>PACKAGE | PKG<br>CODE |
|------------------|-----------------|-----------------|-------------|
| MAX391ESE        | -40°C to +85°C  | 16 Narrow SO    | S16-2       |
| MAX391EUE        | -40°C to +85°C  | 16 TSSOP        | U16-2       |
| MAX391EGE        | -40°C to +85°C  | 16 QFN-EP†      | G1655-3     |
| MAX391EJE        | -40°C to +85°C  | 16 CERDIP       | J16-3       |
| MAX391MJE        | -55°C to +125°C | 6 CERDIP**      | —           |
| <b>MAX392CPE</b> | 0°C to +70°C    | 16 Plastic DIP  | P16-1       |
| MAX392CSE        | 0°C to +70°C    | 16 Narrow SO    | S16-2       |
| MAX392CUE        | 0°C to +70°C    | 16 TSSOP        | U16-2       |
| MAX392CGE        | 0°C to +70°C    | 16 QFN-EP†      | G1655-3     |
| MAX392C/D        | 0°C to +70°C    | Dice*           | —           |
| MAX392EPE        | -40°C to +85°C  | 16 Plastic DIP  | P16-1       |
| MAX392ESE        | -40°C to +85°C  | 16 Narrow SO    | S16-2       |
| MAX392EUE        | -40°C to +85°C  | 16 TSSOP        | U16-2       |
| MAX392EGE        | -40°C to +85°C  | 16 QFN          | G1655-3     |
| MAX392EJE        | -40°C to +85°C  | 16 CERDIP       | J16-3       |
| MAX392MJE        | -55°C to +125°C | 6 CERDIP**      | —           |
| <b>MAX393CPE</b> | 0°C to +70°C    | 16 Plastic DIP  | P16-1       |
| MAX393CSE        | 0°C to +70°C    | 16 Narrow SO    | S16-2       |
| MAX393CUE        | 0°C to +70°C    | 16 TSSOP        | U16-2       |
| MAX393CGE        | 0°C to +70°C    | 16 QFN-EP†      | G1655-3     |
| MAX393C/D        | 0°C to +70°C    | Dice*           | —           |
| MAX393EPE        | -40°C to +85°C  | 16 Plastic DIP  | P16-1       |
| MAX393ESE        | -40°C to +85°C  | 16 Narrow SO    | S16-2       |
| MAX393EUE        | -40°C to +85°C  | 16 TSSOP        | U16-2       |
| MAX393EGE        | -40°C to +85°C  | 16 QFN-EP†      | G1655-3     |
| MAX393EJE        | -40°C to +85°C  | 16 CERDIP       | J16-3       |
| MAX393MJE        | -55°C to +125°C | 6 CERDIP**      | —           |

\*Contact factory for dice specifications.

\*\*Contact factory for availability and processing to MIL-STD-883.

†EP = Exposed pad.

### Chip Topography



| MAX391 |      | MAX392 |      | MAX393 |      |
|--------|------|--------|------|--------|------|
| PIN    | NAME | PIN    | NAME | PIN    | NAME |
| A      | NC1  | A      | N01  | A      | N01  |
| B      | NC4  | B      | N04  | B      | N04  |
| C      | NC3  | C      | N03  | C      | NC3  |
| D      | NC2  | D      | N02  | D      | NC2  |

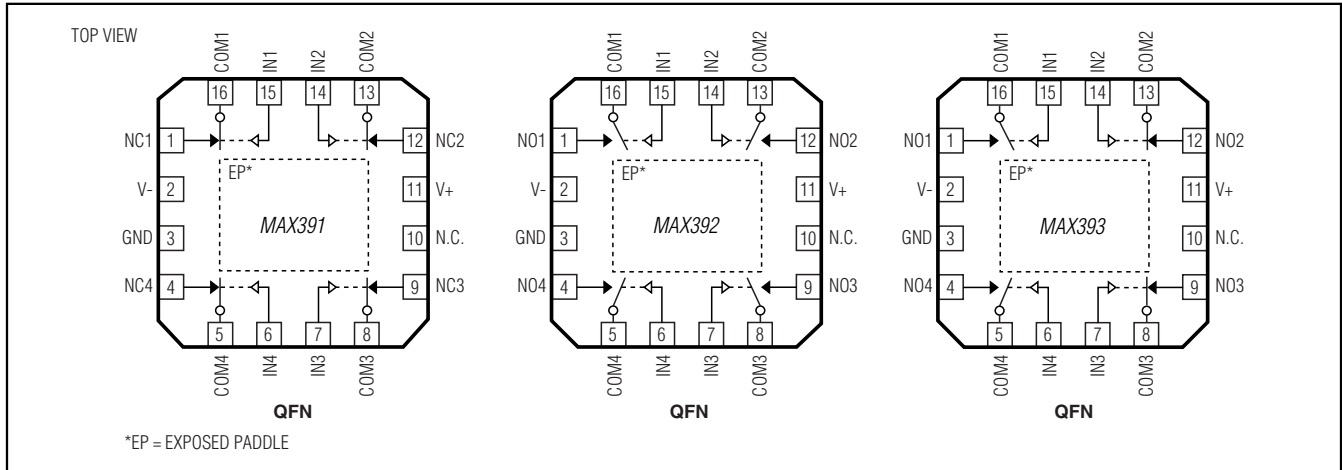
TRANSISTOR COUNT: 76

SUBSTRATE CONNECTED TO V+

# MAX391/MAX392/MAX393

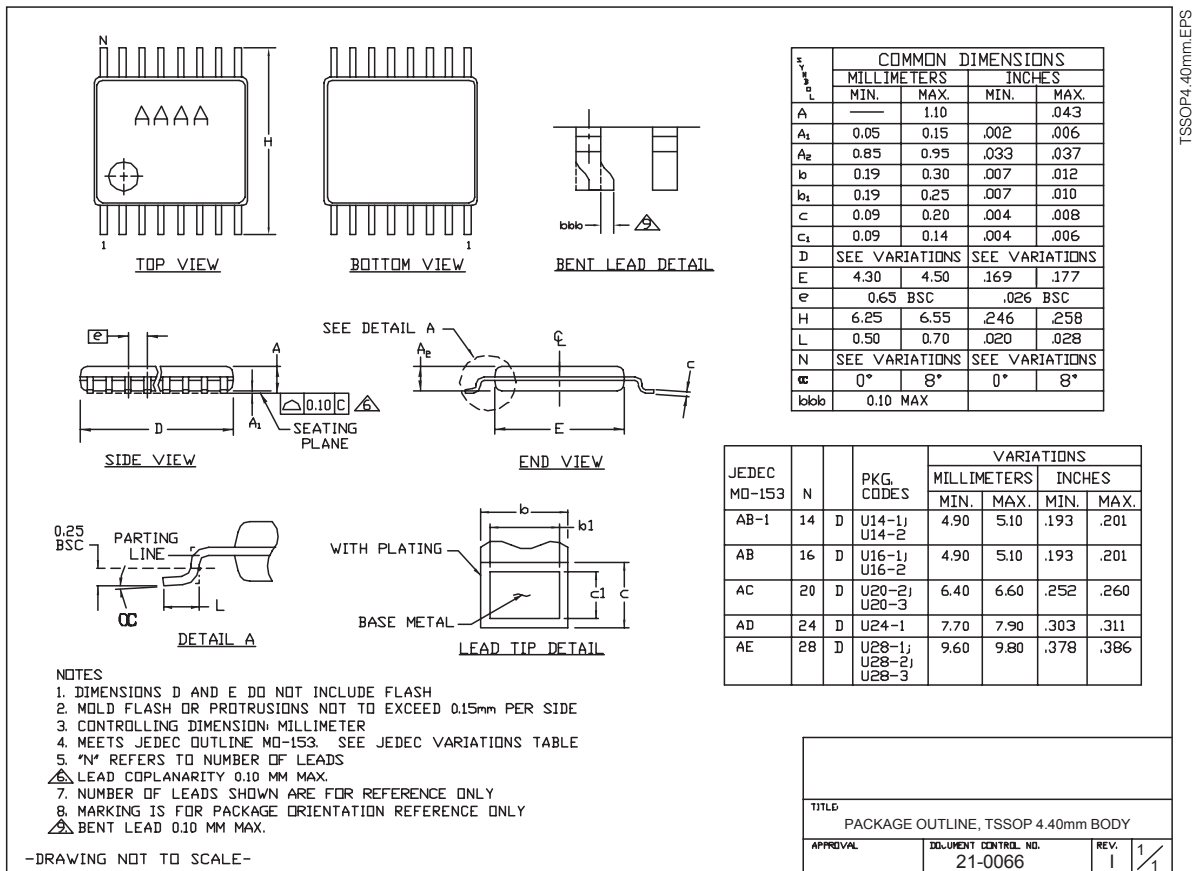
## Precision, Quad, SPST Analog Switches

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



### 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](http://www.maxim-ic.com/packages).)

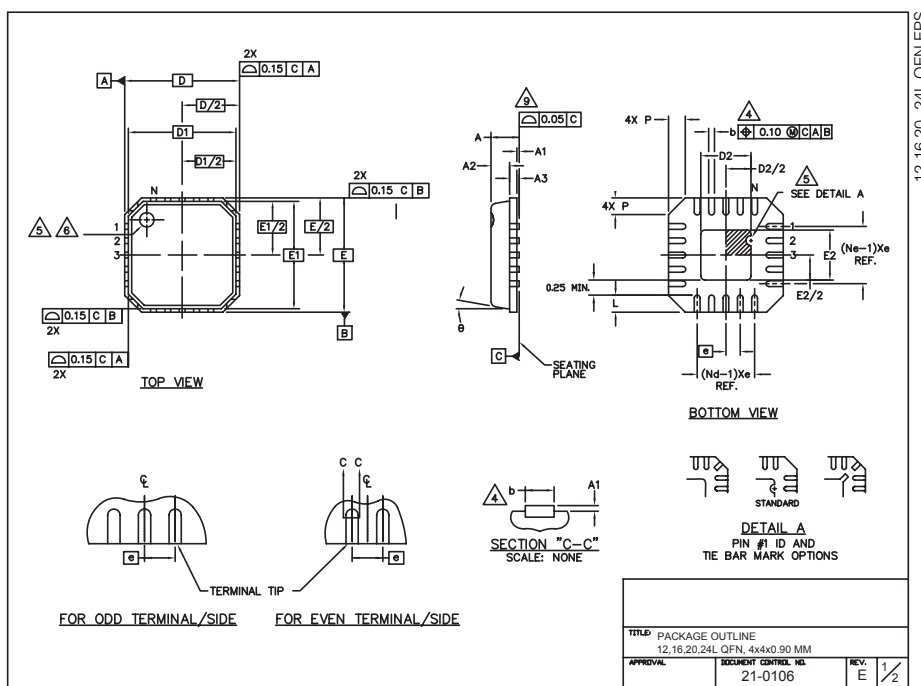


# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### 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](http://www.maxim-ic.com/packages).)



#### NOTES:

- DIE THICKNESS ALLOWABLE IS 0.305mm MAXIMUM (.012 INCHES MAXIMUM).
- DIMENSIONING & TOLERANCES CONFORM MUST TO ASME Y14.5M. - 1994.
- N IS THE NUMBER OF TERMINALS.  
Nd IS THE NUMBER OF TERMINALS IN X-DIRECTION &  
Ne IS THE NUMBER OF TERMINALS IN Y-DIRECTION.
- DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.25mm FROM TERMINAL TIP.
- THE PIN #1 IDENTIFIER MUST BE EXISTED ON THE TOP SURFACE OF THE PACKAGE BY USING INDENTATION MARK OR INK/LASER MARKED. DETAILS OF PIN #1 IDENTIFIER IS OPTIONAL, BUT MUST BE LOCATED WITHIN ZONE INDICATED.
- EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL.
- ALL DIMENSIONS ARE IN MILLIMETERS.
- PACKAGE WARPAGE MAX 0.05mm.
- APPLIED FOR EXPOSED PAD AND TERMINALS.  
EXCLUDE EMBEDDING PART OF EXPOSED PAD FROM MEASURING.
- MEETS JEDEC MO220; EXCEPT DIMENSION "b".
- THIS PACKAGE OUTLINE APPLIES TO PUNCHED QFN (STEPPED SIDES).

| S<br>E<br>W<br>O<br>L | COMMON<br>DIMENSIONS |      |      | N<br>O. |
|-----------------------|----------------------|------|------|---------|
|                       | MIN.                 | NOM. | MAX. |         |
| A                     | 0.80                 | 0.90 | 1.00 | E       |
| A1                    | 0.00                 | 0.01 | 0.05 |         |
| A2                    | 0.00                 | 0.65 | 0.80 | E       |
| A3                    | 0.20 REF.            |      |      |         |
| D                     | 4.00 BSC             |      |      | E       |
| D1                    | 3.75 BSC             |      |      |         |
| E                     | 4.00 BSC             |      |      | E       |
| E1                    | 3.75 BSC             |      |      |         |
| Ø                     | 0"                   | -    | 12"  | E       |
| P                     | 0.24                 | 0.42 | 0.60 |         |

| PITCH VARIATION A |      |      |      | No. of | PITCH VARIATION B |      |      |      | No. of | PITCH VARIATION C |      |      |      | No. of | PITCH VARIATION D |      |      |      | No. of |
|-------------------|------|------|------|--------|-------------------|------|------|------|--------|-------------------|------|------|------|--------|-------------------|------|------|------|--------|
| MIN.              | NOM. | MAX. |      |        | MIN.              | NOM. | MAX. |      |        | MIN.              | NOM. | MAX. |      |        | MIN.              | NOM. | MAX. |      |        |
| 0.60 BSC          |      |      |      |        | 0.65 BSC          |      |      |      |        | 0.50 BSC          |      |      |      |        | 0.50 BSC          |      |      |      |        |
| 12                |      |      |      | 3      | 16                |      |      |      | 3      | 20                |      |      |      | 3      | 24                |      |      |      | 3      |
| Nd                |      |      |      | 3      | Nd                |      |      |      | 4      | Nd                |      |      |      | 3      | Nd                |      |      |      | 3      |
| Ne                |      |      |      | 3      | Ne                |      |      |      | 4      | Ne                |      |      |      | 3      | Ne                |      |      |      | 3      |
| L                 | 0.50 | 0.60 | 0.75 |        | L                 | 0.50 | 0.60 | 0.75 |        | L                 | 0.50 | 0.60 | 0.75 |        | L                 | 0.30 | 0.40 | 0.50 |        |
| b                 | 0.28 | 0.33 | 0.40 |        | b                 | 0.23 | 0.28 | 0.35 |        | b                 | 0.18 | 0.3  | 0.30 |        | b                 | 0.18 | 0.23 | 0.30 |        |

| PKG.<br>CODE | EXPOSED PAD VARIATION |      |      |      |      |      |
|--------------|-----------------------|------|------|------|------|------|
|              | D2                    |      |      | F2   |      |      |
|              | MIN.                  | NOM. | MAX. | MIN. | NOM. | MAX. |
| G1244-2      | 1.95                  | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 |
| G1644-1      | 1.95                  | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 |
| G2044-3      | 1.95                  | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 |
| G2044-4      | 1.55                  | 1.70 | 1.85 | 1.55 | 1.70 | 1.85 |
| G2444-1      | 1.95                  | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 |

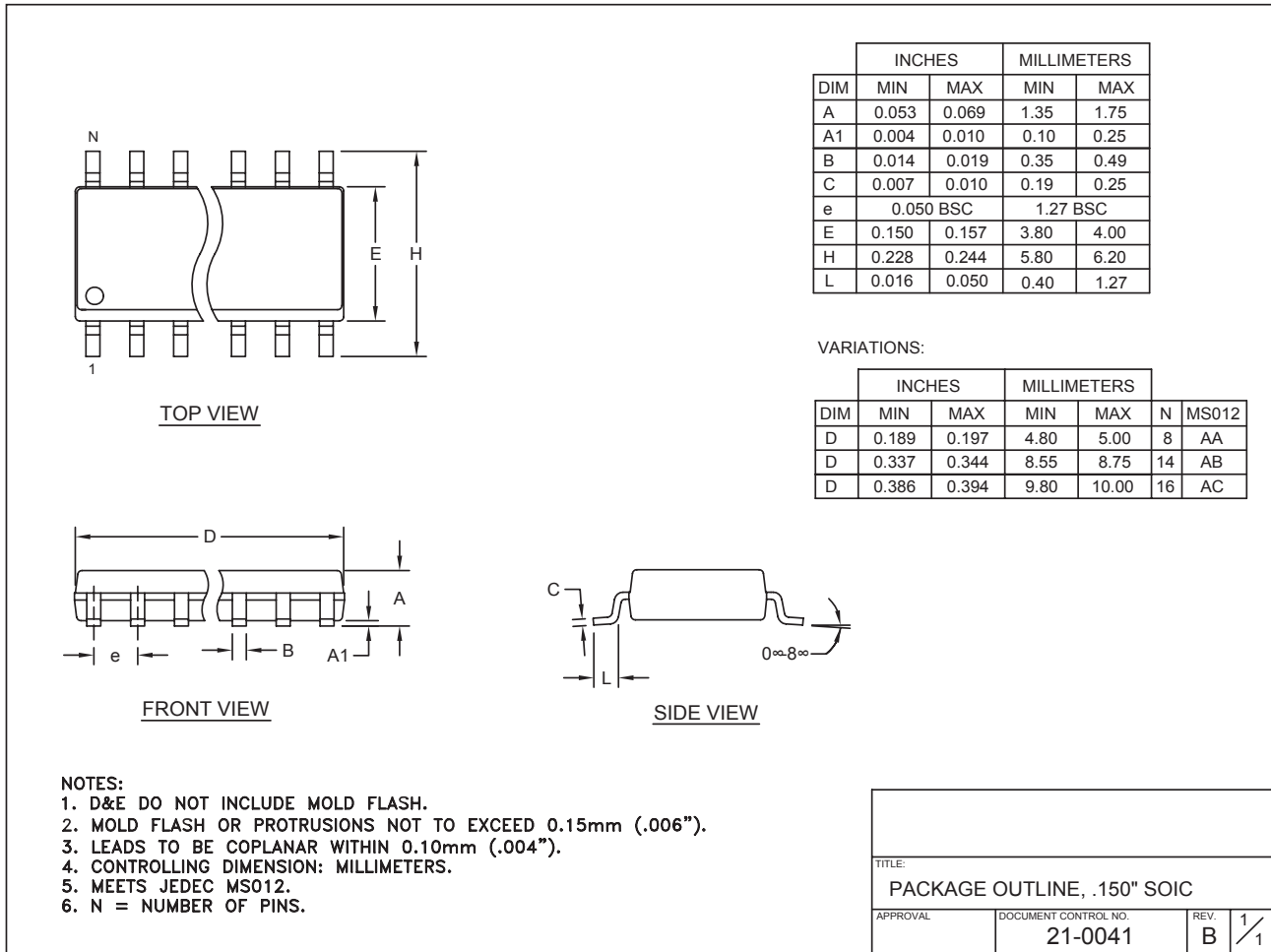
| TITLE: PACKAGE OUTLINE           |                       |      |     |
|----------------------------------|-----------------------|------|-----|
| 12, 16, 20, 24L QFN, 4x4x0.90 MM |                       |      |     |
| APPROVAL                         | DOCUMENT CONTROL, REL | REV. | 2/2 |
|                                  | 21-0106               | E    |     |

# MAX391/MAX392/MAX393

## Precision, Quad, SPST Analog Switches

### 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](http://www.maxim-ic.com/packages).)



### Revision History

Pages changed at Rev 3: 1-11, 13



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**13**

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