



# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

## General Description

The MAX4800/MAX4801/MAX4802 provide high-voltage switching on eight channels for ultrasonic imaging and printer applications. The devices utilize BCD MOS process technology to provide eight high-voltage low-charge-injection SPST switches, controlled by a digital interface. Data is clocked into an internal 8-bit shift register and retained by a programmable latch with enable and clear inputs. A power-on reset function ensures that all switches are open on power-up.

The MAX4800/MAX4801/MAX4802 operate with a wide range of high-voltage supplies including:  $V_{PP}/V_{NN} = +100V/-100V$ ,  $+185V/-15V$ , and  $+40V/-160V$ . The digital interface operates from a separate  $V_{DD}$  supply from  $+2.7V$  to  $+13.2V$ . Digital inputs DIN, CLK,  $\overline{LE}$ , and CLR are  $+13.2V$  tolerant, independent of the  $V_{DD}$  supply voltage. The MAX4802 provides integrated  $35k\Omega$  bleed resistors on each switch terminal to discharge capacitive loads.

The MAX4800 and MAX4802 are drop-in replacements for the Supertex HV20220 and HV232. The devices are available in the 48-pin TQFP, 26-bump CSBGA, and 28-pin PLCC packages. The MAX4801 is a drop-in replacement for the Supertex HV20320 and is available in the 28-pin PLCC package. All devices are specified for the commercial  $0^{\circ}C$  to  $+70^{\circ}C$  temperature range.

## Applications

Ultrasound Imaging  
Printers

## Features

- ◆ Pin-Compatible Replacement for Supertex HV20220 (MAX4800)
- ◆ Pin-Compatible Replacement for Supertex HV20320 (MAX4801)
- ◆ Pin-Compatible Replacement for Supertex HV232 (MAX4802)
- ◆ Flexible High-Voltage Supplies Up to  $V_{PP} - V_{NN} = 200V$
- ◆ Low-Charge Injection, Low-Capacitance  $22\Omega$  Switches
- ◆ DC to 10MHz Analog-Signal Frequency Range
- ◆ -77dB Off Isolation at 5MHz
- ◆ Low  $10\mu A$  Quiescent Current
- ◆ Integrated Bleed Resistors (MAX4802)
- ◆ Available in PLCC, TQFP, and CSBGA Packages

MAX4800/MAX4801/MAX4802

## Ordering Information/Selector Guide

| PART       | BLEED RESISTORS | SECOND SOURCE | PIN-PACKAGE |
|------------|-----------------|---------------|-------------|
| MAX4800CCM | No              | HV20220FG     | 48 TQFP     |
| MAX4800CQI | No              | HV20220PJ     | 28 PLCC     |
| MAX4800CXZ | No              | HV220**       | 26 CSBGA    |
| MAX4801CQI | No              | HV20320PJ     | 28 PLCC     |
| MAX4802CCM | Yes             | HV232FG       | 48 TQFP     |
| MAX4802CQI | Yes             | HV232PJ       | 28 PLCC     |
| MAX4802CXZ | Yes             | HV230GA       | 26 CSBGA    |

**Note:** All devices are specified over the commercial  $0^{\circ}C$  to  $+70^{\circ}C$  temperature range.

\*\*Not pin-for-pin compatible.



# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

|                                                       |                                    |
|-------------------------------------------------------|------------------------------------|
| V <sub>DD</sub> Logic-Supply Voltage                  | -0.5V to +15V                      |
| V <sub>PP</sub> - V <sub>NN</sub> Supply Voltage      | 220V                               |
| V <sub>PP</sub> Positive-Supply Voltage               | -0.5V to V <sub>NN</sub> + 220V    |
| V <sub>NN</sub> Negative-Supply Voltage               | +0.5V to -220V                     |
| Logic Inputs $\overline{LE}$ , CLR, CLK, DIN          | -0.5V to +15V                      |
| DOUT                                                  | -0.5V to V <sub>DD</sub> + 0.5V    |
| RGND (MAX4802)                                        | -4.5V to +0.5V                     |
| COM <sub>-</sub> , NO <sub>-</sub>                    | V <sub>NN</sub> to V <sub>PP</sub> |
| Continuous Power Dissipation (T <sub>A</sub> = +70°C) |                                    |
| 28-Pin PLCC (derate 10.5mW/°C above +70°C)            | 842mW                              |

|                                             |                 |
|---------------------------------------------|-----------------|
| 48-Pin TQFP (derate 22.7mW/°C above +70°C)  | 1818mW          |
| 26-Pin CSBGA (derate 11.8mW/°C above +70°C) | 941mW           |
| Operating Temperature Range                 | 0°C to +70°C    |
| Storage Temperature Range                   | -65°C to +150°C |
| Junction Temperature Range                  | +150°C          |
| Lead Temperature (Soldering, 10s)           | +300°C          |
| Bump Temperature (Soldering) Lead-Free      | +260°C          |
| Bump Temperature (Soldering) Lead           | +245°C          |

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

(V<sub>DD</sub> = +2.7V to +13.2V, V<sub>PP</sub> = +40V to V<sub>NN</sub> + 200V, V<sub>NN</sub> = -15V to -160V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Note 1)

| PARAMETER                                     | SYMBOL                                  | CONDITIONS                                                                                                                               |                             |                        | MIN                     | TYP | MAX                     | UNITS |
|-----------------------------------------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------|-------------------------|-----|-------------------------|-------|
| ANALOG SWITCH                                 |                                         |                                                                                                                                          |                             |                        |                         |     |                         |       |
| Analog Signal Range                           | V <sub>COM_</sub> ,<br>V <sub>NO_</sub> | (Note 2)                                                                                                                                 |                             |                        | V <sub>NN</sub> +<br>10 |     | V <sub>PP</sub> -<br>10 | V     |
| Small-Signal Switch<br>On-Resistance          | R <sub>ONS</sub>                        | V <sub>PP</sub> = +40V,<br>V <sub>NN</sub> = -160V,<br>V <sub>COM_</sub> = 0                                                             | I <sub>COM</sub> = 5mA      | T <sub>A</sub> = 0°C   |                         |     | 30                      | Ω     |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +25°C |                         | 26  | 38                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +70°C |                         |     | 48                      |       |
|                                               |                                         |                                                                                                                                          | I <sub>COM</sub> =<br>200mA | T <sub>A</sub> = 0°C   |                         |     | 25                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +25°C |                         | 22  | 27                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +70°C |                         |     | 32                      |       |
|                                               |                                         | V <sub>PP</sub> = +100V,<br>V <sub>NN</sub> = -100V,<br>V <sub>COM_</sub> = 0                                                            | I <sub>COM</sub> = 5mA      | T <sub>A</sub> = 0°C   |                         |     | 25                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +25°C |                         | 22  | 27                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +70°C |                         |     | 30                      |       |
|                                               |                                         |                                                                                                                                          | I <sub>COM</sub> =<br>200mA | T <sub>A</sub> = 0°C   |                         |     | 18                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +25°C |                         | 18  | 24                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +70°C |                         |     | 27                      |       |
|                                               |                                         | V <sub>PP</sub> = +160V,<br>V <sub>NN</sub> = -40V<br>or<br>V <sub>PP</sub> = +185V,<br>V <sub>NN</sub> = -15V,<br>V <sub>COM_</sub> = 0 | I <sub>COM</sub> = 5mA      | T <sub>A</sub> = 0°C   |                         |     | 23                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +25°C |                         | 20  | 25                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +70°C |                         |     | 30                      |       |
|                                               |                                         |                                                                                                                                          | I <sub>COM</sub> =<br>200mA | T <sub>A</sub> = 0°C   |                         |     | 22                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +25°C |                         | 16  | 25                      |       |
|                                               |                                         |                                                                                                                                          |                             | T <sub>A</sub> = +70°C |                         |     | 27                      |       |
| Small-Signal Switch<br>On-Resistance Matching | ΔR <sub>ONS</sub>                       | V <sub>PP</sub> = +100V, V <sub>NN</sub> = -100V,<br>V <sub>COM_</sub> = 0, I <sub>COM</sub> = 5mA                                       |                             |                        |                         | 5   | 20                      | %     |
| Large-Signal Switch<br>On-Resistance          | R <sub>ONL</sub>                        | V <sub>COM_</sub> = V <sub>PP</sub> - 10V, I <sub>COM</sub> = 1A                                                                         |                             |                        |                         | 15  |                         | Ω     |
| Shunt Resistance                              | R <sub>INT</sub>                        | NO_ or COM_ to RGND (MAX4802), switch<br>off                                                                                             |                             |                        | 30                      | 35  | 50                      | kΩ    |

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

MAX4800/MAX4801/MAX4802

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{DD} = +2.7V$  to  $+13.2V$ ,  $V_{PP} = +40V$  to  $V_{NN} + 200V$ ,  $V_{NN} = -15V$  to  $-160V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 1)

| PARAMETER                                            | SYMBOL                                    | CONDITIONS                                                                                                                                                            | MIN                                                                                                                                   | TYP               | MAX  | UNITS   |
|------------------------------------------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------|------|---------|
| Switch-Off Leakage                                   | $I_{COM\_ (OFF)}$ ,<br>$I_{NO\_ (OFF)}$   | $V_{COM\_}$ , $V_{NO\_} = V_{PP} - 10V$ or<br>unconnected;<br>RGND unconnected<br>(MAX4802)                                                                           | $T_A = +25^\circ C$<br>$T_A = T_{MIN}$<br>to $T_{MAX}$                                                                                | 1<br>4<br>10      |      | $\mu A$ |
| Switch-Off DC Offset                                 |                                           | $R_L = 100k\Omega$ (MAX4800/MAX4801),<br>No load (MAX4802)                                                                                                            |                                                                                                                                       | 100               | 300  | mV      |
| Switch-On DC Offset                                  |                                           | $R_L = 100k\Omega$ (MAX4800/MAX4801),<br>No load (MAX4802)                                                                                                            |                                                                                                                                       | 100               | 500  | mV      |
| Switch-Output Peak Current<br>(Note 3)               |                                           | $I_{COM\_}$ duty cycle $\leq 0.1\%$                                                                                                                                   | $T_A = 0^\circ C$<br>$T_A = +25^\circ C$<br>$T_A = +70^\circ C$                                                                       | 3<br>2<br>2       |      | A       |
| Switch-Output Isolation Diode<br>Current<br>(Note 3) |                                           | 300ns pulse width, 2%<br>duty cycle                                                                                                                                   | $V_{PP} - V_{NN} \leq 200V$<br>$COM\_$ , NO1–NO7<br>$V_{PP} - V_{NN} \leq 200V$ , NO0<br>$V_{PP} - V_{NN} \leq 160V$<br>$COM\_$ , NO_ | 300<br>30<br>750  |      | mA      |
| <b>SWITCH DYNAMIC CHARACTERISTICS</b>                |                                           |                                                                                                                                                                       |                                                                                                                                       |                   |      |         |
| Off-Isolation (Note 3)                               | $V_{ISO}$                                 | $f = 5MHz$ , $R_L = 1k\Omega$ , $C_L = 15pF$<br>$f = 5MHz$ , $R_L = 50\Omega$                                                                                         | -30<br>-58                                                                                                                            | -33<br>-77        |      | dB      |
| Crosstalk (Note 3)                                   | $V_{CT}$                                  | $f = 5MHz$ , $R_L = 50\Omega$                                                                                                                                         | -60                                                                                                                                   | -80               |      | dB      |
| $COM\_$ , NO_<br>Off-Capacitance<br>(Note 3)         | $C_{COM\_}$<br>(OFF),<br>$C_{NO\_}$ (OFF) | $V_{COM\_} = 0$ , $V_{NO\_} = 0$ , $f = 1MHz$                                                                                                                         | 4                                                                                                                                     | 11                | 18   | pF      |
| $COM\_$ On-Capacitance<br>(Note 3)                   | $C_{COM\_}$<br>(ON)                       | $V_{COM\_} = 0$ , $f = 1MHz$                                                                                                                                          | 20                                                                                                                                    | 36                | 56   | pF      |
| Output-Voltage Spike (Note 3)                        | $V_{SPK}$                                 | $R_L = 50\Omega$                                                                                                                                                      | -150                                                                                                                                  |                   | +150 | mV      |
| Charge Injection                                     | Q                                         | $V_{PP} = +40V$ , $V_{NN} = -160V$ , $V_{COM\_} = 0$<br>$V_{PP} = +100V$ , $V_{NN} = -100V$ , $V_{COM\_} = 0$<br>$V_{PP} = +160V$ , $V_{NN} = -40V$ , $V_{COM\_} = 0$ |                                                                                                                                       | 820<br>600<br>350 |      | pC      |
| <b>LOGIC LEVELS</b>                                  |                                           |                                                                                                                                                                       |                                                                                                                                       |                   |      |         |
| Logic-Input Low Voltage                              | $V_{IL}$                                  | $V_{DD} \geq +4.5V$<br>$V_{DD} < +4.5V$                                                                                                                               |                                                                                                                                       | 1.5<br>0.75       |      | V       |
| Logic-Input High Voltage                             | $V_{IH}$                                  | $V_{DD} \geq +4.5V$<br>$V_{DD} < +4.5V$                                                                                                                               | $V_{DD} - 1.5$<br>$V_{DD} - 0.75$                                                                                                     |                   |      | V       |
| Logic-Input Capacitance (Note 3)                     | $C_{IN}$                                  |                                                                                                                                                                       |                                                                                                                                       | 10                |      | pF      |
| Logic-Input Leakage                                  | $I_{IN}$                                  |                                                                                                                                                                       | -1                                                                                                                                    |                   | +1   | $\mu A$ |
| DOOUT Low Voltage                                    | $V_{OL}$                                  | $V_{DD} \geq +4.5V$ , $I_{SINK} = 1mA$<br>$V_{DD} < +4.5V$ , $I_{SINK} = 0.5mA$                                                                                       |                                                                                                                                       | 0.4<br>0.4        |      | V       |

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{DD} = +2.7V$  to  $+13.2V$ ,  $V_{PP} = +40V$  to  $V_{NN} + 200V$ ,  $V_{NN} = -15V$  to  $-160V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 1)

| PARAMETER                                | SYMBOL           | CONDITIONS                                                                                 |                                                  |                        | MIN                   | TYP | MAX                   | UNITS |
|------------------------------------------|------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------|------------------------|-----------------------|-----|-----------------------|-------|
| DOUT High Voltage                        | V <sub>OH</sub>  | V <sub>DD</sub> ≥ +4.5V, I <sub>SOURCE</sub> = 0.5mA                                       |                                                  |                        | V <sub>DD</sub> - 0.5 |     |                       | V     |
|                                          |                  | V <sub>DD</sub> < +4.5V, I <sub>SOURCE</sub> = 0.25mA                                      |                                                  |                        | V <sub>DD</sub> - 0.5 |     |                       | V     |
| POWER SUPPLIES                           |                  |                                                                                            |                                                  |                        |                       |     |                       |       |
| V <sub>DD</sub> Supply Voltage           |                  |                                                                                            |                                                  |                        | 2.7                   |     | 13.2                  | V     |
| V <sub>PP</sub> Supply Voltage           |                  |                                                                                            |                                                  |                        | 40                    |     | V <sub>NN</sub> + 200 | V     |
| V <sub>NN</sub> Supply Voltage           |                  |                                                                                            |                                                  |                        | -160                  |     | -15                   | V     |
| V <sub>DD</sub> Supply Quiescent Current | I <sub>DDQ</sub> | V <sub>IL</sub> = 0, V <sub>IH</sub> = V <sub>DD</sub> , f <sub>CLK</sub> = 0              |                                                  |                        |                       |     | 15                    | μA    |
| V <sub>DD</sub> Supply Dynamic Current   | I <sub>DD</sub>  | V <sub>DD</sub> = +5V, V <sub>IL</sub> = 0, V <sub>IH</sub> = +5V, f <sub>CLK</sub> = 5MHz |                                                  |                        |                       |     | 4                     | mA    |
| V <sub>PP</sub> Supply Quiescent Current | I <sub>PPQ</sub> | All switches remain on or off, I <sub>COM</sub> (ON) = 5mA                                 |                                                  |                        |                       | 10  | 50                    | μA    |
| V <sub>PP</sub> Supply Dynamic Current   | I <sub>PP</sub>  | 50kHz output switching frequency with no load                                              | V <sub>PP</sub> = +40V, V <sub>NN</sub> = -160V  | T <sub>A</sub> = 0°C   |                       |     | 6.5                   | mA    |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +25°C |                       |     | 6.5                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +70°C |                       |     | 6.5                   |       |
|                                          |                  |                                                                                            | V <sub>PP</sub> = +100V, V <sub>NN</sub> = -100V | T <sub>A</sub> = 0°C   |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +25°C |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +70°C |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            | V <sub>PP</sub> = +160V, V <sub>NN</sub> = -40V  | T <sub>A</sub> = 0°C   |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +25°C |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +70°C |                       |     | 4.0                   |       |
| V <sub>NN</sub> Supply Quiescent Current | I <sub>NNQ</sub> | All switches remain on or off, I <sub>COM</sub> (ON) = 5mA                                 |                                                  |                        |                       | 10  | 50                    | μA    |
| V <sub>NN</sub> Supply Dynamic Current   | I <sub>NN</sub>  | 50kHz output switching frequency with no load                                              | V <sub>PP</sub> = +40V, V <sub>NN</sub> = -160V  | T <sub>A</sub> = 0°C   |                       |     | 6.5                   | mA    |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +25°C |                       |     | 6.5                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +70°C |                       |     | 6.5                   |       |
|                                          |                  |                                                                                            | V <sub>PP</sub> = +100V, V <sub>NN</sub> = -100V | T <sub>A</sub> = 0°C   |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +25°C |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +70°C |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            | V <sub>PP</sub> = +160V, V <sub>NN</sub> = -40V  | T <sub>A</sub> = 0°C   |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +25°C |                       |     | 4.0                   |       |
|                                          |                  |                                                                                            |                                                  | T <sub>A</sub> = +70°C |                       |     | 4.0                   |       |

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

## TIMING CHARACTERISTICS

( $V_{DD} = +2.7V$  to  $+13.2V$ ,  $V_{PP} = +40V$  to  $V_{NN} + 200V$ ,  $V_{NN} = -15V$  to  $-160V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 1)

| PARAMETER                                  | SYMBOL     | CONDITIONS                                                                 | MIN                          | TYP | MAX | UNITS   |
|--------------------------------------------|------------|----------------------------------------------------------------------------|------------------------------|-----|-----|---------|
| <b>ANALOG SWITCH</b>                       |            |                                                                            |                              |     |     |         |
| Turn-On Time                               | $t_{ON}$   | $V_{NO\_} = V_{PP} - 10V$ , $R_L = 10k\Omega$ , $V_{NN} = -40V$ to $-160V$ |                              |     | 5   | $\mu s$ |
| Turn-Off Time                              | $t_{OFF}$  | $V_{NO\_} = V_{PP} - 10V$ , $R_L = 10k\Omega$ , $V_{NN} = -40V$ to $-160V$ |                              |     | 5   | $\mu s$ |
| Output Switching Frequency                 | $f_{SW}$   | Duty cycle = 50%                                                           |                              |     | 50  | kHz     |
| Maximum $V_{COM\_}$ , $V_{NO\_}$ Slew Rate | $dV/dt$    | (Note 3)                                                                   | 20                           |     |     | V/ns    |
| <b>LOGIC TIMING</b> (Figure 1)             |            |                                                                            |                              |     |     |         |
| CLK Frequency                              | $f_{CLK}$  | Daisy chaining                                                             | $V_{DD} \geq +4.5V$          |     | 5   | MHz     |
|                                            |            |                                                                            | $V_{DD} \leq +4.5V$          |     | 2.5 |         |
|                                            |            | No daisy chaining                                                          | $V_{DD} \geq +4.5V$          |     | 10  |         |
|                                            |            |                                                                            | $V_{DD} < +4.5V$             |     | 4   |         |
| DIN to CLK Setup Time                      | $t_{DS}$   | $V_{DD} \geq +4.5V$                                                        | 15                           |     |     | ns      |
|                                            |            | $V_{DD} < +4.5V$                                                           | 40                           |     |     |         |
| DIN to CLK Hold Time                       | $t_{DH}$   | $V_{DD} \geq +4.5V$                                                        | 35                           |     |     | ns      |
|                                            |            | $V_{DD} < +4.5V$                                                           | 60                           |     |     |         |
| CLK to $\overline{LE}$ Setup Time          | $t_{CS}$   | $V_{DD} \geq +4.5V$                                                        | 150                          |     |     | ns      |
|                                            |            | $V_{DD} < +4.5V$                                                           | 300                          |     |     |         |
| $\overline{LE}$ Low-Pulse Width            | $t_{WL}$   | $V_{DD} \geq +4.5V$                                                        | 150                          |     |     | ns      |
|                                            |            | $V_{DD} < +4.5V$                                                           | 300                          |     |     |         |
| CLR High-Pulse Width                       | $t_{WC}$   | $V_{DD} \geq +4.5V$                                                        | 150                          |     |     | ns      |
|                                            |            | $V_{DD} < +4.5V$                                                           | 300                          |     |     |         |
| CLK Rise and Fall Times                    | $t_R, t_F$ | $V_{DD} \geq +4.5V$ (Note 3)                                               |                              |     | 1   | $\mu s$ |
|                                            |            | $V_{DD} < +4.5V$ (Note 3)                                                  |                              |     | 1   |         |
| CLK to DOUT Delay                          | $t_{DO}$   | $V_{DD} = +5V \pm 10\%$ ,<br>$C_L \leq 50pF$                               | $T_A = 0^\circ C$            | 55  | 150 | ns      |
|                                            |            |                                                                            | $T_A = +25^\circ C$          | 60  | 150 |         |
|                                            |            |                                                                            | $T_A = +70^\circ C$          | 70  | 150 |         |
|                                            |            | $V_{DD} = +3V \pm 10\%$ ,<br>$C_L \leq 50pF$                               | $T_A = T_{MIN}$ to $T_{MAX}$ | 70  | 280 |         |

**Note 1:** Specifications at  $0^\circ C$  are guaranteed by correlation and design. Electrical parameters are tested at worst case conditions.

**Note 2:** The analog signal input  $V_{COM\_}$  and  $V_{NO\_}$  must satisfy  $V_{NN} \leq (V_{COM\_}, V_{NO\_}) \leq V_{PP}$ , or remain unconnected during power-up and power-down.

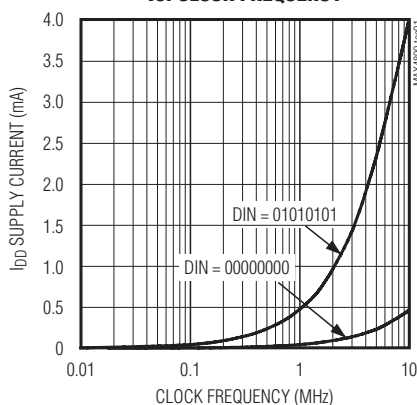
**Note 3:** Guaranteed by characterization; not production tested.

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

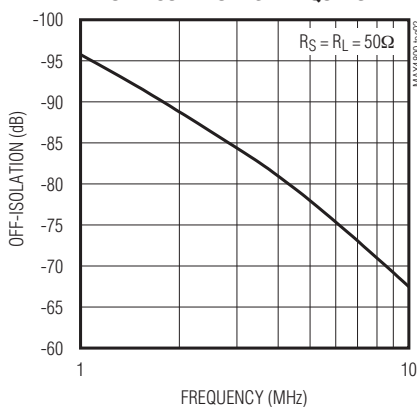
## Typical Operating Characteristics

( $V_{DD} = +5V$ ,  $V_{PP} = +100V$ ,  $V_{NN} = -100V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

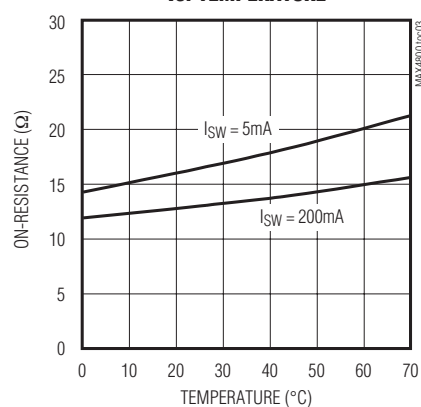
**$I_{DD}$  SUPPLY CURRENT  
vs. CLOCK FREQUENCY**



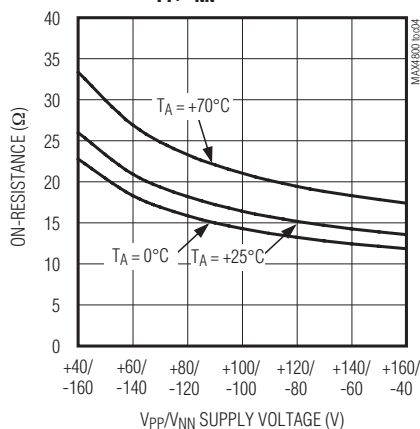
**OFF-ISOLATION vs. FREQUENCY**



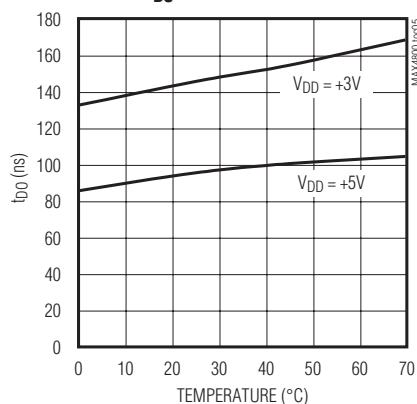
**ON-RESISTANCE  
vs. TEMPERATURE**



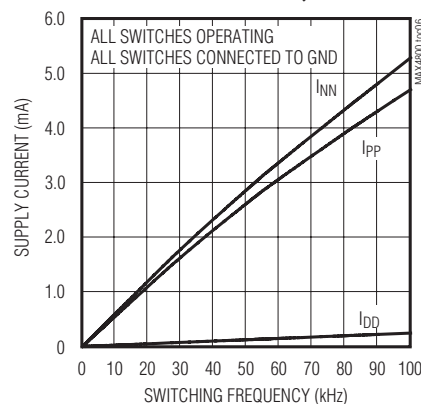
**ON-RESISTANCE  
vs.  $V_{PP}/V_{NN}$  SUPPLY VOLTAGE**



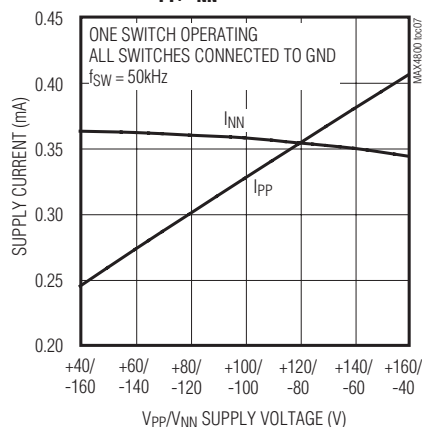
**$t_{PD}$  vs. TEMPERATURE**



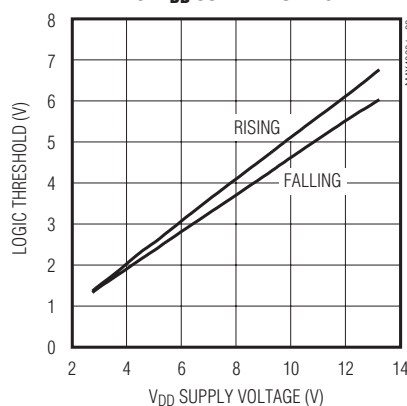
**SUPPLY CURRENT  
vs. SWITCHING FREQUENCY**



**SUPPLY CURRENT  
vs.  $V_{PP}/V_{NN}$  SUPPLY VOLTAGE**



**LOGIC THRESHOLD  
vs.  $V_{DD}$  SUPPLY VOLTAGE**



# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

## Pin Descriptions

| PIN                                                                                                     |                  |                 |                 | NAME            | FUNCTION                                                                                               |
|---------------------------------------------------------------------------------------------------------|------------------|-----------------|-----------------|-----------------|--------------------------------------------------------------------------------------------------------|
| MAX4800<br>TQFP                                                                                         | MAX4800<br>CSBGA | MAX4800<br>PLCC | MAX4801<br>PLCC |                 |                                                                                                        |
| 1                                                                                                       | E4               | 26              | 26              | COM5            | Analog Switch 5 – Common Terminal                                                                      |
| 2, 4, 6, 7, 9,<br>11, 13, 15,<br>17, 19, 21,<br>23, 26, 27,<br>30, 31, 32,<br>38, 40, 42,<br>44, 46, 48 | D6               | 9, 11, 15       | 11, 14, 15      | N.C.            | No Connection. Not connected internally.                                                               |
| 3                                                                                                       | E1               | 27              | 27              | COM4            | Analog Switch 4 – Common Terminal                                                                      |
| 5                                                                                                       | E3               | 28              | 28              | NO4             | Analog Switch 4 – Normally Open Terminal                                                               |
| 8                                                                                                       | D1               | 1               | 1               | COM3            | Analog Switch 3 – Common Terminal                                                                      |
| 10                                                                                                      | D3               | 2               | 2               | NO3             | Analog Switch 3 – Normally Open Terminal                                                               |
| 12                                                                                                      | D4               | 3               | 3               | COM2            | Analog Switch 2 – Common Terminal                                                                      |
| 14                                                                                                      | C3               | 4               | 4               | NO2             | Analog Switch 2 – Normally Open Terminal                                                               |
| 16                                                                                                      | C4               | 5               | 5               | COM1            | Analog Switch 1 – Common Terminal                                                                      |
| 18                                                                                                      | A4               | 6               | 6               | NO1             | Analog Switch 1 – Normally Open Terminal                                                               |
| 20                                                                                                      | C5               | 7               | 7               | COM0            | Analog Switch 0 – Common Terminal                                                                      |
| 22                                                                                                      | D5               | 8               | 8               | NO0             | Analog Switch 0 – Normally Open Terminal                                                               |
| 24                                                                                                      | C6               | 10              | 9               | V <sub>PP</sub> | Positive High-Voltage Supply. Bypass V <sub>PP</sub> to GND with a 0.1μF or greater ceramic capacitor. |
| 25                                                                                                      | C7               | 12              | 10              | V <sub>NN</sub> | Negative High-Voltage Supply. Bypass V <sub>NN</sub> to GND with a 0.1μF or greater ceramic capacitor. |
| 28                                                                                                      | D7               | 13              | 12              | GND             | Ground                                                                                                 |
| 29                                                                                                      | D9               | 14              | 13              | V <sub>DD</sub> | Digital-Supply Voltage. Bypass V <sub>DD</sub> to GND with a 0.1μF or greater ceramic capacitor.       |
| 33                                                                                                      | E9               | 16              | 16              | DIN             | Serial Data Input                                                                                      |
| 34                                                                                                      | E7               | 17              | 17              | CLK             | Serial Clock Input                                                                                     |
| 35                                                                                                      | E6               | 18              | 18              | $\overline{LE}$ | Latch Enable Input, Active Low                                                                         |
| 36                                                                                                      | F7               | 19              | 19              | CLR             | Latch Clear Input                                                                                      |
| 37                                                                                                      | F6               | 20              | 20              | DOUT            | Serial Data Output                                                                                     |
| 39                                                                                                      | E5               | 21              | 21              | COM7            | Analog Switch 7 – Common Terminal                                                                      |
| 41                                                                                                      | F5               | 22              | 22              | NO7             | Analog Switch 7 – Normally Open Terminal                                                               |
| 43                                                                                                      | F4               | 23              | 23              | COM6            | Analog Switch 6 – Common Terminal                                                                      |
| 45                                                                                                      | H4               | 24              | 24              | NO6             | Analog Switch 6 – Normally Open Terminal                                                               |
| 47                                                                                                      | F3               | 25              | 25              | NO5             | Analog Switch 5 – Normally Open Terminal                                                               |

MAX4800/MAX4801/MAX4802

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

## Pin Descriptions (continued)

| PIN                                                                                              |                  |                 | NAME                   | FUNCTION                                                                                               |
|--------------------------------------------------------------------------------------------------|------------------|-----------------|------------------------|--------------------------------------------------------------------------------------------------------|
| MAX4802<br>TQFP                                                                                  | MAX4802<br>CSBGA | MAX4802<br>PLCC |                        |                                                                                                        |
| 1                                                                                                | E4               | 26              | COM5                   | Analog Switch 5 – Common Terminal                                                                      |
| 2, 4, 6, 7, 9,<br>11, 13, 15, 17,<br>19, 21, 23, 26,<br>30, 31, 32, 38,<br>40, 42, 44, 46,<br>48 | —                | 9, 15           | N.C.                   | Not Connected Internally                                                                               |
| 3                                                                                                | E1               | 27              | COM4                   | Analog Switch 4 – Common Terminal                                                                      |
| 5                                                                                                | E3               | 28              | NO4                    | Analog Switch 4 – Normally Open Terminal                                                               |
| 8                                                                                                | D1               | 1               | COM3                   | Analog Switch 3 – Common Terminal                                                                      |
| 10                                                                                               | D3               | 2               | NO3                    | Analog Switch 3 – Normally Open Terminal                                                               |
| 12                                                                                               | D4               | 3               | COM2                   | Analog Switch 2 – Common Terminal                                                                      |
| 14                                                                                               | C3               | 4               | NO2                    | Analog Switch 2 – Normally Open Terminal                                                               |
| 16                                                                                               | C4               | 5               | COM1                   | Analog Switch 1 – Common Terminal                                                                      |
| 18                                                                                               | A4               | 6               | NO1                    | Analog Switch 1 – Normally Open Terminal                                                               |
| 20                                                                                               | C5               | 7               | COM0                   | Analog Switch 0 – Common Terminal                                                                      |
| 22                                                                                               | D5               | 8               | NO0                    | Analog Switch 0 – Normally Open Terminal                                                               |
| 24                                                                                               | C6               | 10              | V <sub>PP</sub>        | Positive High-Voltage Supply. Bypass V <sub>PP</sub> to GND with a 0.1μF or greater ceramic capacitor. |
| 25                                                                                               | C7               | 12              | V <sub>NN</sub>        | Negative High-Voltage Supply. Bypass V <sub>NN</sub> to GND with a 0.1μF or greater ceramic capacitor. |
| 27                                                                                               | D6               | 11              | RGND                   | Bleed Resistor Ground                                                                                  |
| 28                                                                                               | D7               | 13              | GND                    | Ground                                                                                                 |
| 29                                                                                               | D9               | 14              | V <sub>DD</sub>        | Digital-Supply Voltage. Bypass V <sub>DD</sub> to GND with a 0.1μF or greater ceramic capacitor.       |
| 33                                                                                               | E9               | 16              | DIN                    | Serial Data Input                                                                                      |
| 34                                                                                               | E7               | 17              | CLK                    | Serial Clock Input                                                                                     |
| 35                                                                                               | E6               | 18              | $\overline{\text{LE}}$ | Latch Enable Input, Active Low                                                                         |
| 36                                                                                               | F7               | 19              | CLR                    | Latch Clear Input                                                                                      |
| 37                                                                                               | F6               | 20              | DOUT                   | Serial Data Output                                                                                     |
| 39                                                                                               | E5               | 21              | COM7                   | Analog Switch 7 – Common Terminal                                                                      |
| 41                                                                                               | F5               | 22              | NO7                    | Analog Switch 7 – Normally Open Terminal                                                               |
| 43                                                                                               | F4               | 23              | COM6                   | Analog Switch 6 – Common Terminal                                                                      |
| 45                                                                                               | H4               | 24              | NO6                    | Analog Switch 6 – Normally Open Terminal                                                               |
| 47                                                                                               | F3               | 25              | NO5                    | Analog Switch 5 – Normally Open Terminal                                                               |



# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

MAX4800/MAX4801/MAX4802

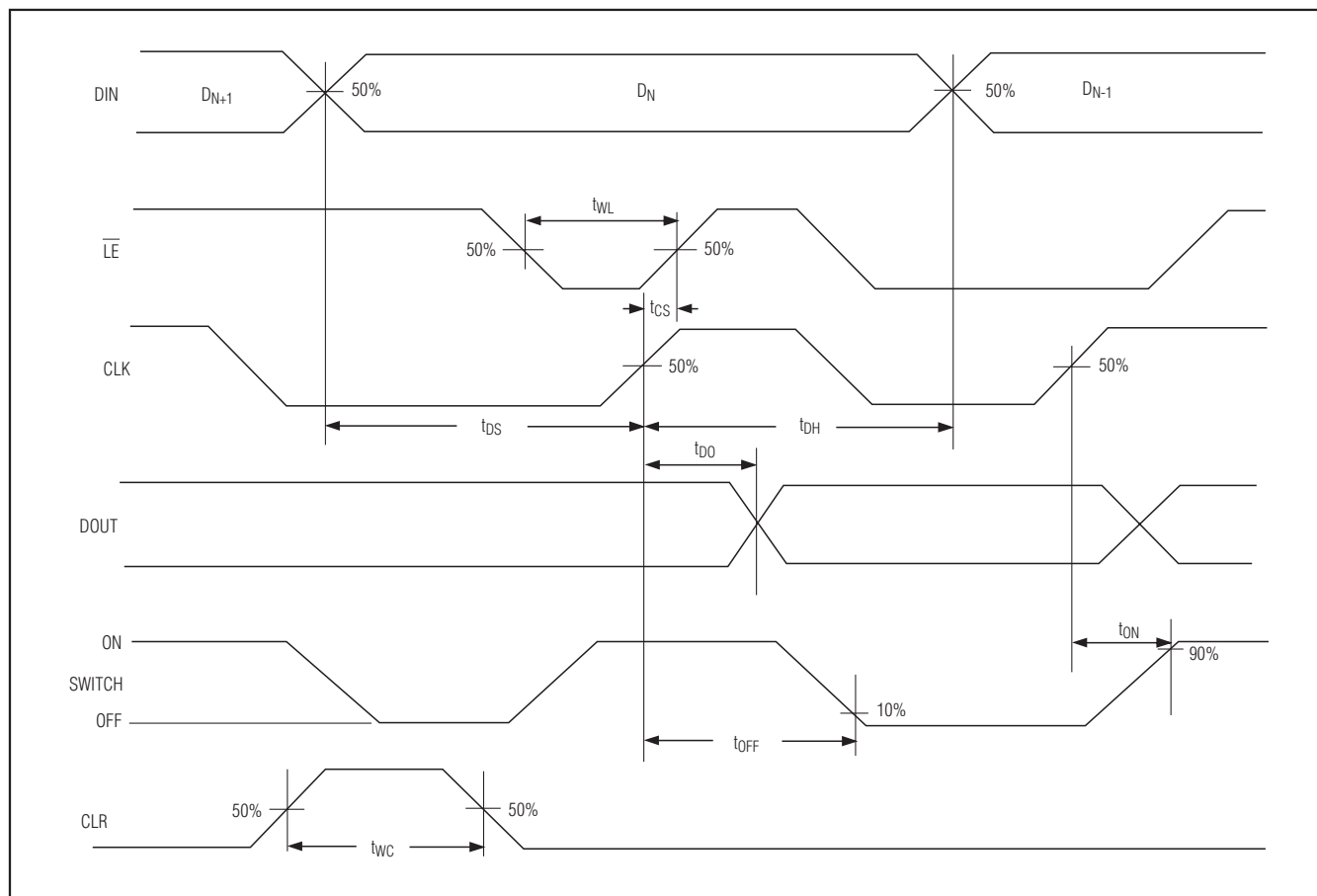


Figure 1. Serial Interface Timing

## Detailed Description

The MAX4800/MAX4801/MAX4802 provide high-voltage switching on eight channels for ultrasound imaging and printer applications. The devices utilize BCDMOS process technology to provide eight high-voltage low-charge-injection SPST switches, controlled by a digital interface. Data is clocked into an internal 8-bit shift register and retained by a programmable latch with enable and clear inputs. A power-on reset function ensures that all switches are open on power-up.

The MAX4800/MAX4801/MAX4802 operate with a wide range of high-voltage supplies including:  $V_{PP}/V_{NN} = +100V/-100V$ ,  $+185V/-15V$ , or  $+40V/-160V$ . The digital interface operates from a separate  $V_{DD}$  supply from  $+2.7V$  to  $+13.2V$ . Digital inputs DIN, CLK,  $\overline{LE}$ , and CLR are  $+13.2V$  tolerant, independent of the  $V_{DD}$  supply voltage. The MAX4802 provides integrated  $35k\Omega$  bleed

resistors on each switch terminal to discharge capacitive loads.

The MAX4800 and MAX4802 are drop-in replacements for the Supertex HV20220 and HV232, respectively. The MAX4801 is a drop-in replacement for the Supertex HV20320.

## Analog Switch

The MAX4800/MAX4801/MAX4802 allow a peak-to-peak analog signal range from  $V_{NN} + 10V$  to  $V_{PP} - 10V$ . Analog switch inputs must be unconnected, or satisfy  $V_{NN} \leq (V_{COM-}, V_{NO-}) \leq V_{PP}$  during power-up and power-down.

## High-Voltage Supplies

The MAX4800/MAX4801/MAX4802 allow a wide range of high-voltage supplies. The devices operate with  $V_{NN}$  from  $-160V$  to  $-15V$  and  $V_{PP}$  from  $+40V$  to  $V_{NN} + 200V$ .

## Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

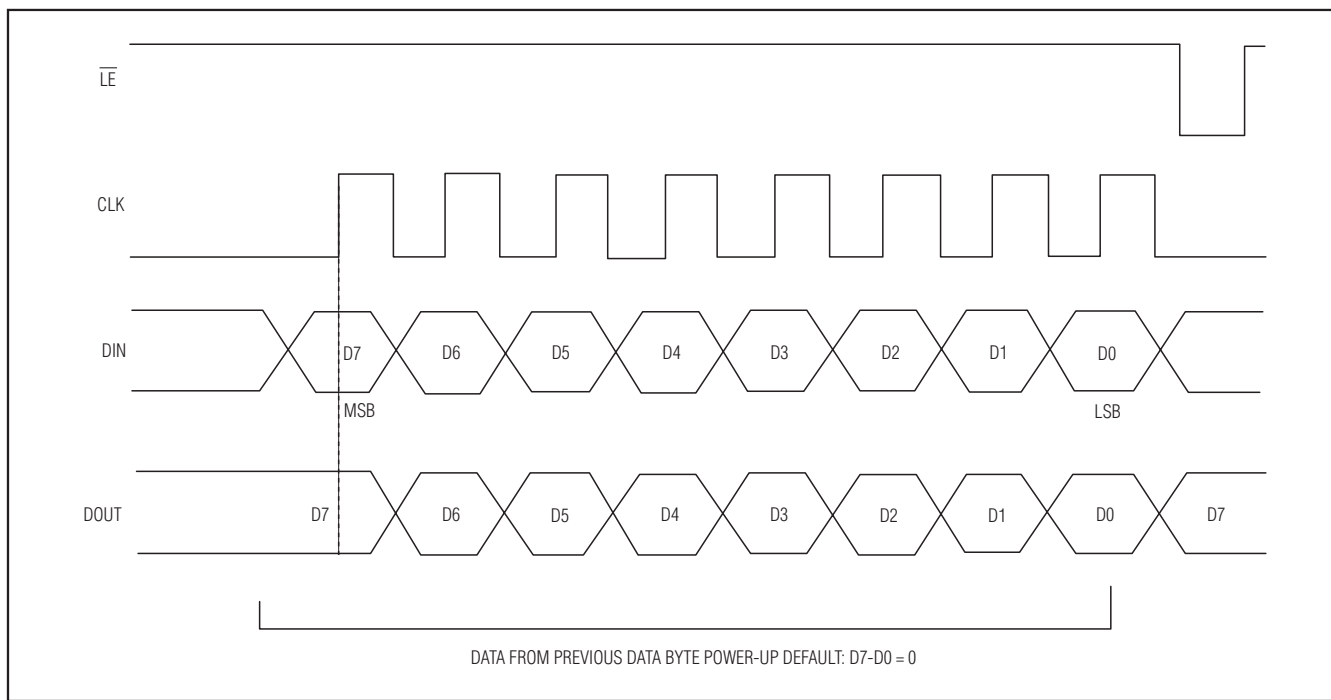


Figure 2. Latch Enable Interface Timing

When  $V_{NN}$  is connected to GND (single-supply applications), the devices operate with  $V_{PP}$  up to +200V. The  $V_{PP}$  and  $V_{NN}$  high-voltage supplies are not required to be symmetrical, but the voltage difference  $V_{PP} - V_{NN}$  must not exceed 200V.

### Bleed Resistors (MAX4802)

The MAX4802 features integrated 35k $\Omega$  bleed resistors to discharge capacitive loads such as piezoelectric transducers. Each analog switch terminal is connected to RGND with a bleed resistor.

### Serial Interface

The MAX4800/MAX4801/MAX4802 are controlled by a serial interface with an 8-bit serial shift register and transparent latch. Each of the eight data bits controls a single analog switch (see Table 1). Data on DIN is clocked with the most significant bit (MSB) first into the shift register on the rising edge of CLK. Data is clocked out of the shift register onto DOUT on the rising edge of CLK. DOUT reflects the status of DIN, delayed by eight clock cycles (see Figures 1 and 2).

### Latch Enable ( $\overline{LE}$ )

Drive  $\overline{LE}$  logic-low to change the contents of the latch and update the state of the high-voltage switches (Figure 2). Drive  $\overline{LE}$  logic-high to freeze the contents of the latch and prevent changes to the switch states. To reduce noise due to clock feedthrough, drive  $\overline{LE}$  logic-high while data is clocked into the shift register. After the data shift register is loaded with valid data, pulse  $\overline{LE}$  logic-low to load the contents of the shift register into the latch.

### Latch Clear (CLR)

The MAX4800/MAX4801/MAX4802 feature a latch clear input. Drive CLR logic-high to reset the contents of the latch to zero and open all switches. CLR does not affect the contents of the data shift register. Pulse  $\overline{LE}$  logic-low to reload the contents of the shift register into the latch.

### Power-On Reset

The MAX4800/MAX4801/MAX4802 feature a power-on reset circuit to ensure all switches are open at power-on. The internal 8-bit serial shift register and latch are set to zero on power-up.

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

**Table 1. Serial Interface Programming**

| DATA BITS |    |    |    |    |    |    |          | CONTROL BITS    |     | FUNCTION            |     |     |     |     |     |     |     |
|-----------|----|----|----|----|----|----|----------|-----------------|-----|---------------------|-----|-----|-----|-----|-----|-----|-----|
| D0 (LSB)  | D1 | D2 | D3 | D4 | D5 | D6 | D7 (MSB) | $\overline{LE}$ | CLR | SW0                 | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | SW7 |
| L         |    |    |    |    |    |    |          | L               | L   | OFF                 |     |     |     |     |     |     |     |
| H         |    |    |    |    |    |    |          | L               | L   | ON                  |     |     |     |     |     |     |     |
|           | L  |    |    |    |    |    |          | L               | L   |                     | OFF |     |     |     |     |     |     |
|           | H  |    |    |    |    |    |          | L               | L   |                     | ON  |     |     |     |     |     |     |
|           |    | L  |    |    |    |    |          | L               | L   |                     |     | OFF |     |     |     |     |     |
|           |    | H  |    |    |    |    |          | L               | L   |                     |     | ON  |     |     |     |     |     |
|           |    |    | L  |    |    |    |          | L               | L   |                     |     |     | OFF |     |     |     |     |
|           |    |    | H  |    |    |    |          | L               | L   |                     |     |     | ON  |     |     |     |     |
|           |    |    |    | L  |    |    |          | L               | L   |                     |     |     |     | OFF |     |     |     |
|           |    |    |    | H  |    |    |          | L               | L   |                     |     |     |     | ON  |     |     |     |
|           |    |    |    |    | L  |    |          | L               | L   |                     |     |     |     |     | OFF |     |     |
|           |    |    |    |    | H  |    |          | L               | L   |                     |     |     |     |     | ON  |     |     |
|           |    |    |    |    |    | L  |          | L               | L   |                     |     |     |     |     |     | OFF |     |
|           |    |    |    |    |    | H  |          | L               | L   |                     |     |     |     |     |     | ON  |     |
|           |    |    |    |    |    |    | L        | L               | L   |                     |     |     |     |     |     |     | OFF |
|           |    |    |    |    |    |    | H        | L               | L   |                     |     |     |     |     |     |     | ON  |
| X         | X  | X  | X  | X  | X  | X  | X        | H               | L   | HOLD PREVIOUS STATE |     |     |     |     |     |     |     |
| X         | X  | X  | X  | X  | X  | X  | X        | X               | H   | OFF                 | OFF | OFF | OFF | OFF | OFF | OFF | OFF |

X = Don't Care

## Applications Information

### Logic Levels

The MAX4800/MAX4801/MAX4802 digital interface inputs CLK, DIN,  $\overline{LE}$ , and CLR are tolerant of up to +13.2V, independent of the V<sub>DD</sub> supply voltage, allowing compatibility with higher voltage controllers.

### Daisy Chaining Multiple Devices

Digital output DOUT is provided to allow the connection of multiple MAX4800/MAX4801/MAX4802 devices by daisy chaining (Figure 3). Connect each DOUT to the DIN of the subsequent device in the chain. Connect CLK,  $\overline{LE}$ , and CLR inputs of all devices, and drive  $\overline{LE}$  logic-low to update all devices simultaneously. Drive CLR high to open all the switches simultaneously. Additional shift registers may be included anywhere in series with the MAX4800/MAX4801/MAX4802 data chain.

### Supply Sequencing and Bypassing

The MAX4800/MAX4801/MAX4802 do not require special sequencing of the V<sub>DD</sub>, V<sub>PP</sub>, and V<sub>NN</sub> supply voltages; however, analog switch inputs must be unconnected, or satisfy  $V_{NN} \leq (V_{COM\_}, V_{NO\_}) \leq V_{PP}$  during power-up and power-down. Bypass V<sub>DD</sub>, V<sub>NN</sub>, and V<sub>PP</sub> to GND with a 0.1μF ceramic capacitor as close to the device as possible.

## Chip Information

PROCESS: BCDMOS

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

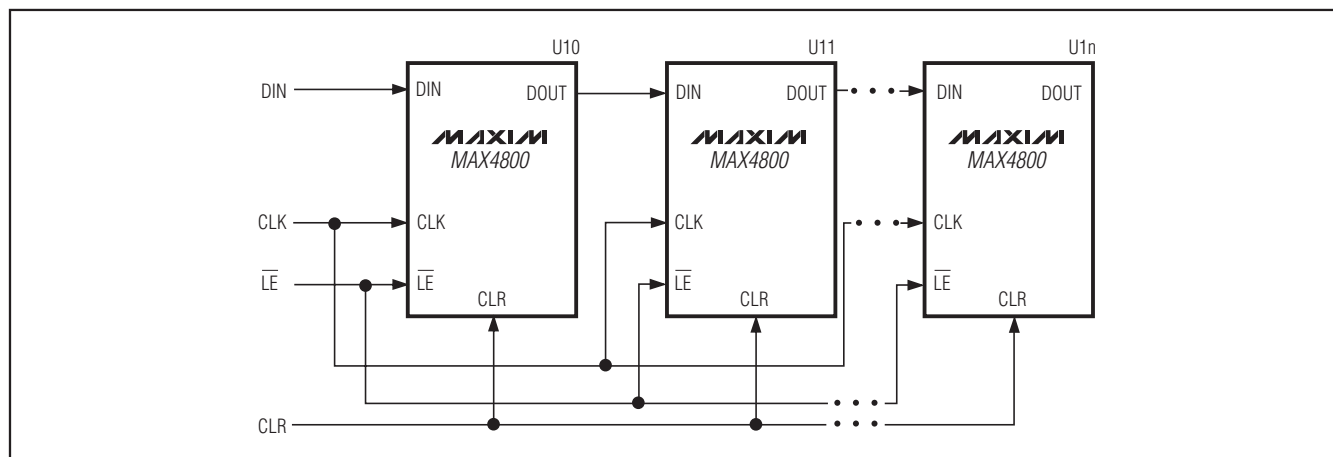
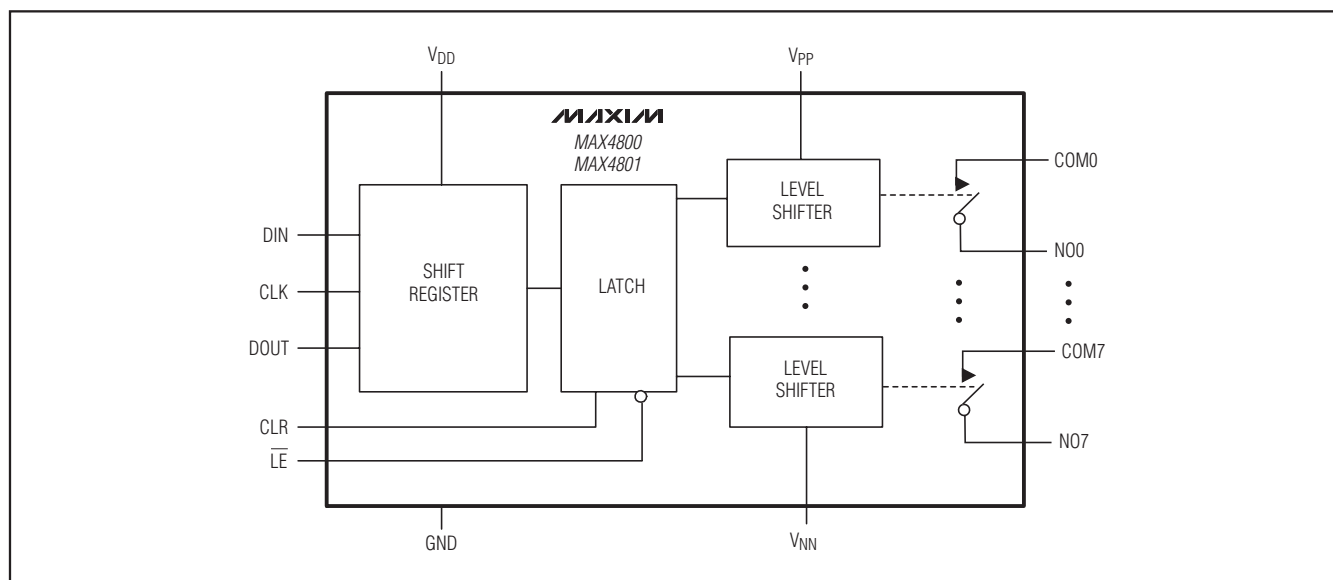


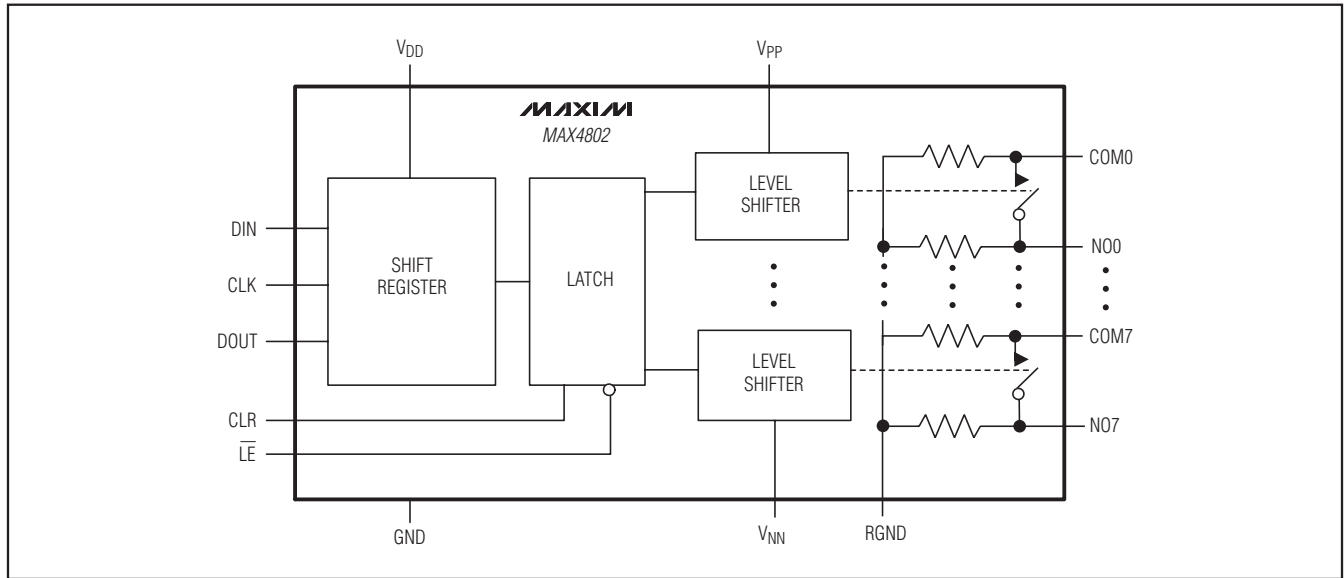
Figure 3. Interfacing Multiple Devices by Daisy-Chaining

## Functional Diagrams



# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

## Functional Diagrams (continued)

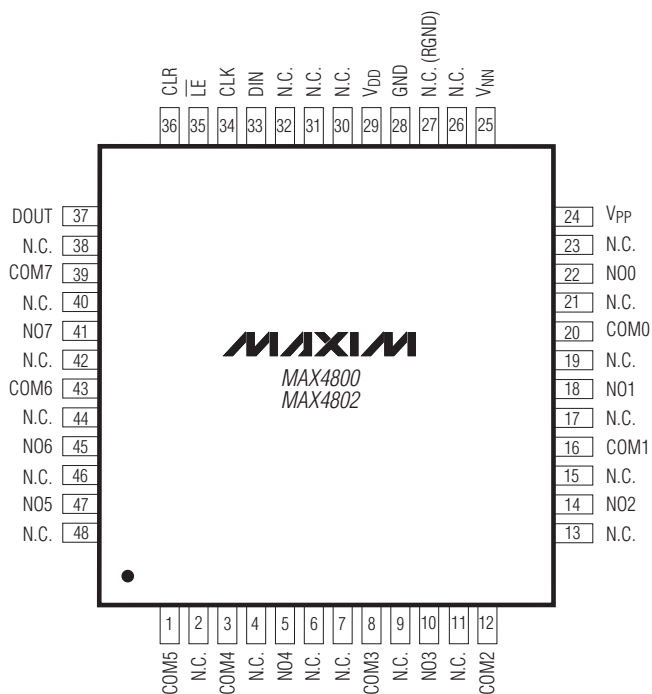


MAX4800/MAX4801/MAX4802

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

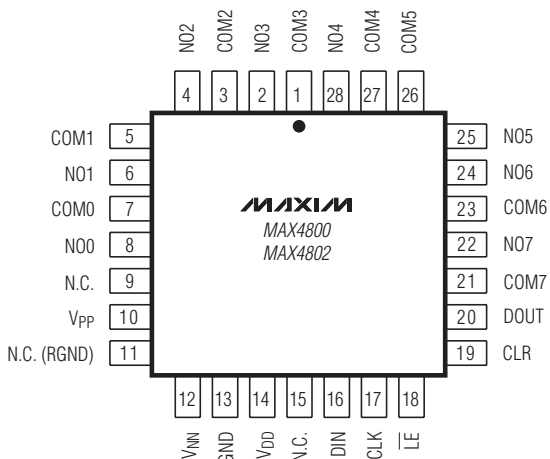
## Pin Configurations

TOP VIEW



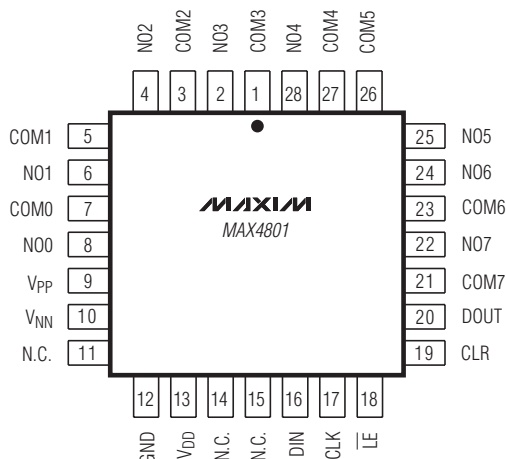
TQFP  
7mm x 7mm

(MAX4802 ONLY)



PLCC

(MAX4802 ONLY)

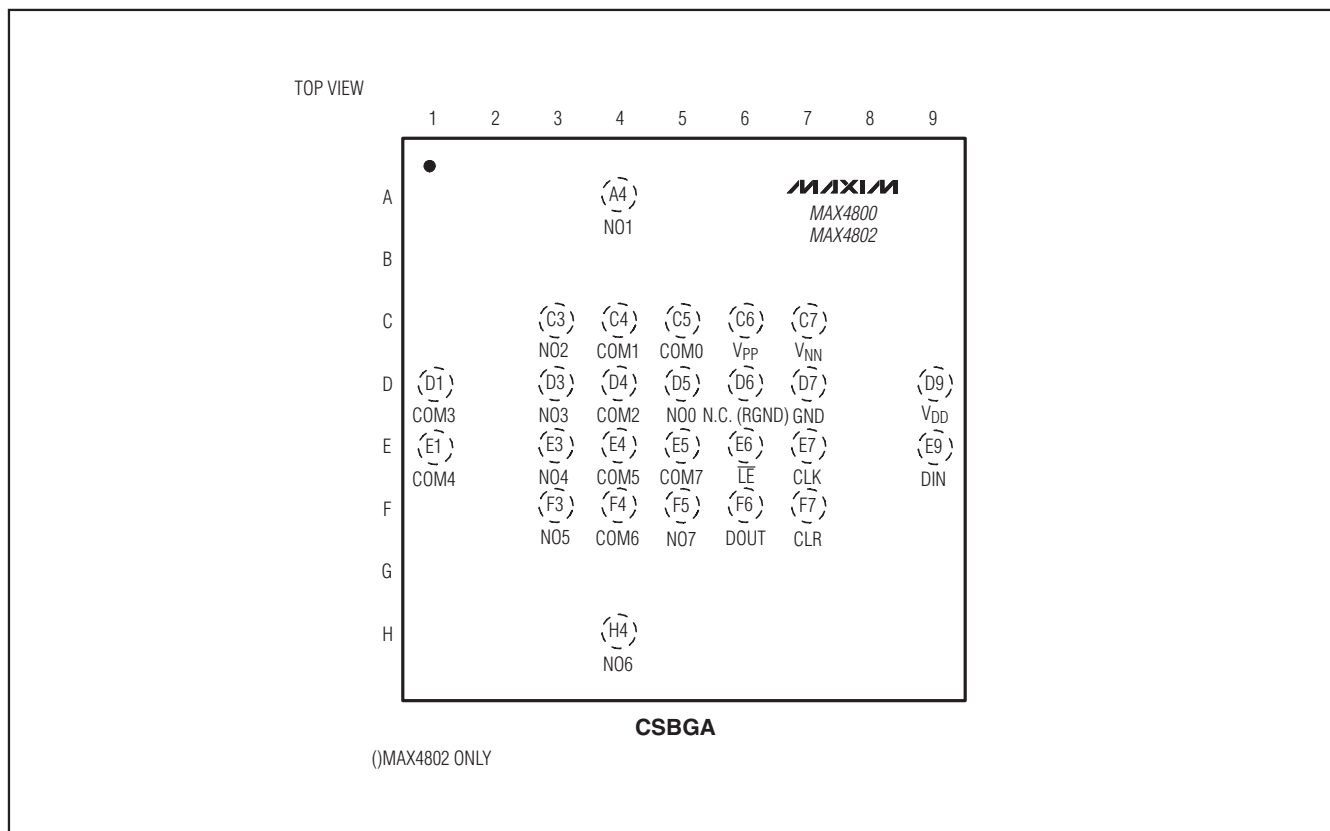


PLCC

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

## Pin Configurations (continued)

MAX4800/MAX4801/MAX4802



## Package Information

For the latest package outline information and land patterns, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | DOCUMENT NO.            |
|--------------|--------------|-------------------------|
| 28 PLCC      | Q28-4        | <a href="#">21-0049</a> |
| 26 CSBGA     | X07265-1     | <a href="#">21-0158</a> |
| 48 TQFP      | C48-6        | <a href="#">21-0054</a> |

# Low-Charge Injection, 8-Channel, High-Voltage Analog Switches

## Revision History

| REVISION<br>NUMBER | REVISION<br>DATE | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                            | PAGES<br>CHANGED               |
|--------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 0                  | 8/06             | Initial release.                                                                                                                                                                                                                                                                                                                                                                                       | —                              |
| 1                  | 3/07             | <ul style="list-style-type: none"><li>• Updated “Second Source” column and revised two package codes in the <i>Ordering Information/Selector Guide</i> section.</li><li>• Updated the pin numbers of the MAX4802 TQFN in the <i>Pin Descriptions</i> column. Replaced the TQFN <i>Pin Configurations</i>.</li><li>• Added package drawing 21-0158 to the <i>Package Information</i> section.</li></ul> | 1, 7, 8, 14, 18, 19,<br>20, 21 |
| 2                  | 5/09             | Deleted TQFN from the <i>Ordering Information/Selector Guide</i> , <i>Pin Descriptions</i> , <i>Pin Configurations</i> , and <i>Package Information</i> sections.                                                                                                                                                                                                                                      | 1, 7, 8, 14, 20, 21            |

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

16 **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600**