

## MAX4908/MAX4909/ MAX4930/MAX4932

## Dual 3:1 Clickless Audio Multiplexers with Negative-Signal Handling

### General Description

The MAX4908/MAX4909/MAX4930/MAX4932 dual 3:1 clickless audio multiplexers feature negative-signal capability that allows signals as low as  $V_{CC} - 5.5V$  to pass through without distortion. These analog multiplexers have a low on-resistance ( $0.38\Omega$ ), low supply current, and operate from a single +1.8V to +5.5V supply.

The MAX4908 has shunt resistors on all input terminals, and the MAX4909 has shunt resistors on all input terminals except X0 and Y0. The MAX4930 has shunt resistors only on the X2 and Y2 terminals, and the MAX4932 has no shunt resistors. The shunt resistor feature reduces click-and-pop sounds by automatically discharging the capacitance at the input terminal when they are not connected. A break-before-make feature further reduces popping.

The MAX4908/MAX4909/MAX4930/MAX4932 use two digital control inputs CB1 and CB2 to switch between signals. The digital control inputs can accept up to +5.5V independent of the supply voltage.

The MAX4908/MAX4909/MAX4930/MAX4932 are available in 12-bump wafer-level package (WLP) and 14-pin TDFN-EP package and operate over the  $-40^{\circ}C$  to  $+85^{\circ}C$  extended temperature range.

### Applications

- Cell Phones
- PDAs and Handheld Devices
- Notebook Computers
- MP3 Players

### Benefits and Features

- Distortion-Free Negative Signal Throughput Down to  $V_{CC} - 5.5V$
- Internal Shunt Resistors Reduce Click-and-Pop Sounds
- High PSRR Reduces Supply Noise
- Low On-Resistance:  $0.38\Omega$  (typ)
- Channel-to-Channel Matching:  $0.1\Omega$  (max)
- On-Resistance Flatness:  $0.35\Omega$  (max)
- Single +1.8V to +5.5V Supply Voltage
- $-70dB$  (typ) Crosstalk (20kHz)
- $-80dB$  (typ) Off-Isolation (20kHz)
- 0.02% (typ) Total Harmonic Distortion
- 50nA Leakage Current
- 50nA Supply Current

### Absolute Maximum Ratings

(All voltages referenced to GND.)

|   |  |
|---|--|
| V <sub>CC</sub> , CB <sub>-</sub> .....   | -0.3V to +6.0V                                     |
| X, X <sub>-</sub> , Y, Y <sub>-</sub> .....   | (V <sub>CC</sub> - 6V) to (V <sub>CC</sub> + 0.3V) |
| Continuous Current X, X <sub>-</sub> , Y, Y <sub>-</sub> .....                              | ±300mA   |
| Peak Current X, X <sub>-</sub> , Y, Y <sub>-</sub> (pulsed at 1ms,<br>50% Duty Cycle) ..... | ±400mA   |
| Peak Current X, X <sub>-</sub> , Y, Y <sub>-</sub> (pulsed at 1ms,<br>10% Duty Cycle) ..... | ±500mA   |

|   |                 |
|---|-----------------|
| Continuous Power Dissipation (T <sub>A</sub> = +70°C)                   |                 |
| 12-Bump WLP (derate 8.5mW/°C above +70°C) .....                         | 678mW           |
| 14-Pin TDFN, Single-Layer Board<br>(derate 18.5mW/°C above +70°C) ..... | 1482mW          |
| 14-Pin TDFN, Multilayer Board<br>(derate 24.4mW/°C above +70°C) .....   | 1951mW          |
| Operating Temperature Range .....                                       | -40°C to +85°C  |
| Junction Temperature .....  | +150°C          |
| Storage Temperature Range .....   | -65°C to +150°C |
| Lead Temperature (soldering, 10s) .....                                 | +300°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>CC</sub> = +2.7V to +5.5V, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V<sub>CC</sub> = +3.0V, T<sub>A</sub> = +25°C.) (Note 1)

| PARAMETER   | SYMBOL   | CONDITIONS  | MIN   | TYP  | MAX             | UNITS |
|---|--|---|---|------|-----------------|-------|
| <b>POWER SUPPLY</b>                                   |  |   |   |      |                 |       |
| Supply Voltage  | V <sub>CC</sub>  |   | 1.8   |      | 5.5             | V     |
| Supply Current  | I <sub>CC</sub>  | V <sub>CC</sub> = +5.5V, V <sub>CB-</sub> = 0V or V <sub>CC</sub>   |   | 0.05 | 2               | μA    |
|   |  | V <sub>CC</sub> = +2.7V, V <sub>CB-</sub> = +0.5V or +1.4V  |   |      | 4               |       |
|   |  | V <sub>CC</sub> = +5.5V, V <sub>CB-</sub> = +0.5V or +1.4V  |   |      | 8               |       |
| <b>ANALOG SWITCH</b>                                  |  |   |   |      |                 |       |
| Analog Signal Range (Note 2)                          | V <sub>X-</sub> , V <sub>Y-</sub> ,<br>V <sub>X</sub> , V <sub>Y</sub> |   | V <sub>CC</sub> -<br>5.5V                             |      | V <sub>CC</sub> | V     |
| On-Resistance (Note 3)                                | R <sub>ON</sub>  | V <sub>CC</sub> = +2.7V; V <sub>X-</sub> = V <sub>Y-</sub> =<br>V <sub>CC</sub> - 5.5V; -1V, 0V, +1V, +2V,<br>V <sub>CC</sub> ; I <sub>X-</sub> = I <sub>Y-</sub> = 100mA         | T <sub>A</sub> = +25°C                                | 0.38 | 0.75            | Ω     |
|   |  |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      | 0.8             |       |
| On-Resistance Match Between Channels (Notes 3 and 4)  | ΔR <sub>ON</sub>   | Between X0 and Y0, X1 and Y1, X2 and Y2;<br>V <sub>CC</sub> = +2.7V; V <sub>X-</sub> or V <sub>Y-</sub> = 0V; I <sub>X-</sub> = I <sub>Y-</sub> = 100mA                           |   |      | 0.1             | Ω     |
| On-Resistance Flatness (Notes 3 and 5)                | R <sub>FLAT</sub>  | V <sub>CC</sub> = +2.7V; V <sub>X-</sub> = V <sub>Y-</sub> = V <sub>CC</sub> - 5.5V,<br>-1V, 0, +1V, +2V, V <sub>CC</sub> ; I <sub>X-</sub> = I <sub>Y-</sub> = 100mA             |   |      | 0.35            | Ω     |
| Shunt Switch Resistance                               | R <sub>SH</sub>  |   | 2   | 3.8  | 6               | kΩ    |
| X0, Y0 Off-Leakage Current (MAX4909/MAX4930/MAX4932)  | I <sub>L(OFF)</sub>  | V <sub>CC</sub> = +2.7V, switch open,<br>V <sub>X0</sub> or V <sub>Y0</sub> = -2.5V or +2.5V,<br>V <sub>X</sub> or V <sub>Y</sub> = +2.5V or -2.5V                                | T <sub>A</sub> = +25°C                                | -50  | +50             | nA    |
|   |  |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | -200 | +200            |       |
|   |  |   | T <sub>A</sub> = +25°C                                | -50  | +50             |       |
| X1, Y1 Off-Leakage Current (MAX4930/MAX4932)          | I <sub>L(OFF)</sub>  | V <sub>CC</sub> = +2.7V, switch open,<br>V <sub>X1</sub> or V <sub>Y1</sub> = -2.5V or +2.5V,<br>V <sub>X</sub> or V <sub>Y</sub> = +2.5V or -2.5V                                | T <sub>A</sub> = +25°C                                | -50  | +50             | nA    |
| T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |  |   | -200  | +200 |                 |       |
| X2, Y2 Off-Leakage Current (MAX4932)                  | I <sub>L(OFF)</sub>  | V <sub>CC</sub> = +2.7V, switch open,<br>V <sub>X2</sub> or V <sub>Y2</sub> = -2.5V or +2.5V,<br>V <sub>X</sub> or V <sub>Y</sub> = +2.5V or -2.5V                                | T <sub>A</sub> = +25°C                                | -50  | +50             | nA    |
| T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |  |   | -200  | +200 |                 |       |
| X, Y On-Leakage Current                               | I <sub>L(ON)</sub>   | V <sub>CC</sub> = +2.7V, switch closed,<br>V <sub>X0</sub> or V <sub>Y0</sub> = -2.5V or +2.5V<br>or unconnected, V <sub>X</sub> = V <sub>Y</sub> = -2.5V<br>or +2.5V or floating | T <sub>A</sub> = +25°C                                | -100 | +100            | nA    |
|   |  |   | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | -300 | +300            |       |

### Electrical Characteristics (continued)

( $V_{CC} = +2.7V$  to  $+5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CC} = +3.0V$ ,  $T_A = +25^{\circ}C$ .) (Note 1)

| PARAMETER                                   | SYMBOL                       | CONDITIONS  | MIN | TYP  | MAX | UNITS   |
|---|------------------------------|---|-----|------|-----|---------|
| <b>DYNAMIC CHARACTERISTICS</b>              |                              |   |     |      |     |         |
| Turn-On Time                                | $t_{ON}$                     | $V_{CC} = +2.7V$ , $CB_{-} =$ low to high, $R_L = 50\Omega$ , $C_L = 5pF$ , Figure 2                |     | 1.0  |     | $\mu s$ |
| Turn-Off Time                               | $t_{OFF}$                    | $V_{CC} = +2.7V$ , $CB_{-} =$ high to low, $R_L = 50\Omega$ , $C_L = 5pF$ , Figure 2                |     | 1.0  |     | $\mu s$ |
| Break-Before-Make Delay Time                | $t_D$                        | $V_{CC} = +2.7V$ , $CB_{-} =$ low to high or high to low, $R_L = 50\Omega$ , $C_L = 5pF$ , Figure 3 | 1.0 | 15   |     | ns      |
| Charge Injection                            | Q                            | $V_X = V_Y = 0V$ , $R_{GEN} = 0\Omega$ , $C_L = 1nF$ , Figure 4                                     |     | 300  |     | pC      |
| Power-Supply Rejection Ratio                | PSRR                         | $f_{SW} = 20kHz$ , $V_X$ or $V_Y = 1V_{RMS}$ , $R_L = 50\Omega$ , $C_L = 5pF$                       |     | 60   |     | dB      |
| Off-Isolation                               | $V_{ISO}$                    | $f_{SW} = 20kHz$ , $V_X = V_Y = 1V_{RMS}$ , $R_L = 50\Omega$ , Figure 5 (Note 6)                    |     | -80  |     | dB      |
| Crosstalk                                   | $V_{CT}$                     | $f_{SW} = 20kHz$ , $V_X$ or $V_Y = 1V_{RMS}$ , $R_L = 50\Omega$ , Figure 5                          |     | -70  |     | dB      |
| Total Harmonic Distortion                   | THD                          | $f_{SW} = 20Hz$ to $20kHz$ , $V_X$ or $V_Y = 0.5V_{P-P}$ , $R_L = 50\Omega$ , DC bias = 0           |     | 0.02 |     | %       |
| X, Y Off-Capacitance                        | $C_{X(OFF)}$<br>$C_{Y(OFF)}$ | $f_{SW} = 1MHz$ , $V_X$ or $V_Y = 0.5V_{P-P}$ , DC bias = 0, Figure 6                               |     | 200  |     | pF      |
| X, Y On-Capacitance                         | $C_{X(ON)}$<br>$C_{Y(ON)}$   | $f_{SW} = 1MHz$ , $V_X$ or $V_Y = 0.5V_{P-P}$ , DC bias = 0, Figure 6                               |     | 450  |     | pF      |
| <b>DIGITAL INPUTS (<math>CB_{-}</math>)</b> |                              |   |     |      |     |         |
| Input Logic-High                            | $V_{IH}$                     |   | 1.4 |      |     | V       |
| Input Logic-Low                             | $V_{IL}$                     |   |     |      | 0.5 | V       |
| Input Leakage Current                       | $I_{CB}$                     | $V_{CB_{-}} = 0V$ or $V_{CC}$   | -1  |      | +1  | $\mu A$ |

**Note 1:** All parameters are production tested at  $T_A = +25^{\circ}C$  and guaranteed by design over the specified temperature range.

**Note 2:** Signals on X, Y,  $X_{-}$ , or  $Y_{-}$  exceeding  $V_{CC}$  are clamped by internal diodes. Limit forward-diode current to maximum current rating.

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

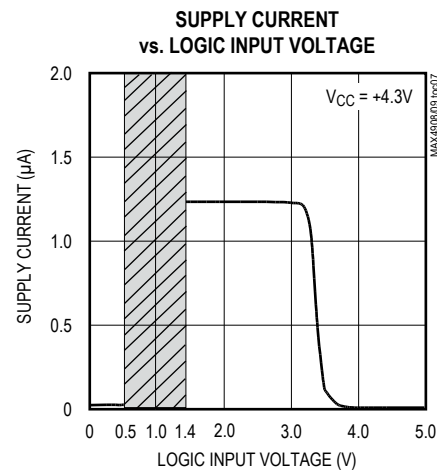
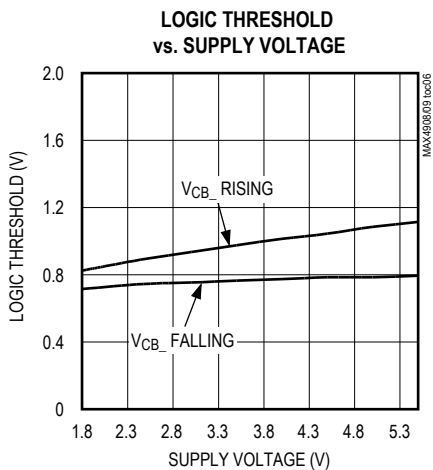
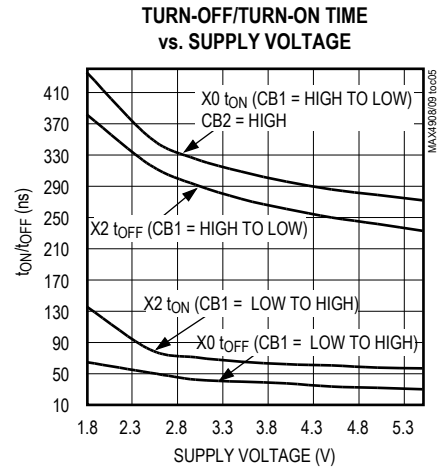
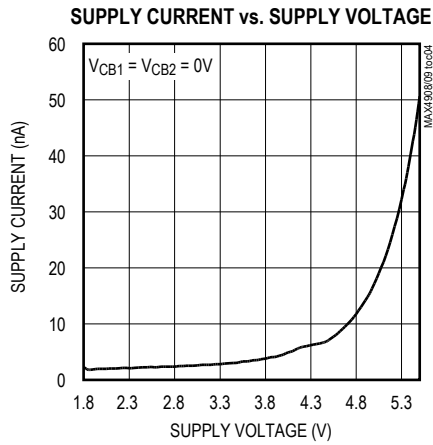
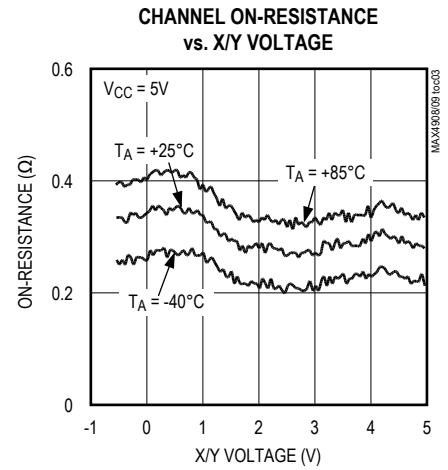
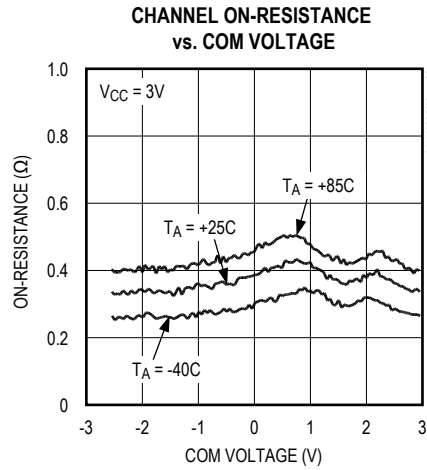
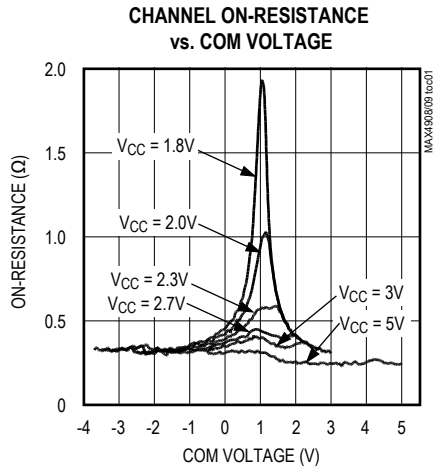
**Note 4:**  $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$ .

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

**Note 6:** X Off-Isolation =  $20\log_{10} [V_X / V_{X_{-}}]$ ,  $V_X$  = output,  $V_{X_{-}}$  = input to off switch. Y Off-Isolation =  $20\log_{10} [V_Y / V_{Y_{-}}]$ ,  $V_Y$  = output,  $V_{Y_{-}}$  = input to off switch.

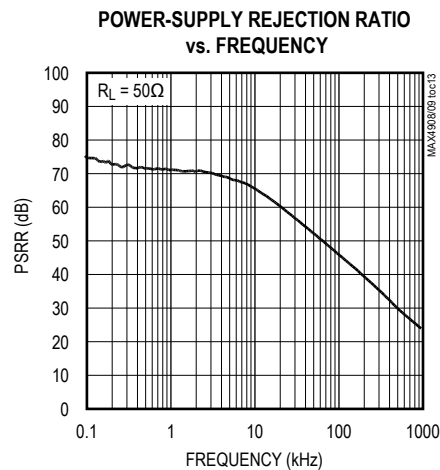
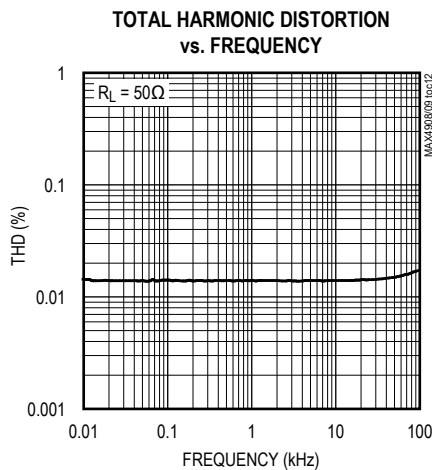
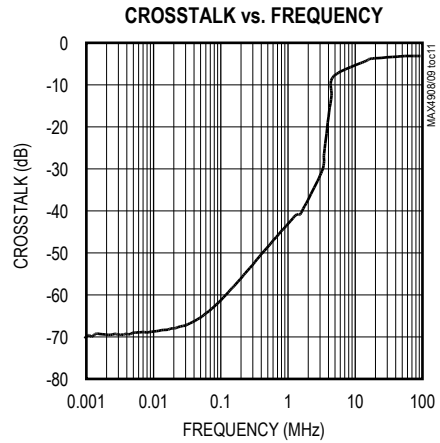
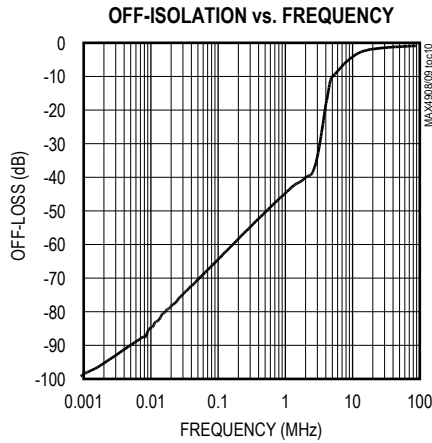
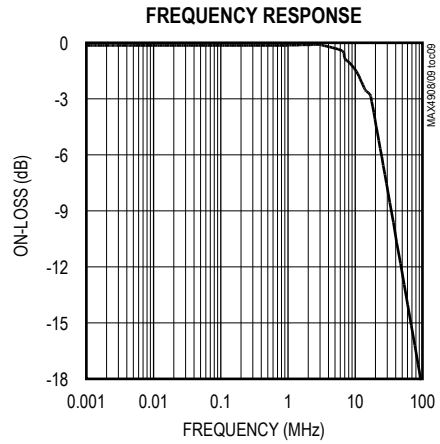
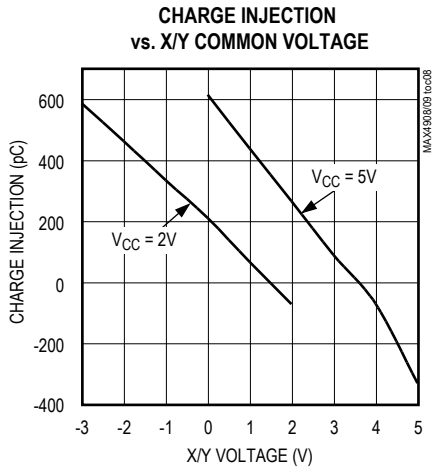
Typical Operating Characteristics

( $V_{CC} = 3.0V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

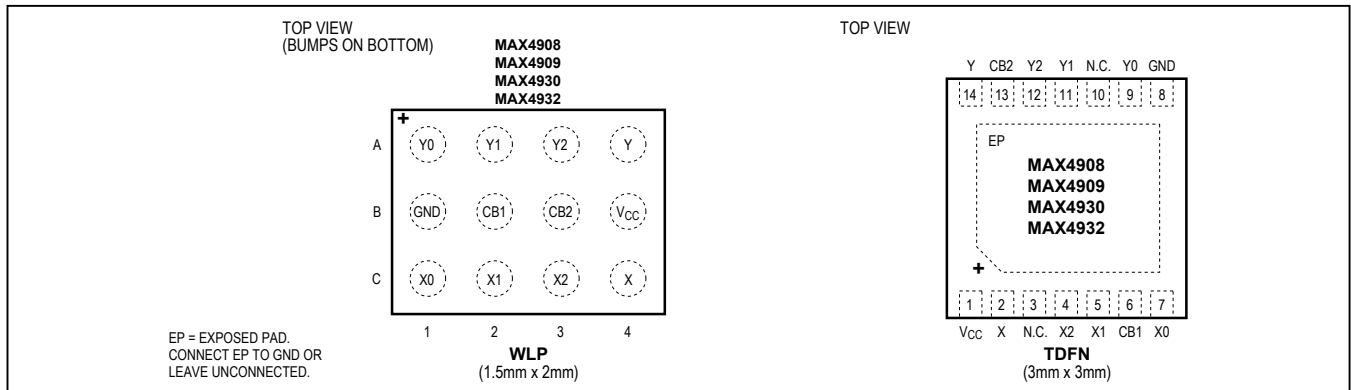


Typical Operating Characteristics (continued)

( $V_{CC} = 3.0V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



### Bump Configurations



### Bump Descriptions

| PIN     |     | NAME            | FUNCTION   |
|---------|-----|-----------------|--|
| TDFN-EP | WLP |                 |  |
| 1       | B4  | V <sub>CC</sub> | Positive Supply Voltage Input                        |
| 2       | C4  | X               | Analog Output X Common Terminal                      |
| 3,10    | —   | N.C.            | No Connection. Not internally connected.             |
| 4       | C3  | X2              | Analog Input X2                                      |
| 5       | C2  | X1              | Analog Input X1                                      |
| 6       | B2  | CB1             | Digital Control Input 1                              |
| 7       | C1  | X0              | Analog Input X0                                      |
| 8       | B1  | GND             | Ground   |
| 9       | A1  | Y0              | Analog Input Y0                                      |
| 11      | A2  | Y1              | Analog Input Y1                                      |
| 12      | A3  | Y2              | Analog Input Y2                                      |
| 13      | B3  | CB2             | Digital Control Input 2                              |
| 14      | A4  | Y               | Analog Output Y Common Terminal                      |
| —       | —   | EP              | Exposed Pad. Connect to ground or leave unconnected. |

## Detailed Description

The MAX4908/MAX4909/MAX4930/MAX4932 dual 3:1 clickless audio multiplexers are low  $0.38\Omega$  (typ) on-resistance, low 150nA (typ) supply current, high power-supply rejection ratio (PSRR) devices that operate from a +1.8V to +5.5V single supply. These devices feature a negative signal capability that allows signals below GND to pass through without distortion and break-before-make switching.

The MAX4908/MAX4909/MAX4930/MAX4932 use two digital control bits CB1 and CB2 to switch between signals (see [Table 1](#)). The MAX4908 has shunt resistors on all the unselected terminals to suppress click-and-pop sounds that may occur from switching to a precharged terminal. The MAX4909 does not have click-and-pop suppression resistors on X0 and Y0 terminals for applications that do not require precharge switching. The MAX4930 only has shunt resistors on X2 and Y2 terminals. The MAX4932 has no shunt resistors on all terminals.

**Table 1. Truth Table**

| CB1 | CB2 | COMMON X        | COMMON Y        |
|-----|-----|-----------------|-----------------|
| 0   | 0   | High Impedance  | High Impedance  |
| 0   | 1   | Connected to X0 | Connected to Y0 |
| 1   | 0   | Connected to X1 | Connected to Y1 |
| 1   | 1   | Connected to X2 | Connected to Y2 |

## Applications Information

### Digital Control Inputs

The MAX4908/MAX4909/MAX4930/MAX4932 logic inputs accept up to +5.5V regardless of supply voltage. For example, with a +3.3V supply, CB\_ can be driven low to GND and high to +5.5V, allowing for mixing of logic levels in a system. Driving CB\_ rail-to-rail minimizes power consumption. For a +3.3V supply voltage, the logic thresholds are +0.5V (low) and +1.4V (high).

### Analog Signal Levels

These devices have a low on-resistance of  $0.38\Omega$  (typ) and the on-resistance flatness is guaranteed over temperature and will show minimal variation over the entire voltage supply range (see the [Typical Operating Characteristics](#)). The on-resistance flatness and low-leakage features make it ideal for bidirectional operation. The switches are bidirectional, so X\_, Y\_, and common terminals X and Y pins can be either inputs or outputs.

These devices pass signals as low as  $V_{CC} - 5.5V$ , including signals below ground with minimal distortion.

## Click-Pop Suppression

The MAX4908 has a  $3.8k\Omega$  (typ) shunt resistor on all of its input terminals to automatically discharge any capacitance when they are not connected to common terminal X and Y. The MAX4909 has shunt resistors on all terminals except X0 and Y0. The MAX4930 only has shunt resistors on X2 and Y2. The shunt resistors reduce audible click-and-pop sounds that occur when switching between audio sources.

Audible clicks and pops are caused when a step DC voltage is switched into the speaker. The DC step transients can be reduced by automatically discharging the side that is not connected to the common terminal, thus reducing any residual DC voltage and clicks and pops.

## Break-Before-Make Switching

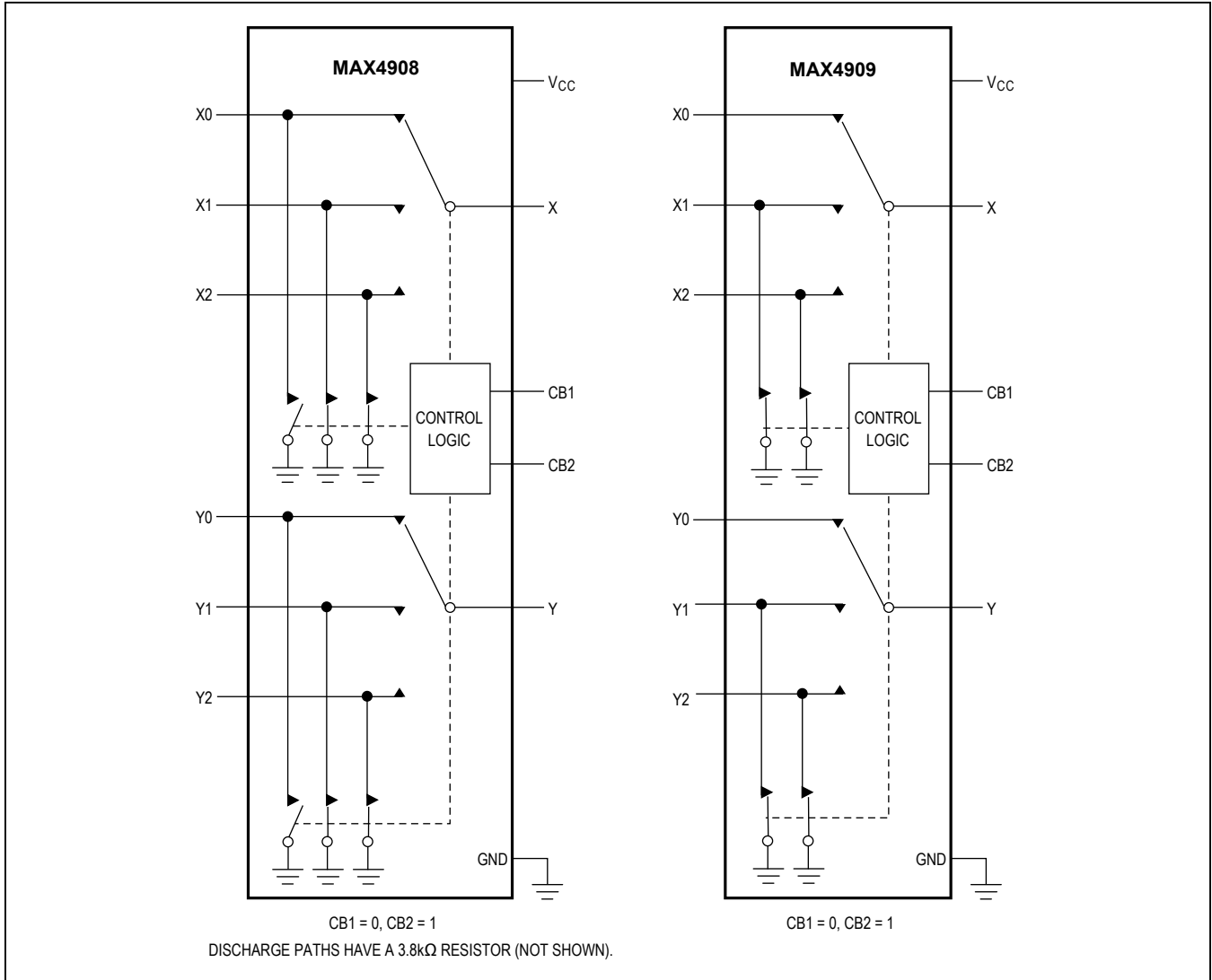
The MAX4908/MAX4909/MAX4930/MAX4932 feature break-before-make switching, which is configured to break (open) the first set of contacts before engaging (closing) the new contacts. This prevents the momentary connection of the old and new signal paths to the output, further reducing click-and-pop sounds.

## Power-Supply Sequencing and Overvoltage Protection

**Caution: Do not exceed the Absolute Maximum Ratings since stresses beyond the listed ratings may cause permanent damage to the device.**

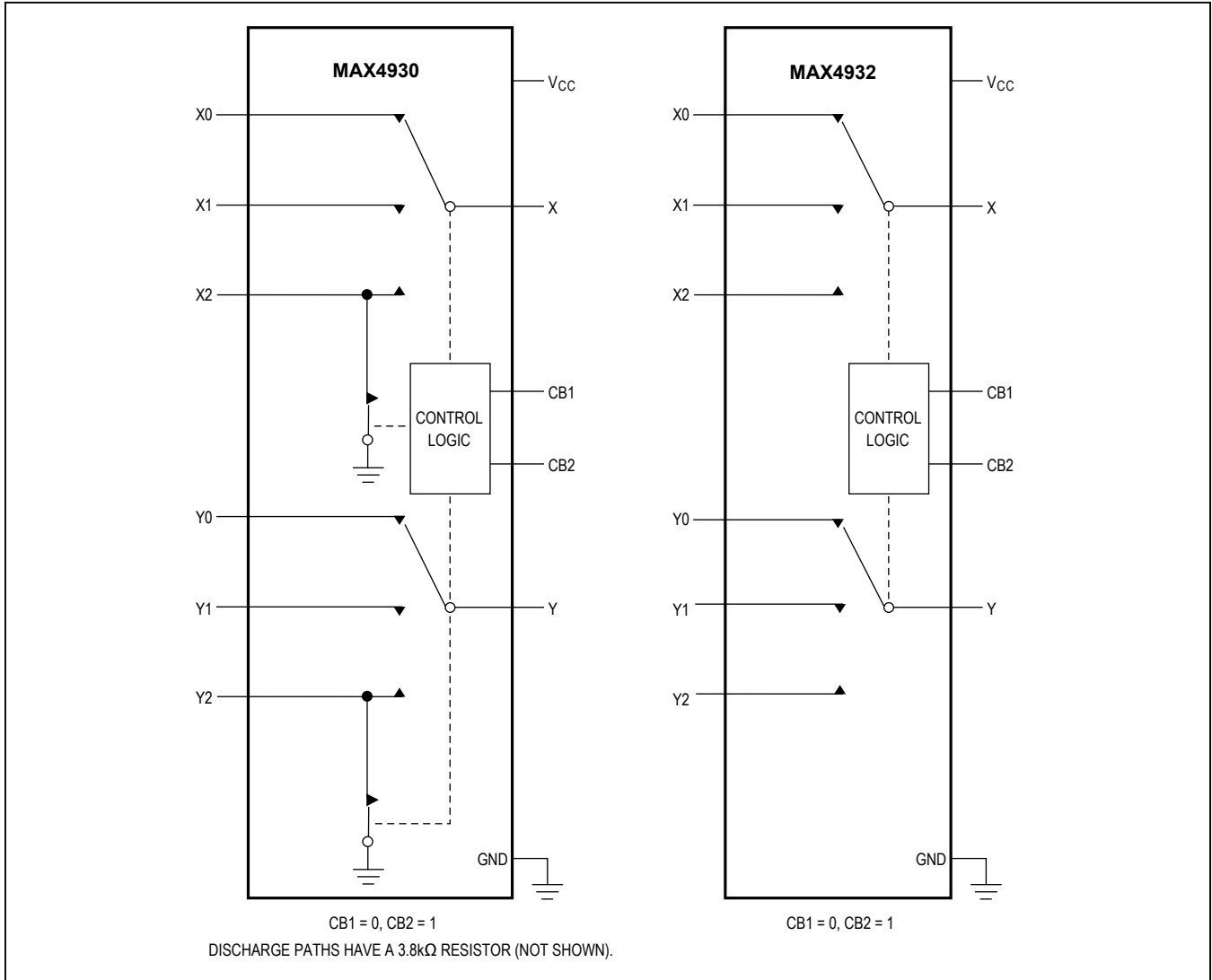
Proper power-supply sequencing is recommended for all CMOS devices. Improper supply sequencing can force the switch into latchup, causing it to draw excessive supply current. The only way out of latchup is to recycle the power and reapply properly. Connect all ground pins first, apply power to  $V_{CC}$ , and finally apply signals to X\_, Y\_, and common terminals. Follow the reverse order upon power-down.

Functional Diagram





Functional Diagram (continued)



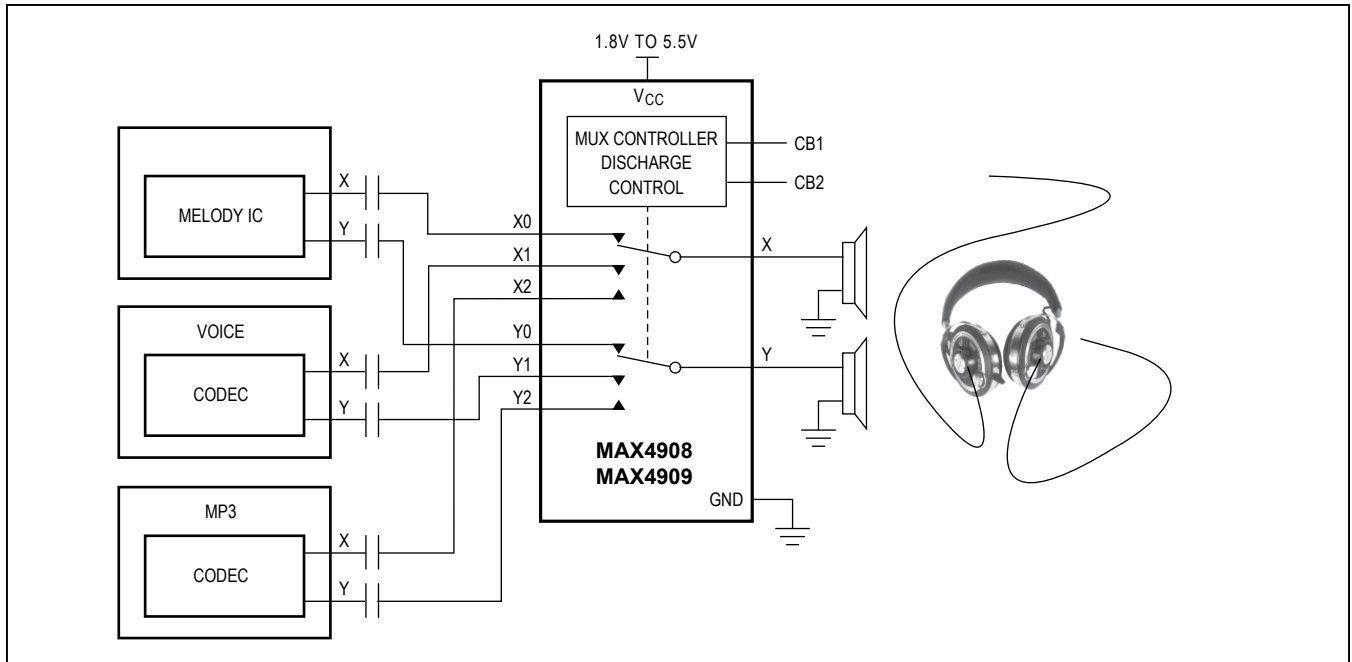


Figure 1. Typical Application Circuit

Test Circuits/Timing Diagrams

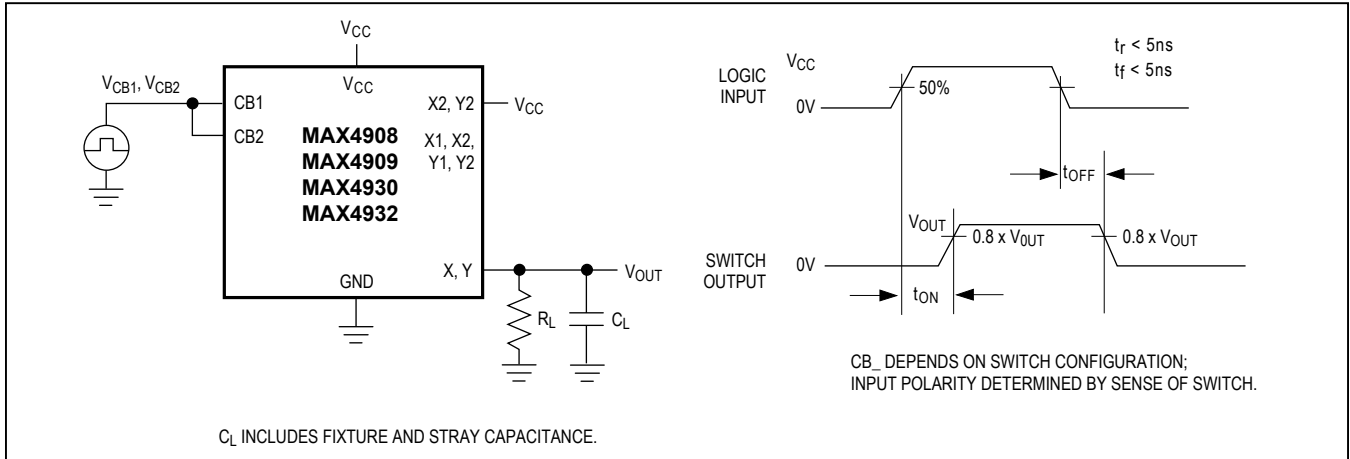


Figure 2. Switching Time

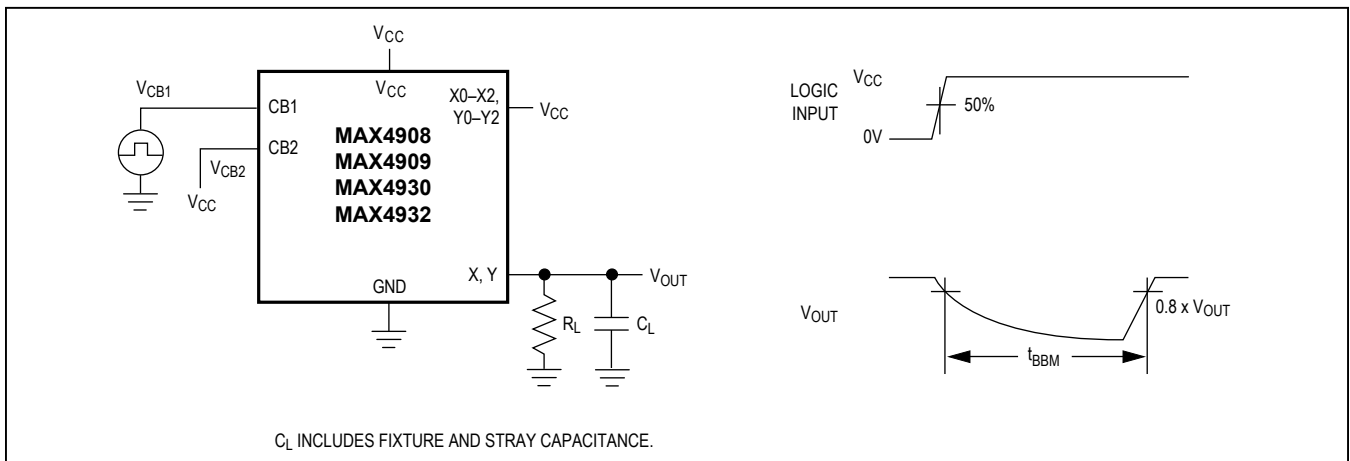


Figure 3. Break-Before-Make Interval

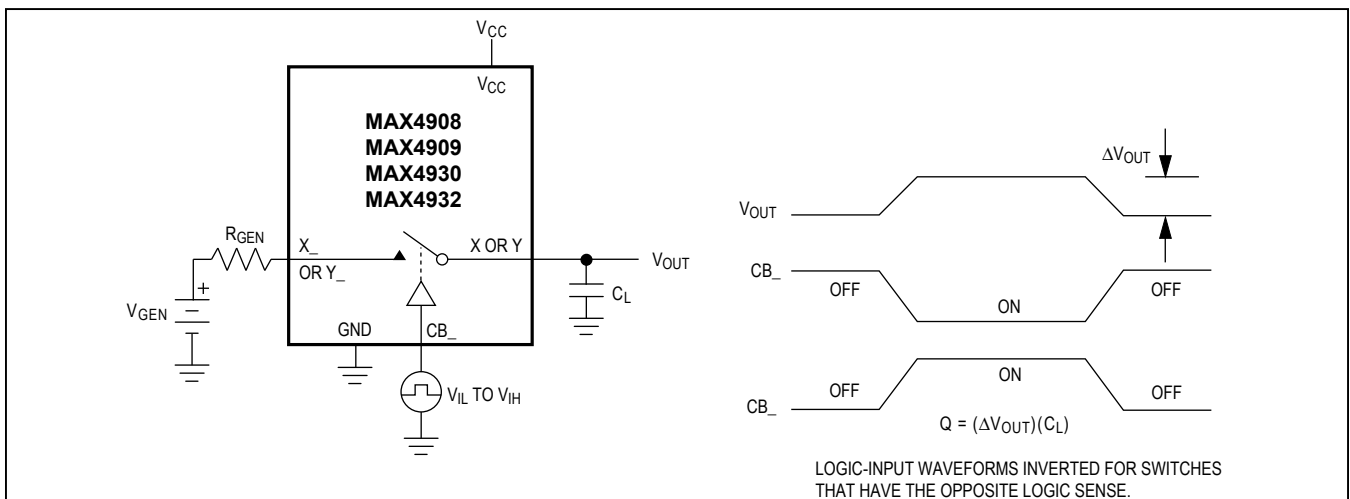


Figure 4. Charge Injection

Test Circuits/Timing Diagrams (continued)

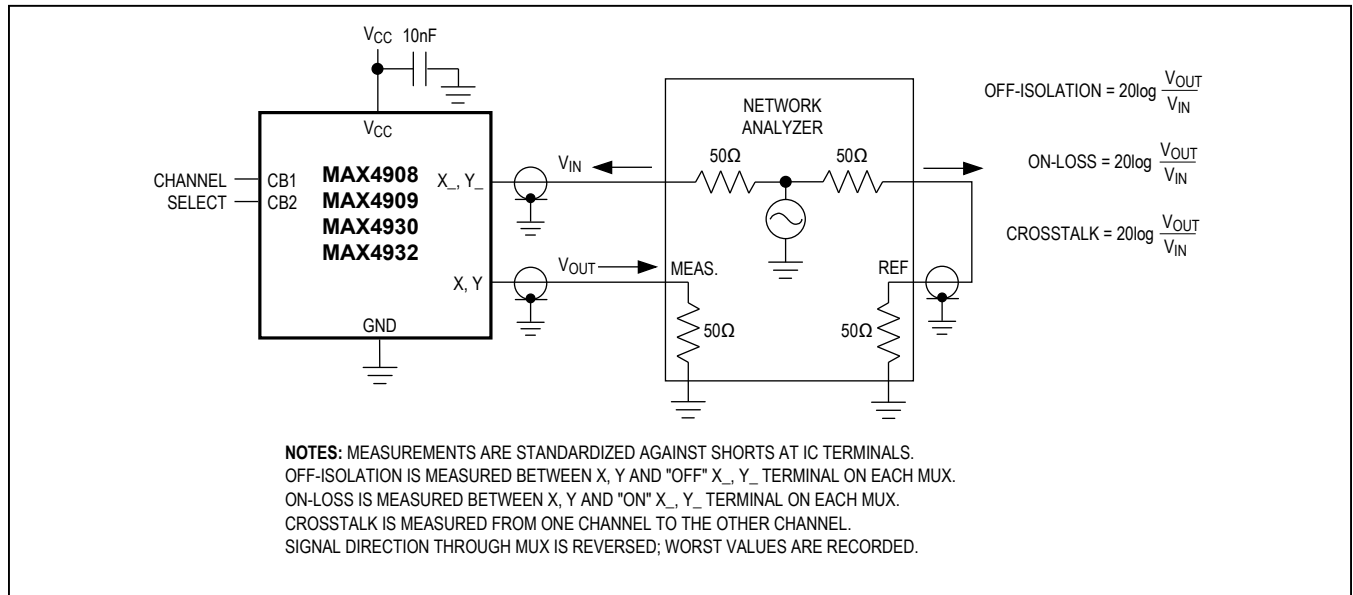


Figure 5. On-Loss, Off-Isolation, and Crosstalk

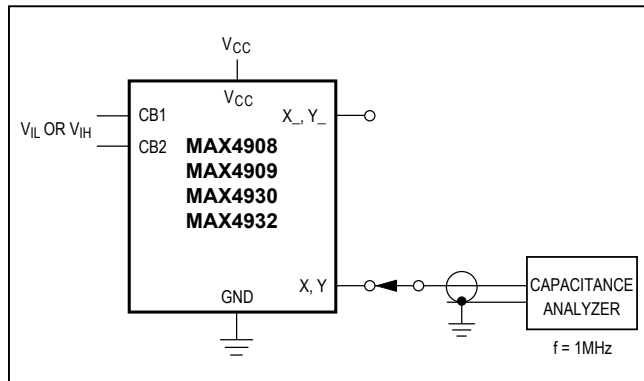


Figure 6. Channel Off/On-Capacitance

MAX4908/MAX4909/  
MAX4930/MAX4932

## Dual 3:1 Clickless Audio Multiplexers with Negative-Signal Handling

### Ordering Information

| PART                 | TEMP RANGE     | PIN-PACKAGE  | TOP MARK |
|----------------------|----------------|--------------|----------|
| <b>MAX4908</b> ETD+T | -40°C to +85°C | 14 TDFN-EP** | ABI      |
| MAX4908EWC+T         | -40°C to +85°C | 12 WLP       | AAF      |
| <b>MAX4909</b> ETD+T | -40°C to +85°C | 14 TDFN-EP** | ABJ      |
| MAX4909EWC+T*        | -40°C to +85°C | 12 WLP       | AAG      |
| <b>MAX4930</b> ETD+T | -40°C to +85°C | 14 TDFN-EP** | ADM      |
| MAX4930EWC+T*        | -40°C to +85°C | 12 WLP       | ADY      |
| <b>MAX4932</b> ETD+T | -40°C to +85°C | 14 TDFN-EP** | ADN      |
| MAX4932EWC+T*        | -40°C to +85°C | 12 WLP       | AAN      |

+Denotes a lead-free/RoHS-compliant package.

T = Tape and reel.

\*Future product—contact factory for availability.

\*\*EP = Exposed pad.

### Chip Information

PROCESS: BiCMOS

### Package Information

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.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.              |
|--------------|--------------|---------------------------|
| 14 TDFN      | T1433+2      | <a href="#">21-0137</a>   |
| 12 WLP       | W121B2+1     | <a href="#">21-100112</a> |

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION   | PAGES CHANGED |
|-----------------|---------------|---|---------------|
| 1               | 7/07          | Adding of the MAX4930/MAX4932   | 1-13          |
| 2               | 6/08          | Changing UCSP to WLP packaging  | 1,2,6,8,11    |
| 3               | 1/16          | Removed future product asterisk from MAX4908EWC+T                                     | 12            |
| 4               | 3/16          | Updated package codes and package outline drawing in <i>Package Information</i> table | 13            |

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at [www.maximintegrated.com](http://www.maximintegrated.com).

*Maxim Integrated cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim Integrated product. No circuit patent licenses are implied. Maxim Integrated reserves the right to change the circuitry and specifications without notice at any time. The parametric values (min and max limits) shown in the Electrical Characteristics table are guaranteed. Other parametric values quoted in this data sheet are provided for guidance.*

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С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибьюторских договоров

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- Специальные условия для постоянных клиентов.
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- Работу по проектам и поставку образцов.
- Формирование склада под заказчика.
- Сертификаты соответствия на поставляемую продукцию (по желанию клиента).
- Тестирование поставляемой продукции.
- Поставку компонентов, требующих военную и космическую приемку.
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- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
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