

# MAX14508E–MAX14511E/ MAX14509AE

# USB 2.0 Hi-Speed and Audio Switches with Negative Signal Capability

## General Description

The MAX14508E–MAX14511E/MAX14509AE high-ESD-protected DPDT switches multiplex Hi-Speed (480Mbps) USB and analog signals such as AC-coupled audio or video. These devices combine the low on-capacitance ( $C_{ON}$ ) and low on-resistance ( $R_{ON}$ ) necessary for high-performance switching applications in portable electronics, and include an internal negative supply to pass audio signals that swing below ground (down to  $V_{CC} - 5.0V$ ). The MAX14508E–MAX14511E/MAX14509AE also handle USB low-/full-speed signaling and operate from a +2.7V to +5.0V supply.

The MAX14508E–MAX14511E feature +5.5V fault protection on COM1 and COM2, making these devices compliant with the USB 2.0 fault-protection specification. The MAX14510E/MAX14511E feature a VBUS detection input (VB) to automatically switch to the USB signal path upon detection of a valid VBUS signal. The MAX14508E/MAX14510E feature internal shunt resistors on the audio path to reduce clicks and pops heard at the output. The MAX14508E/MAX14509E/MAX14509AE have an enable input (EN) to reduce supply current and set all channels to high impedance when driven low.

The MAX14508E–MAX14511E/MAX14509AE are available in a space-saving, 10-pin, 1.4mm x 1.8mm UTQFN package, and operate over the -40°C to +85°C temperature range.

## Applications

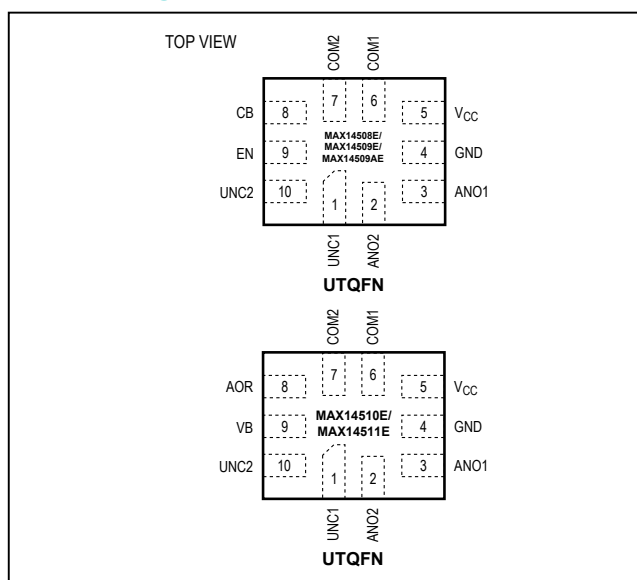
- Cell Phones
- MP3 Players
- Notebook Computers
- PDAs

*Typical Operating Circuit appears at end of data sheet.*

## Benefits and Features

- Single +2.7V to +5.0V Supply Voltage
- Low 12μA Supply Current
- -3dB Bandwidth: 950MHz (typ)
- Low 2.4Ω (typ) On-Resistance
- Low 20mΩ (typ)  $R_{ON}$  Flatness
- THD+N: 0.05%
- COM Analog Inputs Fault Protected Against Shorts to +5.5V (MAX14508E/MAX14509E/MAX14510E/MAX14511E)
- Internal Shunt Resistors for Click-and-Pop Reduction (MAX14508E/MAX14510E)
- VBUS Detection for Automatic Switch Path Selection (MAX14510E/MAX14511E)
- Space-Saving Package: 10-Pin, 1.4mm x 1.8mm UTQFN

## Pin Configurations



## Ordering Information/Selector Guide

| PART           | PIN-PACKAGE       | VBUS DETECTION/<br>ENABLE LINE | FAULT PROTECTION | SHUNT RESISTORS | TOP<br>MARK |
|----------------|-------------------|--------------------------------|------------------|-----------------|-------------|
| MAX14508EEVB+  | 10 Ultra-Thin QFN | Enable                         | Yes              | Yes             | AAH         |
| MAX14509EEVB+* | 10 Ultra-Thin QFN | Enable                         | Yes              | No              | AAI         |
| MAX14509AEVB+  | 10 Ultra-Thin QFN | Enable                         | No               | No              | AAL         |
| MAX14510EEVB+  | 10 Ultra-Thin QFN | VBUS                           | Yes              | Yes             | AAJ         |
| MAX14511EEVB+* | 10 Ultra-Thin QFN | VBUS                           | Yes              | No              | AAK         |

**Note:** All devices operate over the -40°C to +85°C temperature range.

+Denotes a lead(Pb)-free/RoHS-compliant package.

\*Future product—contact factory for availability.



## Absolute Maximum Ratings

(Voltages referenced to GND.)

|                                                                      |                                            |
|----------------------------------------------------------------------|--------------------------------------------|
| $V_{CC}$ , CB, EN, VB, AOR.....                                      | -0.3V to +6.0V                             |
| COM <sub>-</sub> ( $V_{EN} > V_{IH}$ ) (Note 1).....                 | ( $V_{CC} - 5.0V$ ) to +6.0V               |
| COM <sub>-</sub> ( $V_{EN} < V_{IL}$ ) .....                         | -0.3V to +6.0V                             |
| ANO <sub>-</sub> ( $V_{EN} > V_{IH}$ ).....                          | ( $V_{CC} - 5.0V$ ) to ( $V_{CC} + 0.3V$ ) |
| ANO <sub>-</sub> ( $V_{EN} < V_{IL}$ ) .....                         | -0.3V to ( $V_{CC} + 0.3V$ )               |
| UNC <sub>-</sub> .....                                               | -0.3V to ( $V_{CC} + 0.3V$ )               |
| Continuous Current into Any Terminal.....                            | ±100mA                                     |
| Continuous Power Dissipation ( $T_A = +70^{\circ}C$ )                |                                            |
| 10-Pin UTQFN (derate 6.9mW/ $^{\circ}C$ above $+70^{\circ}C$ ) ..... | 559mW                                      |

Junction-to-Case Thermal Resistance ( $\theta_{JC}$ ) (Note 2)

10-Pin UTQFN.....20.1 $^{\circ}C/W$

Junction-to-Ambient Thermal Resistance ( $\theta_{JA}$ ) (Note 2)

10-Pin UTQFN.....143.1 $^{\circ}C/W$

Operating Temperature Range.....-40 $^{\circ}C$  to +85 $^{\circ}C$

Junction Temperature Range .....

-40 $^{\circ}C$  to +150 $^{\circ}C$

Storage Temperature Range.....-65 $^{\circ}C$  to +150 $^{\circ}C$

Lead Temperature (soldering, 10s) .....

+300 $^{\circ}C$

**Note 1:** Limits are only for the MAX14508E/MAX14509E/MAX14510E/MAX14511E. For the MAX14509AE ( $V_{CC} \geq 2.7V$ ), the limits are from ( $V_{CC} - 5.0V$ ) to min of 6.0V or ( $V_{CC} + 1.0V$ ).

**Note 2:** Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

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

( $V_{CC} = +2.7V$  to  $+5.0V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CC} = +3.0V$ ,  $T_A = +25^{\circ}C$ .) (Note 3)

| PARAMETER                        | SYMBOL                     | CONDITIONS                                                                                      | MIN                                                                                    | TYP | MAX            | UNITS   |
|----------------------------------|----------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----|----------------|---------|
| Operating Power-Supply Range     | $V_{CC}$                   |                                                                                                 | 2.7                                                                                    |     | 5.0            | V       |
| Supply Current                   | $I_{CC}$                   | $V_{CC} = 3.3V$                                                                                 | MAX14508E/MAX14509E/<br>MAX14509AE, $V_{EN} = 0V$                                      |     | 1              | $\mu A$ |
|                                  |                            |                                                                                                 | ( $V_{EN} = V_{CC}$ , $V_{CB} = 0V$ ) or<br>( $V_{AOR} = 0V$ , $V_{VB} > V_{VBDET}$ )  |     | 6 12           |         |
|                                  |                            |                                                                                                 | ( $V_{EN} = V_{CC}$ , $V_{CB} = V_{CC}$ ) or<br>( $V_{AOR} = V_{CC}$ , $V_{VB} = 0V$ ) |     | 6 12           |         |
|                                  |                            | $V_{CC} = 5.0V$                                                                                 | MAX14508E/MAX14509E/<br>MAX14509AE, $V_{EN} = 0V$                                      |     | 1              |         |
|                                  |                            |                                                                                                 | ( $V_{EN} = V_{CC}$ , $V_{CB} = 0V$ ) or<br>( $V_{AOR} = 0V$ , $V_{VB} > V_{VBDET}$ )  |     | 6 12           |         |
|                                  |                            |                                                                                                 | ( $V_{EN} = V_{CC}$ , $V_{CB} = V_{CC}$ ) or<br>( $V_{AOR} = V_{CC}$ , $V_{VB} = 0V$ ) |     | 6 12           |         |
| Power-Supply Rejection Ratio     | PSRR                       | $f = 10kHz$ , $V_{CC} = 3.0 \pm 0.3V$ , $R_{COM-} = 50\Omega$                                   |                                                                                        | 60  |                | dB      |
| COM Overvoltage Detect Threshold | $V_{FP}$                   | MAX14508E/MAX14509E/MAX14510E/<br>MAX14511E, $V_{CC} = +2.7V$ to $+3.3V$ ,<br>Figure 1 (Note 4) | $V_{CC} + 0.8$                                                                         |     | $V_{CC} + 1.6$ | V       |
| Fault-Protection Response Time   | $t_{FP}$                   | $V_{COM} = 1V$ to $5V$ step, $V_{CC} = 3.0V$ , $R_{UNC-} + R_{ANO-} = 1k\Omega$                 |                                                                                        | 1.3 | 5.0            | $\mu s$ |
| Fault-Protection Recovery Time   | $t_{FPR}$                  | $V_{COM} = 5V$ to $1V$ step, $V_{CC} = 3.0V$ , $R_{UNC-} + R_{ANO-} = 1k\Omega$                 |                                                                                        | 2   |                | $\mu s$ |
| Analog Signal Range              | $V_{UNC-}$                 |                                                                                                 | 0                                                                                      |     | $V_{CC}$       | V       |
|                                  | $V_{ANO-}$ ,<br>$V_{COM-}$ | $V_{EN} > V_{IH}$                                                                               | $V_{CC} - 5.0$                                                                         |     | $V_{CC}$       |         |
|                                  |                            | $V_{EN} < V_{IL}$                                                                               | 0                                                                                      |     | $V_{CC}$       |         |

## Electrical Characteristics (continued)

( $V_{CC} = +2.7V$  to  $+5.0V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CC} = +3.0V$ ,  $T_A = +25^{\circ}C$ .) (Note 3)

| PARAMETER                                 | SYMBOL                 | CONDITIONS                                                                                                                                                                                                                                    | MIN  | TYP  | MAX  | UNITS      |
|-------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| ANO_ On-Resistance                        | $R_{ON(ANO\_)}$        | $V_{CC} = 3.0V$ ; $V_{ANO\_} = -1.5V, +1.5V$ ;<br>$I_{COM\_} = 10mA$                                                                                                                                                                          |      | 2.4  | 5    | $\Omega$   |
| UNC_ On-Resistance                        | $R_{ON(UNC\_)}$        | $V_{CC} = 3.0V$ ; $V_{UNC\_} = 0V$ , $V_{CC}$ ; $I_{COM\_} = 10mA$                                                                                                                                                                            |      | 2.4  | 5    | $\Omega$   |
|                                           |                        | MAX14509AE, $V_{CC} = 2.7V$ , $V_{COM\_} = 3.6V$ ,<br>$I_{COM\_} = 10mA$                                                                                                                                                                      |      | 2.4  | 5    |            |
| ANO_ On-Resistance Match Between Channels | $\Delta R_{ON(ANO\_)}$ | $V_{CC} = 3.0V$ , $V_{ANO\_} = 0V$ , $I_{COM\_} = 10mA$<br>(Notes 5, 6)                                                                                                                                                                       |      |      | 0.2  | $\Omega$   |
| UNC_ On-Resistance Match Between Channels | $\Delta R_{ON(UNC\_)}$ | $V_{CC} = 3.0V$ , $V_{UNC\_} = 0V$ , $I_{COM\_} = 10mA$<br>(Notes 5, 6)                                                                                                                                                                       |      |      | 0.2  | $\Omega$   |
| ANO_ On-Resistance Flatness               | $R_{FLAT(ANO\_)}$      | $V_{CC} = 3.0V$ , $I_{COM\_} = 10mA$ , $V_{ANO\_} = -1.5V$ to<br>$+1.5V$ (Note 7)                                                                                                                                                             |      | 0.03 | 0.25 | $\Omega$   |
| UNC_ On-Resistance Flatness               | $R_{FLAT(UNC\_)}$      | $V_{CC} = 3.0V$ , $I_{COM\_} = 10mA$ , $V_{UNC\_} = 0V$ to<br>$V_{CC}$ (Note 7)                                                                                                                                                               |      | 0.05 | 0.5  | $\Omega$   |
| Shunt Switch Resistance                   | $R_{SH}$               | MAX14508E/MAX14510E, $I_{ANO\_} = 10mA$                                                                                                                                                                                                       |      | 100  | 200  | $\Omega$   |
| AOR Pulldown Resistance                   | $R_{AOR}$              |                                                                                                                                                                                                                                               | 250  |      | 1200 | k $\Omega$ |
| UNC_ Off-Leakage Current                  | $I_{UNC\_}(OFF)$       | $V_{CC} = 3.0V$ ; $V_{UNC\_} = +2.5V, 0V$ ;<br>$V_{COM\_} = -1.5V, +2.5V$ ; $V_{EN} = V_{CC}$ for<br>MAX14508E/MAX14509E/MAX14509AE                                                                                                           | -10  |      | +10  | nA         |
| ANO_ Off-Leakage Current                  | $I_{ANO\_}(OFF)$       | MAX14509E/MAX14511E/MAX14509AE;<br>$V_{CC} = 3.0V$ ; $V_{ANO\_} = +2.5V, 0V$ ;<br>$V_{COM\_} = 0V, +2.5V$                                                                                                                                     | -10  |      | +10  | nA         |
| COM_ Off-Leakage Current                  | $I_{COM\_}(OFF)$       | MAX14508E/MAX14509E/MAX14509AE,<br>$V_{CC} = 3.0V$ , $V_{EN} = 0V$ , $V_{COM\_} = 3.6V$ ,<br>$V_{UNC\_} = V_{ANO\_} = 0V$                                                                                                                     | -10  |      | +10  | $\mu A$    |
|                                           |                        | MAX14508E/MAX14509E/MAX14509AE,<br>$V_{CC} = 3.3V$ , $V_{EN} = 0V$ , $V_{COM\_} = 0V$ ,<br>$V_{UNC\_} = V_{ANO\_} = 0V$                                                                                                                       | -10  |      | +10  | nA         |
|                                           |                        | $V_{CC} = 0V$ , $V_{COM\_} = 3.6V$ , $V_{UNC\_} = V_{ANO\_} = 0V$                                                                                                                                                                             | 10   |      | 600  | $\mu A$    |
| COM_ On-Leakage Current                   | $I_{COM\_}(ON)$        | USB mode<br>$V_{CC} = 3.0V$ ; $V_{ANO\_} = 0V, 2.5V$ ;<br>unconnected;<br>$V_{COM\_} = 0V, 2.5V$                                                                                                                                              | -200 |      | +200 | nA         |
|                                           |                        | Audio mode<br>$V_{CC} = 3.0V$ ; $V_{UNC\_} = 0V, 2.5V$ ;<br>unconnected;<br>$V_{COM\_} = -1.5V, +2.5V$                                                                                                                                        | -200 |      | +200 |            |
| Turn-On Time<br>(Figure 2)                | $t_{ON}$               | ANO_ to COM_,<br>$V_{CC} = 3.0V$<br>( $V_{ANO\_} = 1.5V$ , $R_L = 50\Omega$ ,<br>$V_{EN} = V_{CC}$ , $V_{CB} = 0V$ to $V_{CC}$ )<br>or ( $V_{AOR} = 0V$ , $V_{VB} = 5.0V$ to<br>$0V$ ) or ( $V_{VB} = 5.0V$ ,<br>$V_{AOR} = 0V$ to $V_{CC}$ ) |      | 14   | 60   | $\mu s$    |
|                                           |                        | UNC_ to COM_,<br>$V_{CC} = 3.0V$<br>( $V_{UNC\_} = 1.5V$ , $R_L = 50\Omega$ ,<br>$V_{EN} = V_{CC}$ , $V_{CB} = V_{CC}$ to $0V$ )<br>or ( $V_{AOR} = 0V$ ,<br>$V_{VB} = 0V$ to $5.0V$ )                                                        |      | 14   | 60   |            |

## Electrical Characteristics (continued)

( $V_{CC} = +2.7V$  to  $+5.0V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CC} = +3.0V$ ,  $T_A = +25^{\circ}C$ .) (Note 3)

| PARAMETER                               | SYMBOL                 | CONDITIONS                                                                                                        |                                                                                                                                                                                                                                                                          | MIN                      | TYP  | MAX                     | UNITS |
|-----------------------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------|-------------------------|-------|
| Turn-Off Time<br>(Figure 2)             | t <sub>OFF</sub>       | ANO_ from<br>COM_,<br>V <sub>CC</sub> = 3.0V                                                                      | (V <sub>ANO_</sub> = 1.5V, R <sub>L</sub> = 50Ω,<br>V <sub>EN</sub> = V <sub>CC</sub> , V <sub>CB</sub> = V <sub>CC</sub> to<br>0V) or (V <sub>AOR</sub> = 0V, V <sub>VB</sub> =<br>0V to 5.0V) or (V <sub>VB</sub> = 5.0V,<br>V <sub>AOR</sub> = V <sub>CC</sub> to 0V) |                          | 1.4  | 5                       | μs    |
|                                         |                        | ANO_ from<br>COM_,<br>V <sub>CC</sub> = 3.0V                                                                      | (V <sub>UNC_</sub> = 1.5V, R <sub>L</sub> = 50Ω,<br>V <sub>EN</sub> = V <sub>CC</sub> , V <sub>CB</sub> = 0V to<br>V <sub>CC</sub> ) or (V <sub>AOR</sub> = 0V, V <sub>VB</sub><br>= 5.0V to 0V or V <sub>VB</sub> = 5.0V,<br>V <sub>AOR</sub> = 0V to V <sub>CC</sub> ) |                          | 0.7  | 5                       |       |
| Break-Before-Make Time<br>Delay         | t <sub>D</sub>         | R <sub>L</sub> = 50Ω                                                                                              |                                                                                                                                                                                                                                                                          |                          | 13.5 |                         | μs    |
| Output Skew Same Switch                 | t <sub>SK(P)</sub>     | Figure 3 (Note 5)                                                                                                 |                                                                                                                                                                                                                                                                          |                          | 40   |                         | ps    |
| Output Skew Between<br>Switches         | t <sub>SK(O)</sub>     | Figure 3 (Note 5)                                                                                                 |                                                                                                                                                                                                                                                                          |                          | 40   |                         | ps    |
| ANO_ Off-Capacitance                    | C <sub>ANO_(OFF)</sub> | V <sub>COM_</sub> = 0.5V <sub>P-P</sub> , DC bias = 0V, f = 1MHz<br>(Note 5)                                      |                                                                                                                                                                                                                                                                          |                          | 8    |                         | pF    |
| UNC_ Off-Capacitance                    | C <sub>UNC_(OFF)</sub> | V <sub>COM_</sub> = 0.5V <sub>P-P</sub> , DC bias = 0V, f = 240MHz<br>(Note 5)                                    |                                                                                                                                                                                                                                                                          |                          | 3.3  |                         | pF    |
| On-Capacitance (Note 5)                 | C <sub>COM(ON)</sub>   | UNC_ to COM_, V <sub>COM_</sub> = 0.5V <sub>P-P</sub> ,<br>DC bias = 0V, f = 240MHz                               |                                                                                                                                                                                                                                                                          |                          | 8    |                         | pF    |
|                                         |                        | ANO_ to COM_, V <sub>COM_</sub> = 0.5V <sub>P-P</sub> ,<br>DC bias = 0V, f = 1MHz                                 |                                                                                                                                                                                                                                                                          |                          | 8    |                         | pF    |
| AC PERFORMANCE                          |                        |                                                                                                                   |                                                                                                                                                                                                                                                                          |                          |      |                         |       |
| ANO_ -3dB Bandwidth                     | BWA <sub>NO_</sub>     | R <sub>S</sub> = R <sub>L</sub> = 50Ω, V <sub>ANO_</sub> = 0dBm, Figure 4                                         |                                                                                                                                                                                                                                                                          |                          | 950  |                         | MHz   |
| UNC_ -3dB Bandwidth                     | BWA <sub>NC_</sub>     | R <sub>S</sub> = R <sub>L</sub> = 50Ω, V <sub>UNC_</sub> = 0dBm, Figure 4                                         |                                                                                                                                                                                                                                                                          |                          | 950  |                         | MHz   |
| Off-Isolation                           | V <sub>ISO</sub>       | f = 100kHz, V <sub>COM_</sub> = 1V <sub>RMS</sub> , R <sub>S</sub> = R <sub>L</sub> = 50Ω,<br>Figure 4            |                                                                                                                                                                                                                                                                          |                          | -65  |                         | dB    |
| Crosstalk                               | V <sub>CT</sub>        | f = 100kHz, V <sub>COM_</sub> = 1V <sub>RMS</sub> , R <sub>S</sub> = R <sub>L</sub> = 50Ω,<br>Figure 4 (Note 8)   |                                                                                                                                                                                                                                                                          |                          | -70  |                         | dB    |
| Total Harmonic Distortion<br>Plus Noise | THD+N                  | ANO_ to COM_, f = 20Hz to 20kHz,<br>V <sub>COM_</sub> = 0.5V <sub>P-P</sub> , DC bias = 0V, R <sub>L</sub> = 600Ω |                                                                                                                                                                                                                                                                          |                          | 0.05 |                         | %     |
| LOGIC INPUT                             |                        |                                                                                                                   |                                                                                                                                                                                                                                                                          |                          |      |                         |       |
| Input Logic-High                        | V <sub>IH</sub>        |                                                                                                                   |                                                                                                                                                                                                                                                                          | 1.6                      |      |                         | V     |
| Input Logic-Low                         | V <sub>IL</sub>        |                                                                                                                   |                                                                                                                                                                                                                                                                          |                          |      | 0.4                     | V     |
| Input Leakage Current                   | I <sub>IN</sub>        | MAX14508E/MAX14509E/MAX14509AE,<br>V <sub>CB</sub> = 0V or V <sub>CC</sub>                                        |                                                                                                                                                                                                                                                                          | -1                       |      | +1                      | μA    |
| VBUS Detection Threshold                | V <sub>VBDET</sub>     |                                                                                                                   |                                                                                                                                                                                                                                                                          | V <sub>CC</sub> +<br>0.2 |      | V <sub>CC</sub> +<br>1V | v     |

MAX14508E–MAX14511E/  
MAX14509AE

USB 2.0 Hi-Speed and Audio Switches  
with Negative Signal Capability

Electrical Characteristics (continued)

(V<sub>CC</sub> = +2.7V to +5.0V, 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 3)

| PARAMETER      | SYMBOL | CONDITIONS       | MIN | TYP | MAX | UNITS |
|----------------|--------|------------------|-----|-----|-----|-------|
| ESD PROTECTION |        |                  |     |     |     |       |
| All Pins       |        | Human Body Model |     | ±2  |     | kV    |
| COM1, COM2     |        | Human Body Model |     | ±15 |     | kV    |

- Note 3:** All devices are 100% production tested at T<sub>A</sub> = +25°C. All temperature limits are guaranteed by design.
- Note 4:** The switch turns off for voltages above V<sub>FP</sub>, protecting downstream circuits in case of a fault condition.
- Note 5:** Guaranteed by design.
- Note 6:** ΔR<sub>ON(MAX)</sub> = ABS(R<sub>ON(CH1)</sub> - R<sub>ON(CH2)</sub>)
- Note 7:** Flatness is defined as the difference between the maximum and minimum value of on-resistance, as measured over specified analog signal ranges.
- Note 8:** Between two switches.

Test Circuits/Timing Diagrams

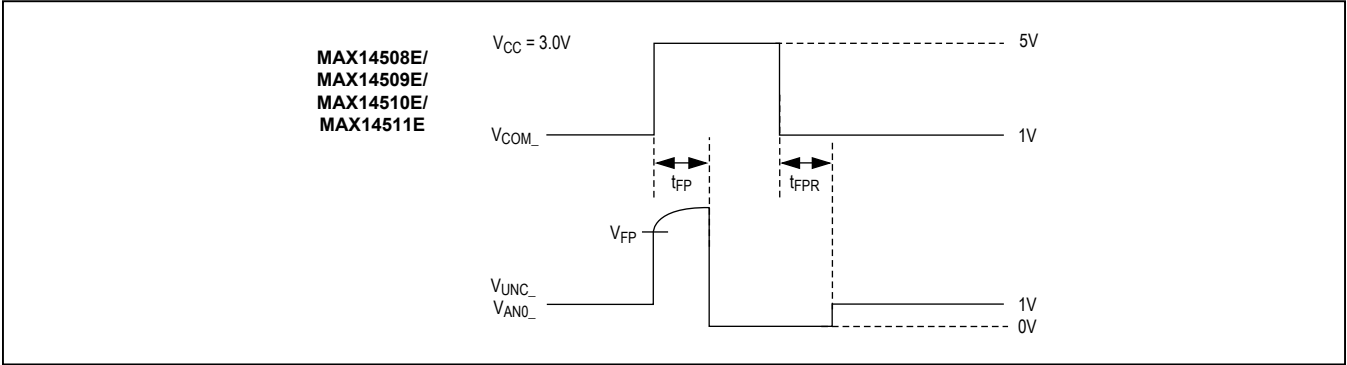


Figure 1. Fault Protection

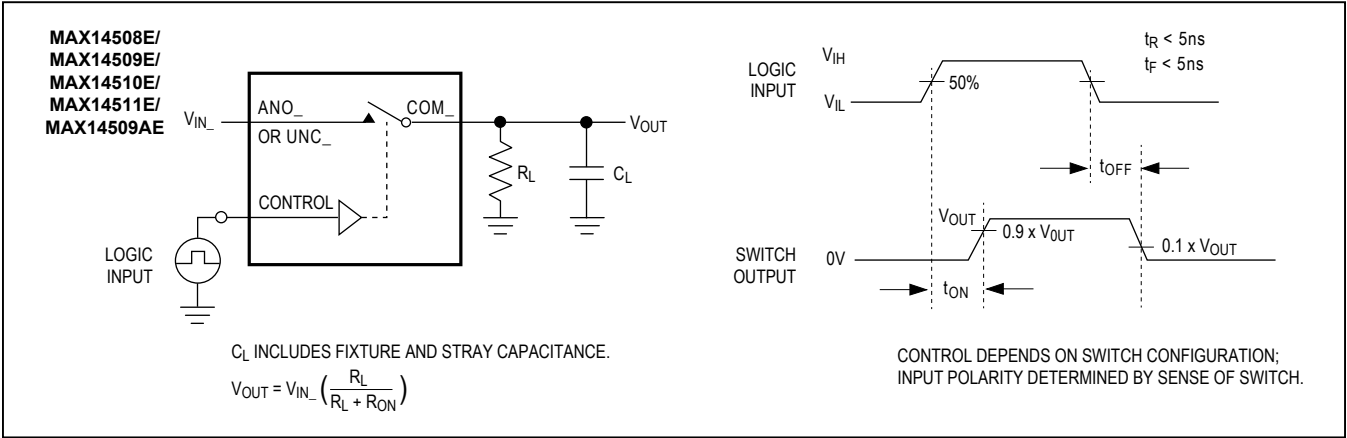


Figure 2. Switching Time

Test Circuits/Timing Diagrams (continued)

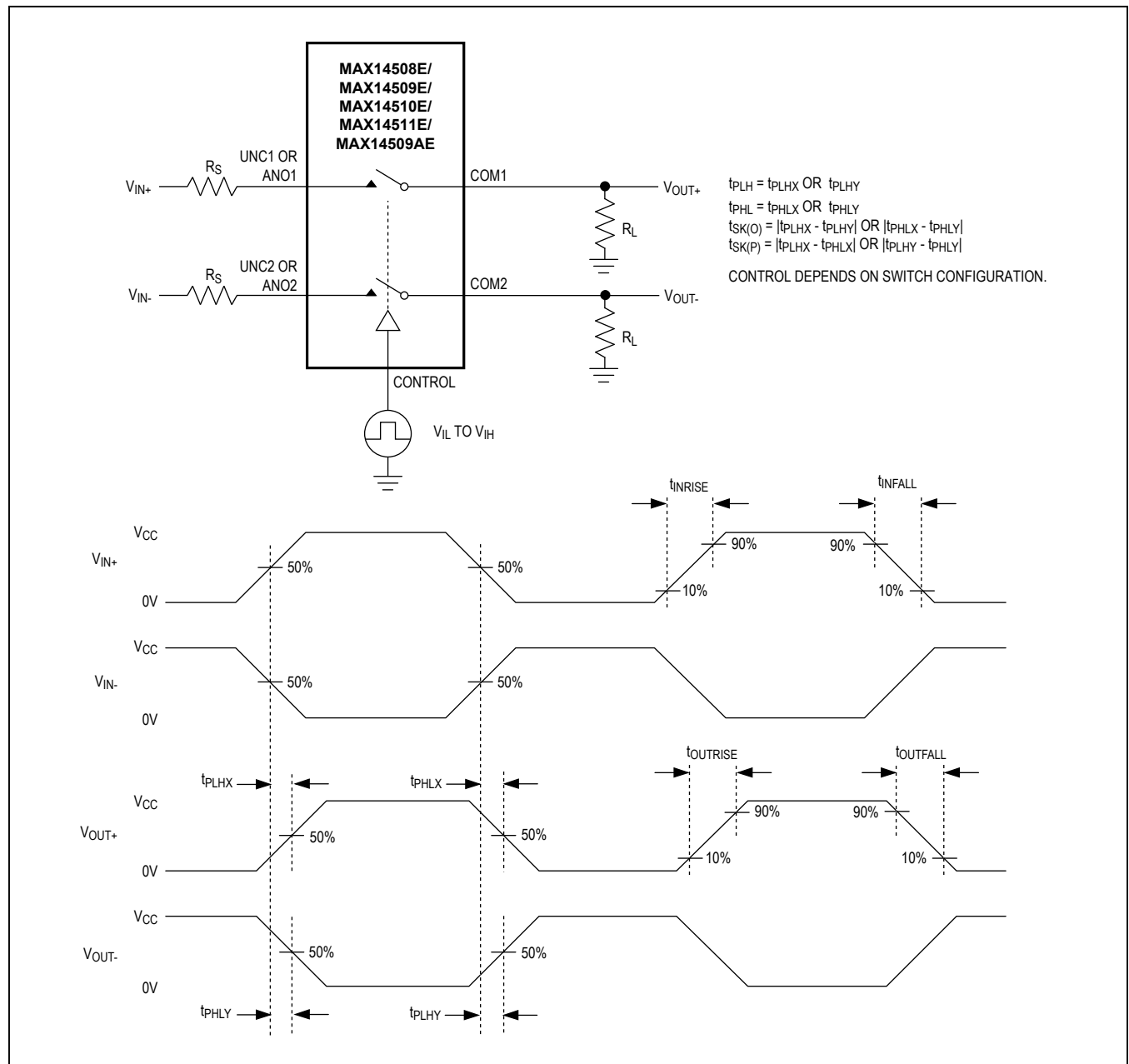


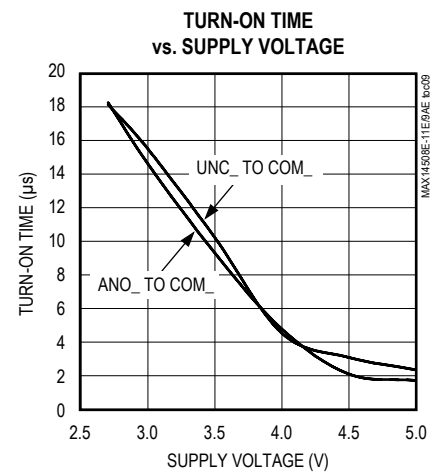
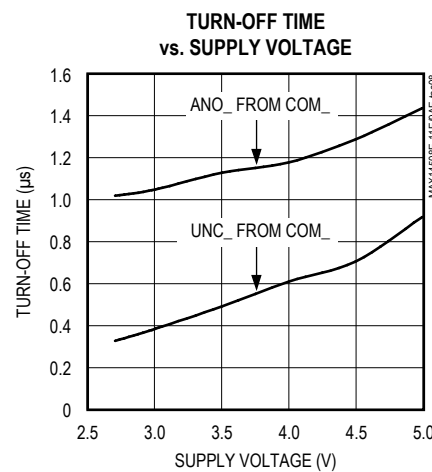
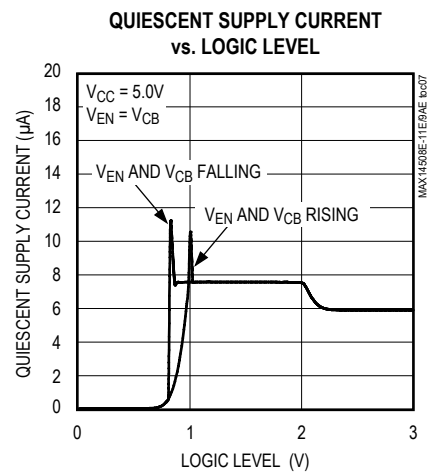
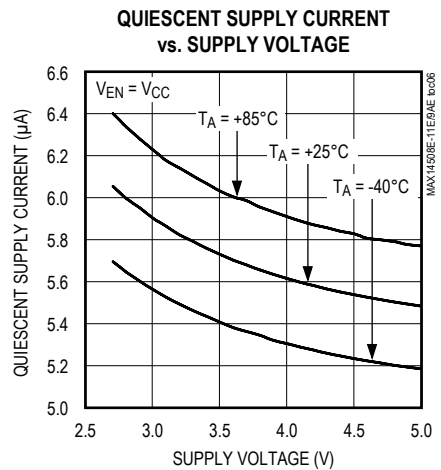
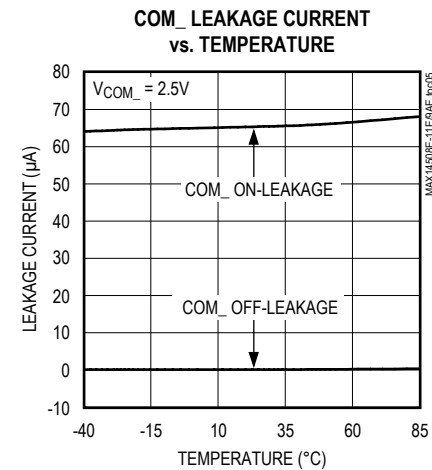
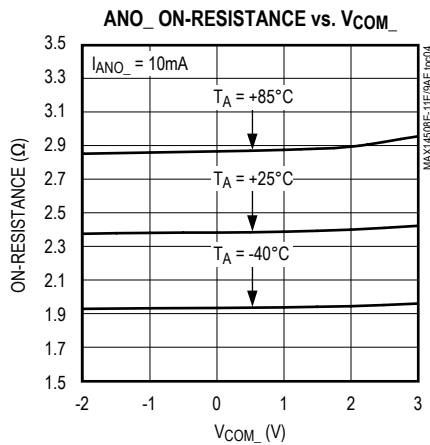
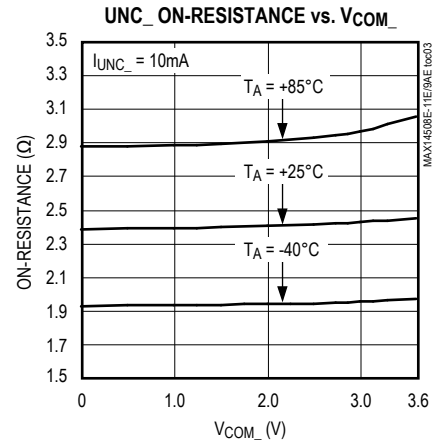
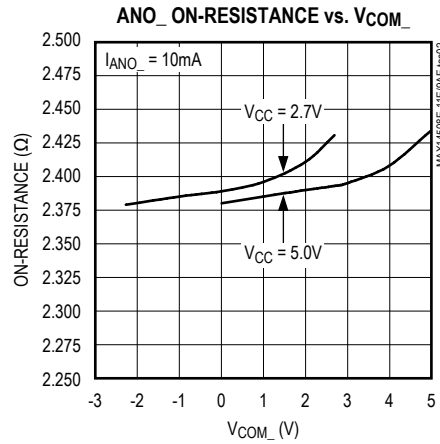
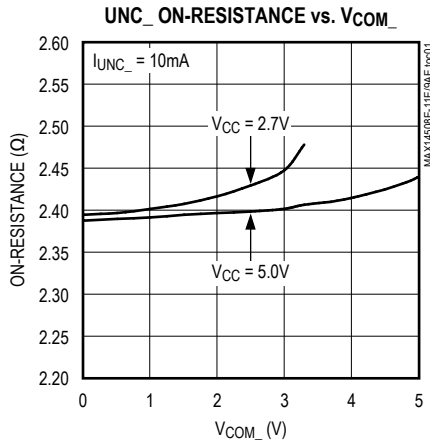
Figure 3. Output Skew

[illegible]

Figure 4. On-Loss, Off-Isolation, and Crosstalk

## Typical Operating Characteristics

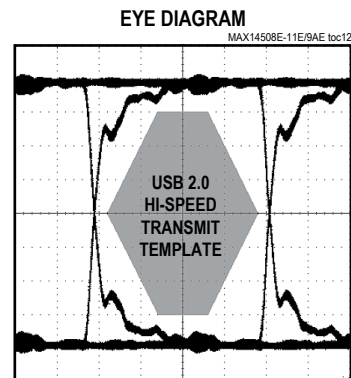
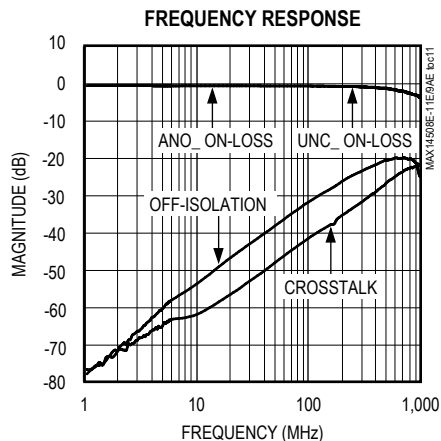
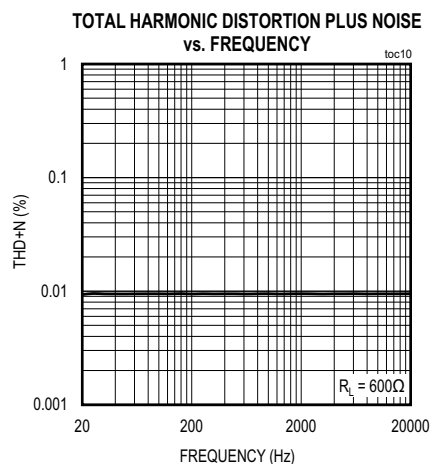
( $V_{CC} = 3.0V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)





## Typical Operating Characteristics (continued)

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



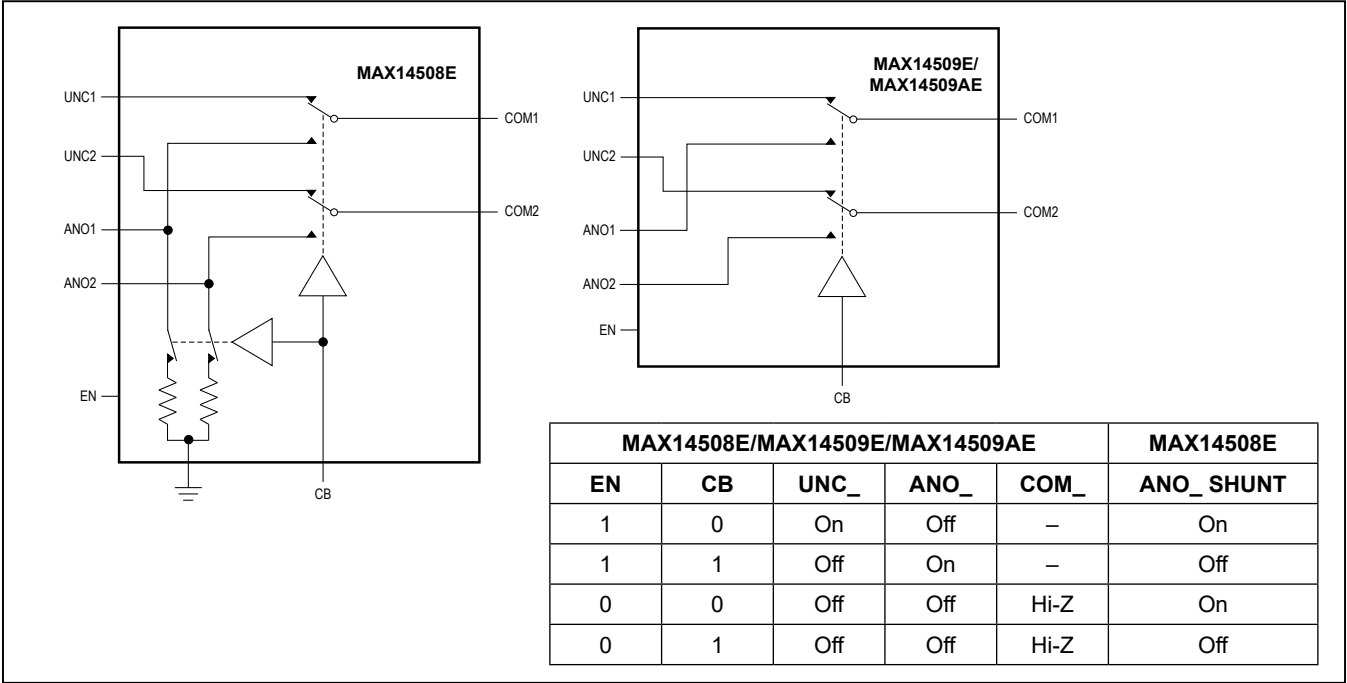
## Pin Description

| PIN                                    |                         | NAME     | FUNCTION                                                                                                                                                                      |
|----------------------------------------|-------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MAX14508E/<br>MAX14509E/<br>MAX14509AE | MAX14510E/<br>MAX14511E |          |                                                                                                                                                                               |
| 1                                      | 1                       | UNC1     | USB Input 1. Normally closed terminal for switch 1.                                                                                                                           |
| 2                                      | 2                       | ANO2     | Audio Input 2. Normally open terminal for switch 2.                                                                                                                           |
| 3                                      | 3                       | ANO1     | Audio Input 1. Normally open terminal for switch 1.                                                                                                                           |
| 4                                      | 4                       | GND      | Ground                                                                                                                                                                        |
| 5                                      | 5                       | $V_{CC}$ | Positive Supply-Voltage Input. Bypass $V_{CC}$ to GND with a 0.1 $\mu F$ capacitor as close to the device as possible.                                                        |
| 6                                      | 6                       | COM1     | Common Terminal for Switch 1                                                                                                                                                  |
| 7                                      | 7                       | COM2     | Common Terminal for Switch 2                                                                                                                                                  |
| 8                                      | —                       | CB       | Digital Control Input. Drive CB low to connect COM_ to UNC_. Drive CB high to connect COM_ to ANO_.                                                                           |
| 9                                      | —                       | EN       | Active-High Enable Input. Drive EN high for normal operation. Drive EN low to put switches in high impedance. Do not connect negative signals to ANO_ or COM_ when EN is low. |
| 10                                     | 10                      | UNC2     | USB Input 2. Normally closed terminal for switch 2.                                                                                                                           |
| —                                      | 8                       | AOR      | Audio Override Input. Drive AOR low to have VB control the switch. Drive AOR high to connect COM_ to ANO_. AOR has an internal pulldown resistor to GND.                      |
| —                                      | 9                       | VB       | VBUS Detection Input. If $V_{VB} \geq V_{VBDET}$ , COM_ connects to UNC_. Otherwise, COM_ connects to ANO_.                                                                   |

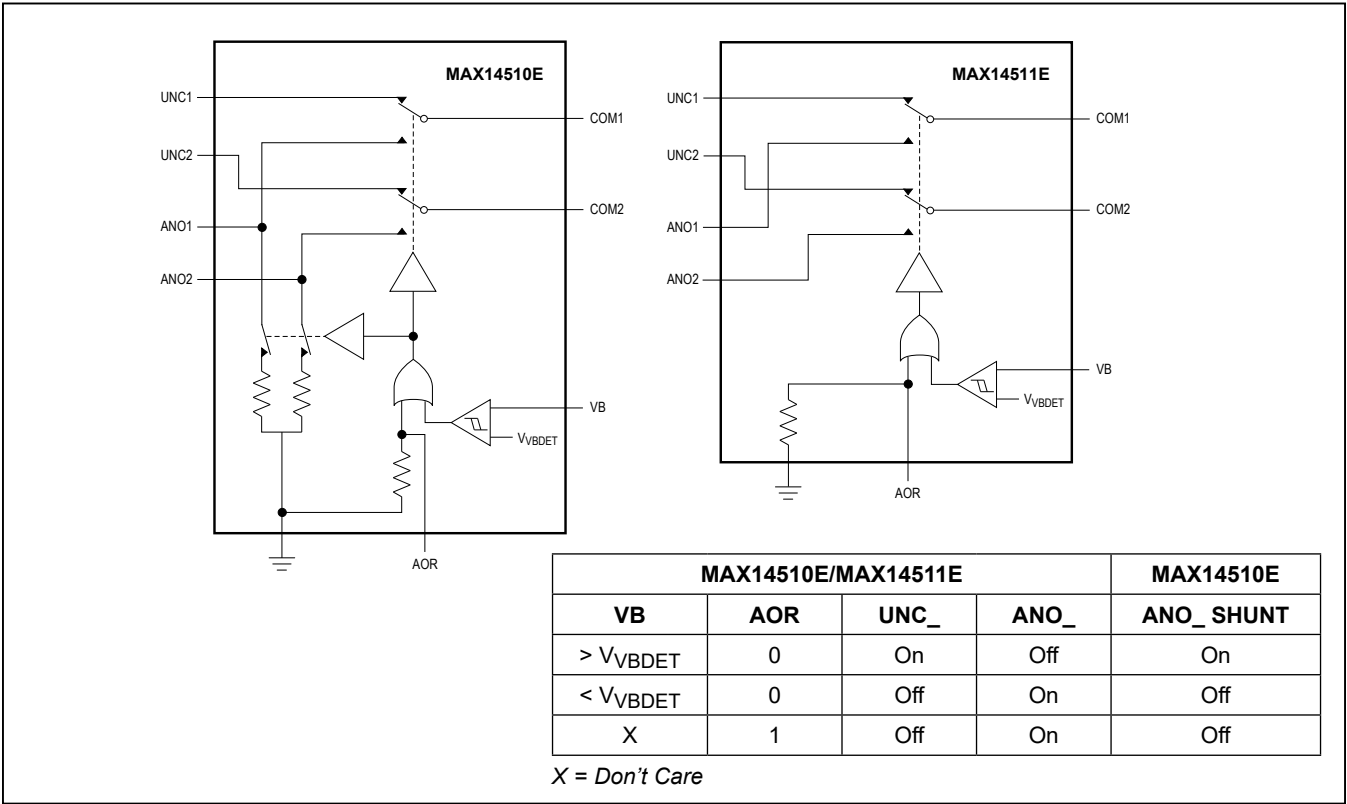
MAX14508E–MAX14511E/  
MAX14509AE

USB 2.0 Hi-Speed and Audio Switches  
with Negative Signal Capability

MAX14508E/MAX14509E/MAX14509AE Functional Diagrams/Truth Table



MAX14510E/MAX14511E Functional Diagrams/Truth Table



## MAX14508E–MAX14511E/ MAX14509AE

### Detailed Description

The MAX14508E–MAX14511E/MAX14509AE are high-ESD-protected single DPDT switches that operate from a +2.7V to +5.0V supply and are designed to multiplex USB 2.0 Hi-Speed signals and AC-coupled analog signals. These switches combine the low on-capacitance ( $C_{ON}$ ) and low on-resistance ( $R_{ON}$ ) necessary for high-performance switching applications. These devices meet the requirements for USB low-speed and full-speed signaling. The negative signal capability of the analog channel allows signals below ground to pass through without distortion.

### Analog Signal Levels

The MAX14508E–MAX14511E/MAX14509AE are bidirectional, allowing ANO\_, UNC\_, and COM\_ to be configured as either inputs or outputs. Note that UNC\_ and ANO\_ are only protected against ESD up to  $\pm 2\text{kV}$  (Human Body Model) and may require additional ESD protection if used as outputs. These devices feature a charge pump that generates a negative supply to allow analog signals as low as  $V_{CC} - 5.0\text{V}$  to pass through ANO\_. This allows AC-coupled signals that drop below ground to pass when operating from a single power supply. The negative charge pump is controlled by the enable line and the output of the COM\_ fault protection circuit. The negative charge pump is active when EN is high and  $V_{COM\_} < V_{FP}$ . Note that if the fault protection is activated by a COM\_ voltage greater than  $V_{FP}$ , there must not be a negative voltage attached to the ANO\_ inputs. For the MAX14508E/MAX14509E/MAX14509AE connect negative signals to ANO\_ or COM\_ only when EN is driven high.

### Overvoltage Fault Protection

The MAX14508E–MAX14511E feature overvoltage fault protection on COM\_, allowing compliance with USB requirements for voltage levels. Fault protection is triggered if the voltage applied to COM\_ rises above  $V_{FP}$ , protecting the switch and USB transceiver from damaging voltage levels.

### VBUS Detection Input

The MAX14510E/MAX14511E feature a VBUS detection input (VB) that connects COM\_ to UNC\_ when  $V_{VB}$  exceeds the VBUS detection threshold ( $V_{VBDET}$ ). For applications where VBUS is always present, drive the Audio Override Input (AOR) high to connect ANO\_ to COM\_ (see the [MAX14510E/MAX14511E Functional Diagrams/Truth Table](#)). Drive AOR low to have VB control the switch position. Drive AOR rail-to-rail to minimize power consumption.

## USB 2.0 Hi-Speed and Audio Switches with Negative Signal Capability

### Digital Control Input (CB)

The MAX14508E/MAX14509E/MAX14509AE provide a single-bit control logic input, CB. CB controls the switch position as shown in the [MAX14508E/MAX14509E/MAX14509AE Functional Diagrams/Truth Table](#). Drive CB rail-to-rail to minimize power consumption.

### Enable Input (EN)

The MAX14508E/MAX14509E/MAX14509AE feature a shutdown mode that reduces the supply current to less than 10nA and places the switches in high impedance. Drive EN low to place the devices in shutdown mode. Drive EN high for normal operation.

### Click-and-Pop Suppression

The switched 100 $\Omega$  shunt resistors on the MAX14508E/MAX14510E automatically discharge any capacitance at the ANO\_ terminals when they are unconnected from COM\_. This reduces audio click-and-pop sounds that may occur when switching between USB and audio sources.

## Applications Information

### Extended ESD Protection

ESD-protection structures are incorporated on all pins to protect against electrostatic discharges up to  $\pm 2\text{kV}$  (Human Body Model) encountered during handling and assembly. COM1 and COM2 are further protected against ESD up to  $\pm 15\text{kV}$  (Human Body Model) without damage. **The ESD structures withstand high ESD both in normal operation and when the device is powered down.** After an ESD event, the MAX14508E–MAX14511E/MAX14509AE continue to function without latchup.

### ESD Test Conditions

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test setup, test methodology, and test results.

### Human Body Model

[Figure 5](#) shows the Human Body Model. [Figure 6](#) shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest that is then discharged into the device through a 1.5k $\Omega$  resistor.

### Layout

USB Hi-Speed requires careful PCB layout with 45 $\Omega$  single-ended/90 $\Omega$  differential controlled-impedance matched traces of equal lengths. Ensure that bypass capacitors are as close to the device as possible. Use large ground planes where possible.

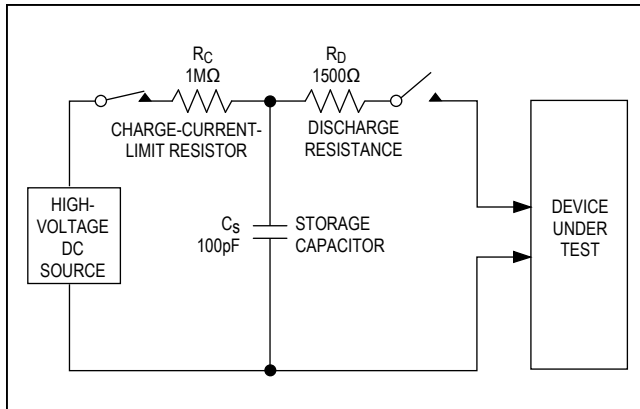


Figure 5. Human Body ESD Test Model

### Power-Supply Sequencing

**Caution:** Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the device.

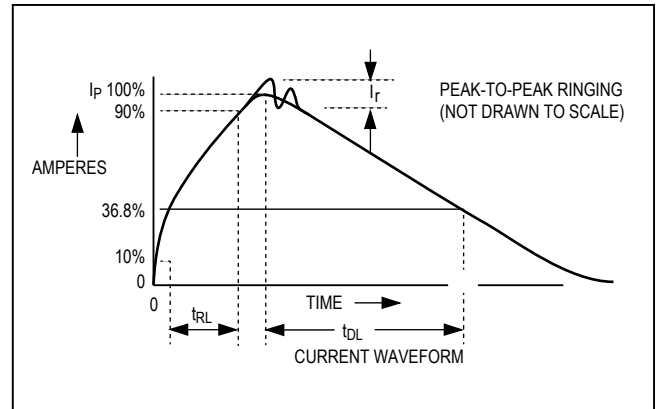


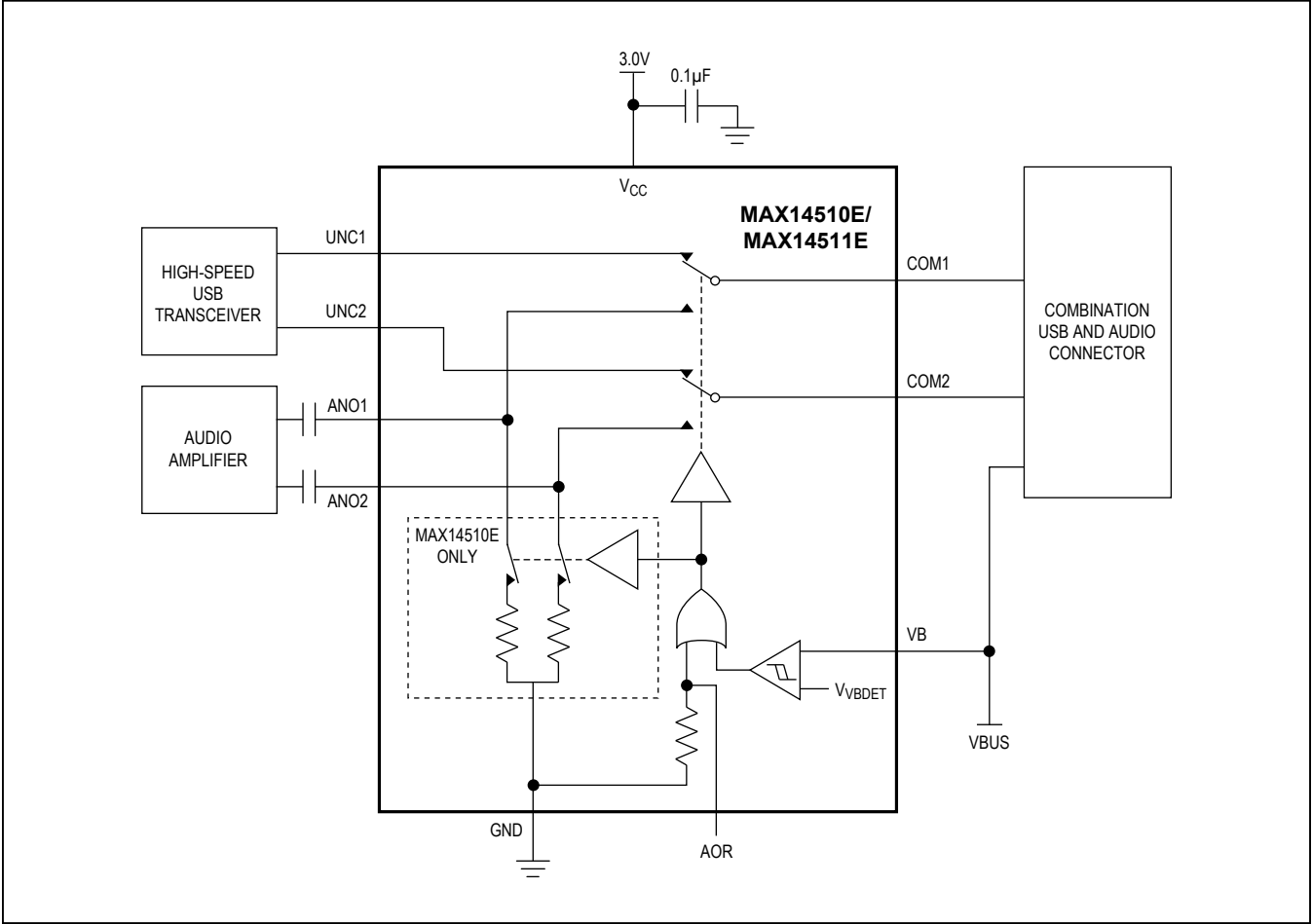
Figure 6. Human Body Current Waveform

Proper power-supply sequencing is recommended for all devices. Apply  $V_{CC}$  before applying analog signals, especially if the analog signal is not current limited.

MAX14508E–MAX14511E/  
MAX14509AE

USB 2.0 Hi-Speed and Audio Switches  
with Negative Signal Capability

Typical Operating Circuit



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 | OUTLINE NO.             |
|-------------------|--------------|-------------------------|
| 10 Ultra-Thin QFN | V101A1CN+1   | <a href="#">21-0028</a> |

## Revision History

| REVISION<br>NUMBER | REVISION<br>DATE | DESCRIPTION                                                                                                                                                                                                             | PAGES<br>CHANGED  |
|--------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 0                  | 5/08             | Initial release                                                                                                                                                                                                         | —                 |
| 1                  | 3/09             | Released the MAX14510E, updated <i>Absolute Maximum Ratings</i> , <i>Electrical Characteristics</i> , Figure 4, and <i>Layout</i> section.                                                                              | 1, 2, 3, 5, 8, 12 |
| 2                  | 5/17             | Updated Total Harmonic Distortion Plus Noise typical value in <i>Electrical Characteristics</i> table and updated TOC10 in <i>Typical Operating Characteristics</i> section, corrected THD+N, TOC10, and packaging code | 4, 10, 14         |
| 3                  | 11/17            | Updated <i>Electrical Characteristics</i> table                                                                                                                                                                         | 2, 4              |

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).

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### Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: [info@moschip.ru](mailto:info@moschip.ru)

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