19-0616; Rev 0; 7/06

EVALUATION KIT AVAILABLE

# USB 2.0 High-Speed, Fault-Tolerant 3:1, 4:1 Multiplexers



## General Description

The MAX4899E/MAX4899AE analog multiplexers combine the low on-capacitance ($C_{ON}$) and low on-resistance ($R_{ON}$) necessary for high-performance switching applications. These devices are designed for USB 2.0 high-speed applications at 480Mbps. The MAX4899E/MAX4899AE also handle all the requirements for USB low- and full-speed signaling.

The MAX4899E is a dual 3:1 multiplexer whereas the MAX4899AE is a dual 4:1 multiplexer. The MAX4899E/MAX4899AE feature two digital inputs, $C_0$ and $C_1$, to control the analog signal path. Typical applications include switching a USB connector between USB and other operations such as serial communications, audio, and video.

An enable input ($\overline{EN}$) is provided to disable all channels and place the device into a high-impedance (off) state, as well as reducing power consumption.

The MAX4899E/MAX4899AE operate from a 2.7V to 3.6V power-supply voltage and are protected against +5.5V shorts to $COM_A$- and $COM_A$+. In addition, $COM_A$+ and $COM_A$- are normally connected to outside circuitry and feature ±15kV ESD protection. The MAX4899E/MAX4899AE are available in a 3mm x 3mm, 16-pin TQFN package and operate over the -40°C to +85°C temperature range.

## Applications

Cell Phones

Digital Still Cameras

PDAs

Digital Video Cameras

MPEG-4 Players

Portable GPS

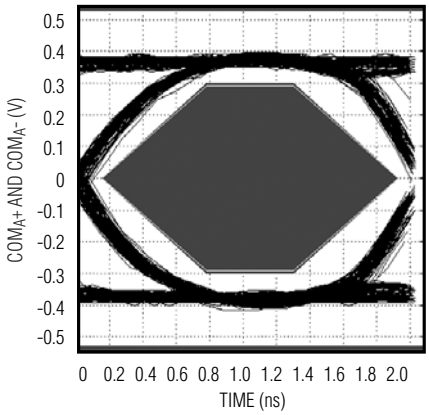
Combination Products

KVM

## Features

- **Single 2.7V to 3.6V Power-Supply Voltage**
- **Low 4Ω (typ) On-Resistance ($R_{ON}$)**
- **-3dB Bandwidth: 425MHz**
- **Fault Tolerant to Meet Full USB 2.0 Specification**
- **COM_ Protected to ±15kV ESD Protection per Human Body Model (MIL-STD-883; Method 3015)**
- **Low Operating Current (200µA), Ultra-Low Quiescent Current (3.0µA max) in Standby Mode**
- **Low Threshold Eliminates the Need for Translators in 1.8V Low Voltage Systems**
- **Tiny 16-Pin, 3mm x 3mm, Lead-Free TQFN Package**

## Eye Diagram




**NOTE:** UI = 2.08ns
MASK = USB 2.0 HIGH SPEED

***Pin Configurations appear at end of data sheet.***

## Ordering Information/Selector Guide

| PART | PIN-PACKAGE | MUX CONFIGURATION | TOP MARK | PKG CODE |
|---|---|---|---|---|
| **MAX4899E**ETE+ | 16 TQFN-EP* | DUAL 3:1 | AEY | T1633-4 |
| **MAX4899AE**ETE+ | 16 TQFN-EP* | DUAL 4:1 | AEZ | T1633-4 |

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

*+Denotes lead-free package.*
**EP = Exposed paddle.*

# USB 2.0 High-Speed, Fault-Tolerant 3:1, 4:1 Multiplexers

## ABSOLUTE MAXIMUM RATINGS

(All Voltages Referenced to GND.)
V+ .....-0.3V to +4V
$\overline{QP}$, $\overline{EN}$, $C_0$, $C_1$, (Note 1) .....-0.3V to +4V
$COM_{A+}$, $COM_{A\_}$, USB0+, USB0-, USB1+, USB1-, USB2+, USB2-, USB3+, USB3- .....-0.3V to +5.5V
Continuous Current ($COM_{A\_}$ to USB_) .....±120mA
Peak Current ($COM_{A\_}$ to USB_) (pulsed at 1ms, 10% duty cycle) .....±240mA

Continuous Power Dissipation ($T_A$ = +70°C)
16-Pin TQFN (derate 20.8mW/°C above +70°C) .....1667mW
Operating Temperature Range .....-40°C to +85°C
Storage Temperature Range .....-65°C to +150°C
Junction Temperature .....+150°C
Lead Temperature (soldering, 10s) .....+300°C

**Note 1:** Signals exceeding GND are clamped by internal diodes. Limit forward-diode current to maximum current rating.

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

## ELECTRICAL CHARACTERISTICS

(V+ = +2.7V to +3.6V, $T_A$ = -40°C to +85°C, $\overline{QP}$ = low, $\overline{EN}$ = low, unless otherwise noted. Typical values are at V+ = +3.3V and $T_A$ = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| **ANALOG SWITCH ($COM_{A\_}$, USB__)** | | | | | | | |
| On-Resistance | $R_{ON}$ | V+ = 2.7V, $I_{COMA\_}$ = -10mA, $V_{COMA\_}$ = 0V, 1.5V, $\overline{QP}$ = low | $T_A$ = +25°C | | 4 | 5 | Ω |
| | | | $T_A$ = -40°C to +85°C | | | 6 | |
| | | V+ = 2.7V, $I_{COMA\_}$ = -10mA, $V_{COM\_}$ = 0V, 1.5V, 2.7V, $\overline{QP}$ = low | $T_A$ = +25°C | | 4 | 7 | |
| | | | $T_A$ = -40°C to +85°C | | | 8 | |
| | | V+ = 2.7V, $I_{COMA\_}$ = -10mA, $V_{COMA\_}$ = 0V, 1.5V, $\overline{QP}$ = high | $T_A$ = +25°C | | 8 | 17 | |
| | | | $T_A$ = -40°C to +85°C | | | 18 | |
| | | V+ = 3.0V, $I_{COMA\_}$ = -10mA, $V_{COMA\_}$ = 0V, 1.5V, $\overline{QP}$ = high | $T_A$ = +25°C | | 4 | 12 | |
| | | | $T_A$ = -40°C to +85°C | | | 13 | |
| On-Resistance Match Between Channels | $\Delta R_{ON}$ | V+ = 2.7V, $I_{COMA\_}$ = -10mA, $V_{COMA\_}$ = 0V, 1.5V, 2.7V | $T_A$ = +25°C | | 0.5 | 0.8 | Ω |
| | | | $T_A$ = -40°C to +85°C | | | 1.0 | |
| On-Resistance Flatness | $R_{FLAT (ON)}$ | V+ = 2.7V, $I_{COMA\_}$ = -10mA, $V_{COMA\_}$ = 0V, 1.5V, 2.7V | | | 0.5 | 1.1 | Ω |
| Off-Leakage Current | $I_{L(OFF)}$ | V+ = 3.6V, $V_{COMA\_}$ = $V_{USB\_\_}$ = 0.3V, 3.3V | | -1 | | +1 | µA |
| On-Leakage Current | $I_{L(ON)}$ | V+ = 3.6V, $V_{COMA\_}$ = $V_{USB\_\_}$ = 0.3V, 3.3V | | -1 | | +1 | µA |
| Quiescent Supply Current | I+ | V+ = 3.6V, $C_0$ = $C_1$ = 0 or V+ | $\overline{QP}$ = low | | 250 | 600 | µA |
| | | | $\overline{QP}$ = high | | | 3 | |
| Fault-Protection Trip Threshold | $V_{FP}$ | V+ = 3.3V | | 3.6 | 3.9 | 4.2 | V |
| **ESD PROTECTION** | | | | | | | |
| $COM_{A+}$, $COM_{A-}$ | | Human Body Model | | | ±15 | | kV |

## ELECTRICAL CHARACTERISTICS (continued)

(V+ = +2.7V to +3.6V, $T_A$ = -40°C to +85°C, $\overline{QP}$ = low, $\overline{EN}$ = low, unless otherwise noted. Typical values are at V+ = +3.3V and $T_A$ = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **SWITCH AC PERFORMANCE (Note 3)** | | | | | | |
| On-Loss | $ON_{LOSS}$ | f = 10MHz, 0 < $V_{IN}$ < 1V, Figure 1 | | 0.5 | | dB |
| Crosstalk | $V_{CT1}$, $V_{DCT1}$ | f = 50MHz, Figure 1 | | -50 | | dB |
| Off-Isolation | $V_{ISO}$ | f = 50MHz, Figure 1 | | -45 | | dB |
| Charge-Pump Noise | $V_{QP}$ | $COM_{A\_}$, USB_, $R_L$ = $R_S$ = 50Ω (Note 4) | | 100 | | µV |
| Bandwidth -3dB | BW | $R_S$ = $R_L$ = unbalanced 50Ω | | 425 | | MHz |
| Off-Capacitance | $C_{OFF}$ | f = 1MHz, $COM_{A\_}$, USB_, Figure 2 | | 10.5 | | pF |
| On-Capacitance | $C_{ON}$ | f = 1MHz, $COM_{A\_}$, USB_, Figure 2 | | 15 | | pF |
| Propagation Delay | $t_{PD}$ | $R_L$ = $R_S$ = 50Ω, Figure 3 | | 200 | | ps |
| Output Skew Same Switch | $t_{SK}$ | Skew between opposite transitions in same switch, Figure 3 | | 100 | | ps |
| Fault-Protection Response Time | $t_{FP}$ | $V_{COMA\_}$ = 0V to 5V to $V_{USB\_\_}$ = 2.5V, $R_L$ = 50Ω, $C_L$ = 10pF, Figure 4 | | 1 | | µs |
| Fault-Protection Recovery Time | $t_{FPR}$ | $V_{COMA\_}$ = 5V to 3V to $V_{USB\_\_}$ = 1.5V, $R_L$ = 50Ω, $C_L$ = 10pF, Figure 4 | | 1 | | µs |
| Charge Injection | Q | $V_{GEN}$ = 0, $C_L$ = 1000pF, Figure 5 | | 25 | | pC |
| Enable Turn-On Time | $t_{ON}$ | $V_{USB0+}$ = V+, $R_L$ = 50Ω, $C_L$ = 10pF, Figure 6 | | 2.8 | | µs |
| Enable Turn-Off Time | $t_{OFF}$ | $V_{USB0+}$ = V+, $R_L$ = 50Ω, $C_L$ = 10pF, Figure 6 | | 3 | | ns |
| Address Transition Time | $t_{TRANS}$ | $V_{USB0+}$ = V+, $R_L$ = 50Ω, $C_L$ = 10pF, Figure 7 | | 1.2 | | µs |
| Total Harmonic Distortion Plus Noise | THD+N | f = 20Hz to 20kHz, $V_{COMA\_}$ = $1V_{P-P}$, $R_L$ = 600Ω | | 0.02 | | % |
| **SWITCH LOGIC ($\overline{QP}$, $\overline{EN}$, $C_0$, $C_1$)** | | | | | | |
| Logic-Input Voltage Low | $V_{IL}$ | | | | 0.4 | V |
| Logic-Input Voltage High | $V_{IH}$ | | 1.4 | | | V |
| Input Logic Hysteresis | $V_{HYST}$ | | | 100 | | mV |
| Input Leakage Current | $I_{LEAK}$ | V+ = 3.6V, $C_0$ = 0 or V+, $C_1$ = 0 or V+ | -1 | | 1 | µA |

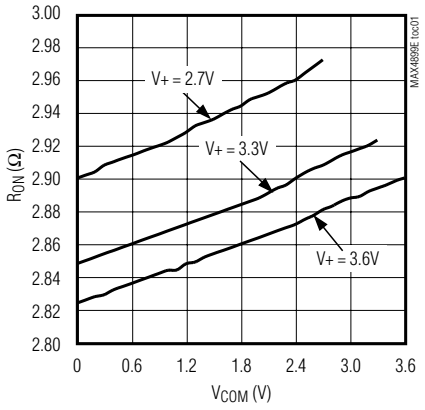
**Note 2:** Limits at -40°C are guaranteed by design.
**Note 3:** Guaranteed by design.
**Note 4:** Charge-pump noise is specified as a peak-to-peak value.

# USB 2.0 High-Speed, Fault-Tolerant 3:1, 4:1 Multiplexers

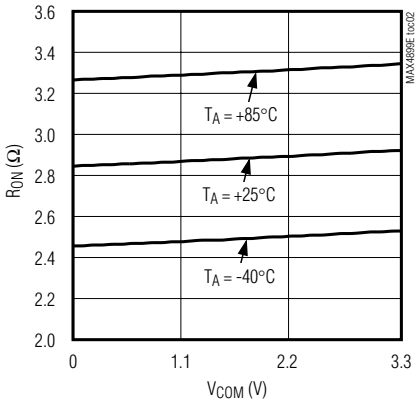
## Typical Operating Characteristics

(V+ = 3.3V, $\overline{QP}$ = $\overline{EN}$ = low, $T_A$ = +25°C, unless otherwise noted.)

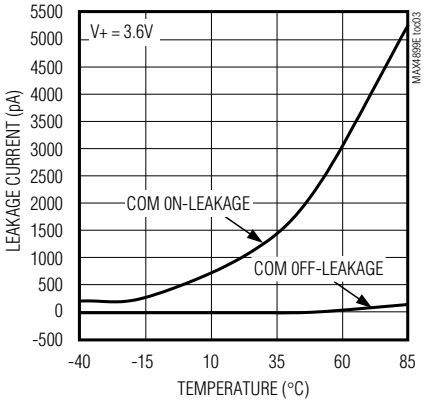
**ON-RESISTANCE vs. $V_{COM}$**



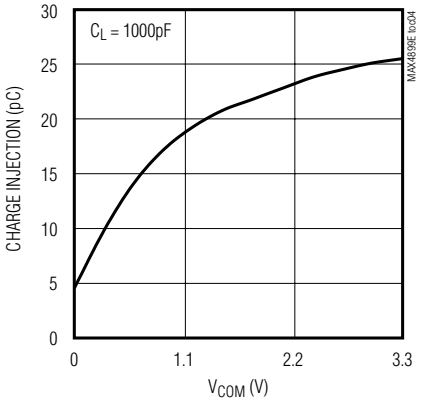

**ON-RESISTANCE vs. $V_{COM}$**



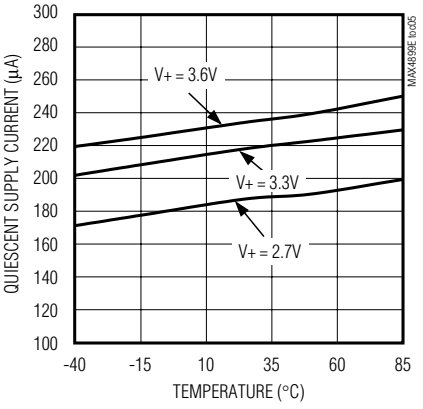

**LEAKAGE CURRENT vs. TEMPERATURE**



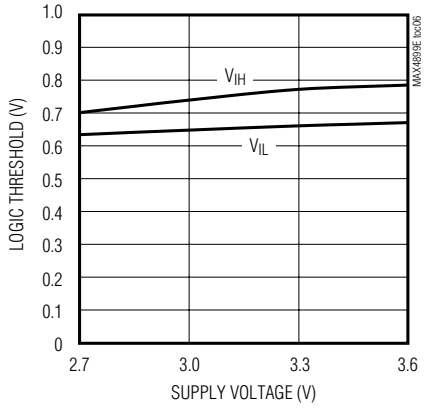

**CHARGE INJECTION vs. $V_{COM}$**



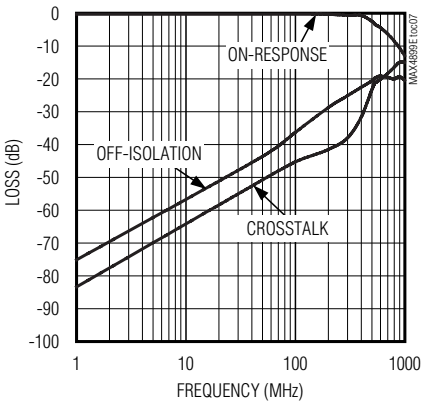

**QUIESCENT SUPPLY CURRENT vs. TEMPERATURE**



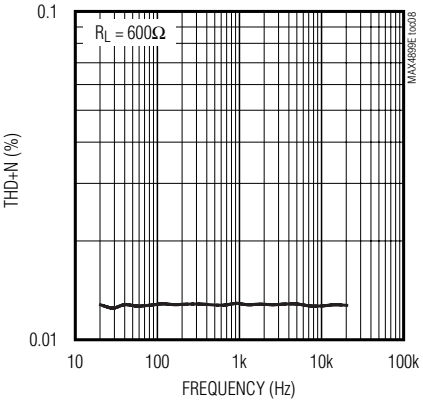

**LOGIC THRESHOLD vs. SUPPLY VOLTAGE**



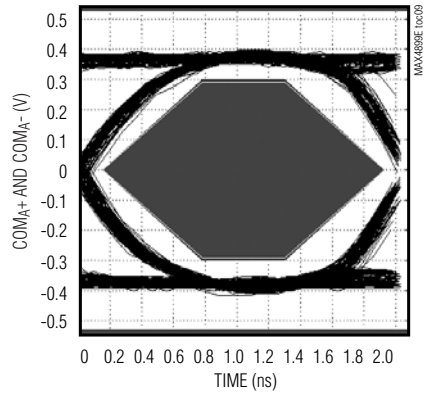

**FREQUENCY RESPONSE**




**TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY**




**EYE DIAGRAM**



## Pin Description

| PIN | | NAME | FUNCTION |
|---|---|---|---|
| MAX4899E | MAX4899AE | | |
| 1 | 1 | GND | Ground |
| 2 | 2 | $COM_A+$ | Analog Switch Common D+ Terminal |
| 3 | 3 | $COM_A-$ | Analog Switch Common D- Terminal |
| 4 | 4 | V+ | Positive Supply-Voltage Input. Connect V+ to a 2.7V to 3.6V supply voltage. Bypass V+ to GND with a 0.1µF capacitor placed as close as possible to the device. |
| 5 | 5 | $C_1$ | Digital Control Input 1. $C_1$ and $C_0$ control the analog signal path as shown in the *Functional Diagrams section*. |
| 6 | 6 | $C_0$ | Digital Control Input 0. $C_1$ and $C_0$ control the analog signal path as shown in the *Functional Diagrams section*. |
| 7, 8 | — | N.C. | No Connection. Not internally connected. |
| — | 7 | USB3- | Analog Switch 3 D- Terminal |
| — | 8 | USB3+ | Analog Switch 3 D+ Terminal |
| 9 | 9 | USB2- | Analog Switch 2 D- Terminal |
| 10 | 10 | USB2+ | Analog Switch 2 D+ Terminal |
| 11 | 11 | USB1+ | Analog Switch 1 D+ Terminal |
| 12 | 12 | USB1- | Analog Switch 1 D- Terminal |
| 13 | 13 | USB0+ | Analog Switch 0 D+ Terminal |
| 14 | 14 | USB0- | Analog Switch 0 D- Terminal |
| 15 | 15 | $\overline{EN}$ | Active-Low Enable Input. For normal operation, drive $\overline{EN}$ low. Drive $\overline{EN}$ high to place all channels in a high-impedance state. The internal charge pump is turned off when $\overline{EN}$ is a logic-high. |
| 16 | 16 | $\overline{QP}$ | Active-Low Charge-Pump Enable Input. Drive $\overline{QP}$ low for normal operation. Drive $\overline{QP}$ high to disable the charge pump with the switches still active at a reduced analog signal range and higher $R_{ON}$. |
| — | — | EP | Exposed Paddle. Connect EP to GND. |

# USB 2.0 High-Speed, Fault-Tolerant 3:1, 4:1 Multiplexers

## Test Circuits/Timing Diagrams

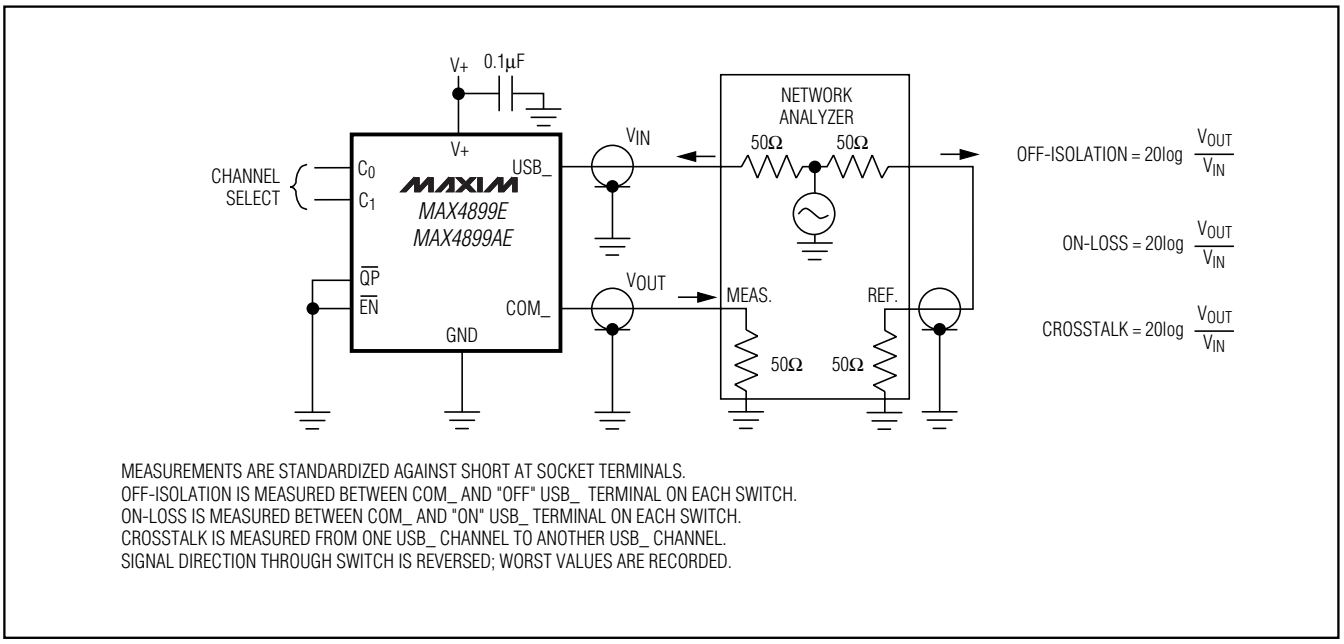



*Figure 1. Off-Isolation, On-Loss, and Crosstalk*

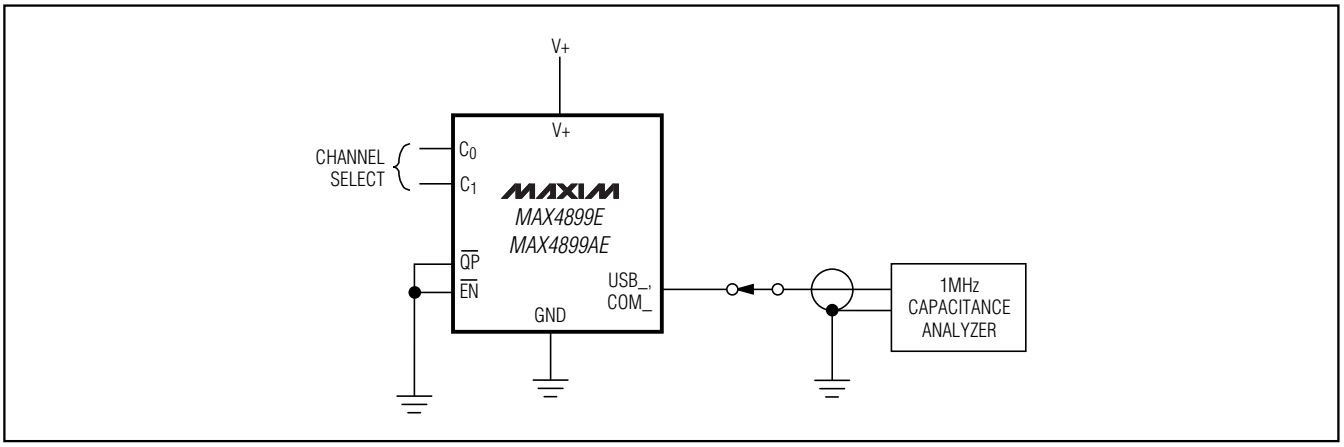



*Figure 2. Channel Off-/On-Capacitance*

## Test Circuits/Timing Diagrams (continued)

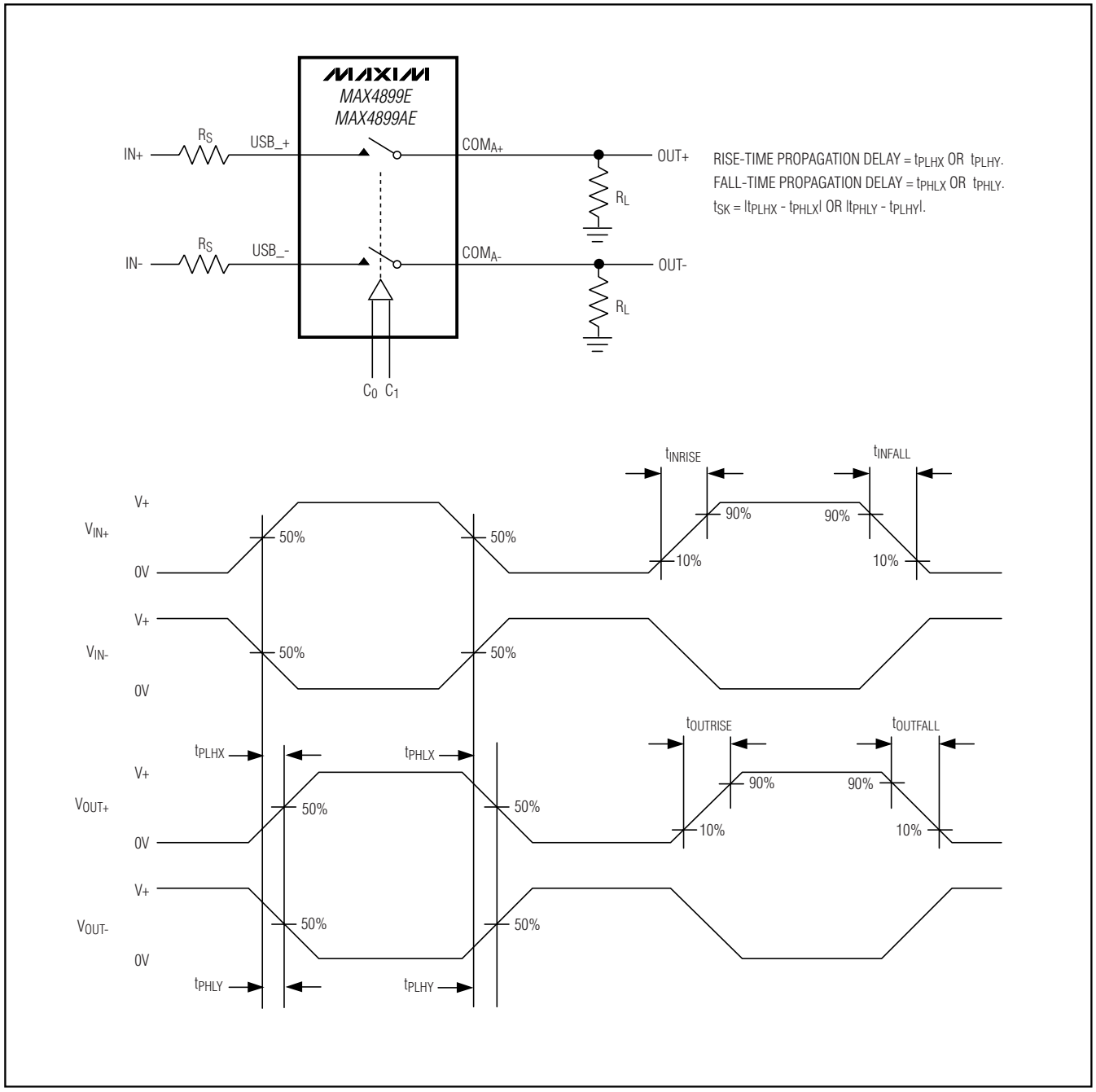



*Figure 3. Propagation Delay and Output Skew*

# USB 2.0 High-Speed, Fault-Tolerant 3:1, 4:1 Multiplexers

## Test Circuits/Timing Diagrams (continued)

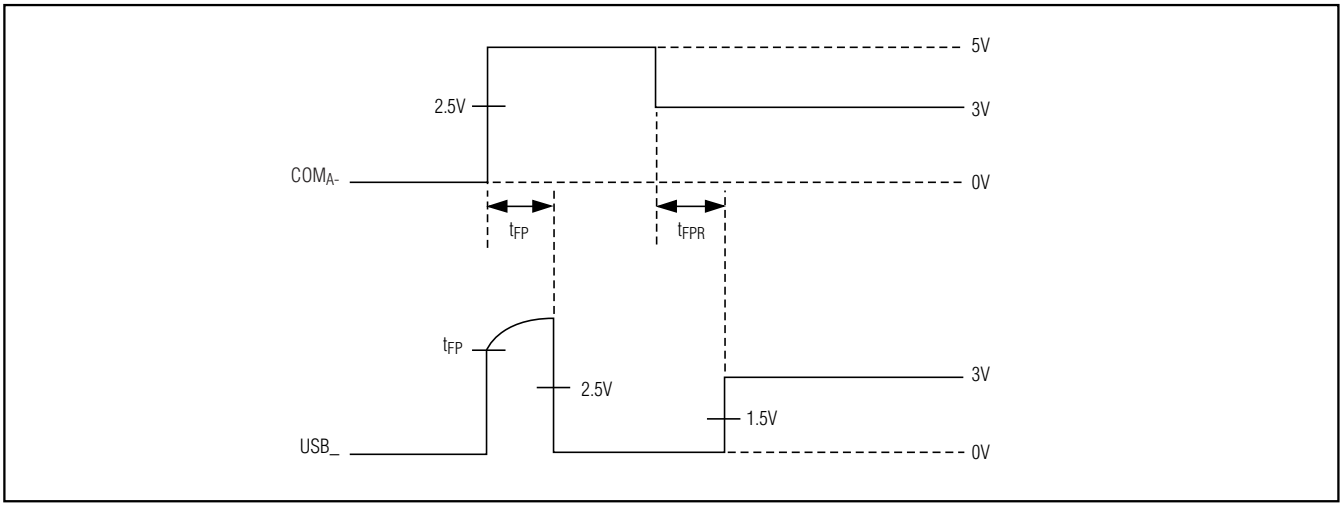



*Figure 4. Fault-Protection Response/Recovery Time*

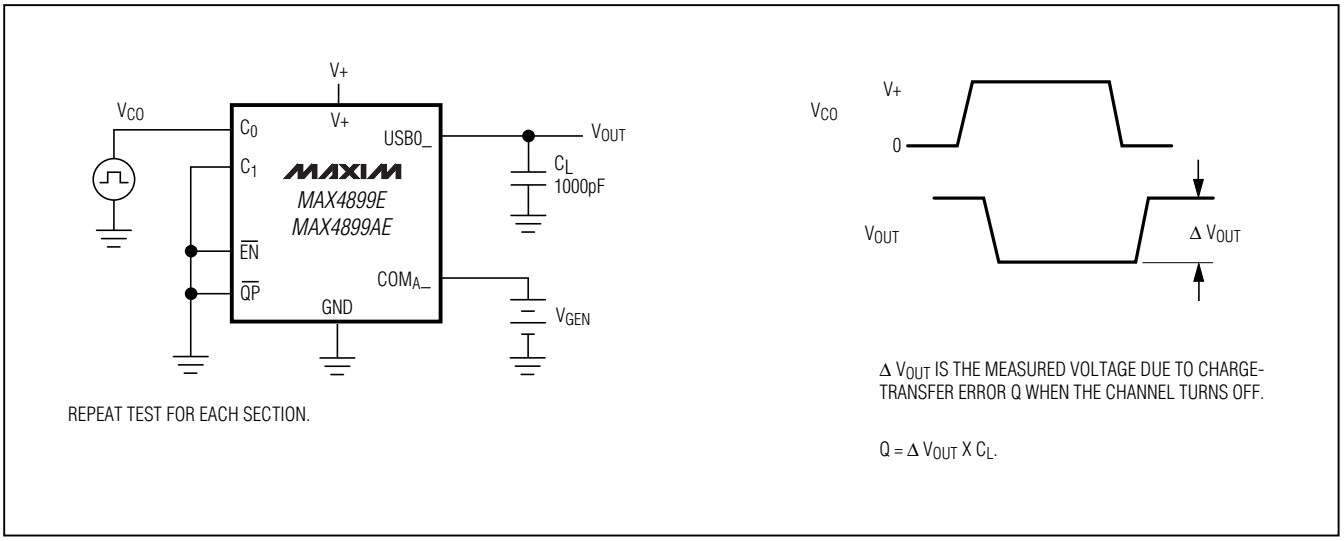



*Figure 5. Charge Injection*

## Test Circuits/Timing Diagrams (continued)

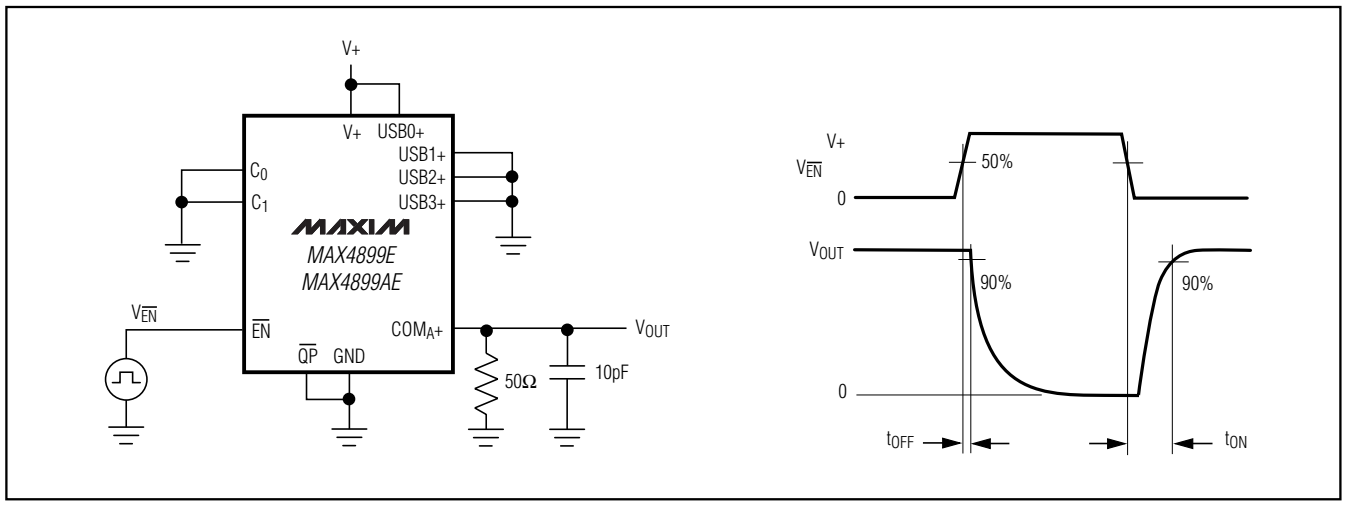



*Figure 6. Enable Switching Times*

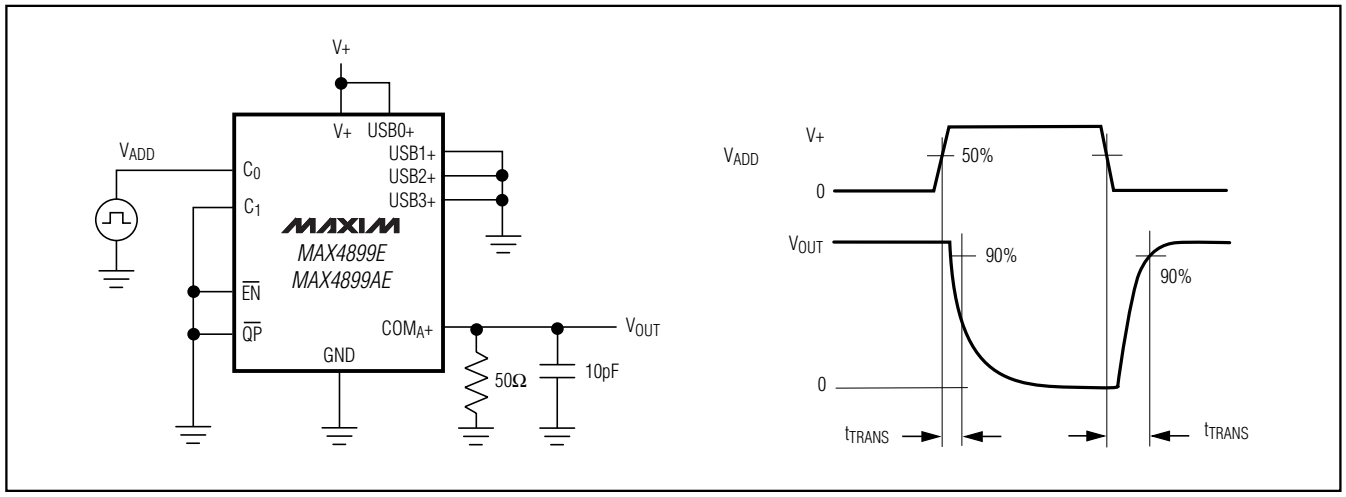



*Figure 7. Address Transition Time*

# USB 2.0 High-Speed, Fault-Tolerant 3:1, 4:1 Multiplexers

## Detailed Description

The MAX4899E/MAX4899AE analog multiplexers combine the low on-capacitance ($C_{ON}$) and low on-resistance ($R_{ON}$) necessary for high-performance switching applications. These devices are designed for USB 2.0 high-speed applications at 480Mbps. The MAX4899E/MAX4899AE also handle all the requirements for USB low- and full-speed signaling. In the case of USB low/full speed, these devices can function normally even if the supply voltage is 2.7V, even though the USB signal may be higher than the supply voltage.

The MAX4899E is a dual 3:1 multiplexer, whereas the MAX4899AE is a dual 4:1 multiplexer. The MAX4899E/MAX4899AE feature two digital inputs, $C_0$ and $C_1$, to control the analog signal path. Typical applications include switching a USB connector between USB and other operations such as serial communications, audio, and video.

An enable input ($\overline{EN}$) is provided to disable all channels and place the device into a high-impedance (off) state, as well as shutting off the charge pump for minimum power consumption. The MAX4899E/MAX4899AE feature an additional charge-pump enable input ($\overline{QP}$) to disable the charge pump. The switches remain active at a lower analog signal range and higher $R_{ON}$.

The MAX4899E/MAX4899AE operate from a 2.7V to 3.6V power-supply voltage and are current-limit protected against +5.5V shorts to $COM_A$- and $COM_A$+.

### Digital Control Inputs ($C_0$, $C_1$)

The MAX4899E/MAX4899AE provide two digital control inputs ($C_0$, $C_1$) to select the analog signal path between the $COM_A$_ and USB__ channels. The truth tables for the MAX4899E/MAX4899AE are shown in the *Functional Diagrams.* Since the MAX4899E only has three USB__ channels, the code $C_1$:$C_0$ = 1:1 can be used to place all channels into a high-impedance state. This is particularly useful for eliminating the extra control line to the $\overline{EN}$ input that is normally used for disabling all channels. Driving $C_0$ and $C_1$ rail-to-rail minimizes power consumption.

### Enable Input ($\overline{EN}$)

The MAX4899E/MAX4899AE feature an enable input ($\overline{EN}$) that when driven high places all channels into a high-impedance state, as an all-off feature. The internal charge pump is also disabled when $\overline{EN}$ is high, thus minimizing the quiescent supply current. For normal operation, drive $\overline{EN}$ low.

### Charge-Pump Enable Input ($\overline{QP}$)

The charge-pump input ($\overline{QP}$) disables and enables the internal charge pump. Drive $\overline{QP}$ high to disable the charge pump and reduce the quiescent supply current. With the charge pump disabled, the MAX4899E/MAX4899AE still function normally; however, the analog signal range is reduced and the switch on-resistance ($R_{ON}$) is increased. The analog signal range with the charge pump disabled is 0V to 1.5V. For normal operation, drive $\overline{QP}$ low.

### Analog Signal Levels

Signals applied to $COM_A$+ are routed to the USB_+ terminals, and signals applied to $COM_A$- are routed to the USB_- terminals. These multiplexers are bidirectional, allowing $COM_A$_ and USB_ to be configured as either inputs or outputs. The D+ and D- notation in the *Pin Description* table is arbitrary and can be interchanged. For example, USB D+ signals can be applied to $COM_A$- and are routed to the USB_- terminals. Additionally, these multiplexers can be used for non-USB signals. $COM_A$+ and $COM_A$- are normally connected to outside circuitry and are ±15kV ESD protected.

The MAX4899E is a dual 3:1 multiplexer, allowing $COM_A$+ to be routed to one of three USB_+ channels, and $COM_A$- to be routed to one of three USB_- channels. The MAX4899AE is a dual 4:1 multiplexer, allowing $COM_A$+ to be routed to one of four USB_+ channels, and $COM_A$- to be routed to one of four USB_- channels.

### Overvoltage Fault Protection

The MAX4899E/MAX4899AE feature +5.5V fault protection to $COM_A$+ and $COM_A$-. When a fault occurs between 4.5V to 5.5V, the switch automatically goes into a current-limiting mode that limits current to less than 2mA. Fault protection prevents these switches and downstream devices from being damaged due to shorts to the USB bus voltage rail.

## Applications Information

### USB Switching

The MAX4899E/MAX4899AE analog multiplexers are fully compliant with the USB 2.0 specification. The low on-resistance and low on-capacitance of these multiplexers make them ideal for high-performance switching applications. The MAX4899E/MAX4899AE are ideal for routing USB data lines and for applications that require switching between different data types (see Figure 8).

### Board Layout

High-speed switches require proper layout and design procedures for optimum performance. Keep design-controlled impedance PC board traces as short as possible. Ensure that bypass capacitors are placed as close to the device as possible and use large ground planes where possible.

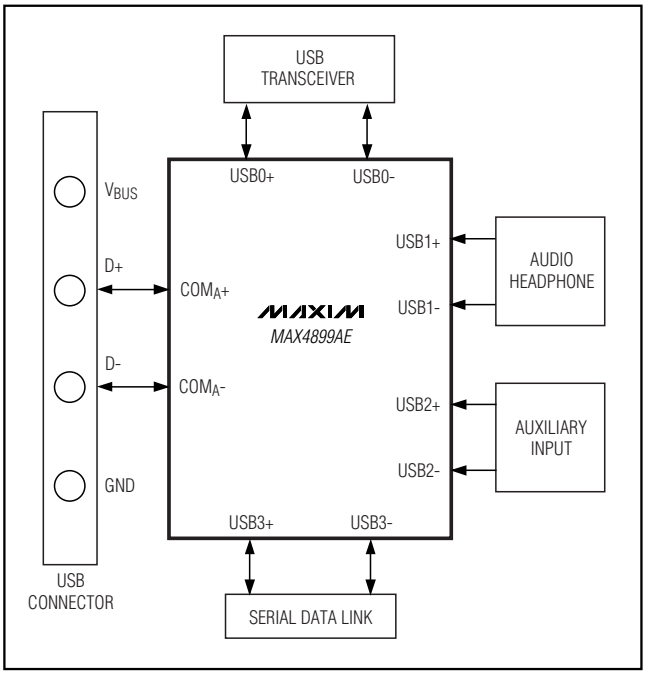



*Figure 8. MAX4899AE Multiplexing Four Data Types*

### ESD Protection

As with all Maxim devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The $COM_A$+ and $COM_A$- lines have extra protection against static electricity. Maxim's engineers have developed state-of-the-art structures to protect these pins against ESD of ±15kV without damage. The ESD structures withstand high ESD in all states: normal operation, tri-state output mode, and powered down. After an ESD event, Maxim's E-versions keep working without latch-up, whereas competing products can latch and must be powered down to remove latch-up.

### Human Body Model

The MAX4899E/MAX4899AE $COM_A$+ and $COM_A$- pins are characterized for ±15kV ESD protection using the Human Body Model (MIL-STD-883, Method 3015). Figure 9a shows the Human Body Model and Figure 9b 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, which is then discharged into the device through a 1.5kΩ resistor.

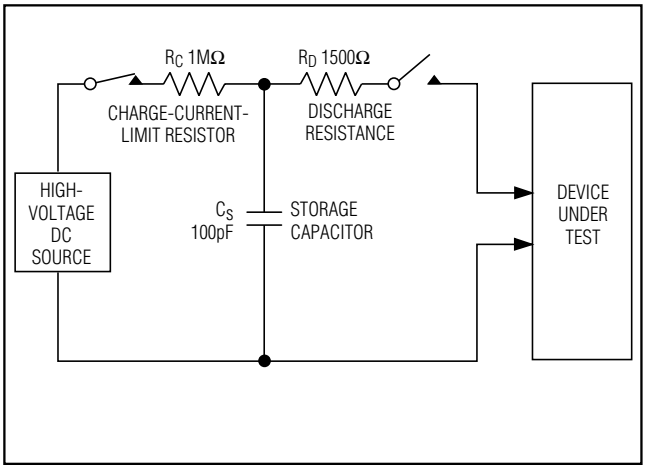



*Figure 9a. Human Body ESD Test Model*

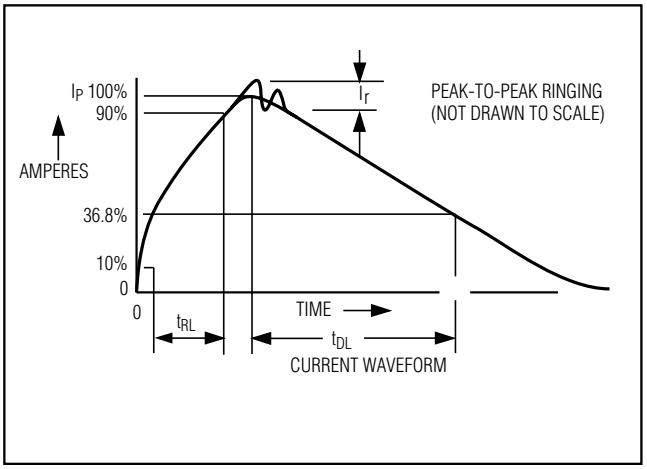


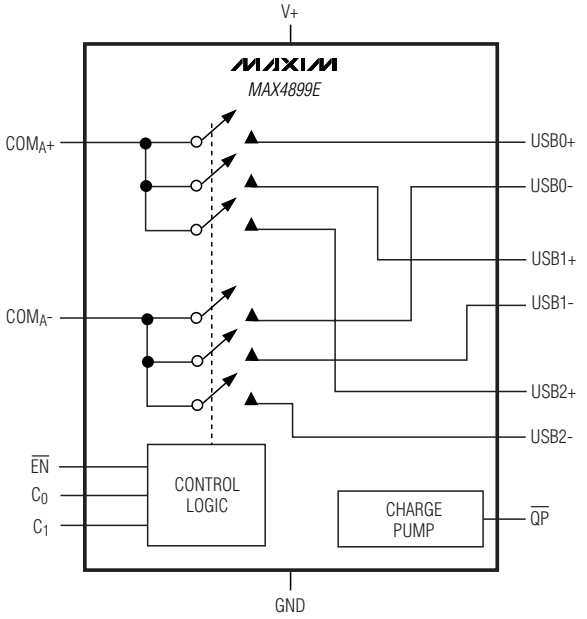

*Figure 9b. Human Body Model Current Waveform*

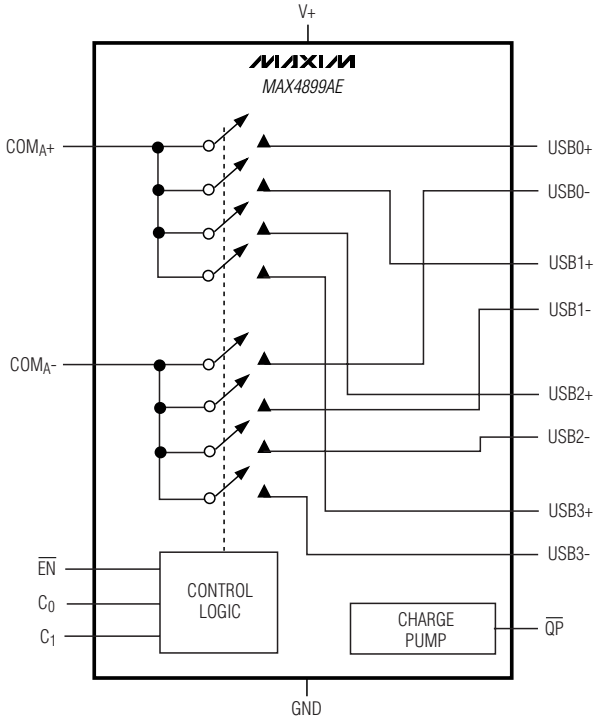
## Chip Information

PROCESS: BiCMOS

# USB 2.0 High-Speed, Fault-Tolerant 3:1, 4:1 Multiplexers

## Functional Diagrams



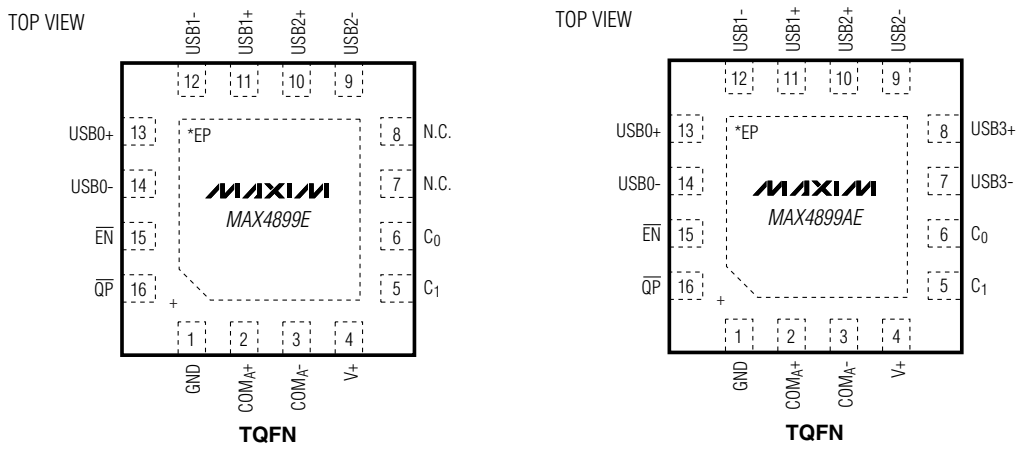




| MAX4899E | | | | | |
|---|---|---|---|---|---|
| $\overline{QP}$ | $\overline{EN}$ | $C_1$ | $C_0$ | FUNCTION | COMMENT |
| 0 | 0 | 0 | 0 | $COM_A$+ →USB0+<br>$COM_A$- →USB0- | NORMAL OPERATION |
| 0 | 0 | 0 | 1 | $COM_A$+ →USB1+<br>$COM_A$- →USB1- | NORMAL OPERATION |
| 0 | 0 | 1 | 0 | $COM_A$+ →USB2+<br>$COM_A$- →USB2- | NORMAL OPERATION |
| 0 | 0 | 1 | 1 | HIGH-Z | ALL OFF |
| 0 | 1 | X | X | HIGH-Z | ALL OFF |
| 1 | 1 | X | X | HIGH-Z | ALL OFF |
| 1 | 0 | 0 | 0 | $COM_A$+ →USB0+<br>$COM_A$- →USB0- | LARGER $R_{ON}$ |
| 1 | 0 | 0 | 1 | $COM_A$+ →USB1+<br>$COM_A$- →USB1- | LARGER $R_{ON}$ |
| 1 | 0 | 1 | 0 | $COM_A$+ →USB2+<br>$COM_A$- →USB2- | LARGER $R_{ON}$ |
| 1 | 0 | 1 | 1 | HIGH-Z | ALL OFF |

| MAX4899AE | | | | | |
|---|---|---|---|---|---|
| $\overline{QP}$ | $\overline{EN}$ | $C_1$ | $C_0$ | FUNCTION | COMMENT |
| 0 | 0 | 0 | 0 | $COM_A$+ →USB0+<br>$COM_A$- →USB0- | NORMAL OPERATION |
| 0 | 0 | 0 | 1 | $COM_A$+ →USB1+<br>$COM_A$- →USB1- | NORMAL OPERATION |
| 0 | 0 | 1 | 0 | $COM_A$+ →USB2+<br>$COM_A$- →USB2- | NORMAL OPERATION |
| 0 | 0 | 1 | 1 | $COM_A$+ →USB3+<br>$COM_A$- →USB3- | NORMAL OPERATION |
| 0 | 1 | X | X | HIGH-Z | ALL OFF |
| 1 | 1 | X | X | HIGH-Z | ALL OFF |
| 1 | 0 | 0 | 0 | $COM_A$+ →USB0+<br>$COM_A$- →USB0- | LARGER $R_{ON}$ |
| 1 | 0 | 0 | 1 | $COM_A$+ →USB1+<br>$COM_A$- →USB1- | LARGER $R_{ON}$ |
| 1 | 0 | 1 | 0 | $COM_A$+ →USB2+<br>$COM_A$- →USB2- | LARGER $R_{ON}$ |
| 1 | 0 | 1 | 1 | $COM_A$+ →USB3+<br>$COM_A$- →USB3- | LARGER $R_{ON}$ |

X = 1 or 0.

## Pin Configurations

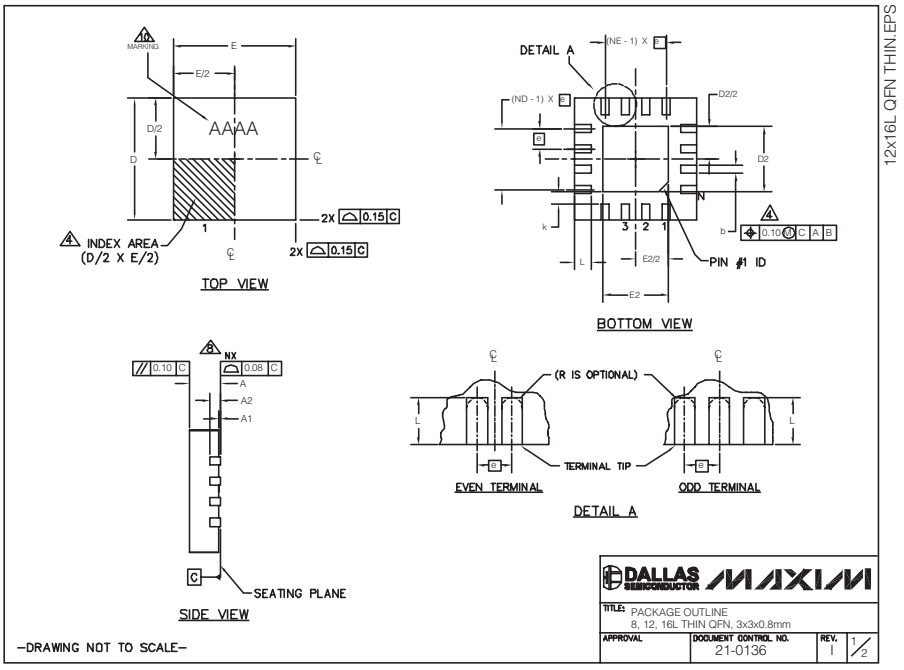



*CONNECT EXPOSED PAD TO GND

# USB 2.0 High-Speed, Fault-Tolerant 3:1, 4:1 Multiplexers

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)




| PKG | 8L 3x3 | | | 12L 3x3 | | | 16L 3x3 | | |
|---|---|---|---|---|---|---|---|---|---|
| REF. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.70 | 0.75 | 0.80 | 0.70 | 0.75 | 0.80 | 0.70 | 0.75 | 0.80 |
| b | 0.25 | 0.30 | 0.35 | 0.20 | 0.25 | 0.30 | 0.20 | 0.25 | 0.30 |
| D | 2.90 | 3.00 | 3.10 | 2.90 | 3.00 | 3.10 | 2.90 | 3.00 | 3.10 |
| E | 2.90 | 3.00 | 3.10 | 2.90 | 3.00 | 3.10 | 2.90 | 3.00 | 3.10 |
| e | 0.65 BSC. | | | 0.50 BSC. | | | 0.50 BSC. | | |
| L | 0.35 | 0.55 | 0.75 | 0.45 | 0.55 | 0.65 | 0.30 | 0.40 | 0.50 |
| N | 8 | | | 12 | | | 16 | | |
| ND | 2 | | | 3 | | | 4 | | |
| NE | 2 | | | 3 | | | 4 | | |
| A1 | 0 | 0.02 | 0.05 | 0 | 0.02 | 0.05 | 0 | 0.02 | 0.05 |
| A2 | 0.20 REF | | | 0.20 REF | | | 0.20 REF | | |
| k | 0.25 | - | - | 0.25 | - | - | 0.25 | - | - |

EXPOSED PAD VARIATIONS

| PKG. CODES | D2 | | | E2 | | | PIN ID | JEDEC |
|---|---|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | | |
| TQ833-1 | 0.25 | 0.70 | 1.25 | 0.25 | 0.70 | 1.25 | 0.35 x 45° | WEEC |
| T1233-1 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-1 |
| T1233-3 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-1 |
| T1233-4 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-1 |
| T1633-2 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-2 |
| T1633F-3 | 0.65 | 0.80 | 0.95 | 0.65 | 0.80 | 0.95 | 0.225 x 45° | WEED-2 |
| T1633FH-3 | 0.65 | 0.80 | 0.95 | 0.65 | 0.80 | 0.95 | 0.225 x 45° | WEED-2 |
| T1633-4 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-2 |
| T1633-5 | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45° | WEED-2 |

NOTES:

1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.20 mm AND 0.25 mm FROM TERMINAL TIP.
6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
7. DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
8. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS .
9. DRAWING CONFORMS TO JEDEC MO220 REVISION C.
10. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
11. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
12. WARPAGE NOT TO EXCEED 0.10mm.

–DRAWING NOT TO SCALE–

DALLAS SEMICONDUCTOR MAXIM
TITLE: PACKAGE OUTLINE 8, 12, 16L THIN QFN, 3x3x0.8mm
APPROVAL
DOCUMENT CONTROL NO. 21-0136
REV. I
2/2

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