



# Quad-SPDT, Clickless Audio Switches with Negative Signal Handling

## General Description

The MAX4910/MAX4911/MAX4912 quad, single-pole/double-throw (SPDT), clickless audio switches feature negative signal capability that allows signals as low as  $V_{CC}-5.5V$  to pass through without distortion. These analog switches have a low on-resistance, low supply current, and operate from a single +1.8V to +5.5V supply.

The MAX4910/MAX4911/MAX4912 have internal shunt resistors that automatically discharge the capacitance at the normally open (NO) and normally closed (NC) terminals when they are not connected. The MAX4910/MAX4911 have shunt resistors on all NO and NC terminals and the MAX4912 has shunt resistors on all NO, NC1, and NC3 terminals. These shunt resistors reduce click-and-pop sounds that occur when switching audio signals between precharged points. A break-before-make feature further reduces popping.

The MAX4910/MAX4912 control the switches in pairs with two control bits CB1 and CB2. The MAX4911 has one control bit to switch all four switches and an enable pin  $\overline{EN}$  to put the switches in a high-impedance mode. The MAX4912 has two terminals without shunt resistors for switching applications that do not require pre-discharge switching.

The MAX4910/MAX4911/MAX4912 are available in a tiny 16-pin TQFN-EP (3mm x 3mm) 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

## 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 (0.37 $\Omega$ )
- ◆ 0.1 $\Omega$  Channel-to-Channel Matching
- ◆ 0.35 $\Omega$  On-Resistance Flatness
- ◆ +1.8V to +5.5V Single-Supply Voltage
- ◆ -80dB Crosstalk (20kHz)
- ◆ -90dB Off-Isolation (20kHz)
- ◆ 0.05% Total Harmonic Distortion
- ◆ Enable Control (MAX4911)
- ◆ 10nA Leakage Current
- ◆ 150nA Supply Current

## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK	PKG CODE
MAX4910ETE+	$-40^{\circ}C$ to $+85^{\circ}C$	16 TQFN-EP**	ADY	T1633-4
MAX4911ETE+*	$-40^{\circ}C$ to $+85^{\circ}C$	16 TQFN-EP**	ADZ	T1633-4
MAX4912ETE+*	$-40^{\circ}C$ to $+85^{\circ}C$	16 TQFN-EP**	AEA	T1633-4

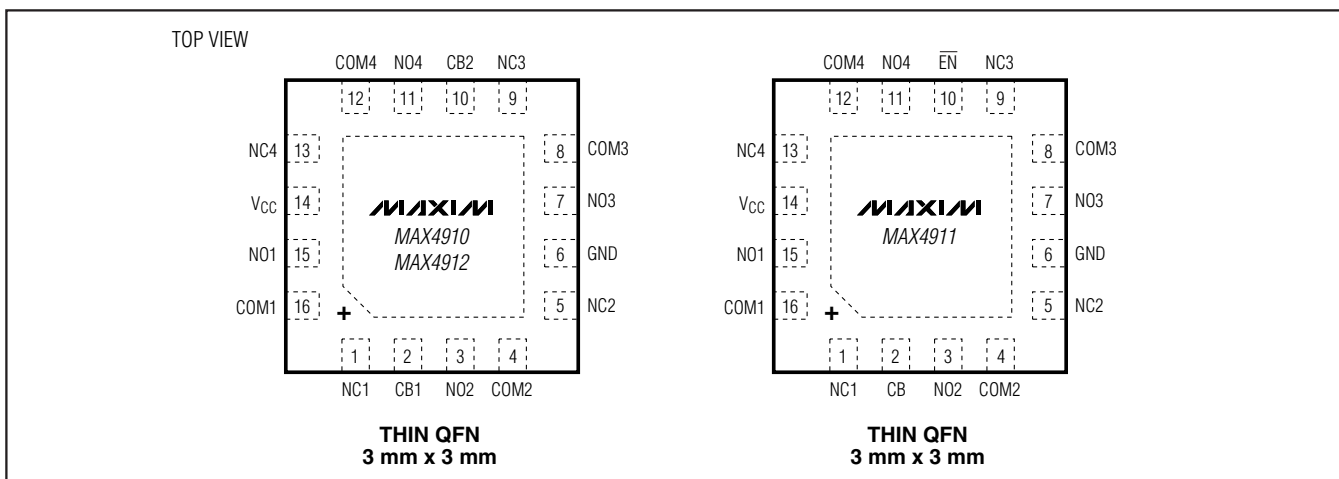
+ Denotes lead-free package.

\*Future product—contact factory for availability.

\*\*EP = Exposed pad.

Typical Operating Circuit appears at end of data sheet.

## Pin Configurations



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## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

V <sub>CC</sub> , CB <sub>-</sub> , EN <sub>-</sub> .....	-0.3V to +6.0V
COM <sub>-</sub> , NC <sub>-</sub> , NO <sub>-</sub> .....	(V <sub>CC</sub> - 6V) to (V <sub>CC</sub> + 0.3V)
Continuous Current NO <sub>-</sub> , NC <sub>-</sub> , COM <sub>-</sub> .....	±300mA
Peak Current NO <sub>-</sub> , NC <sub>-</sub> , COM <sub>-</sub> (pulsed at 1ms, 50% duty cycle) .....	±400mA
Peak Current NO <sub>-</sub> , NC <sub>-</sub> , COM <sub>-</sub> (pulsed at 1ms, 10% duty cycle) .....	±500mA

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

16-Pin TQFN, Single-Layer Board (derate 15.6mW/°C above +70°C) .....	1250mW
16-Pin TQFN, Multilayer Board (derate 20.8mW/°C above +70°C) .....	1667mW
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, EN<sub>-</sub> = low (MAX4911 only), 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>-</sub></sub> = V <sub>EN<sub>-</sub></sub> = 0V or V <sub>CC</sub>		0.15	2	μA
		V <sub>CC</sub> = +2.7V, V <sub>CB<sub>-</sub></sub> = V <sub>EN<sub>-</sub></sub> = +0.5V or +1.4V			4	
		V <sub>CC</sub> = +5.5V, V <sub>CB<sub>-</sub></sub> = V <sub>EN<sub>-</sub></sub> = +0.5V or +1.4V			8	
<b>ANALOG SWITCH</b>						
Analog Signal Range	V <sub>NC<sub>-</sub></sub> , V <sub>NO<sub>-</sub></sub> , V <sub>COM<sub>-</sub></sub>	(Note 2)	V <sub>CC</sub> - 5.5V		V <sub>CC</sub>	V
On-Resistance (Note 3)	R <sub>ON</sub>	Channels 1 and 3, V <sub>CC</sub> = +3.3V, V <sub>NC<sub>-</sub></sub> or V <sub>NO<sub>-</sub></sub> = V <sub>CC</sub> - 5.5V, -1V, 0V, +1V, +2V, V <sub>CC</sub> , I <sub>COM1</sub> = I <sub>COM3</sub> = 100mA	T <sub>A</sub> = +25°C	0.37	0.75	Ω
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		0.8	
		Channels 2 and 4, V <sub>CC</sub> = +3.3V, V <sub>NC<sub>-</sub></sub> or V <sub>NO<sub>-</sub></sub> = V <sub>CC</sub> - 5.5V, -1V, 0V, +1V, +2V, V <sub>CC</sub> , I <sub>COM2</sub> = I <sub>COM4</sub> = 100mA	T <sub>A</sub> = +25°C	0.72	1.45	Ω
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		1.6	
On-Resistance Match Between Channels (Notes 3, 4)	ΔR <sub>ON</sub>	Channels 1 and 3, V <sub>CC</sub> = +3.3V, V <sub>NC<sub>-</sub></sub> or V <sub>NO<sub>-</sub></sub> = 0, I <sub>COM<sub>-</sub></sub> = 100mA			0.1	Ω
		Channels 2 and 4, V <sub>CC</sub> = +3.3V, V <sub>NC<sub>-</sub></sub> or V <sub>NO<sub>-</sub></sub> = 0, I <sub>COM<sub>-</sub></sub> = 100mA			0.1	
On-Resistance Flatness (Note 5)	R <sub>FLAT</sub>	Channels 1 and 3, V <sub>CC</sub> = +3.3V, V <sub>NC<sub>-</sub></sub> = V <sub>NO<sub>-</sub></sub> = V <sub>CC</sub> - 5.5V, -1V, 0V, +1V, +2V, V <sub>CC</sub> , I <sub>COM<sub>-</sub></sub> = 100mA			0.35	Ω
		Channels 2 and 4, V <sub>CC</sub> = +3.3V, V <sub>NC<sub>-</sub></sub> = V <sub>NO<sub>-</sub></sub> = V <sub>CC</sub> - 5.5V, -1V, 0V, +1V, +2V, V <sub>CC</sub> , I <sub>COM<sub>-</sub></sub> = 100mA			0.6	
Shunt Switch Resistance	R <sub>SH</sub>		2	3.8	6	kΩ

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MAX4910/MAX4911/MAX4912

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = +2.7V$  to  $+5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ ,  $\overline{EN} = \text{low}$  (MAX4911 only), 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	
NC_ Off-Leakage Current	I <sub>NC_(OFF)</sub>	MAX4912 (NC2 and NC4) only: $V_{CC} = +2.7V$ , switch open, $V_{NC\_} = -2.5V$ or $+2.5V$ , $V_{COM\_} = +2.5V$ or $-2.5V$	$T_A = +25^{\circ}C$	-10		+10	nA
			$T_A = T_{MIN}$ to $T_{MAX}$	-50		+50	
COM_ On-Leakage Current	I <sub>COM_(ON)</sub>	$V_{CC} = +2.7V$ , switch closed; $V_{NC\_}$ or $V_{NO\_} = -2.5V$ , $+2.5V$ , or floating; $V_{COM\_} = -2.5V$ , $+2.5V$ , or floating	$T_A = +25^{\circ}C$	-10		+10	nA
			$T_A = T_{MIN}$ to $T_{MAX}$	-100		+100	
<b>DYNAMIC CHARACTERISTICS</b>							
Turn-On Time	t <sub>ON</sub>	$V_{CC} = +2.7V$ , $CB\_ = \text{low to high}$ , $R_L = 50\Omega$ , $C_L = 5pF$ , $V_{NO\_} = +1.5V$ , Figure 2		0.055	0.15	$\mu s$	
Turn-Off Time	t <sub>OFF</sub>	$V_{CC} = +2.7V$ , $CB\_ = \text{high to low}$ , $R_L = 50\Omega$ , $C_L = 5pF$ , $V_{NO\_} = +1.5V$ , Figure 2		0.3	1.0	$\mu s$	
Break-Before-Make Delay Time	t <sub>D</sub>	$V_{CC} = +2.7V$ , $CB\_ = \text{low to high or high to low}$ , $R_L = 50\Omega$ , $C_L = 5pF$ , $V_{NC\_} = V_{NO\_} = +1.5V$ , Figure 3	1	25		ns	
Charge Injection	Q	$V_{GEN\_} = 0$ , $R_{GEN\_} = 0$ , $C_L = 1nF$ , Figure 4		300		pC	
Power-Supply Rejection Ratio	PSRR	$f = 20kHz$ , $V_{COM\_} = 1V_{RMS}$ , $R_L = 50\Omega$ , $C_L = 5pF$		60		dB	
Off-Isolation	V <sub>ISO</sub>	$f = 20kHz$ , $V_{COM\_} = 1V_{RMS}$ , $R_L = 50\Omega$ , Figure 5 (Note 6)		-90		dB	
Crosstalk	V <sub>CT</sub>	$f = 20kHz$ , $V_{COM\_} = 1V_{RMS}$ , $R_L = 50\Omega$ , Figure 5		-80		dB	
Total Harmonic Distortion	THD	$f = 20Hz$ to $20kHz$ , $V_{COM\_} = 0.5V_{P-P}$ , $R_L = 50\Omega$ , DC bias = 0		0.05		%	
NO_, NC_ Off-Capacitance	C <sub>NO_(OFF)</sub>	$f = 1MHz$ , $V_{COM\_} = 0.5V_{P-P}$ , DC bias = 0, Figure 6		100		pF	
COM On-Capacitance	C <sub>COM_(ON)</sub>	$f = 1MHz$ , $V_{COM\_} = 0.5V_{P-P}$ , DC bias = 0, Figure 6		200		pF	
<b>DIGITAL INPUTS (CB_, <math>\overline{EN}</math>)</b>							
Input Logic High	V <sub>IH</sub>		1.4			V	
Input Logic Low	V <sub>IL</sub>			0.5		V	
Input Leakage Current	I <sub>CB</sub> , I <sub><math>\overline{EN}</math></sub>	$V_{CB\_} = V_{\overline{EN}} = 0V$ or $V_{CC}$	-1		+1	$\mu A$	

**Note 1:** All parameters are production tested at  $T_A = +85^{\circ}C$  and guaranteed by design over the specified temperature range.

**Note 2:** Signals on COM\_, NO\_, or NC\_ 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:**  $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$ .

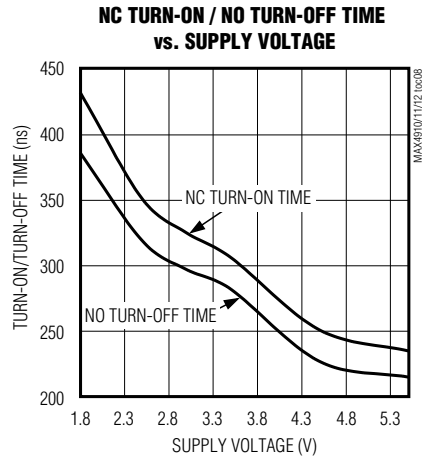
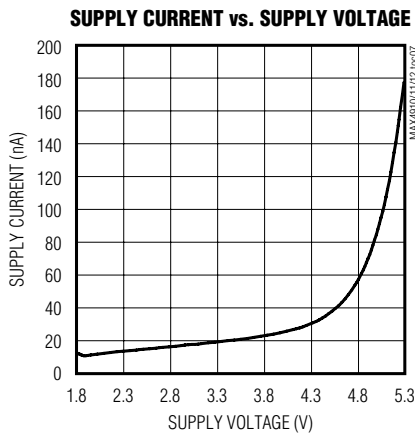
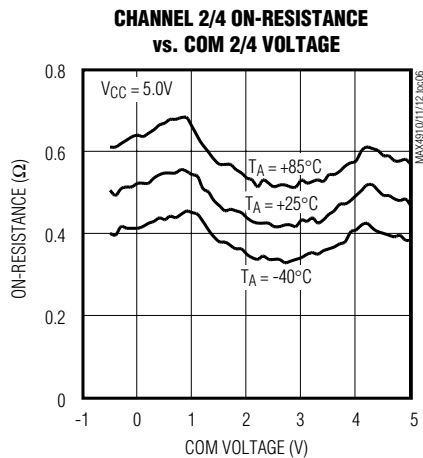
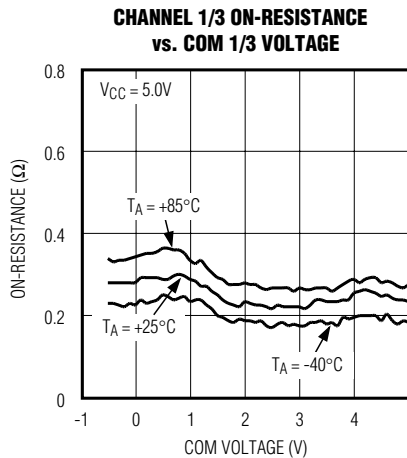
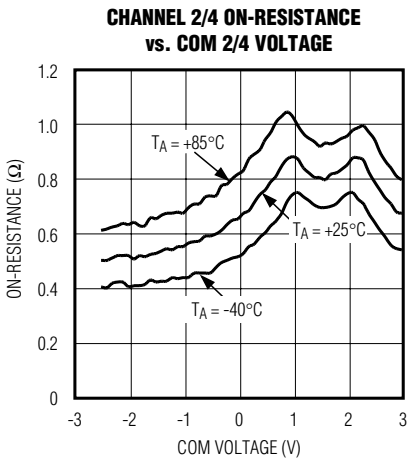
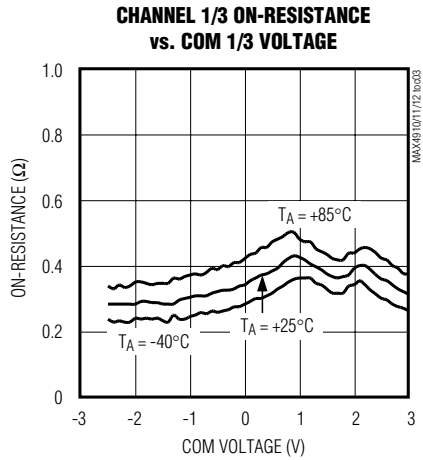
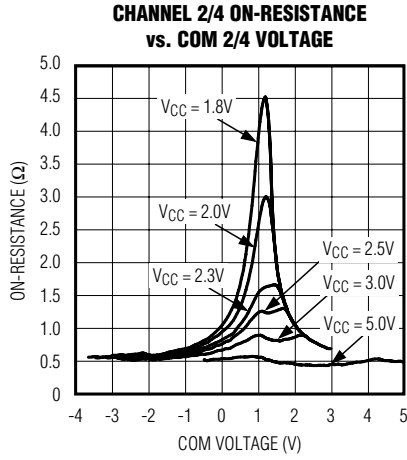
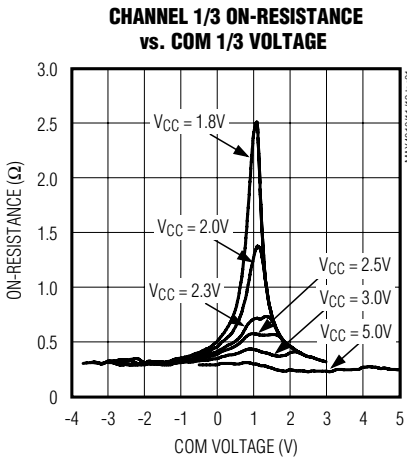
**Note 5:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

**Note 6:** Off-isolation =  $20\log_{10} [V_{COM\_} / V_{NO\_}]$ ,  $V_{COM\_}$  = output,  $V_{NO\_}$  = input to off switch.

# Quad-SPDT, Clickless Audio Switches with Negative Signal Handling

## Typical Operating Characteristics

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

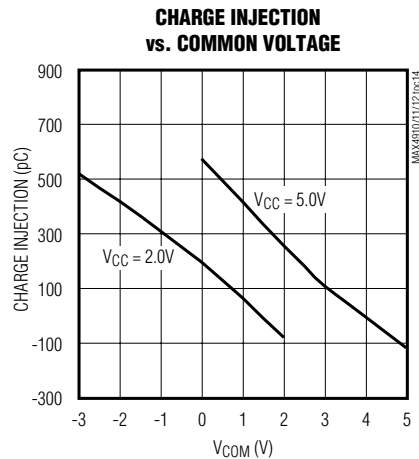
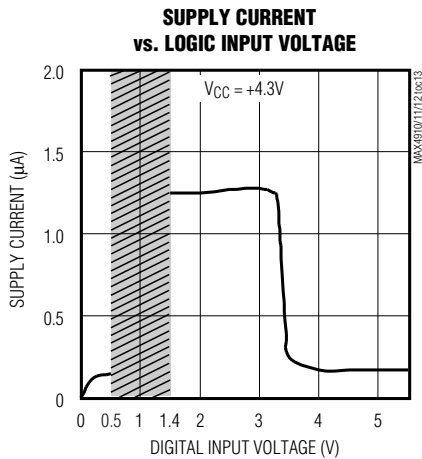
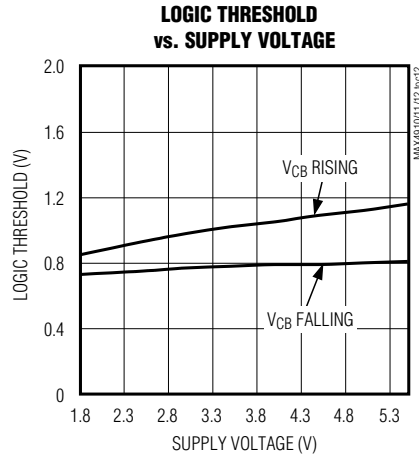
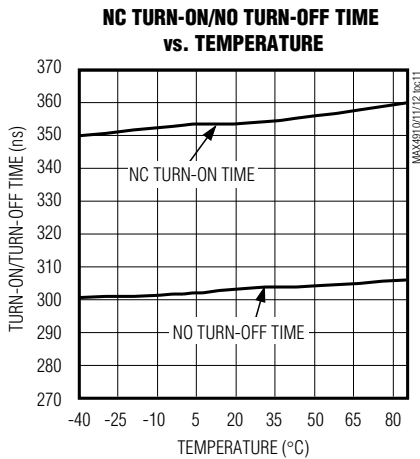
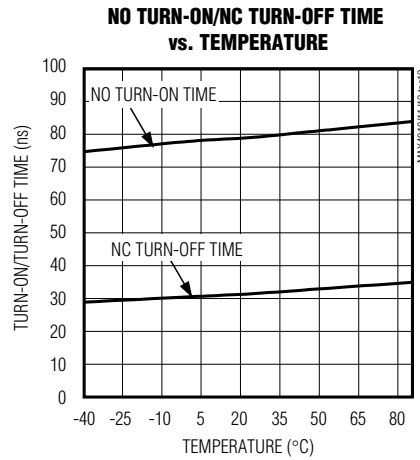
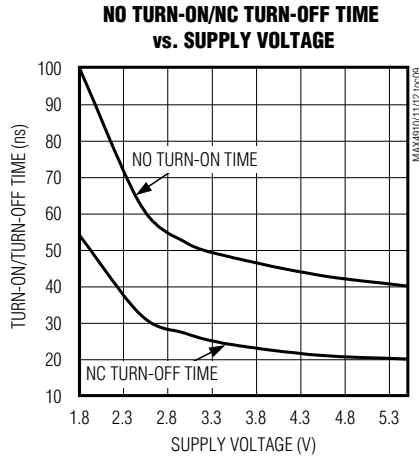


# Quad-SPDT, Clickless Audio Switches with Negative Signal Handling

## Typical Operating Characteristics (continued)

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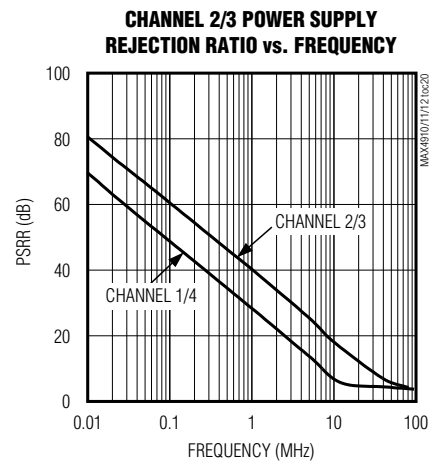
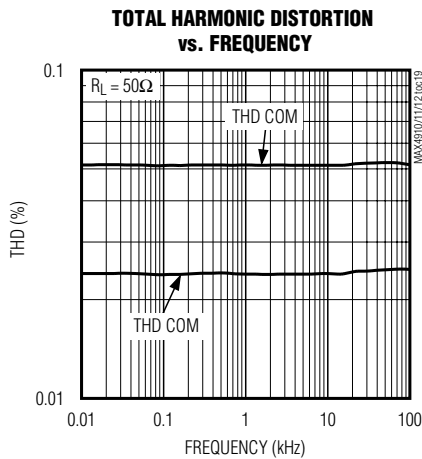
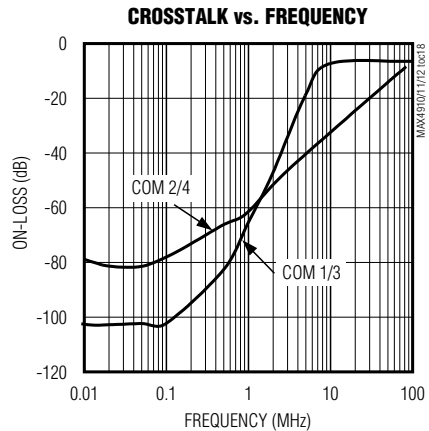
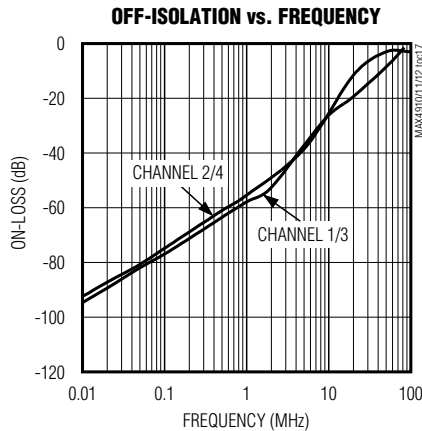
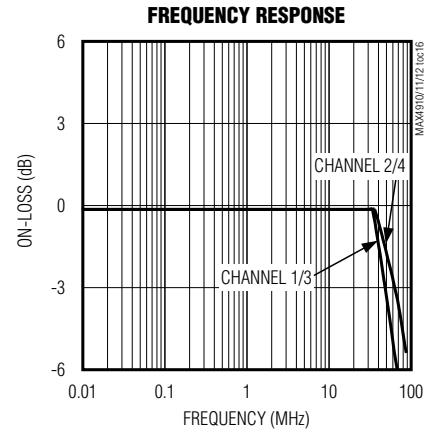
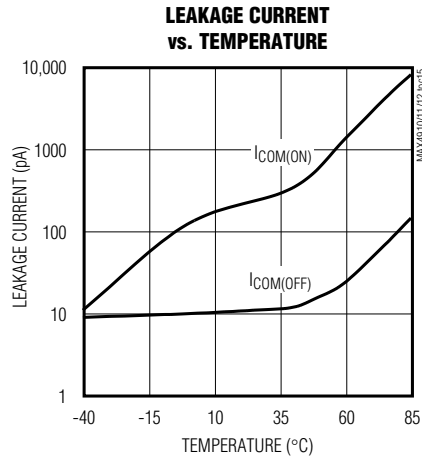
MAX4910/MAX4911/MAX4912



# Quad-SPDT, Clickless Audio Switches with Negative Signal Handling

## Typical Operating Characteristics (continued)

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



# Quad-SPDT, Clickless Audio Switches with Negative Signal Handling

## Pin Description

MAX4910/MAX4911/MAX4912

PIN		NAME	FUNCTION
MAX4910/ MAX4912	MAX4911		
1	1	NC1	Analog Switch 1—Normally Closed Terminal
2	—	CB1	Digital Control Input for Analog Switch 1 and Analog Switch 3
—	2	CB	Digital Control Input for All Analog Switches
3	3	NO2	Analog Switch 2—Normally Open Terminal
4	4	COM2	Analog Switch 2—Common Terminal
5	5	NC2	Analog Switch 2—Normally Closed Terminal
6	6	GND	Ground
7	7	NO3	Analog Switch 3—Normally Open Terminal
8	8	COM3	Analog Switch 3—Common Terminal
9	9	NC3	Analog Switch 3—Normally Closed Terminal
10	—	CB2	Digital Control Input for Analog Switch 2 and Analog Switch 4.
—	10	$\overline{EN}$	Enable Input. Driving $\overline{EN}$ high causes all switches to be high impedance. Pull $\overline{EN}$ low for normal operation.
11	11	NO4	Analog Switch 4—Normally Open Terminal
12	12	COM4	Analog Switch 4—Common Terminal
13	13	NC4	Analog Switch 4—Normally Closed Terminal
14	14	V <sub>CC</sub>	Positive Supply Voltage Input
15	15	NO1	Analog Switch 1—Normally Open Terminal
16	16	COM1	Analog Switch 1—Common Terminal
—	—	EP	Exposed Pad. Connect to Ground

## Detailed Description

The MAX4910/MAX4911/MAX4912 quad SPDT audio switches are low on-resistance, low 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 MAX4910/MAX4912 have two digital control inputs CB1 and CB2 where each bit controls a pair of switches (see Table 1). The MAX4911 has an active-low enable  $\overline{EN}$  and a digital control bit CB. Driving  $\overline{EN}$  low takes the switches out of high impedance and CB controls all four switches (see Table 2). The MAX4910/MAX4911 have shunt resistors on all their NO and NC terminals to suppress click-and-pop sounds that may occur from switching to a precharged terminal. The MAX4912 does not have click-and-pop suppression resistors on NC2 and NC4 for applications that do not require predischarge switching.

Table 1. MAX4910/MAX4912 Truth Tables

CB1	NC1	NO1	NC3	NO3
0	On	Off	On	Off
1	Off	On	Off	On
CB2	NC2	NO2	NC4	NO4
0	On	Off	On	Off
1	Off	On	Off	On

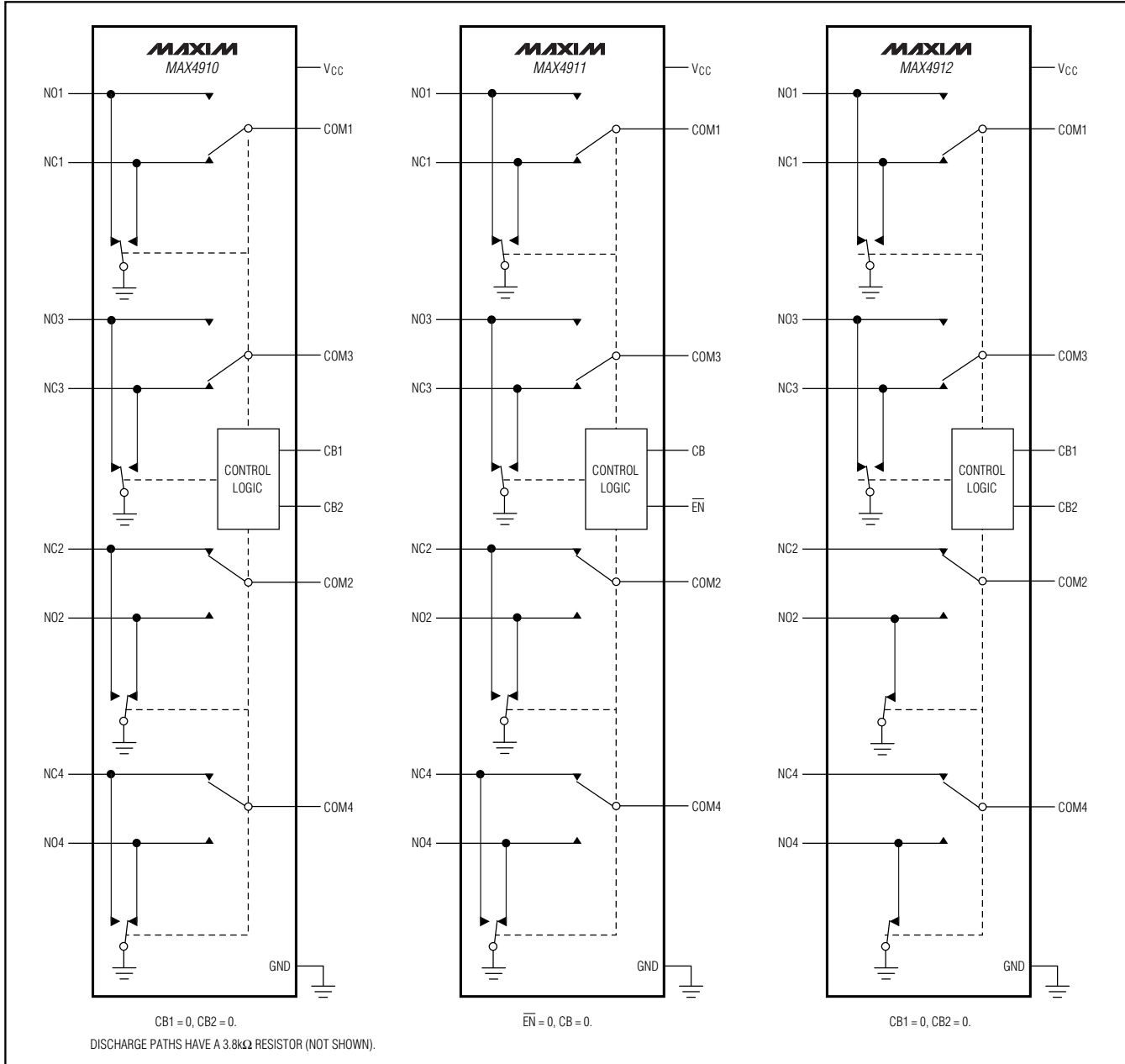
Table 2. MAX4911 Truth Table

$\overline{EN}$	CB	NC_	NO_
1	X	Off	Off
0	1	Off	On
0	0	On	Off

X = Don't care.

# Quad-SPDT, Clickless Audio Switches with Negative Signal Handling

## Functional Diagrams



### Applications Information

#### Digital Control Inputs

The MAX4910/MAX4911/MAX4912 logic inputs accept up to +5.5V, regardless of supply voltage. For example, with a +3.3V supply, CB1, CB2, CB, and EN can be driven

low to GND and high to +5.5V, allowing for mixed logic levels in a system. Driving CB, CB1, CB2, and EN rail-to-rail minimizes power consumption. For a +3.3V supply voltage, the logic thresholds are +0.5V (low) and +1.4V (high).





# Quad-SPDT, Clickless Audio Switches with Negative Signal Handling

## Test Circuits/Timing Diagrams

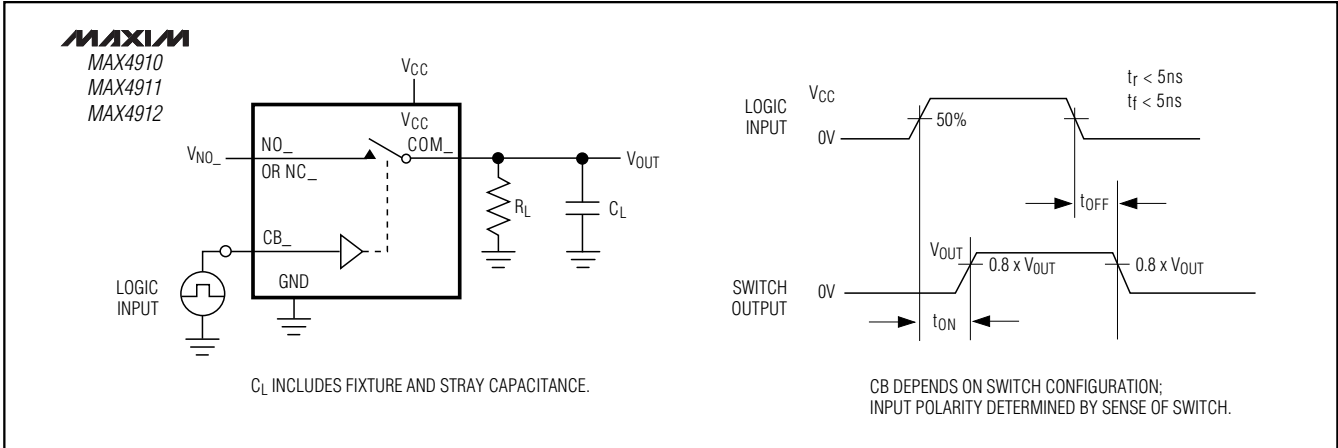


Figure 2. Switching Time

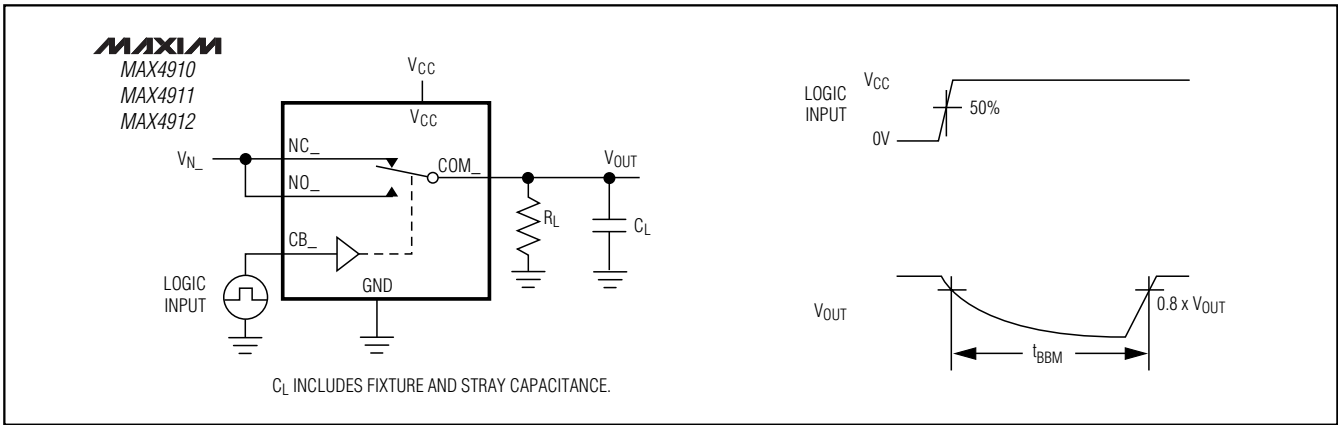


Figure 3. Break-Before-Make Interval

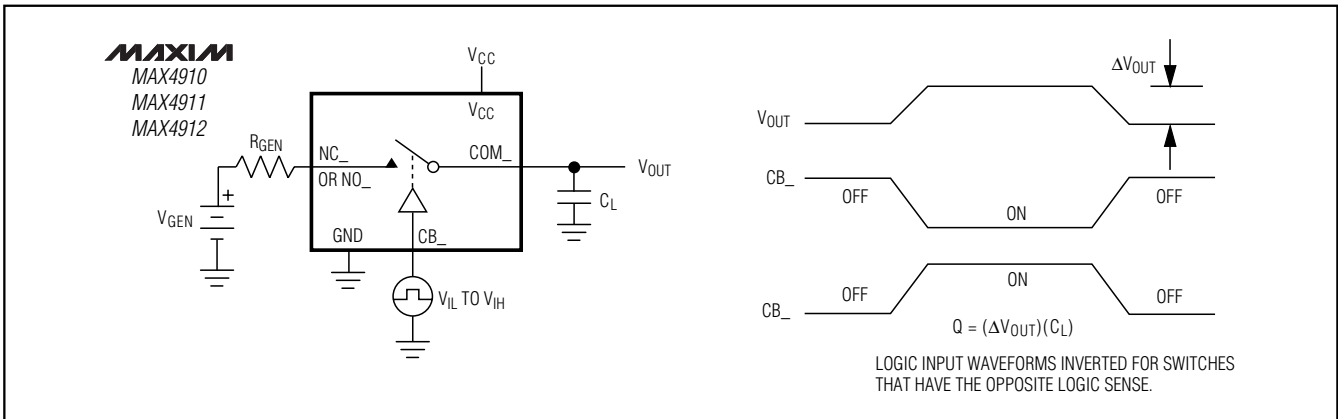


Figure 4. Charge Injection

# Quad-SPDT, Clickless Audio Switches with Negative Signal Handling

## Test Circuits/Timing Diagrams (continued)

MAX4910/MAX4911/MAX4912

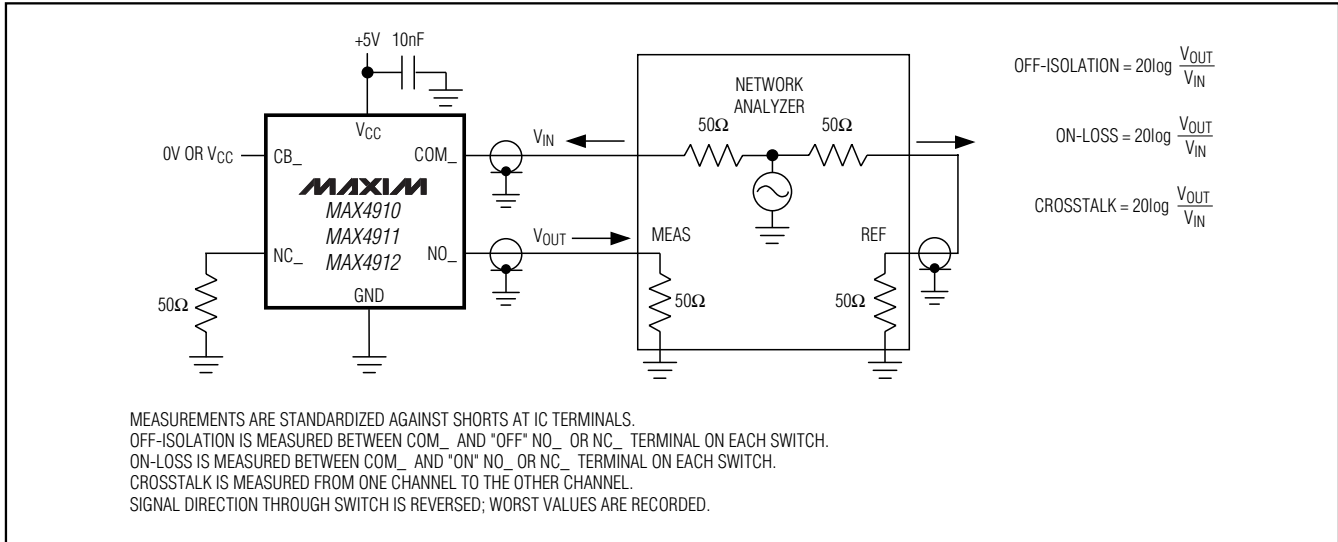


Figure 5. On-Loss, Off-Isolation, and Crosstalk

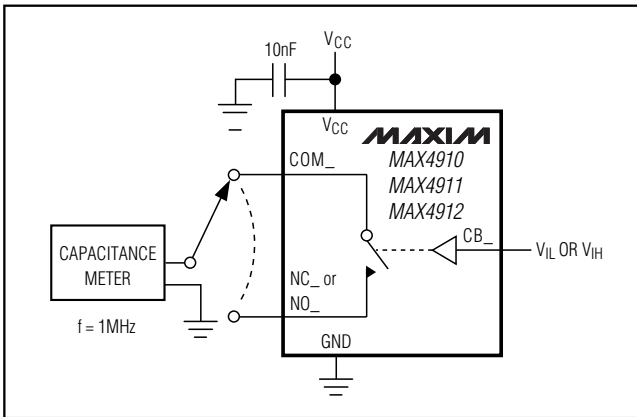
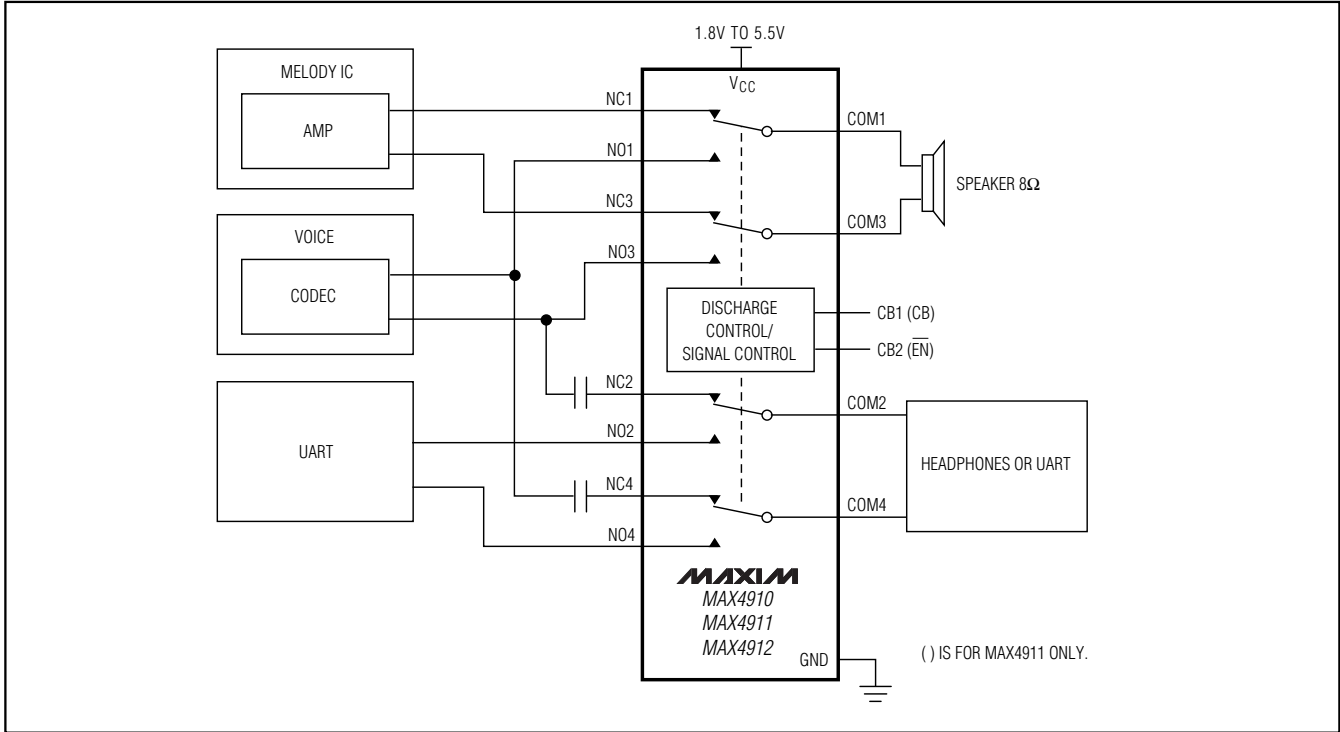


Figure 6. Channel Off-/On-Capacitance

# Quad-SPDT, Clickless Audio Switches with Negative Signal Handling

## Typical Operating Circuit



## Chip Information

PROCESS: BiCMOS



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[FSA3051TMX](#) [NLAS4684FCTCG](#) [NLAS5223BLMNR2G](#) [NLVAS4599DTT1G](#) [NLX2G66DMUTCG](#) [425541DB](#) [425528R](#) [099044FB](#)  
[NLAS5123MNR2G](#) [PI5A4157CEX](#) [NLAS4717EPFCT1G](#) [PI5A3167CCEX](#) [SLAS3158MNR2G](#) [PI5A392AQE](#) [PI5A4157ZUEX](#)  
[PI5A3166TAEX](#) [FSA634UCX](#) [XS3A1T3157GMX](#) [TC4066BP\(N,F\)](#) [DG302BDJ-E3](#) [PI5A100QEX](#) [HV2605FG-G](#) [HV2301FG-G](#)  
[RS2117YUTQK10](#) [RS2118YUTQK10](#) [RS2227XUTQK10](#) [ADG452BRZ-REEL7](#) [MAX4066ESD+](#) [MAX391CPE+](#) [MAX4730EXT+T](#)  
[MAX314CPE+](#) [BU4066BCFV-E2](#) [MAX313CPE+](#) [BU4S66G2-TR](#) [NLASB3157MTR2G](#) [TS3A4751PWR](#) [NLAS4157DFT2G](#)  
[NLAST4599DFT2G](#) [NLAST4599DTT1G](#) [DG419LDY+T](#) [DG300BDJ-E3](#) [DG2503DB-T2-GE1](#) [TC4W53FU\(TE12L,F\)](#) [HV2201FG-G](#)  
[74HC2G66DC.125](#) [DG3257DN-T1-GE4](#) [ADG1611BRUZ-REEL7](#) [DG2535EDQ-T1-GE3](#) [LTC201ACN#PBF](#) [74LV4066DB,118](#)