_General Description

The MAX4910/MAX4911/MAX4912 quad, singlepole/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-andpop 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 $\overline{\text{EN}}$ 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°C to +85°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 (0.37Ω)
- ♦ 0.1Ω Channel-to-Channel Matching
- ♦ 0.35Ω 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°C to +85°C	16 TQFN-EP**	ADY	T1633-4
MAX4911ETE+*	-40°C to +85°C	16 TQFN-EP**	ADZ	T1633-4
MAX4912ETE+*	-40°C to +85°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



Maxim Integrated Products 1

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

0.3V to +6.0V
$(V_{CC} - 6V)$ to $(V_{CC} + 0.3V)$
/±300mA
lsed at 1ms,
±400mA
lsed at 1ms,
±500mA

Continuous Power Dissipation ($T_A = +70^{\circ}$ C	C)
$(derate 15 \text{ Gm})/(^{\circ}\text{C})$	1250mW/
16-Pin TOEN, Multilayer Board	12001111
(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

 $(V_{CC} = +2.7V \text{ to } +5.5V, T_A = -40^{\circ}C \text{ to } +85^{\circ}C, \overline{EN} = \text{low (MAX4911 only), unless otherwise noted. Typical values are at V_{CC} = +3.0V, T_A = +25^{\circ}C.)$ (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	ТҮР	MAX	UNITS
POWER SUPPLY							
Supply Voltage	VCC			1.8		5.5	V
		$V_{CC} = +5.5V$, $V_{CB} = V_{\overline{EN}} = 0V$ or V_{CC}			0.15	2	
Supply Current	ICC	$V_{CC} = +2.7V$, $V_{CB} = V_{\overline{EN}} = +$	+0.5V or +1.4V			4	μA
		$V_{CC} = +5.5V$, $V_{CB} = V_{\overline{EN}} = +$	+0.5V or +1.4V			8	
ANALOG SWITCH		1					
Analog Signal Range	V _{NC_} , V _{NO_} , V _{COM_} ,	(Note 2)		V _{CC} - 5.5V		Vcc	V
	R _{ON}	Channels 1 and 3, V _{CC} = +3.3V, V _{NC} or V _{NO} = V _{CC} - 5.5V, -1V, 0V, +1V, +2V, V _{CC} , I _{COM1} = I _{COM3} = 100mA	$T_A = +25^{\circ}C$		0.37	0.75	0
On-Resistance			$T_A = T_{MIN}$ to T_{MAX}			0.8	52
(Note 3)		Channels 2 and 4, V_{CC} = +3.3V, V_{NC} or V_{NO} = V_{CC} - 5.5V, -1V, 0V, +1V, +2V, V_{CC} , I_{COM2} = I_{COM4} = 100mA	$T_A = +25^{\circ}C$		0.72	1.45	0
			$T_A = T_{MIN}$ to T_{MAX}			1.6	52
On-Resistance Match	On-Resistance Match Channels 1 and 3, $V_{CC} = +3.3V$, V_{NC} or $V_{NO} = 0$, $I_{COM} = 100$ mA		$3V, V_{NC} \text{ or } V_{NO} = 0,$			0.1	0
(Notes 3, 4)	ΔηΟΝ	Channels 2 and 4, V_{CC} = +3.3V, V_{NC} or V_{NO} = 0, I_{COM} = 100mA				0.1	52
On-Resistance Flatness (Note 5)	Rflat	Channels 1 and 3, V_{CC} = +3.3V, V_{NC} = V_{NO} = V_{CC} - 5.5V, -1V, 0V, +1V, +2V, V_{CC} , I_{COM} = 100mA				0.35	0
		Channels 2 and 4, V_{CC} = +3.3V, V_{NC} = V_{NO} = V_{CC} - 5.5V, -1V, 0V, +1V, +2V, V_{CC} , I_{COM} = 100mA				0.6	22
Shunt Switch Resistance	R _{SH}			2	3.8	6	kΩ



ELECTRICAL CHARACTERISTICS (continued)

 $(V_{CC} = +2.7V \text{ to } +5.5V, T_A = -40^{\circ}C \text{ to } +85^{\circ}C, \overline{EN} = \text{low (MAX4911 only), unless otherwise noted. Typical values are at V_{CC} = +3.0V, T_A = +25^{\circ}C.)$ (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	ТҮР	MAX	UNITS
NC_ Off-Leakage Current	INC_(OFF)	MAX4912 (NC2 and NC4) only: $V_{CC} = +2.7V$, switch	T _A = +25°C	-10		+10	
		open, V _{NC} = -2.5V or +2.5V, V _{COM} = +2.5V or -2.5V	$T_A = T_{MIN}$ to T_{MAX}	-50		+50	nA
		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	5
COM_On-Leakage Current	ICOM_(ON)		$T_A = T_{MIN}$ to T_{MAX}	-100		+100	ΠA
DYNAMIC CHARACTERISTIC	CS						
Turn-On Time	ton	V_{CC} = +2.7V, CB_ = low to high, R _L = 50 Ω , C _L = 5pF, V _{NO} = +1.5V, Figure 2			0.055	0.15	μs
Turn-Off Time	toff	V_{CC} = +2.7V, CB_ = high to low, R _L = 50 Ω , C _L = 5pF, V _{NO} _ = +1.5V, Figure 2			0.3	1.0	μs
Break-Before-Make Delay Time	tD	V_{CC} = +2.7V, CB_ = low to high or high to low, RL = 50 Ω , CL = 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		рС
Power-Supply Rejection Ratio	PSRR	f = 20kHz, V_{COM} = 1 V_{RMS} , R_L = 50 Ω , C_L = 5pF			60		dB
Off-Isolation	VISO	f = 20kHz, V _{COM} = 1V _{RMS} , R _L = 50 Ω , Figure 5 (Note 6)			-90		dB
Crosstalk	V _{CT}	f = 20kHz, V_{COM} = 1 V_{RMS} , R_L = 50 Ω , 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 _{NO_(OFF)}	$f = 1MHz$, $V_{COM} = 0.5V_{P-P}$, DC bias = 0, Figure 6			100		рF
COM On-Capacitance	CCOM_(ON)	f = 1MHz, V_{COM} = 0.5Vp.p, DC bias = 0, Figure 6			200		рF
DIGITAL INPUTS (CB_, EN)							
Input Logic High	VIH			1.4			V
Input Logic Low	VIL					0.5	V
Input Leakage Current	ICB, IEN	$V_{CB_{-}} = V_{\overline{EN}} = 0V$ or V_{CC}		-1		+1	μA

Note 1: All parameters are production tested at T_A = +85°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.

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

Typical Operating Characteristics



Typical Operating Characteristics (continued)

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



MAX4910/MAX4911/MAX4912

Typical Operating Characteristics (continued)

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







FREQUENCY (kHz)





Pin Description

PIN					
MAX4910/ MAX4912	MAX4911	NAME	FUNCTION		
1	1	NC1	Analog Switch 1—Normally Closed Terminal		
2		CB1	Digital Control Input for Analog Switch 1 and Analog Switch 3		
—	2	СВ	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	ĒN	Enable Input. Driving $\overline{\text{EN}}$ high causes all switches to be high impedance. Pull $\overline{\text{EN}}$ 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	Vcc	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 EN and a digital control bit CB. Driving 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

EN	СВ	NC_	NO_
1	Х	Off	Off
0	1	Off	On
0	0	On	Off

X = Don't care.







_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 dri-

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





Figure 1. Typical Application Circuit

Analog Signal Levels

The MAX4910/MAX4911/MAX4912 on-resistance is channel dependant. Channels 1 and 3 have an on-resistance of 0.37Ω (typ), and channels 2 and 4 have an on-resistance of 0.72Ω (typ). The on-resistance flatness is guaranteed over temperature and shows minimal variation over the entire voltage supply range (see the *Typical Operating Characteristics*). The on-resistance flatness and low-leakage features make it ideal for bidirectional operation. The switches are bidirectional, so the NO_, NC_, and COM_ pins can be either inputs or outputs.

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

Click-and-Pop Suppression

The MAX4910/MAX4911 have a $3.8k\Omega$ (typ) shunt resistor on all their NO and NC terminals to automatically discharge any capacitance when they are not connected to COM. The MAX4912 has shunt resistors on all NO, NC1, and NC3 terminals. The shunt resistors reduce audible click-and-pop sounds that occur when switching between audio sources.

Audible clicks and pops are caused when a step DC voltage is switched into the speaker. The DC step tran-

sients can be reduced by automatically discharging the side that is not connected to the COM terminal, reducing any residual DC voltage and reducing clicks and pops.

Break-Before-Make Switching

The MAX4910/MAX4911/MAX4912 feature breakbefore-make switching, which is configured to break (open) the first set of contacts before engaging (closing) the new contacts. This prevents the momentary connection of the old and new signal paths to the output, reducing click-and-pop sounds.

Power-Supply Sequencing and Overvoltage Protection Caution: Do not exceed the Absolute Maximum Ratings since stresses beyond the listed ratings

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

may cause permanent damage to the device.



Test Circuits/Timing Diagrams **MIXIM** MAX4910 Vçc tr < 5ns MAX4911 V_{CC} tf < 5ns LOGIC MAX4912 Vcc 50% INPUT ٥V NO COM V_{NO} VOUT OR NC_ Ş tori CL R CB_ VOUT 0.8 x V_{OUT} 0.8 x V_{OUT} GND SWITCH LOGIC Л 0V INPUT OUTPUT Ŧ ton CL INCLUDES FIXTURE AND STRAY CAPACITANCE. CB DEPENDS ON SWITCH CONFIGURATION; INPUT POLARITY DETERMINED BY SENSE OF SWITCH.

Figure 2. Switching Time



Figure 3. Break-Before-Make Interval



Figure 4. Charge Injection

Test Circuits/Timing Diagrams (continued)



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



Figure 6. Channel Off-/On-Capacitance



Chip Information

PROCESS: BiCMOS

MAX4910/MAX4911/MAX4912

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 <u>www.maxim-ic.com/packages</u>.)



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