19-4244; Rev 1; 12/08

EVALUATION KIT AVAILABLE

Dual SPDT Negative Rail Analog Switches with ±VCC Capability

General Description

The MAX14504/MAX14505/MAX14505A/MAX14506 dual single-pole/double-throw (SPDT) audio switches feature negative signal capability that allows signals from -VCC to +VCC to pass without distortion. They feature high continuous current ratings of 550mA (continuous) and 850mA (pulsed). These analog switches have low on-resistance, low supply current, and operate from a single +2.3V to +5.5V supply.

The MAX14505/MAX14505A have internal shunt switches that discharge the audio amplifier AC-coupling capacitance at the normally open (NO) terminals. This reduces click-and-pop sounds that occur when switching audio signals between precharged points. The MAX14504/MAX14505/MAX14505A/MAX14506 control the switches with control bit, CB, and feature an enable input, $\overline{EN}$, that place COM in a high-impedance mode.

The MAX14504/MAX14505/MAX14505A/MAX14506 are fully specified to operate from a single +2.3V to +5.5V power supply. These devices are available in a 1.56mm x 2.14mm, 12-bump WLP package, and operate over the -40°C to +85°C extended temperature range.

Applications

Cell Phones

MP3 Players

Portable Audio Equipment

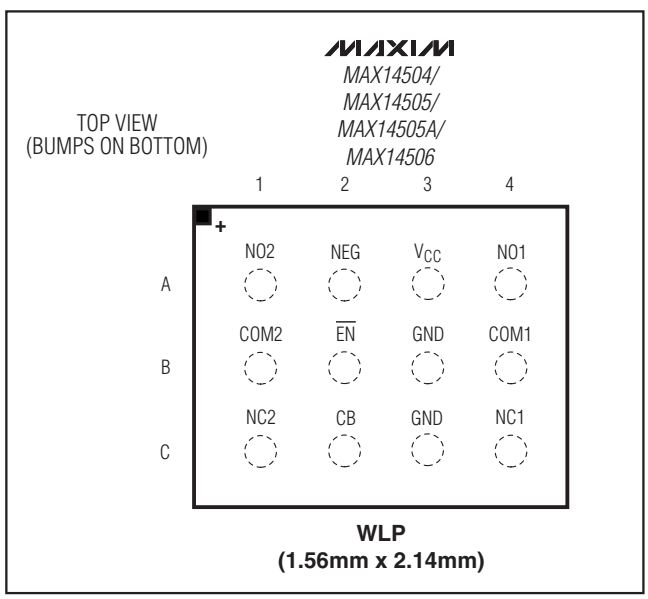
Speaker Switching

Typical Operating Circuit appears at end of data sheet.

Features

- **Distortion-Free Negative Signal Throughput from -VCC to +VCC**
- **Internal Shunt Switches Reduce Click/Pop (MAX14505/MAX14505A)**
- **Low On-Resistance 0.36Ω (typ)**
- **1mΩ (typ) On-Resistance Flatness**
- **COM High Impedance for $\overline{EN}$ = High**
- **Low 0.2µA (max) Shutdown Current (MAX14505A/MAX14506)**
- **+2.3V to +5.5V Single-Supply Voltage**
- **Small, 1.56mm x 2.14mm, 12-Bump WLP Package**

Pin Configuration



WLP
(1.56mm x 2.14mm)

Ordering Information/Selector Guide

PART	PIN-PACKAGE	TOP MARK	COM SIGNAL RANGE FOR $\overline{EN}$ = VCC	CLICKLESS
MAX14504EWC+	12 WLP	AAH	±VCC	NO
MAX14505EWC+*	12 WLP	AAI	±VCC	YES
MAX14505AEWC+	12 WLP	AAK	0 to +VCC	YES
MAX14506EWC+*	12 WLP	AAJ	0 to +VCC	NO

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

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

**Future product—contact factory for availability.*

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

Dual SPDT Negative Rail Analog Switches with ±VCC Capability

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND, unless otherwise noted.)
V_{CC} .....-0.3V to +6.0V
NC_, NO_, COM_ (Note 1).....$-V_{CC}$ - 0.3V to V_{CC} + 0.3V
NC_, NO_, COM_ (MAX14505A/MAX14506, $\overline{EN}$ = V_{CC}) (Note 1).....-0.3V to V_{CC} + 0.3V
CB, $\overline{EN}$.....-0.3V to +6V
Continuous Current (NC_, NO_, COM_).....±550mA
Continuous Current on Shunt Switches.....±5mA
Peak Current (NC_, NO_, COM_) (pulsed at 1ms, 10% duty cycle).....±850mA

Continuous Power Dissipation (T_A = +70°C) for multilayer board: 12-Pin WLP (derate 8.5mW/°C above +70°C) 678mW
Operating Temperature Range .....-40°C to +85°C
Junction Temperature.....+150°C
Storage Temperature Range .....-65°C to +150°C
Package Junction-to-Ambient Thermal Resistance (θ_{JA}) (Note 2).....118°C/W
Lead Temperature (soldering).....+300°C

Note 1: Signals on NC_, NO_, and COM_ exceeding $-V_{CC}$ or $+V_{CC}$ are clamped by internal diodes. For $\overline{EN} \geq V_{IH}$ signals on NC_, NO_, and COM_ exceeding 0 or $+V_{CC}$ are clamped by internal diodes (MAX14505A/MAX14506). Limit forward-diode current to maximum current rating.

Note 2: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a 4-layer board. For detailed information on package thermal considerations, refer to **www.maxim-ic.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} = +2.3 to +5.5V, T_A = T_{MIN} to T_{MAX}, C_{NEG} = 3.3nF, unless otherwise noted. Typical values are at V_{CC} = +3.0V, T_A = +25°C, unless otherwise noted.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	NC_, NO_, COM_	$V_{\overline{EN}}$ = 0		-V_{CC}		+V_{CC}	V
		$V_{\overline{EN}}$ = V_{CC}	(MAX14504/ MAX14505)	-V_{CC}		+V_{CC}	
			(MAX14505A/ MAX14506)	0		+V_{CC}	
On-Resistance	R_{ON}	V_{CC} = +3.0V, $I_{COM_}$ = 50mA, $V_{NC_}$, $V_{NO_}$ = -V_{CC} to V_{CC}	T_A = +25°C		0.36	0.5	Ω
			T_A = T_{MIN} to T_{MAX}			0.65	
On-Resistance Match Between Channels	ΔR_{ON}	V_{CC} = +3.0V, $I_{NC_}$ = $I_{NO_}$ = 50mA; between NC_ and NO_ only			10		mΩ
On-Resistance Flatness	$R_{FLAT (ON)}$	V_{CC} = +3.0V, $I_{NC_}$ = $I_{NO_}$ = 50mA, $V_{NC_}$, $V_{NO_}$ = -V_{CC} to V_{CC} (Note 4)			1		mΩ
Shunt Switch Resistance	R_{SHUNT}	$V_{NO_}$ = +100mV		15	55	120	Ω

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +2.3 to +5.5V, T_A = T_{MIN} to T_{MAX}, C_{NEG} = 3.3nF, unless otherwise noted. Typical values are at V_{CC} = +3.0V, T_A = +25°C, unless otherwise noted.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
NC_ or NO_ Off-Leakage Current	$I_{NC_ (OFF)}$, $I_{NO_ (OFF)}$	V_{CC} = +3.0V, switch open; $V_{NO_}$ = -2.5V, +2.5V; $V_{COM_}$ = +2.5V, -2.5V, unconnected (MAX14504/MAX14506)	-50		+50	nA
		V_{CC} = +3.0V, switch open; $V_{NC_}$ = -2.5V, +2.5V; $V_{COM_}$ = +2.5V, -2.5V, unconnected	-50		+50	
COM_ On-Leakage Current	$I_{COM_ (ON)}$	V_{CC} = +3.0V, switch closed; $V_{COM_}$ = +2.5V, -2.5V ; $V_{NC_}$ or $V_{NO_}$ = +2.5V, -2.5V, unconnected	-100		+100	nA
DYNAMIC TIMING (Note 5)						
Turn-On Time	t_{ON}	$V_{NO_}$ or $V_{NC_}$ = 0, R_L = 50Ω, Figure 1		14	60	ms
Turn-Off Time	t_{OFF}	$V_{NO_}$ or $V_{NC_}$ = 0, R_L = 50Ω, Figure 1		1.5	3	µs
AUDIO PERFORMANCE						
Total Harmonic Distortion Plus Noise	THD+N	f = 20Hz to 20kHz, $V_{COM_}$ = 0.5V_{P-P}, R_S = R_L = 50Ω; DC bias = 0		0.001		%
Off-Isolation	V_{ISO}	R_S = R_L = 50Ω; $V_{COM_}$ = 0.5V_{P-P}, f = 20kHz (Note 6), Figure 2		-84		dB
Crosstalk	V_{CT}	R_S = R_L = 50Ω; $V_{COM_}$ = 0.5V_{P-P}, f = 20kHz (Note 7), Figure 2		-90		dB
NC_ or NO_ Off-Capacitance	$C_{NC_ (OFF)}$, $C_{NO_ (OFF)}$	$V_{NC_/NO_}$ = 0.5V_{P-P}, f = 1MHz; Figure 3		65		pF
COM_ On-Capacitance	$C_{COM_ (ON)}$	$V_{NC_/NO_}$ = 0.5V_{P-P}, f = 1MHz; Figure 3		125		pF
LOGIC INPUT (CB, $\overline{EN}$)						
Input Logic-High	V_{IH}		1.4			V
Input Logic-Low	V_{IL}				0.5	V
Input Leakage Current	I_{IN}	V_{CB} = $V_{\overline{EN}}$ = 0 or V_{CC}	-1		+1	µA

Dual SPDT Negative Rail Analog Switches with ±VCC Capability

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +2.3 to +5.5V, T_A = T_{MIN} to T_{MAX}, C_{NEG} = 3.3nF, unless otherwise noted. Typical values are at V_{CC} = +3.0V, T_A = +25°C, unless otherwise noted.) (Note 3)

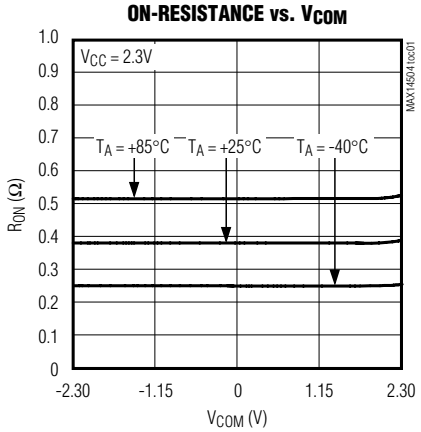
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY						
Power-Supply Range	V_{CC}		2.3		5.5	V
Power-Supply Rejection Ratio (PSRR)		$R_{COM_}$ = 50Ω, f = 10kHz		78		dB
V_{CC} Supply Current	I_{CC}	V_{CC} = +3.0V, $V_{\overline{EN}}$ = 0, V_{CB} = 0 or V_{CC}		12	23	µA
		V_{CC} = +5.5V, $V_{\overline{EN}}$ = 0, V_{CB} = 0 or V_{CC}		21	41	
V_{CC} Shutdown Supply Current	I_{CC_SHDN}	V_{CC} = +3.0V, $V_{\overline{EN}}$ = V_{CC} (MAX14504/MAX14505)			15	µA
		V_{CC} = +5.5V, $V_{\overline{EN}}$ = V_{CC} (MAX14504/MAX14505)			29	
		V_{CC} = +3.0V, $V_{\overline{EN}}$ = V_{CC} (MAX14505A/MAX14506)			0.15	
		V_{CC} = +5.5V, $V_{\overline{EN}}$ = V_{CC} (MAX14505A/MAX14506)			0.2	
Supply Current Increase with Supply Voltage	I_{CC_CTRL}	V_{CC} = 5.5V, V_{CB} = $V_{\overline{EN}}$ = 0.5V or 1.4V		2	5	µA
Negative Charge-Pump Output	V_{NEG}	C_{NEG} = 3.3nF	-1.01V_{CC}	-V_{CC}	-0.95V_{CC}	V

Note 3: All parameters are production tested at T_A = +85°C, and guaranteed by design over the specified temperature range.
Note 4: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.
Note 5: All timing is measured using 20% and 80% levels.
Note 6: Off-Isolation = $20\log_{10}[V_{COM_}/(V_{NO_}$ or $V_{NC_})]$, $V_{COM_}$ = output, $V_{NO_}$ or $V_{NC_}$ = input to off switch.
Note 7: Between any two switches.

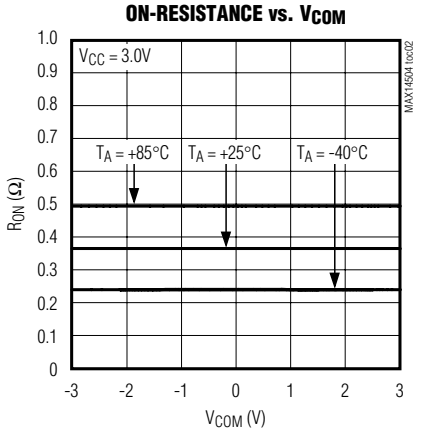
Typical Operating Characteristics

(V_{CC} = 3.0V, T_A = +25°C, unless otherwise noted.)

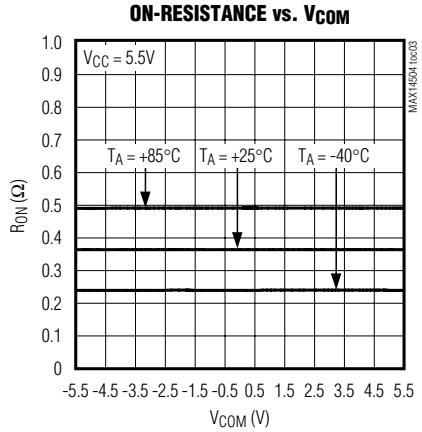
ON-RESISTANCE vs. V_{COM}



ON-RESISTANCE vs. V_{COM}



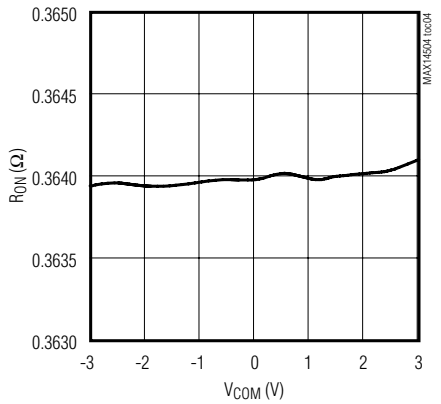
ON-RESISTANCE vs. V_{COM}



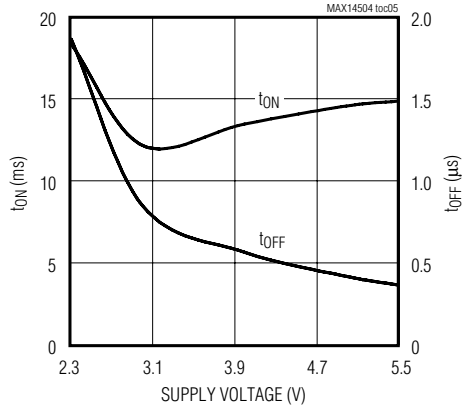
Typical Operating Characteristics (continued)

(V_{CC} = 3.0V, T_A = +25°C, unless otherwise noted.)

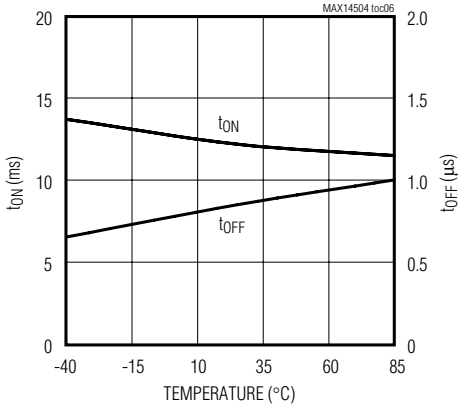
R_{ON} FLATNESS vs. V_{COM}



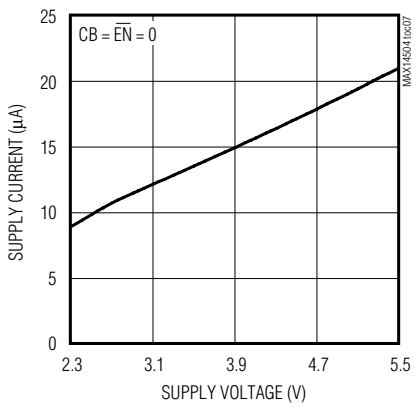
NC_/NO_ TURN-ON/TURN-OFF TIME vs. SUPPLY VOLTAGE



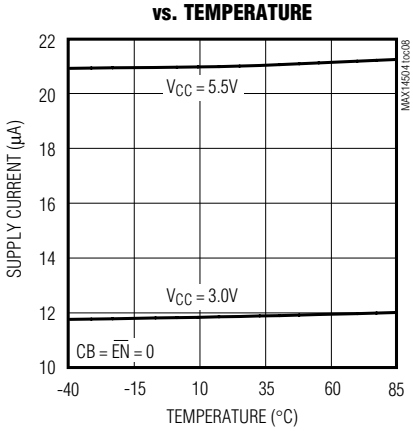
NC_/NO_ TURN-ON/TURN-OFF TIME vs. TEMPERATURE



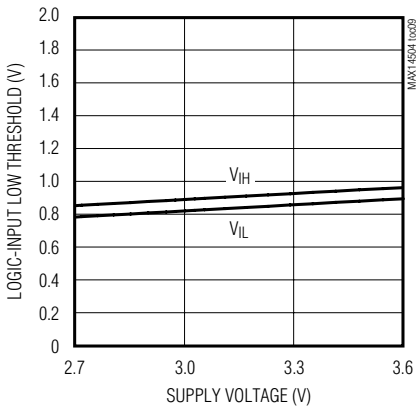
SUPPLY CURRENT vs. SUPPLY VOLTAGE



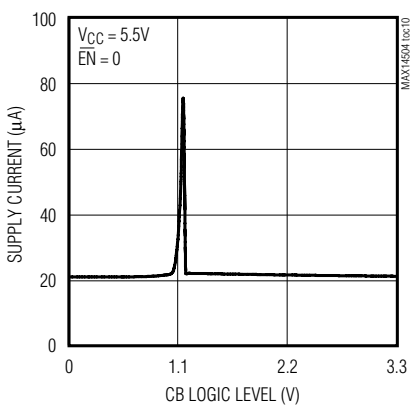
SUPPLY CURRENT vs. TEMPERATURE



LOGIC-INPUT LOW THRESHOLD vs. SUPPLY VOLTAGE



SUPPLY CURRENT vs. CB LOGIC LEVEL

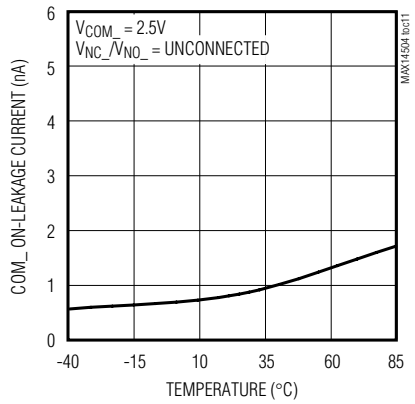


Dual SPDT Negative Rail Analog Switches with ±VCC Capability

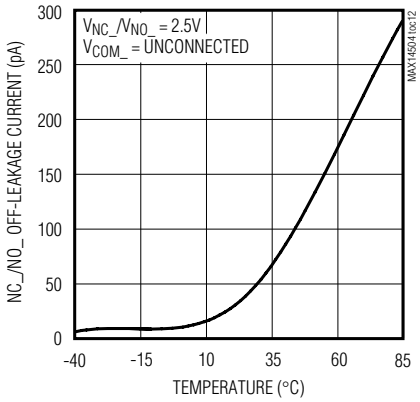
Typical Operating Characteristics (continued)

(V_{CC} = 3.0V, T_A = +25°C, unless otherwise noted.)

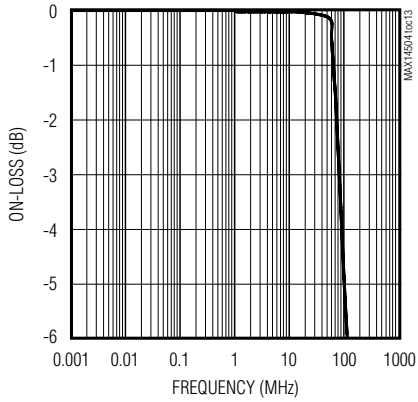
COM_ ON-LEAKAGE CURRENT vs. TEMPERATURE



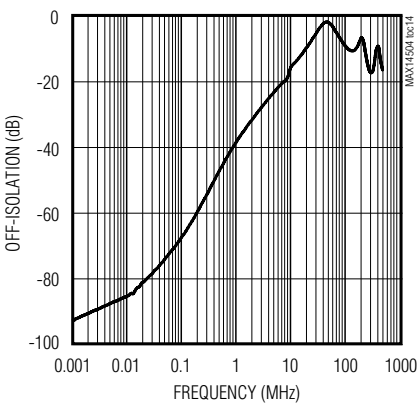
NC_/NO_ OFF-LEAKAGE CURRENT vs. TEMPERATURE



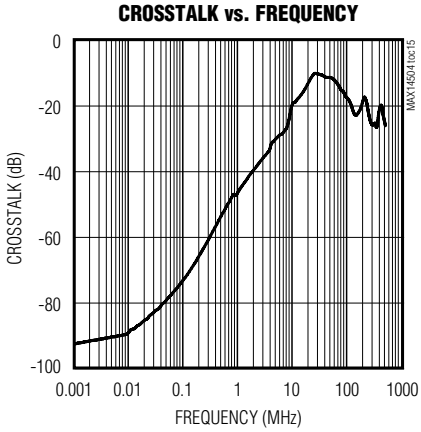
ON-LOSS vs. FREQUENCY



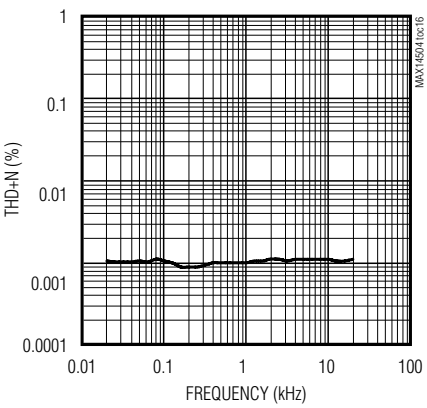
OFF-ISOLATION vs. FREQUENCY



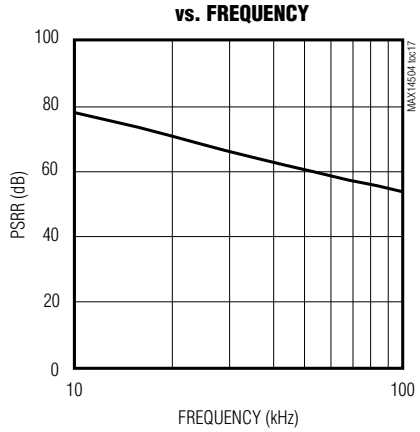
CROSSTALK vs. FREQUENCY



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



Test Circuits/Timing Diagrams

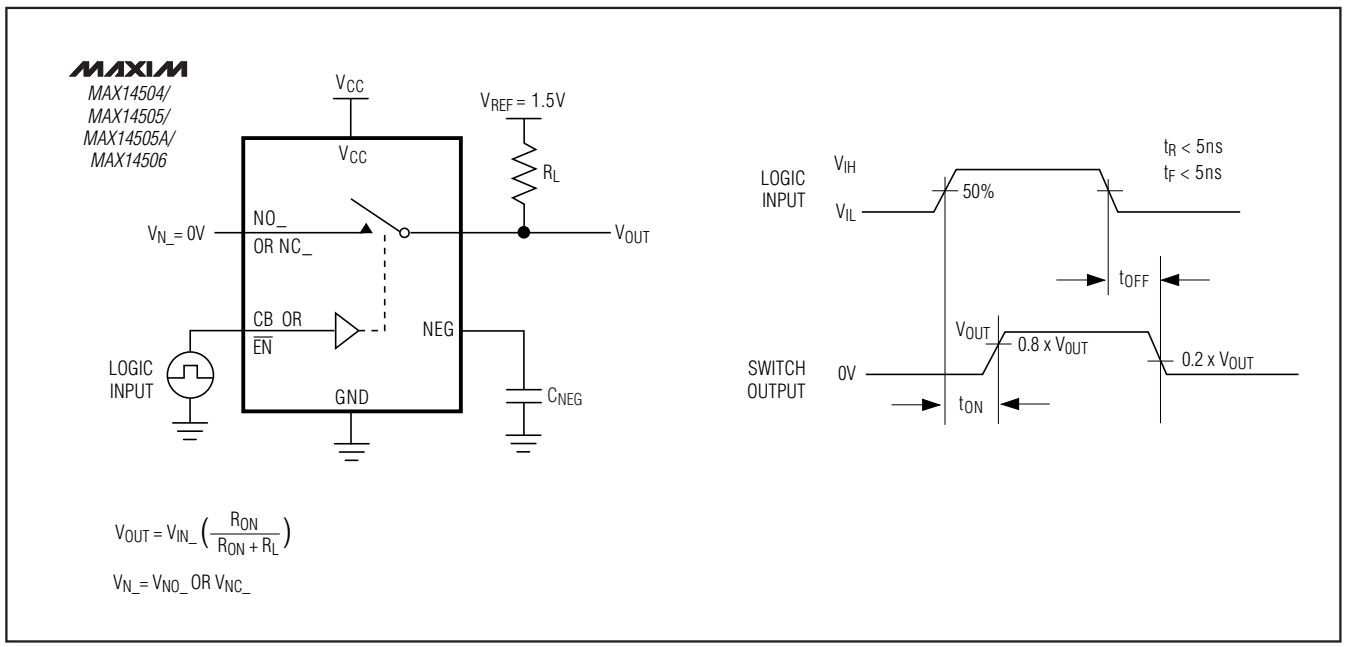


Figure 1. Switching Time

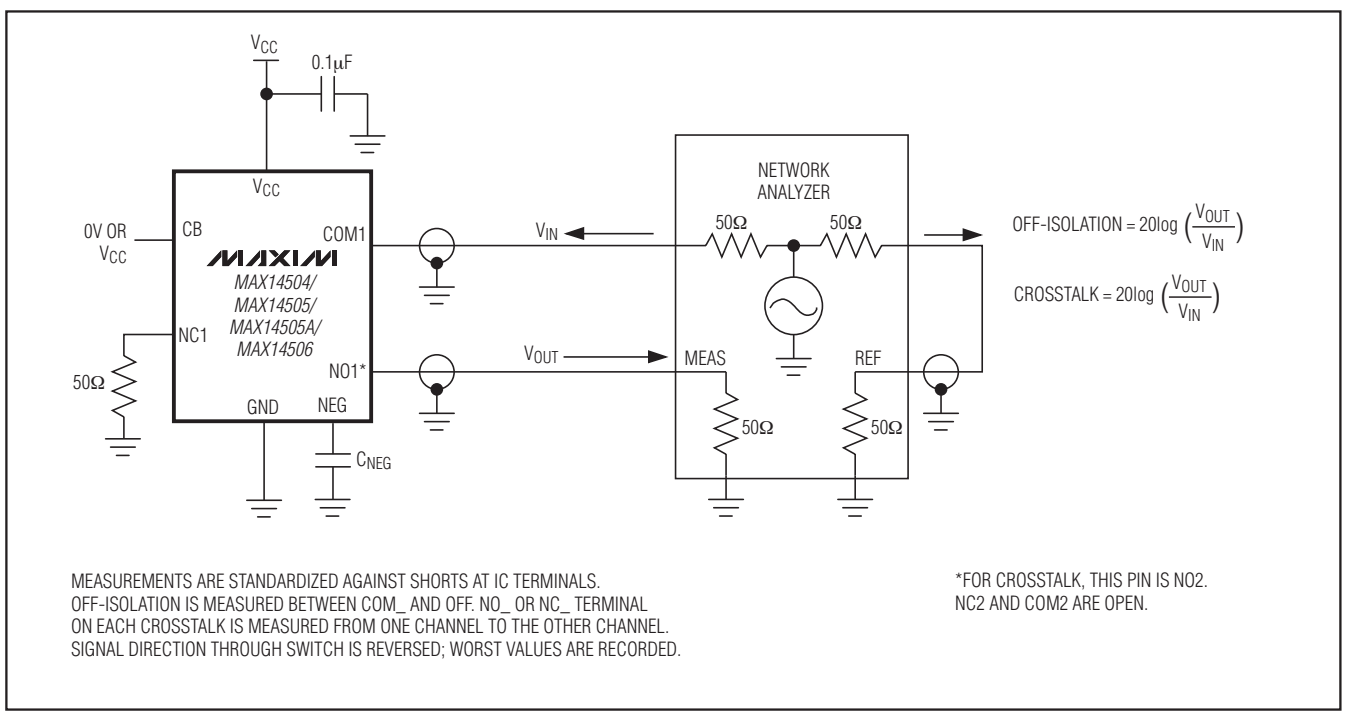


Figure 2. Off-Isolation and Crosstalk

Dual SPDT Negative Rail Analog Switches with ±VCC Capability

Test Circuits/Timing Diagrams (continued)

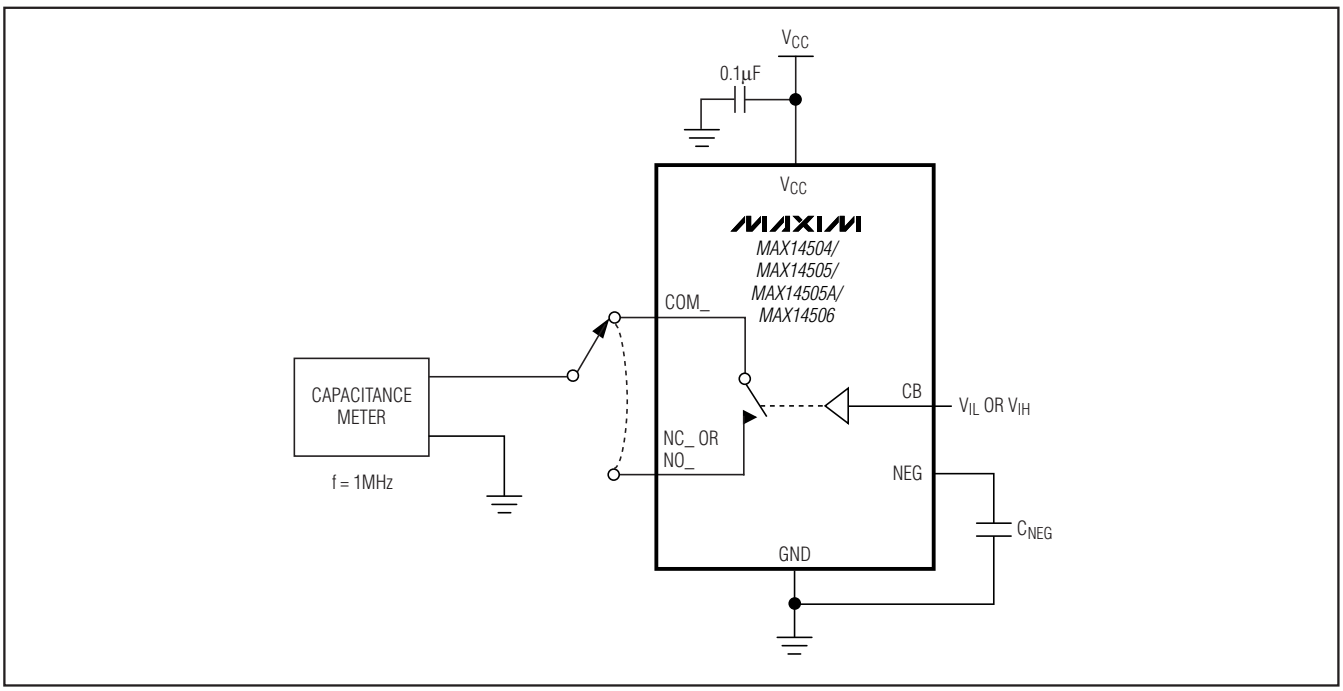


Figure 3. Channel Off-/On-Capacitance

Pin Description

PIN	NAME	FUNCTION
A1	NO2	Analog Switch 2, Normally Open Terminal
A2	NEG	Negative Supply Voltage Output. Connect NEG to GND with a 3.3nF capacitor. Do not use NEG to power any external circuitry.
A3	V_{CC}	Positive Supply Voltage Input. Connect V_{CC} to a +2.3V to +5.5V supply voltage. Bypass V_{CC} to GND with a 0.1µF ceramic capacitor placed as close as possible to the device.
A4	NO1	Analog Switch 1, Normally Open Terminal
B1	COM2	Analog Switch 2, Common Terminal
B2	$\overline{EN}$	Active-Low Enable Input. Drive $\overline{EN}$ high to put switches in a high-impedance mode. Shunt click/pop switches are not affected by the state of $\overline{EN}$. The MAX14505A/MAX14506 enter a low current state when $\overline{EN}$ is driven high.
B3, C3	GND	Ground
B4	COM1	Analog Switch 1, Common Terminal
C1	NC2	Analog Switch 2, Normally Closed Terminal
C2	CB	Control Bit Input. CB controls switch 1 and switch 2. See the *Functional Diagram/Truth Table*.
C4	NC1	Analog Switch 1, Normally Closed Terminal

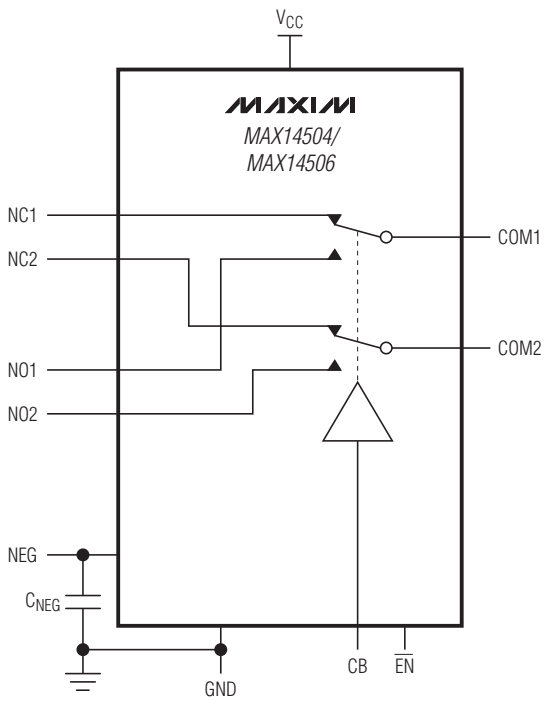
Detailed Description

The MAX14504/MAX14505/MAX14505A/MAX14506 are low on-resistance, low-voltage, dual SPDT analog switches that operate from a +2.3V to +5.5V single supply. These devices feature a negative signal capability that allows signals as low as -V_{CC} to pass through without distortion.

The MAX14504/MAX14505/MAX14505A/MAX14506 have an enable input $\overline{EN}$ to put the switches in a high-impedance mode. When $\overline{EN}$ = V_{CC}, the MAX14504/MAX14505 terminals have a signal range of -V_{CC} to +V_{CC}. The MAX14505A/MAX14506 terminals have a signal range of 0 to +V_{CC}. The MAX14505A/MAX14506 feature a low supply current when $\overline{EN}$ = V_{CC}.

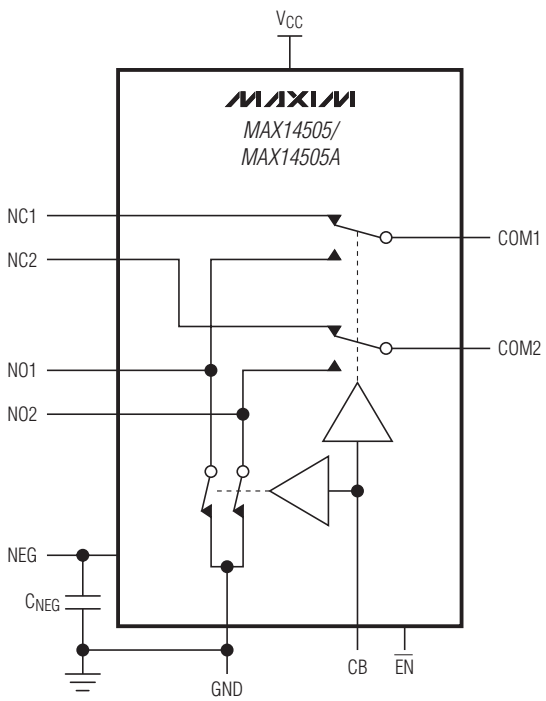
The MAX14505/MAX14505A have internal shunt switches on both NO1 and NO2 terminals to suppress click-and-pop sounds that can occur when switching audio signals between precharged points.

Functional Diagram/Truth Table



$\overline{EN}$	CB	COM_ TO NC_	COM_ TO NO_
1	X	HIGH IMPEDANCE	HIGH IMPEDANCE
0	0	ON	OFF
0	1	OFF	ON

X = DON'T CARE.



$\overline{EN}$	CB	SHUNT SWITCH (MAX14505/MAX14505A)
X	0	ON
X	1	OFF

X = DON'T CARE.

Dual SPDT Negative Rail Analog Switches with ±VCC Capability

Digital Control Inputs

The MAX14504/MAX14505/MAX14505A/MAX14506 logic inputs accept up to +5.5V, regardless of supply voltage. For example, with a +3.3V supply, CB and $\overline{EN}$ can be driven low to GND and high to +5.5V, allowing for mixed logic levels in a system. Using logic levels of V_{IL} = 0 to $V_{IH} \geq V_{CC}$ reduces supply current.

Analog Signal Levels

These devices pass signals from $-V_{CC}$ to $+V_{CC}$ with minimal distortion and very little change in on-resistance (see the *Typical Operating Characteristics*). The switches are bidirectional; therefore, the NO_, NC_, and COM_ terminals can be used as either inputs or outputs.

Click-and-Pop Suppression

The MAX14505/MAX14505A have a shunt switch on NO1 and NO2 terminals to automatically discharge any capacitance when they are not connected to COM1 and COM2. The shunt switch reduces audible click-and-pop sounds that occur when switching between capacitively coupled audio sources. Audible clicks and pops are caused when a step DC voltage is switched into the speaker. The DC step transients are reduced by automatically discharging the side that is not connected to the COM terminal, reducing any residual DC voltage and reducing clicks and pops.

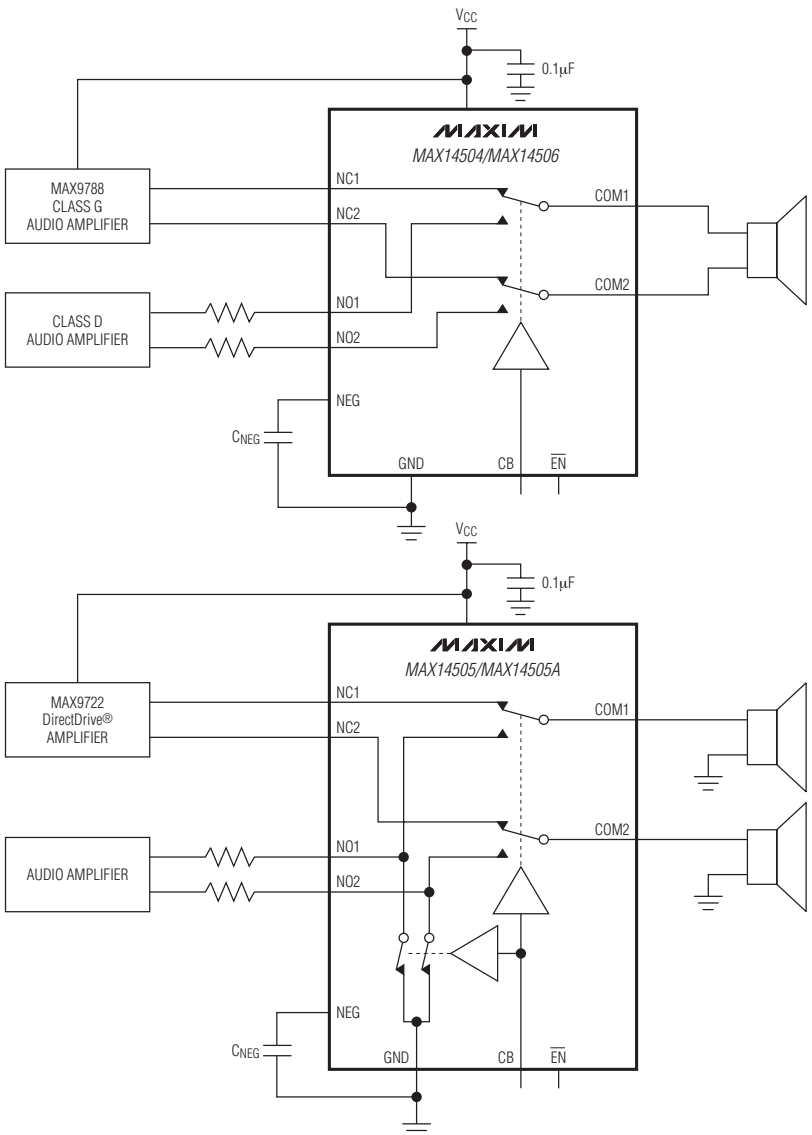
Applications Information

Power-Supply Sequencing

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

Dual SPDT Negative Rail Analog Switches with ±VCC Capability

Typical Operating Circuit



Chip Information

PROCESS: CMOS

Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
12 WLP	W121A2-1	**21-0009**

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Dual SPDT Negative Rail Analog Switches with ±VCC Capability

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	8/08	Initial release	—
1	12/08	Changed *Pin Configuration* and *Pin Description* sections	1, 8, 11

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