



# 0.75Ω, Dual SPDT Audio Switch with Integrated Comparators

MAX4855

## General Description

The MAX4855 dual, single-pole/double-throw (SPDT) switch operates from a single +2V to +5.5V supply and features rail-to-rail signal handling. The MAX4855 has low on-resistance (0.75Ω) with a +3V supply making it ideal for audio switching applications in portable devices. The device also integrates two internal comparators that can be used for headphone detection or mute/send key functions.

The MAX4855 is available in the space-saving (3mm x 3mm), 16-pin thin QFN package and operates over the extended temperature range of -40°C to +85°C.

## Applications

- Speaker Headset Switching
- Audio-Signal Routing
- Cellular Phones
- Notebook Computers
- PDA's and Other Handheld Devices

## Features

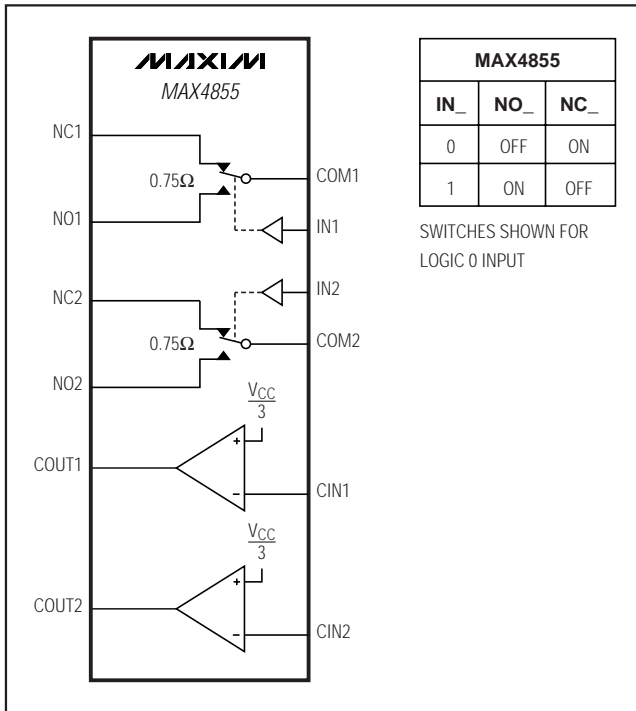
- ◆ Audio Signal Routing
- ◆ 0.75Ω On-Resistance
- ◆ 0.18Ω On-Resistance Flatness
- ◆ 0.07Ω Channel-to-Channel Matching
- ◆ Rail-to-Rail Signal Handling
- ◆ 2 Integrated Comparators
- ◆ 1.8V Logic Compatible
- ◆ 2V to 5.5V Supply Range
- ◆ Available in a Space-Saving (3mm x 3mm), 16-Pin TQFN Package

## Ordering Information

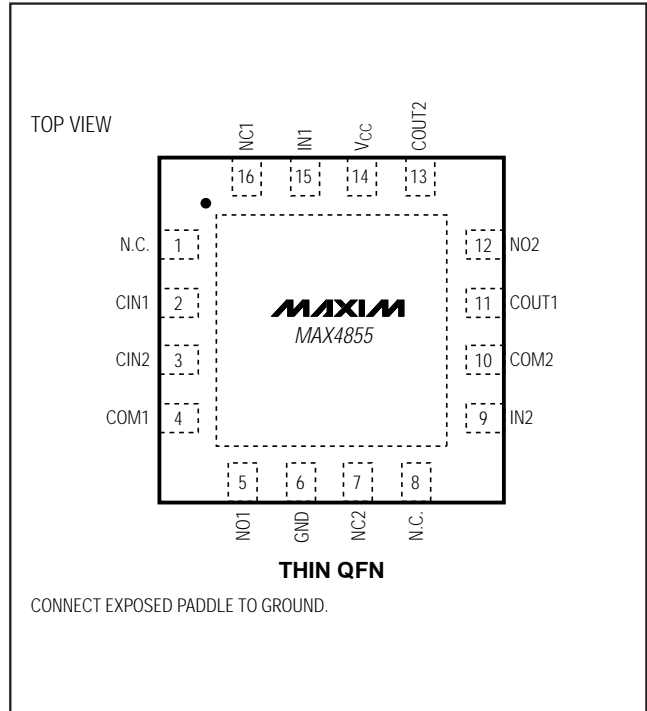
PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX4855ETE	-40°C to +85°C	16 TQFN-EP*	ABY

\*EP = Exposed paddle.

## Block Diagram/Truth Table



## Pin Configuration



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## ABSOLUTE MAXIMUM RATINGS

V <sub>CC</sub> , IN <sub>-</sub> , CIN <sub>-</sub> to GND .....	-0.3V to +6.0V
NO <sub>-</sub> , NC <sub>-</sub> , COM <sub>-</sub> , COUT <sub>-</sub> (Note 1) .....	-0.3V to (V <sub>CC</sub> + 0.3V)
COUT <sub>-</sub> Continuous Current .....	±20mA
Closed Switch Continuous Current COM <sub>-</sub> , NO <sub>-</sub> , NC <sub>-</sub> .....	±300mA
Peak Current COM <sub>-</sub> , NO <sub>-</sub> , NC <sub>-</sub> (pulsed at 1ms, 50% duty cycle) .....	±400mA
Peak Current COM <sub>-</sub> , NO <sub>-</sub> , NC <sub>-</sub> (pulsed at 1ms, 10% duty cycle) .....	±500mA

Continuous Power Dissipation (T <sub>A</sub> = +70°C) 16-Pin Thin QFN (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

**Note 1:** Signals on NO, NC, or COM exceeding V<sub>CC</sub> or GND are clamped by internal diodes. Signals on IN exceeding GND are clamped by an internal diode. 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<sub>CC</sub> = +2.7V to +5.5V, 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, unless otherwise noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V <sub>CC</sub>		2		5.5	V
Supply Current	I <sub>CC</sub>	V <sub>CC</sub> = 5.5V, V <sub>IN<sub>-</sub></sub> = 0V or V <sub>CC</sub>		5	10	μA
<b>ANALOG SWITCH</b>						
Analog Signal Range	V <sub>NO<sub>-</sub></sub> , V <sub>NC<sub>-</sub></sub> , V <sub>COM<sub>-</sub></sub>		0		V <sub>CC</sub>	V
On-Resistance (Note 3)	R <sub>ON</sub>	V <sub>CC</sub> = 2.7V, I <sub>COM<sub>-</sub></sub> = 100mA, V <sub>NC<sub>-</sub></sub> or V <sub>NO<sub>-</sub></sub> = 0V to V <sub>CC</sub>	T <sub>A</sub> = +25°C	0.75	1	Ω
			T <sub>A</sub> = -40°C to +85°C		1.1	
On-Resistance Match Between Channels (Notes 3, 4)	ΔR <sub>ON</sub>	V <sub>CC</sub> = 2.7V, I <sub>COM<sub>-</sub></sub> = 100mA, V <sub>NC<sub>-</sub></sub> or V <sub>NO<sub>-</sub></sub> = 1.5V	T <sub>A</sub> = +25°C	0.075	0.120	Ω
			T <sub>A</sub> = -40°C to +85°C		0.135	
On-Resistance Flatness (Note 5)	R <sub>FLAT</sub>	V <sub>CC</sub> = 2.7V, I <sub>COM<sub>-</sub></sub> = 100mA, V <sub>NC<sub>-</sub></sub> or V <sub>NO<sub>-</sub></sub> = 0.75V, 1.5V, 1.75V	T <sub>A</sub> = +25°C	0.18	0.275	Ω
			T <sub>A</sub> = -40°C to +85°C		0.3	
NO <sub>-</sub> /NC <sub>-</sub> Off-Leakage Current (Note 2)	I <sub>OFF</sub>	V <sub>CC</sub> = 5.5V, V <sub>NC<sub>-</sub></sub> or V <sub>NO<sub>-</sub></sub> = 1V or 4.5V, V <sub>COM<sub>-</sub></sub> = 4.5V or 1V	T <sub>A</sub> = +25°C	-2	+2	nA
			T <sub>A</sub> = -40°C to +85°C	-10	+10	
COM <sub>-</sub> On-Leakage Current (Note 2)	I <sub>ON</sub>	V <sub>CC</sub> = 5.5V; V <sub>NC<sub>-</sub></sub> or V <sub>NO<sub>-</sub></sub> = 1V, 4.5V, or floating; V <sub>COM<sub>-</sub></sub> = 1V, 4.5V, or floating	T <sub>A</sub> = +25°C	-2	+2	nA
			T <sub>A</sub> = -40°C to +85°C	-15	+15	
<b>DYNAMIC CHARACTERISTICS</b>						
Turn-On Time	t <sub>ON</sub>	V <sub>CC</sub> = 2.7V, V <sub>NO<sub>-</sub></sub> or V <sub>NC<sub>-</sub></sub> = 1.5V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 50pF (Figure 1)	T <sub>A</sub> = +25°C	40	60	ns
			T <sub>A</sub> = -40°C to +85°C		100	

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## ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = +2.7V$  to  $+5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CC} = +3.0V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Turn-Off Time	$t_{OFF}$	$V_{CC} = 2.7V$ , $V_{NO\_}$ or $V_{NC\_} = 1.5V$ , $R_L = 300\Omega$ , $C_L = 50pF$ (Figure 1)	$T_A = +25^{\circ}C$	30	40	ns
			$T_A = -40^{\circ}C$ to $+85^{\circ}C$		60	
Break-Before-Make Time Delay (Note 3)	$t_D$	$V_{CC} = 2.7V$ , $V_{NO\_}$ or $V_{NC\_} = 1.5V$ , $R_L = 50\Omega$ , $C_L = 50pF$ (Figure 2)	$T_A = +25^{\circ}C$	15		ns
			$T_A = -40^{\circ}C$ to $+85^{\circ}C$	2		
Charge Injection	$Q$	$V_{COM\_} = 1.5V$ , $R_S = 0\Omega$ , $C_L = 1.0nF$ (Figure 3)		170		pC
Off-Isolation (Note 6)		$f = 100kHz$ , $V_{COM\_} = 1V_{RMS}$ , $R_L = 50\Omega$ , $C_L = 5pF$ (Figure 4)		-75		dB
Crosstalk	$V_{CT}$	$f = 100kHz$ , $V_{COM\_} = 1V_{RMS}$ , $R_L = 50\Omega$ , $C_L = 5pF$ (Figure 4)		-93		dB
-3dB Bandwidth	$BW$	Signal = 0dBm, $R_L = 50\Omega$ , $C_L = 5pF$ (Figure 4)		38		MHz
Total Harmonic Distortion	THD	$f = 20Hz$ to $20kHz$ , $V_{COM\_} = 1V + 2V_{P-P}$ , $R_L = 32\Omega$		0.07		%
NO_/NC_ Off-Capacitance	$C_{OFF}$	$f = 1MHz$ (Figure 5)		50		pF
COM On-Capacitance	$C_{ON}$	$f = 1MHz$ (Figure 5)		150		pF
<b>DIGITAL I/O (IN_)</b>						
Input-Logic High Voltage	$V_{IH}$	$V_{CC} = 2V$ to $3.6V$	1.4			V
		$V_{CC} = 3.6V$ to $5.5V$	1.8			
Input-Logic Low Voltage	$V_{IL}$	$V_{CC} = 2V$ to $3.6V$			0.5	V
		$V_{CC} = 3.6V$ to $5.5V$			0.8	
Input Leakage Current	$I_{IN}$	$V_{IN\_} = 0$ or $5.5V$	-0.5		+0.5	$\mu A$
<b>COMPARATOR</b>						
Comparator Range			0		5.5	V
Comparator Threshold		$V_{CC} = 2V$ to $5.5V$ , falling input	$0.3 \times V_{CC}$	$0.33 \times V_{CC}$	$0.36 \times V_{CC}$	V
Comparator Hysteresis		$V_{CC} = 2V$ to $5.5V$		50		mV
Comparator Output High Voltage		$I_{SOURCE} = 1mA$	$V_{CC} - 0.4V$			V
Comparator Output Low Voltage		$I_{SINK} = 1mA$			0.4	V
Comparator Switching Time		Rising input (Figure 6)		2.5		$\mu s$
		Falling input (Figure 6)		0.5		

**Note 2:** Specifications are 100% tested at  $T_A = +85^{\circ}C$  only, and guaranteed by design and characterization over the specified temperature range.

**Note 3:** Guaranteed by design and characterization; not production tested.

**Note 4:**  $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$ .

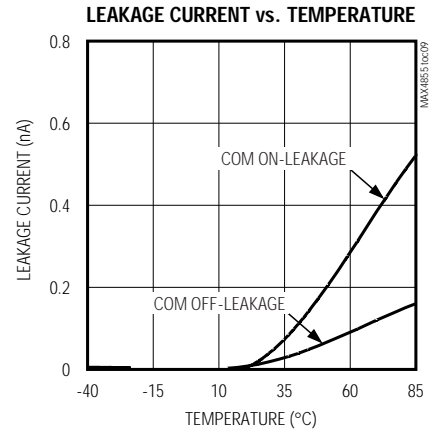
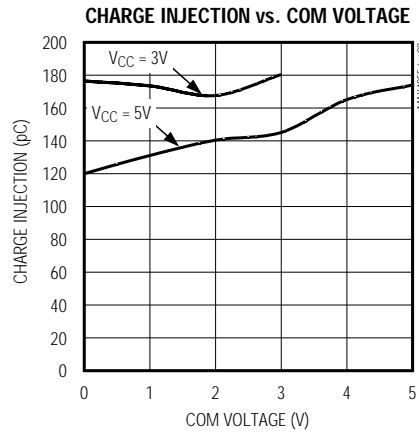
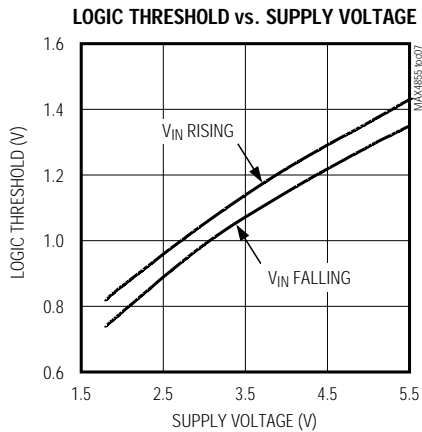
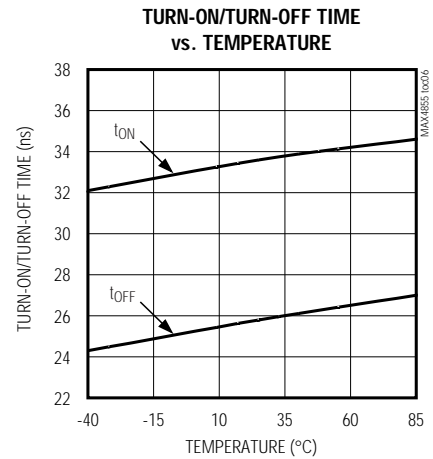
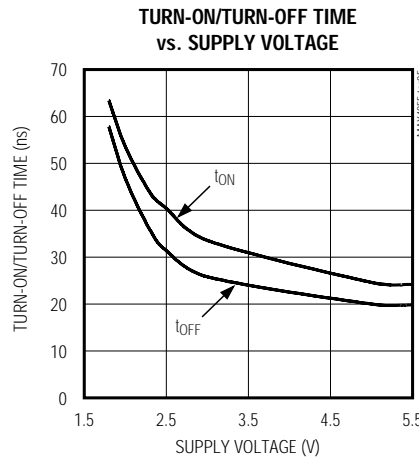
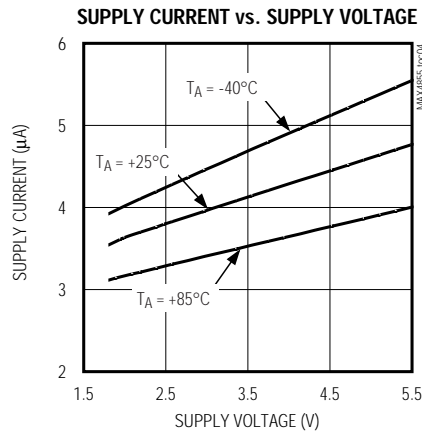
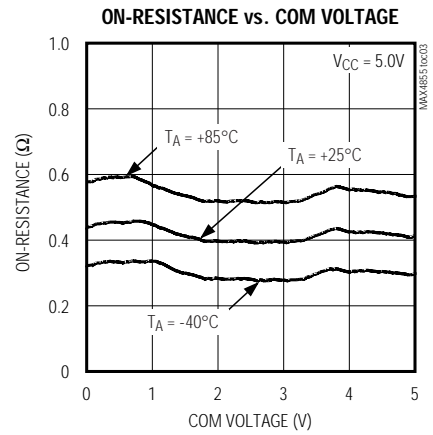
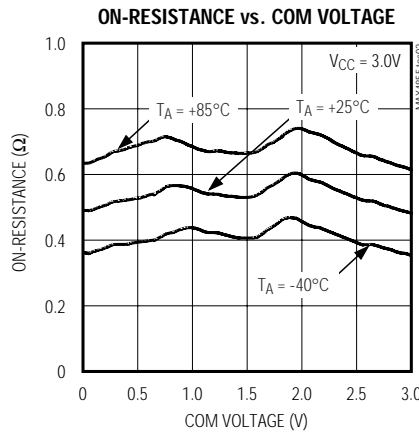
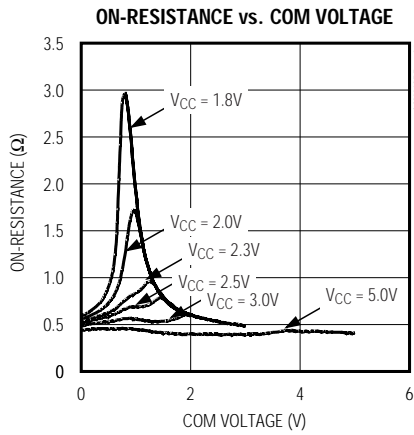
**Note 5:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

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

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## Typical Operating Characteristics

(V<sub>CC</sub> = 3.0V, T<sub>A</sub> = +25°C, unless otherwise noted.)

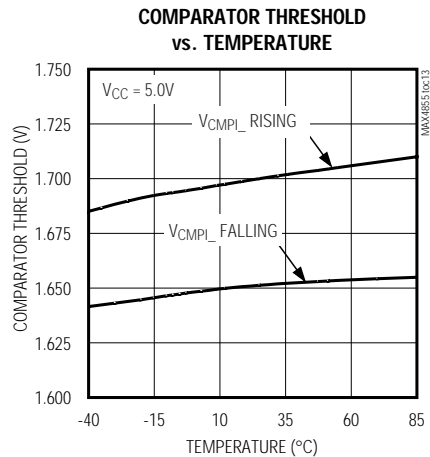
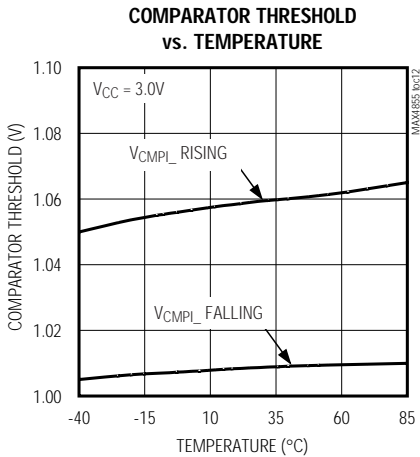
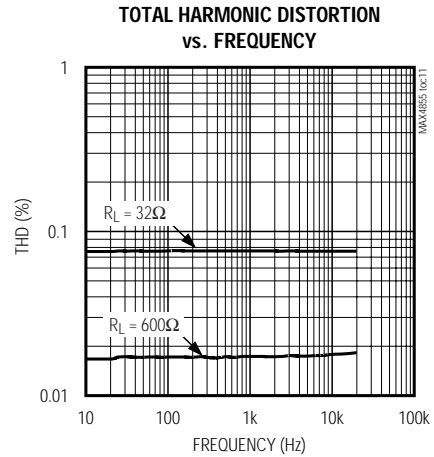
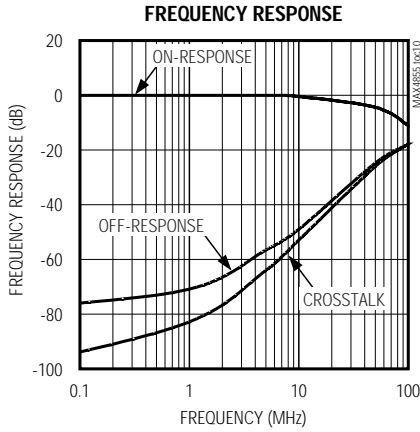


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## Typical Operating Characteristics (continued)

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



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## Pin Description

PIN	NAME	FUNCTION
1, 8	N.C.	No Connection. Not internally connected.
2	CIN1	Inverting Input for Comparator 1
3	CIN2	Inverting Input for Comparator 2
4	COM1	Common Terminal for Analog Switch 1
5	NO1	Normally Open Terminal for Analog Switch 1
6	GND	Ground
7	NC2	Normally Closed Terminal for Analog Switch 2
9	IN2	Digital Control Input for Analog Switch 2. A logic LOW on IN2 connects COM2 to NC2 and a logic HIGH connects COM2 to NO2.
10	COM2	Common Terminal for Analog Switch 2
11	COUT1	Output for Comparator 1
12	NO2	Normally Open Terminal for Analog Switch 2
13	COUT2	Output for Comparator 2
14	V <sub>CC</sub>	Supply Voltage. Bypass to GND with a 0.01μF capacitor as close to the pin as possible.
15	IN1	Digital Control Input for Analog Switch 1. A logic LOW on IN1 connects COM1 to NC1 and a logic HIGH connects COM1 to NO1.
16	NC1	Normally Closed Terminal for Analog Switch 1
EP	—	Exposed Paddle. Connect to PC board ground plane.

## Detailed Description

The MAX4855 dual SPDT, low on-resistance, low-voltage, analog switch operates from a +2V to +5.5V supply and can handle signals up to the power rails. In addition, the MAX4855 integrates two internal comparators that can be used for headphone or mute detection. The comparator threshold is internally generated to be approximately 1/3 of V<sub>CC</sub>.

## Applications Information

### Digital Control Inputs

The logic inputs (IN<sub>1</sub>) accept up to +5.5V even if the supply voltages are below this level. For example, with a +3.3V V<sub>CC</sub> supply, IN<sub>1</sub> can be driven low to GND and high to +5.5V allowing for mixing of logic levels in a system. Driving IN<sub>1</sub> rail-to-rail minimizes power consumption. For a +2V supply voltage, the logic thresholds are 0.5V (low) and 1.4V (high); for a +5V supply voltage, the logic thresholds are 0.8V (low) and 1.8V (high).

## Analog Signal Levels

The on-resistance of these switches changes very little for analog input signals across the entire supply voltage range (see the *Typical Operating Characteristics*). The switches are bidirectional, so the NO<sub>1</sub>, NC<sub>1</sub>, and COM<sub>1</sub> pins can be either inputs or outputs.

### Comparator

The positive terminal of the comparator is internally set to V<sub>CC</sub>/3. When the negative terminal (CIN<sub>1</sub>) is below the threshold (V<sub>CC</sub>/3), the comparator output (COUT<sub>1</sub>) is high. When CIN<sub>1</sub> rises above V<sub>CC</sub>/3, COUT<sub>1</sub> is low.

The comparator threshold allows for detection of headphones since headphone audio signals are typically biased to V<sub>CC</sub>/2.

### Power-Supply Sequencing

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

Proper power-supply sequencing is recommended for all CMOS devices. Always apply V<sub>CC</sub> before applying analog signals, especially if the analog signal is not current-limited.

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Test Circuits/Timing Diagrams

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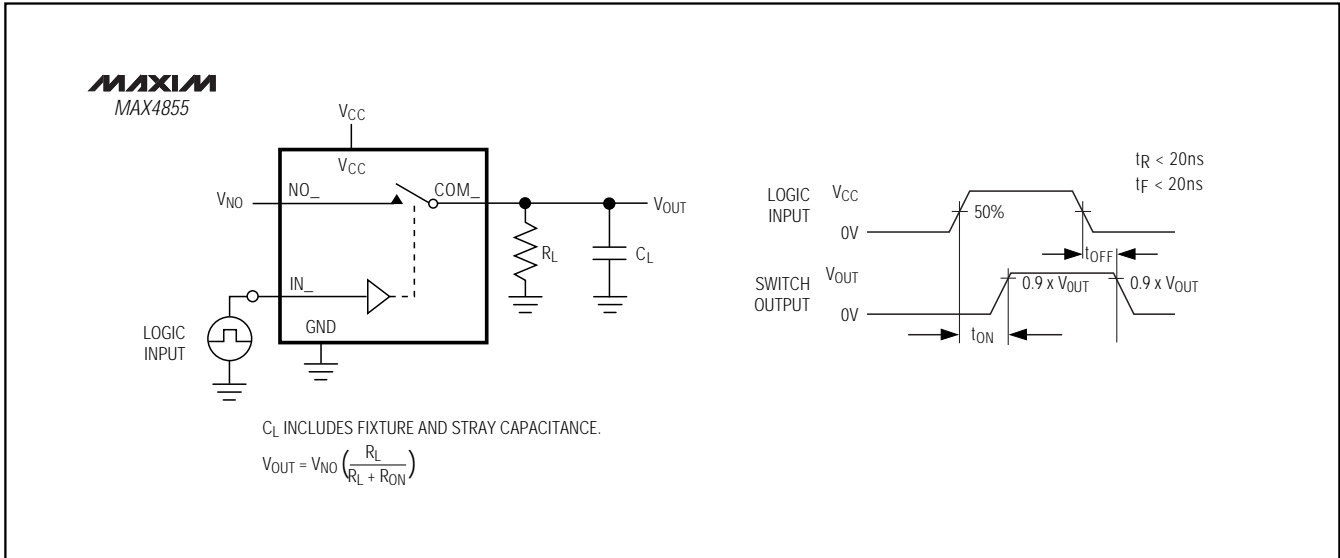


Figure 1. Switching Time

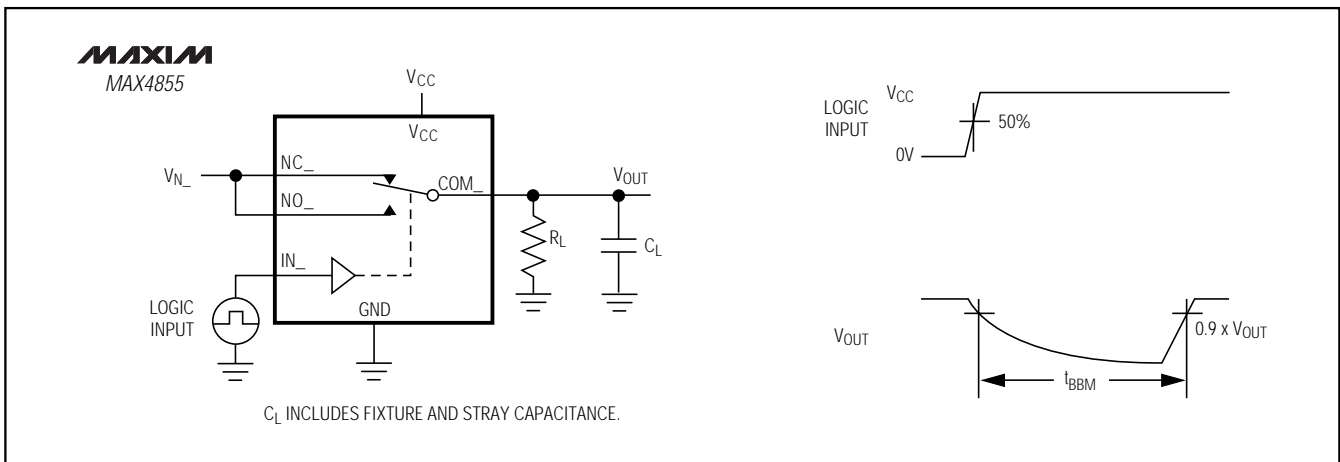


Figure 2. Break-Before-Make Interval

# 0.75Ω, Dual SPDT Audio Switch with Integrated Comparators

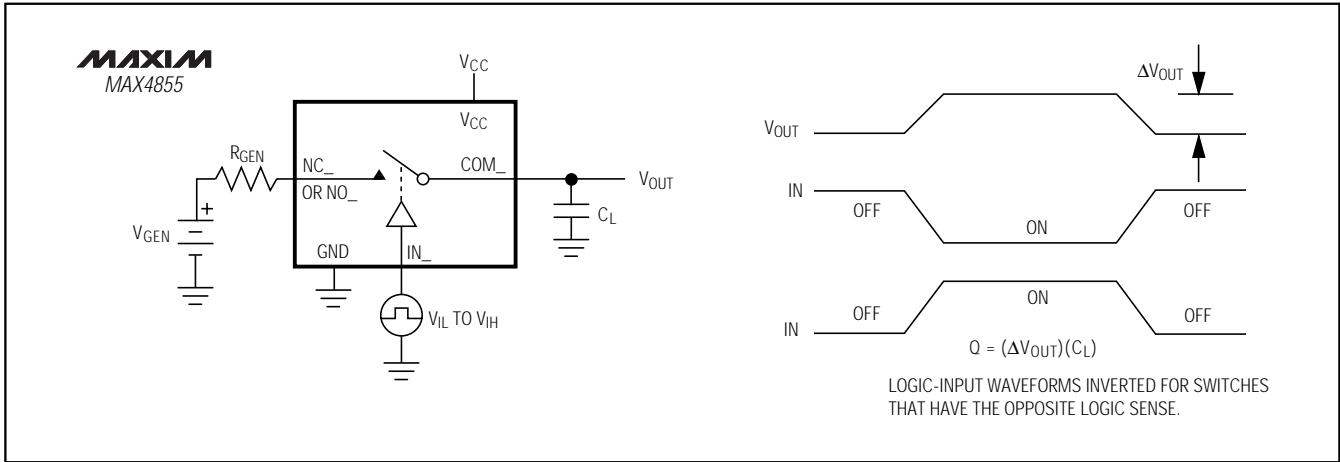


Figure 3. Charge Injection

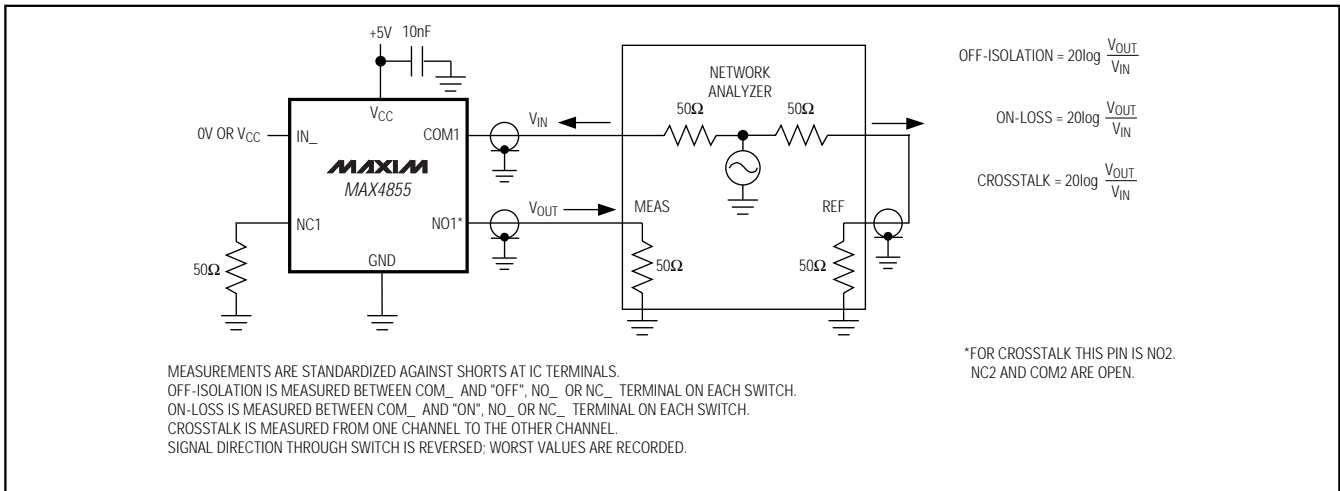


Figure 4. On-Loss, Off-Isolation, and Crosstalk

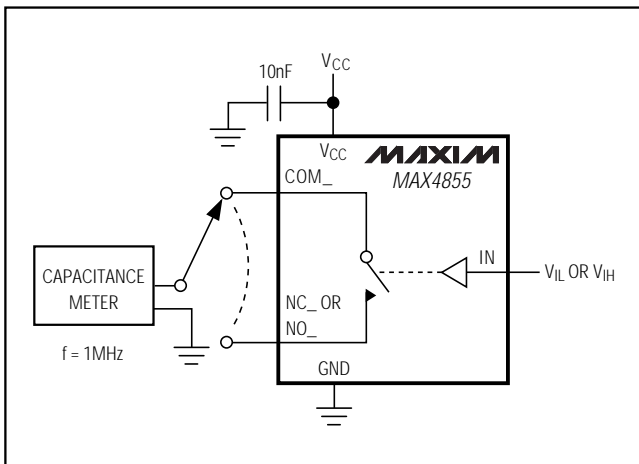


Figure 5. Channel Off-/On-Capacitance



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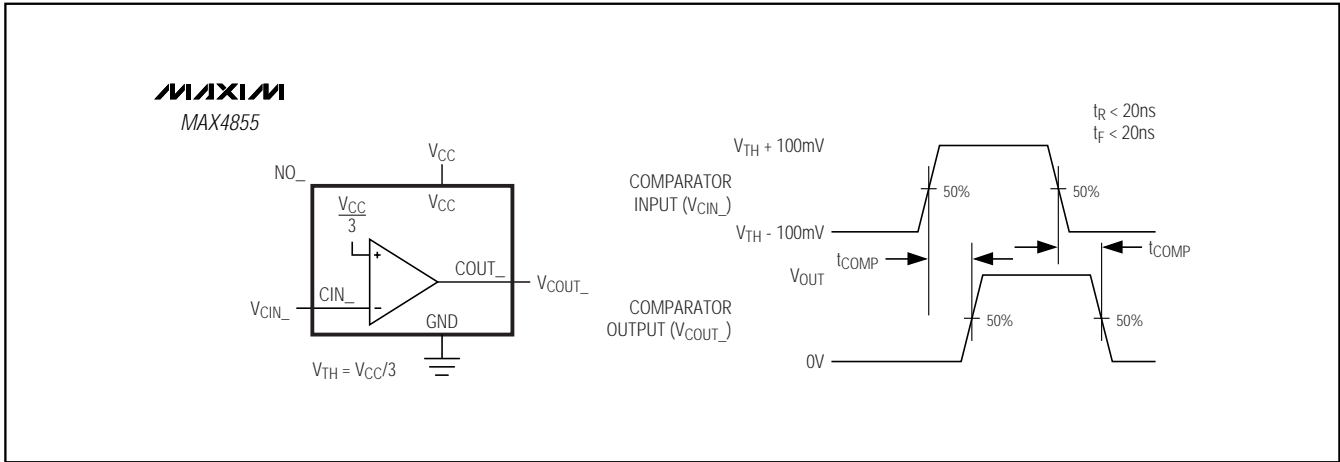
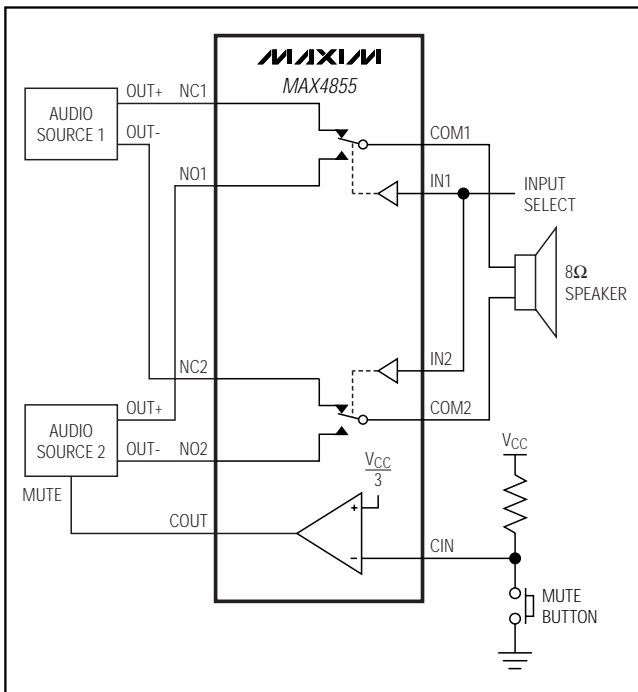


Figure 6. Comparator Switching Time

## Typical Operating Circuit



## Chip Information

TRANSISTOR COUNT: 735

PROCESS: CMOS

