

# MAX14759/MAX14761/MAX14763

## Above- and Below-the-Rails

### Low On-Resistance Analog Switches

#### General Description

The MAX14759/MAX14761/MAX14763 analog switches are capable of passing bipolar signals that are beyond their supply rails. These devices operate from a single +3.0V to +5.5V supply and support signals in the -25V to +25V range.

The MAX14759 is a single-pole/single-throw (SPST) analog switch, while the MAX14761 is a dual-SPST analog switch. The MAX14763 is a single-pole/double-throw (SPDT) analog switch.

The MAX14759 features 1Ω (max) on-resistance with a ±200nA (max) on-leakage current. The MAX14761/MAX14763 feature 2Ω (max) on-resistance with a ±100nA (max) on-leakage current. The low on-resistance and high bandwidth allow use in digital- and analog-signal switching applications.

The MAX14759/MAX14763 are available in an 8-pin (3mm x 3mm) TDFN package. The MAX14761 is available in a 10-pin (3mm x 3mm) TDFN package. These devices are specified over the -40°C to +85°C extended temperature range.

**Ordering Information/Selector Guide** appears at end of data sheet.

For related parts and recommended products to use with this part, refer to [www.maximintegrated.com/MAX14759.related](http://www.maximintegrated.com/MAX14759.related).

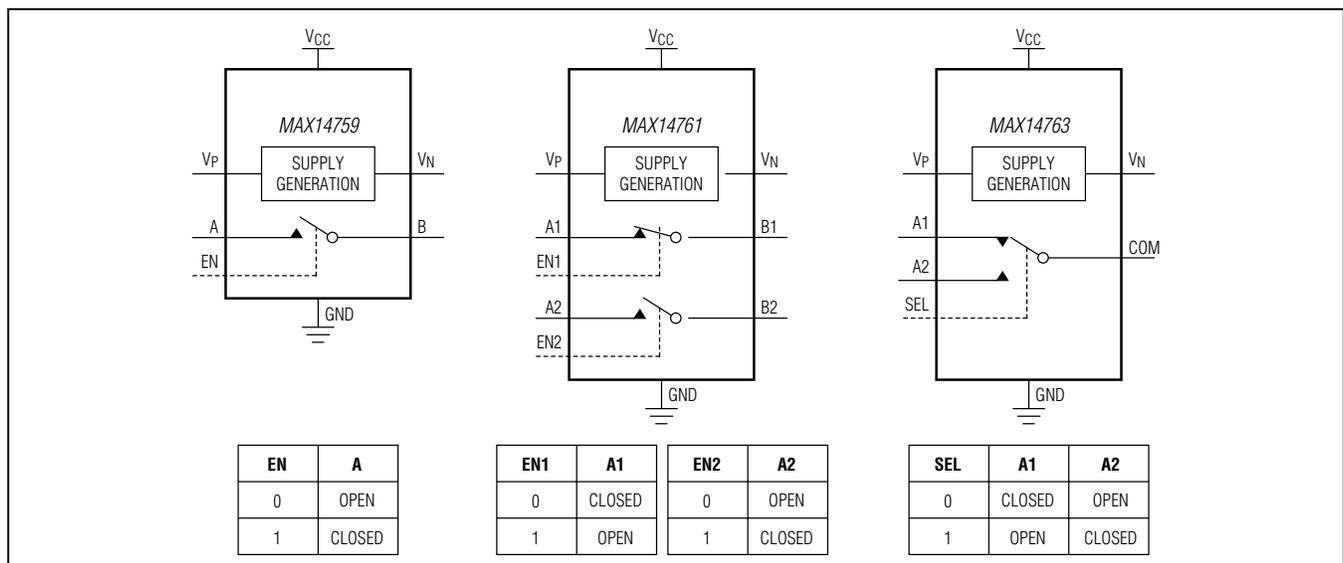
#### Benefits and Features

- ◆ **Simplify Power-Supply Requirements**
  - ◇ +3.0V to +5.5V Supply Range
  - ◇ -25V to +25V Signal Range
- ◆ **High Performance**
  - ◇ Low 1Ω (max) or 2Ω (max) On-Resistance
  - ◇ Low 2.4mΩ (typ) and 5.1mΩ (typ) R<sub>ON</sub> Flatness
  - ◇ 500mA (max) Switch Current for MAX14759
  - ◇ Thermal Shutdown Protection
  - ◇ -40°C to +85°C Operating Temperature Range
  - ◇ High Bandwidth: 100MHz (typ) Insertion Loss
  - ◇ High-ESD Protection Up to 2kV
- ◆ **Save Board Space**
  - ◇ Small 8-Pin and 10-Pin TDFN Packages

#### Applications

Industrial Measurement Systems  
 Instrumentation Systems  
 RS-485 Termination Switching  
 CAN Bus Termination Switching  
 Opto-Relay Replacement  
 Medical Systems  
 ATE Systems  
 Audio Signal Routing and Switching

#### Functional Diagrams/Truth Tables



For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at [www.maximintegrated.com](http://www.maximintegrated.com).



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## Above- and Below-the-Rails Low On-Resistance Analog Switches

### ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = +3.0V$  to  $+5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CC} = 5V$  and  $T_A = +25^{\circ}C$ .) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
On-Leakage Current	$I_{ON}$	$V_A = \pm 25V$ , B1, B2, or COM are unconnected, Figure 1 (MAX14759)	-200		+200	nA
		$V_A = \pm 25V$ , B1, B2, or COM are unconnected, Figure 1 (MAX14761)	-100		+100	
		$V_A = \pm 25V$ , B1, B2, or COM are unconnected, Figure 1 (MAX14763)	-250		+250	
<b>DIGITAL LOGIC</b>						
Input-Voltage Low	$V_{IL}$	$V_{CC} = 3.0V$			0.7	V
		$V_{CC} = 3.6V$			0.7	
		$V_{CC} = 4.5V$			0.8	
		$V_{CC} = 5.5V$			0.8	
Input-Voltage High	$V_{IH}$	$V_{CC} = 3.0V$	1.7			V
		$V_{CC} = 3.6V$	1.9			
		$V_{CC} = 4.5V$	2.0			
		$V_{CC} = 5.5V$	2.1			
Input Current	$I_L$		-1		+1	$\mu A$
<b>AC CHARACTERISTICS</b>						
Power-On Time	$t_{PWRON}$	$C_{VP} = C_{VN} = 100nF$ (Note 3)		50		ms
Enable Turn-On Time	$t_{ON}$	$V_{A-} = \pm 10V$ , $R_L = 10k\Omega$ , Figure 2 (MAX14759/MAX14761)		152	300	$\mu s$
		$V_{A-} = \pm 10V$ , $R_L = 10k\Omega$ , Figure 2 (MAX14763)		1.12	1.8	ms
Enable Turn-Off Time	$t_{OFF}$	$V_{A-} = \pm 10V$ , $R_L = 10k\Omega$ , Figure 2		300	1000	$\mu s$
Break-Before-Make Interval	$t_{BBM}$	$V_{A-} = 1V_{RMS}$ , $R_L = 10k\Omega$ , Figure 3 (MAX14763)		740		$\mu s$
Off-Isolation	$V_{ISO}$	$V_{A-} = 1V_{RMS}$ , $f = 100kHz$ , $R_L = 50\Omega$ , $C_L = 15pF$ , Figure 4		-77		dB
Crosstalk	$V_{CT}$	$R_S = R_L = 50\Omega$ , $f = 100kHz$ , $V_{COM} = 1V_{RMS}$ , Figure 5 (MAX14763)		-83		dB
-3dB Bandwidth	BW	$R_S = 50\Omega$ , $R_L = 50\Omega$ , $V_{A-} = 1V_{P-P}$ , Figure 6		100		MHz
Total Harmonic Distortion Plus Noise	THD+N	$R_S = R_L = 1k\Omega$ , $f = 20Hz$ to $20kHz$		0.0012		%
Charge Injection	Q	$V_{A-} = GND$ , $C_L = 1nF$ , Figure 7		1370		pC
Input Capacitance	$C_{IN}$	At A, A1, A2, B, B1, B2, and COM pins		58		pF
<b>THERMAL PROTECTION</b>						
Thermal Shutdown Temperature	$t_{HYST}$			+154		$^{\circ}C$
Shutdown Temperature Hysteresis	$t_{SHUT}$			24		$^{\circ}C$
<b>ESD PROTECTION</b>						
All Pins		Human Body Model		$\pm 2$		kV

**Note 2:** All devices are 100% production tested at  $T_A = +25^{\circ}C$ . Specifications over operating temperature range are guaranteed by design.

**Note 3:** The power-on time is defined as the settling time for the charge pump's output to reach steady-state value within 1%.

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## Above- and Below-the-Rails Low On-Resistance Analog Switches

### Test Circuits/Timing Diagrams

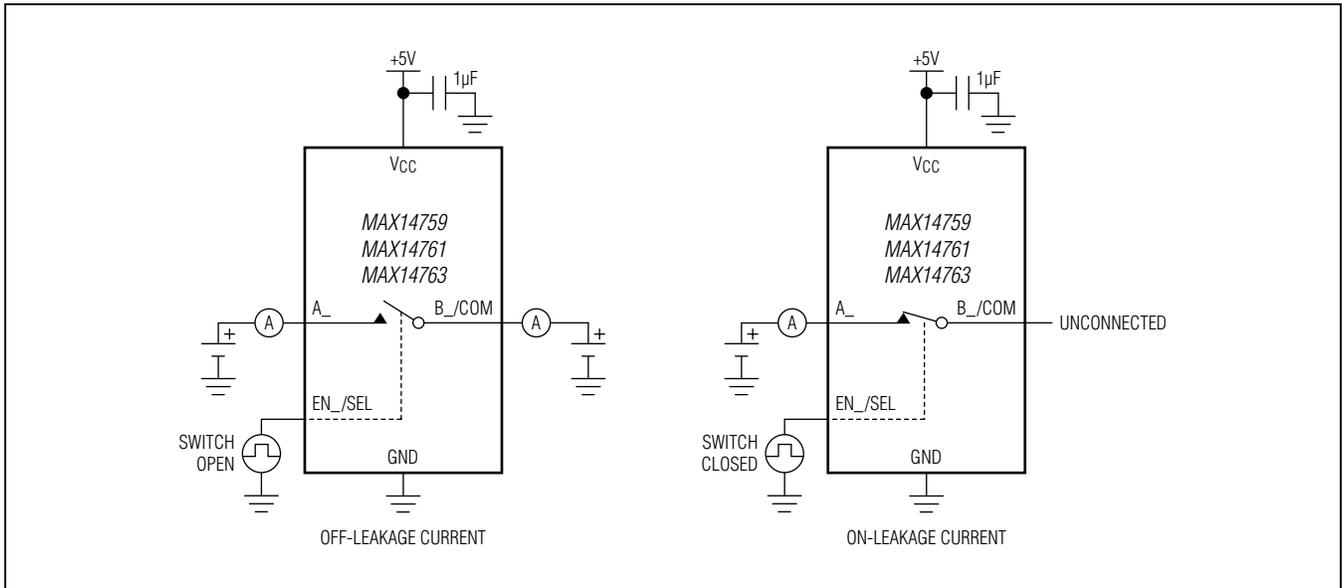


Figure 1. Leakage Current Measurement

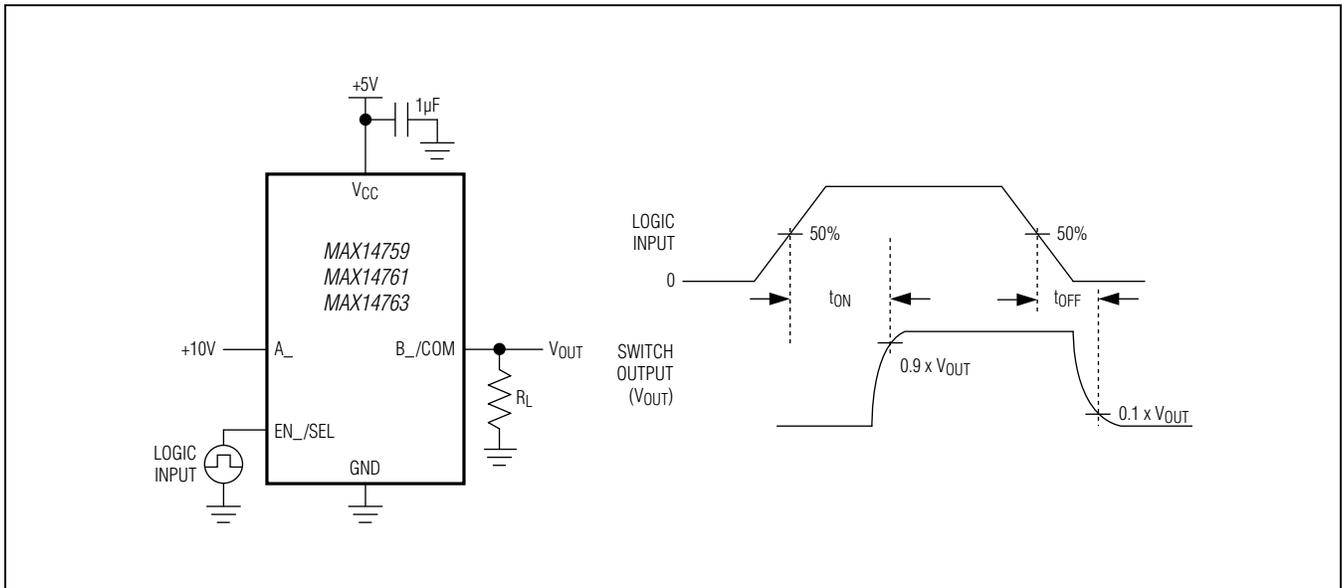


Figure 2. Switching Time

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## Above- and Below-the-Rails

### Low On-Resistance Analog Switches

#### Test Circuits/Timing Diagrams (continued)

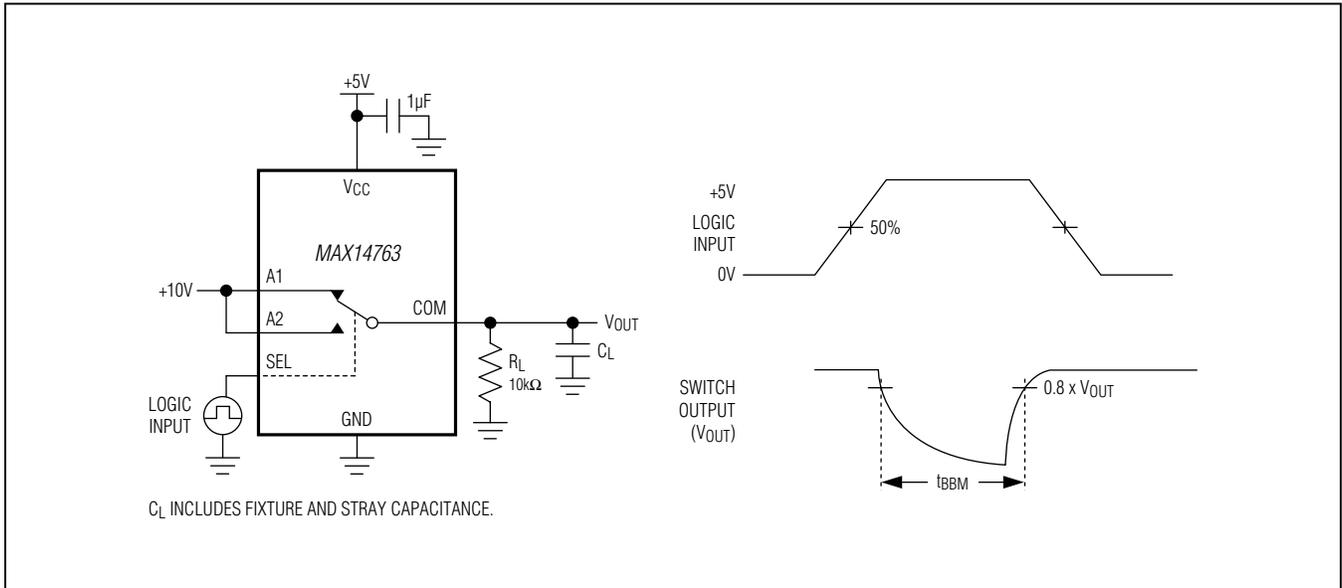


Figure 3. Break-Before-Make

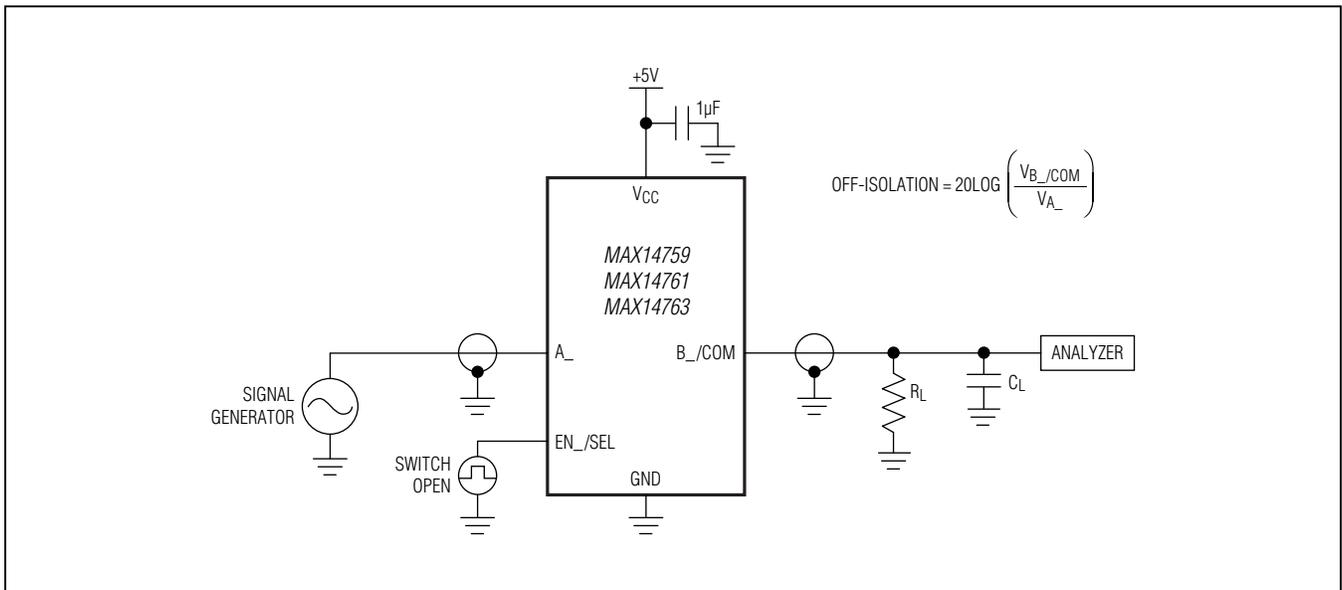


Figure 4. Off-Isolation

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## Above- and Below-the-Rails

### Low On-Resistance Analog Switches

#### Test Circuits/Timing Diagrams (continued)

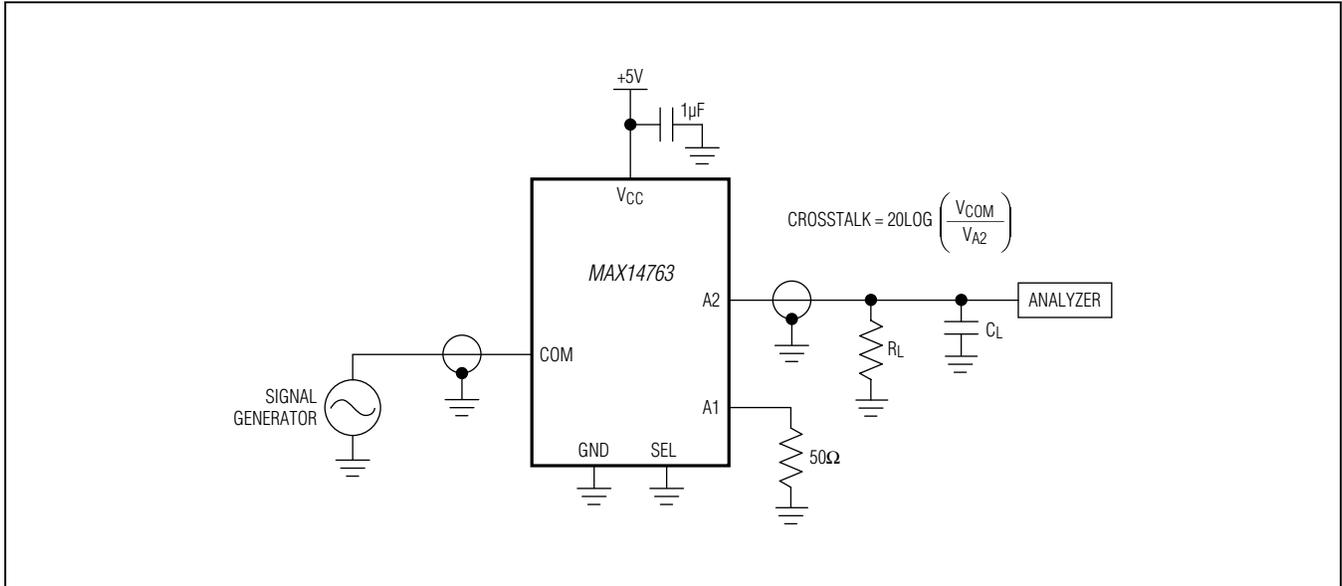


Figure 5. Crosstalk

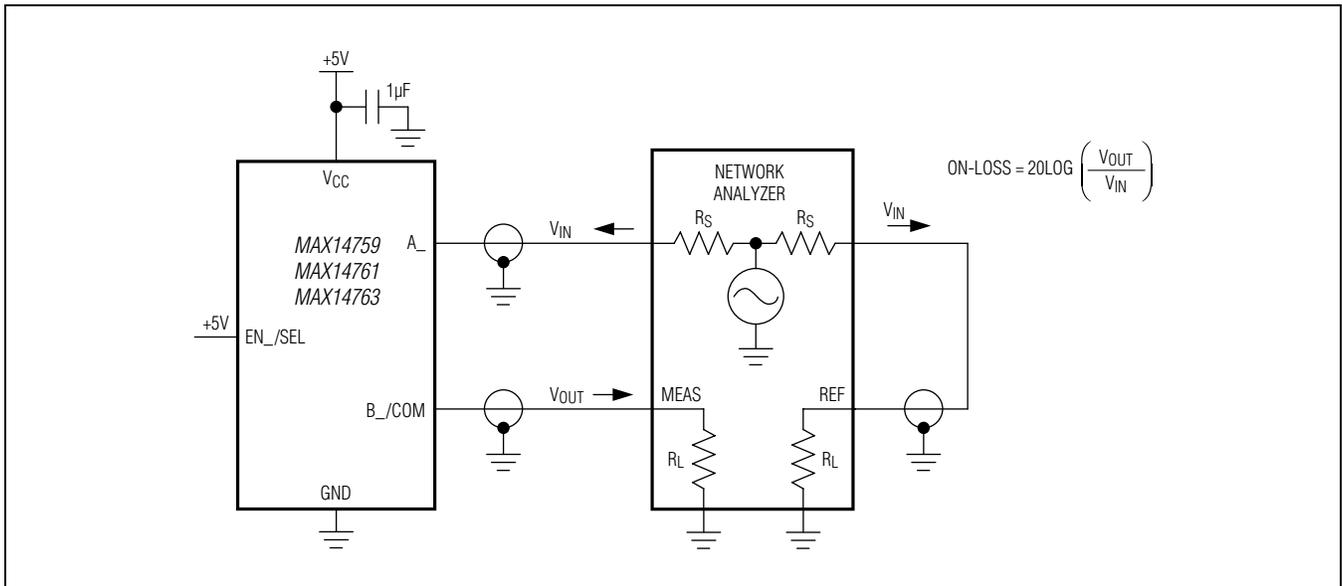


Figure 6. Insertion Loss

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## Above- and Below-the-Rails Low On-Resistance Analog Switches

### Test Circuits/Timing Diagrams (continued)

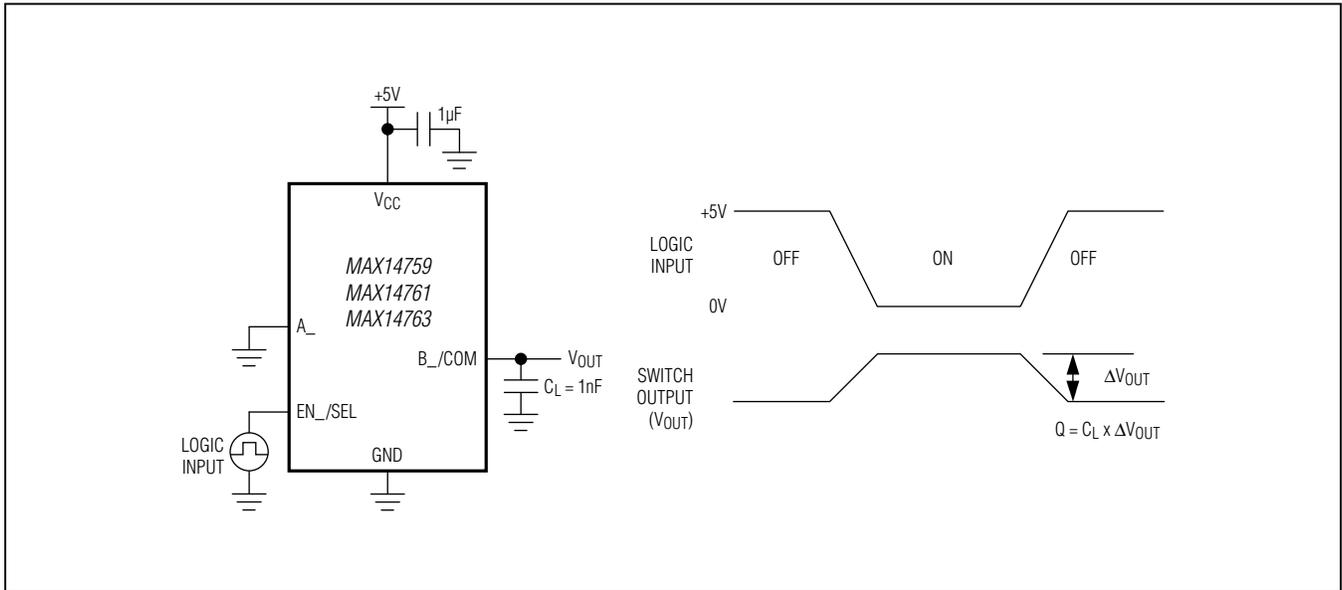
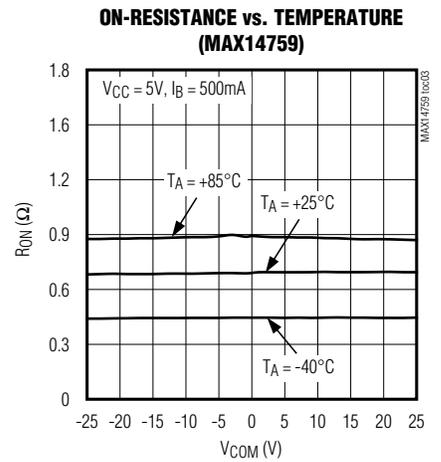
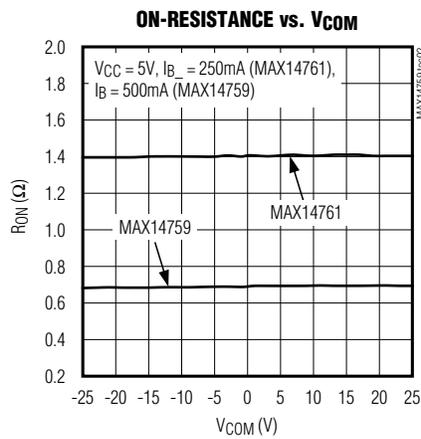
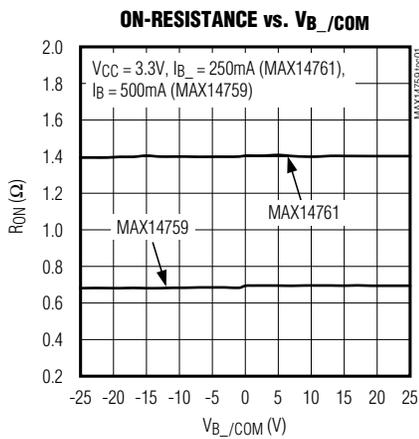


Figure 7. Charge Injection

### Typical Operating Characteristics

( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



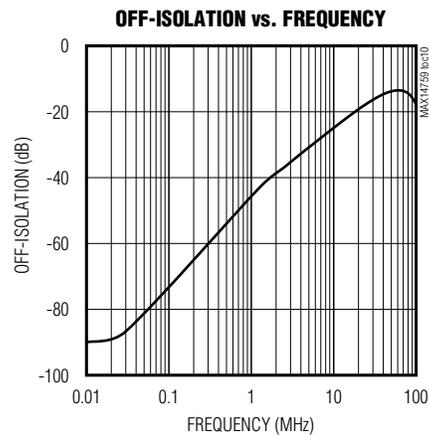
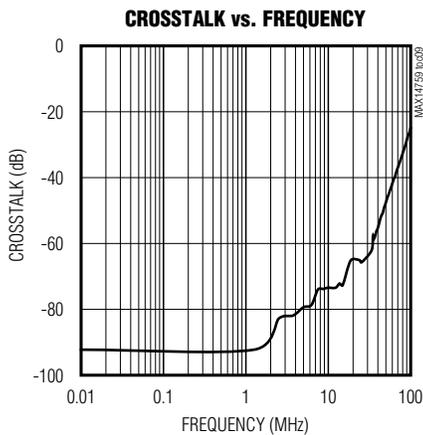
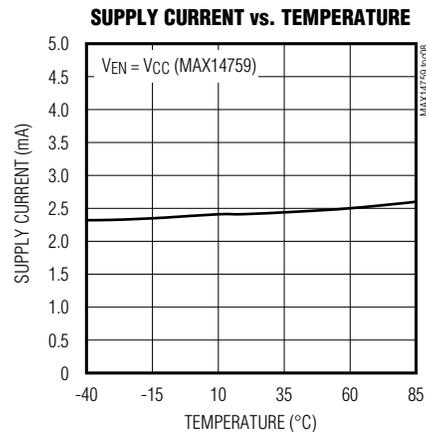
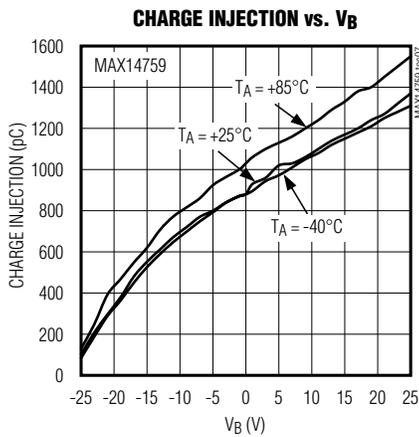
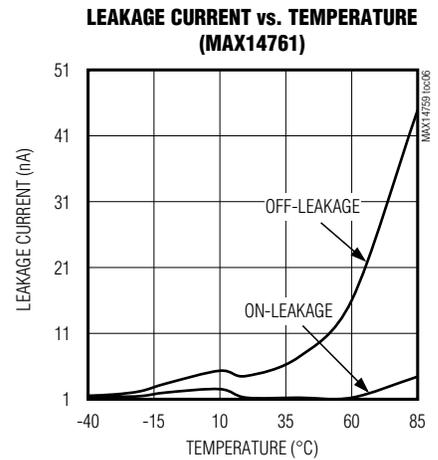
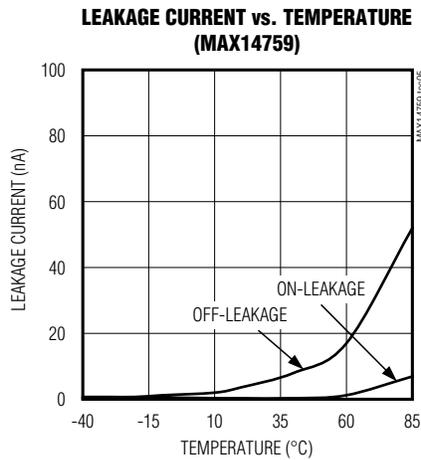
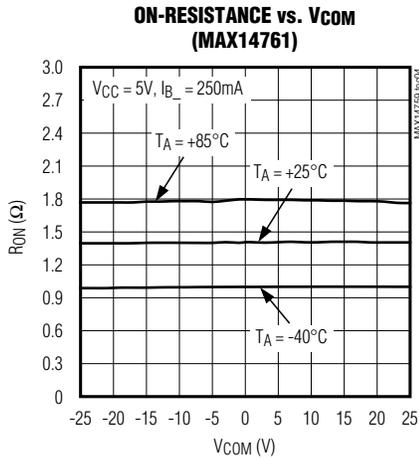
# MAX14759/MAX14761/MAX14763

## Above- and Below-the-Rails

### Low On-Resistance Analog Switches

#### Typical Operating Characteristics (continued)

( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



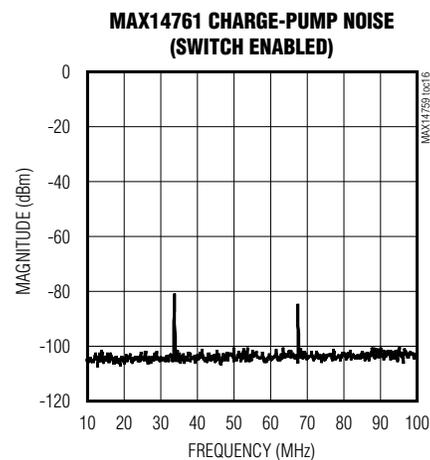
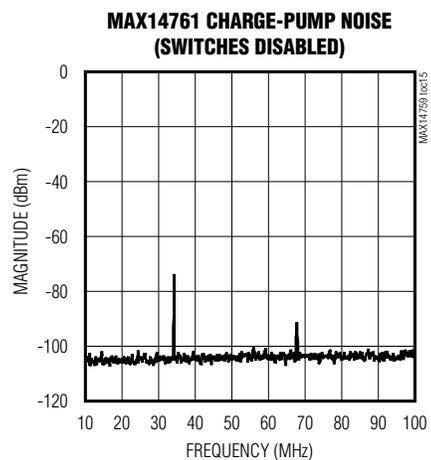
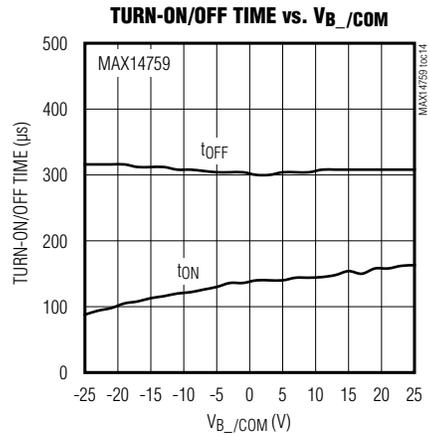
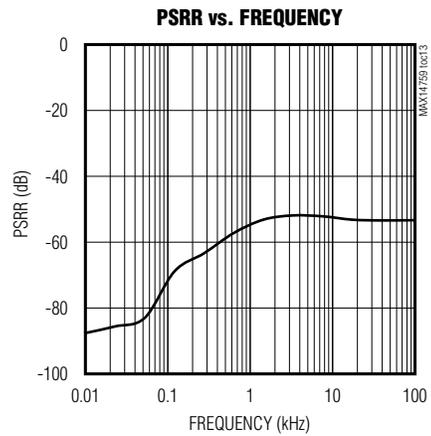
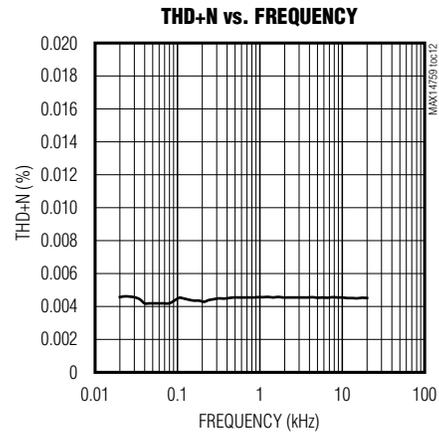
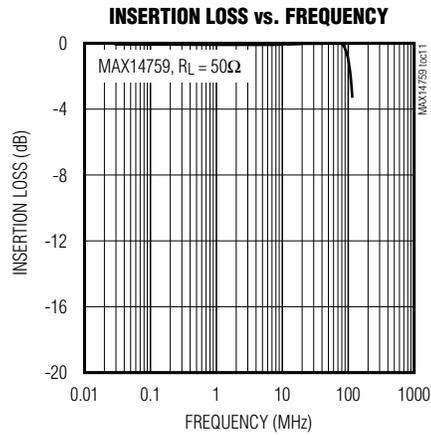
# MAX14759/MAX14761/MAX14763

## Above- and Below-the-Rails

### Low On-Resistance Analog Switches

#### Typical Operating Characteristics (continued)

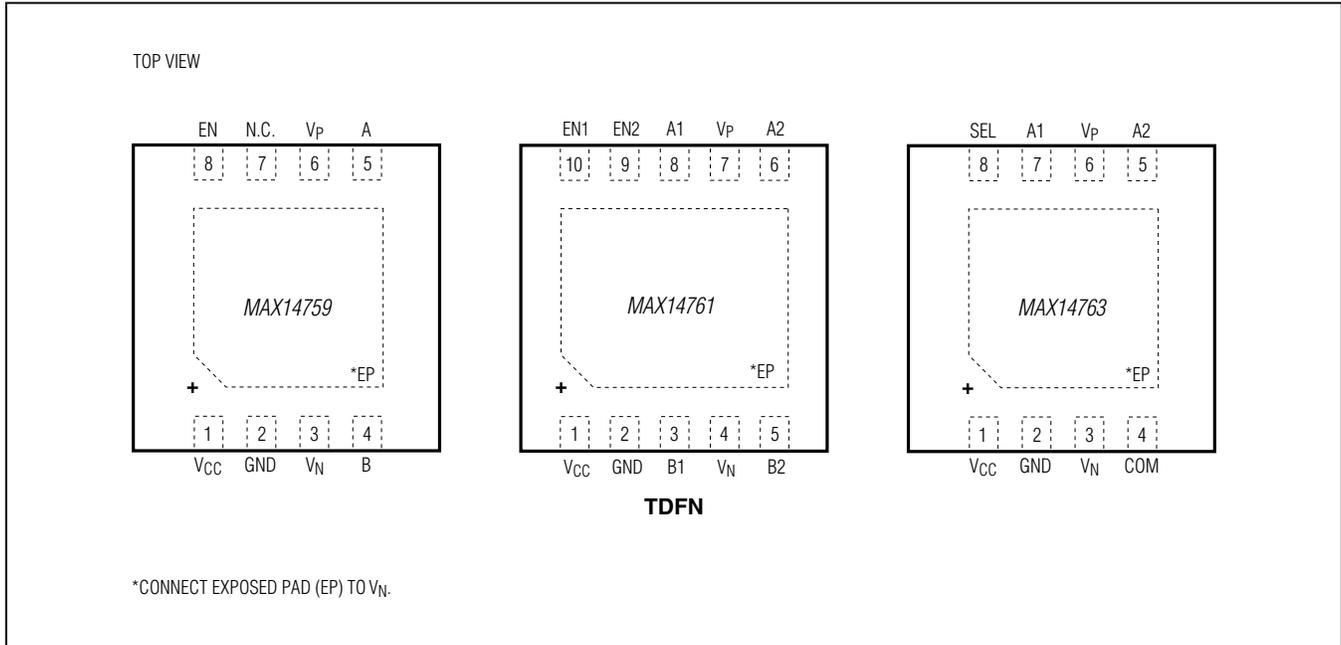
( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



# MAX14759/MAX14761/MAX14763

## Above- and Below-the-Rails Low On-Resistance Analog Switches

### Pin Configurations



### Pin Description

PIN			NAME	FUNCTION
MAX14759	MAX14761	MAX14763		
1	1	1	$V_{CC}$	Positive-Supply Voltage Input. Bypass $V_{CC}$ to GND with a 1 $\mu$ F ceramic capacitor placed as close as possible to the device.
2	2	2	GND	Ground
3	4	3	$V_N$	Negative Voltage Output. Bypass $V_N$ to GND with a 0.1 $\mu$ F, 50V ceramic capacitor placed as close as possible to the device.
4	—	—	B	Analog Switch Common Terminal
—	—	4	COM	Analog Switch Common Terminal
5	—	—	A	Analog Switch Normally Open Terminal
6	7	6	$V_P$	Positive Voltage Output. Bypass $V_P$ to GND with a 0.1 $\mu$ F, 50V ceramic capacitor placed as close as possible to the device.
7	—	—	N.C.	No Connection. Leave unconnected.
8	—	—	EN	Switch Control Input. Drive EN high to close the switch or drive EN low to open the switch.
—	8	7	A1	Analog Switch 1 Normally Closed Terminal

# MAX14759/MAX14761/MAX14763

## Above- and Below-the-Rails Low On-Resistance Analog Switches

### Pin Description (continued)

PIN			NAME	FUNCTION
MAX14759	MAX14761	MAX14763		
—	3	—	B1	Analog Switch 1 Common Terminal
—	6	5	A2	Analog Switch 2 Normally Open Terminal
—	5	—	B2	Analog Switch 2 Common Terminal
—	10	—	EN1	Switch 1 Control Input. Drive EN1 high to open switch 1 or drive EN1 low to close switch 1.
—	9	—	EN2	Switch 2 Control Input. Drive EN2 high to close switch 2 or drive EN2 low to open switch 2.
—	—	8	SEL	Switch Control Input. Drive SEL low to connect the COM terminal to A1 or drive SEL high to connect the COM terminal to A2.
—	—	—	EP	Exposed Pad. Connect EP to $V_N$ . EP is not intended as an electrical connection.

### Detailed Description

The MAX14759/MAX14761/MAX14763 are analog switches capable of handling signals above and below their rails. These devices operate from a single +3.0V to +5.5V supply and support signals in the -25V to +25V range. The low on-resistance and high bandwidth allow for use in digital- and analog-signal switching applications.

#### Integrated Bias Generation

The MAX14759/MAX14761/MAX14763 contain a total of three charge pumps to generate bias voltages for the internal switches: a 5V regulated charge pump, a positive high-voltage (+35V) charge pump, and a negative high-voltage (-27V) charge pump. When  $V_{DD}$  is above 4.7V (typ), the 5V regulated charge pump is bypassed, and  $V_{DD}$  provides the input for the high-voltage charge pumps, reducing overall supply current. An external 0.1 $\mu$ F capacitor is required for each high-voltage charge pump between  $V_P/V_N$  and GND.

#### Analog Signal Range

The devices switch signals in the range from -25V to +25V that are above and below their rails. The on-resistance for these devices exhibit a high degree of flatness of 2.4m $\Omega$  (MAX14759 typ) and 5.1m $\Omega$  (MAX14761/MAX14763 typ) over the whole input voltage range of -25V to +25V. The analog switches allow bidirectional current flow, so A, A1,

A2, B, B1, B2, and COM can be used as either inputs or outputs.

#### Bypass Capacitors

Bias stabilizing capacitors are required on the  $V_P$  and  $V_N$  pins. 1 $\mu$ F ceramic capacitors are suggested for effective operation.  $V_P$  and  $V_N$  are not intended as a power supply for other circuitry.

### Applications Information

#### Nonpowered Condition

The MAX14759/MAX14761/MAX14763 can tolerate input voltages on the A, B, or COM pins in the  $\pm 25$ V range when it is not powered. When  $V_{DD} = 0$ V, the DC input leakage current into the A, B, or COM pins is typically below 1 $\mu$ A. Some devices can have a larger leakage current up to the mA range due to technology spread.

With  $V_{DD}$  not powered, internal diodes between the analog pins and the  $V_P$  and  $V_N$  charge up the external capacitors on  $V_P$  and  $V_N$  when positive and/or negative voltages are applied to these pins. This causes transient input current flow.

Large  $dv/dt$  on the inputs causes large capacitive charging currents, which have to be limited to 300mA to avoid destroying the internal diodes. Hence, the 100nF capacitors on  $V_P$  and  $V_N$ , the  $dv/dt$  must be limited to 3V/ $\mu$ s. Once the capacitors reach their final voltage, the input current decays to the leakage current levels mentioned above.

# MAX14759/MAX14761/MAX14763

## Above- and Below-the-Rails

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#### Differential Termination Resistor Switch

The MAX14759 can be used to switch a differential termination resistor in or out. In RS-485 and CAN applications, both ends of high-speed transmission lines require termination. [Figures 8](#) and [9](#) show an application of RS-485 and CAN termination using two equal resistors. These switches support RS-485's high -7V to +12V common-mode range.

In RS-232/RS-485 multiprotocol applications, the MAX14759 can be used for switching in the line-terminating resistors for RS-485 usage, and can disable the termination resistor for RS-232 operation, as shown in [Figure 10](#).

The MAX14761 is ideal for switching in fail-safe biasing resistors in RS-485 applications, as shown in [Figures 11](#) and [12](#).

#### Audio Amplifier Switch

The MAX14763 is used for selecting between audio amplifier sources to drive loudspeaker applications ([Figures 13](#) and [14](#).)

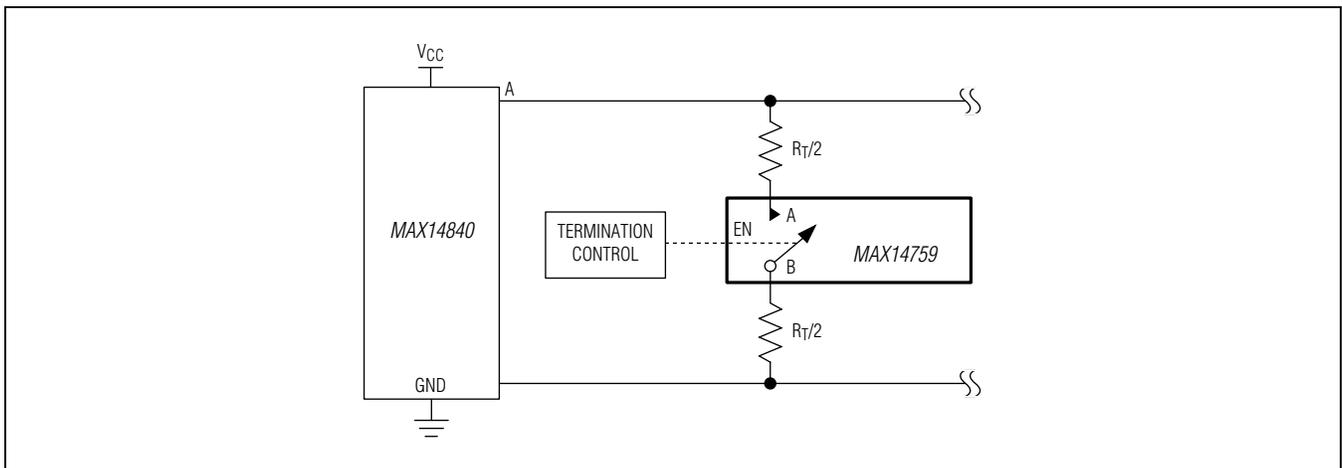


Figure 8. RS-485 Termination Switch

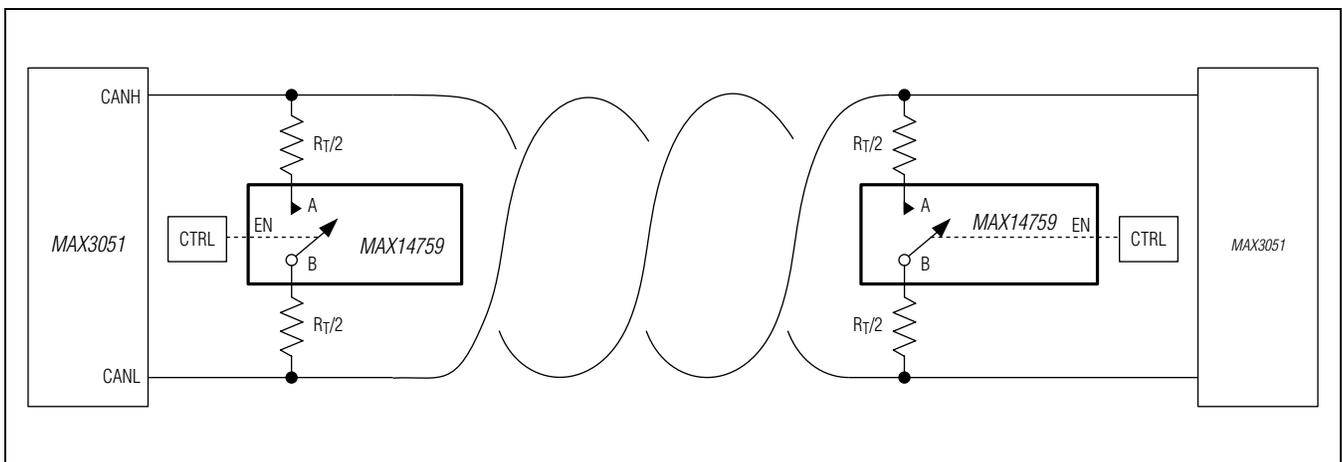


Figure 9. CAN Termination Switch

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## Above- and Below-the-Rails Low On-Resistance Analog Switches

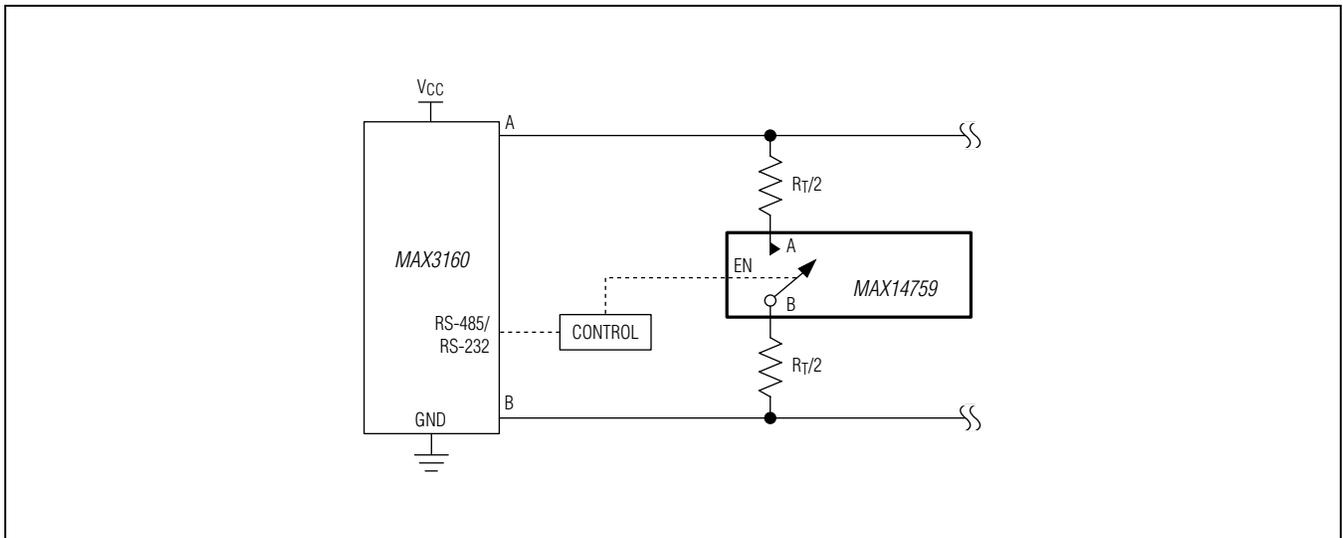


Figure 10. Multiprotocol Termination Switch

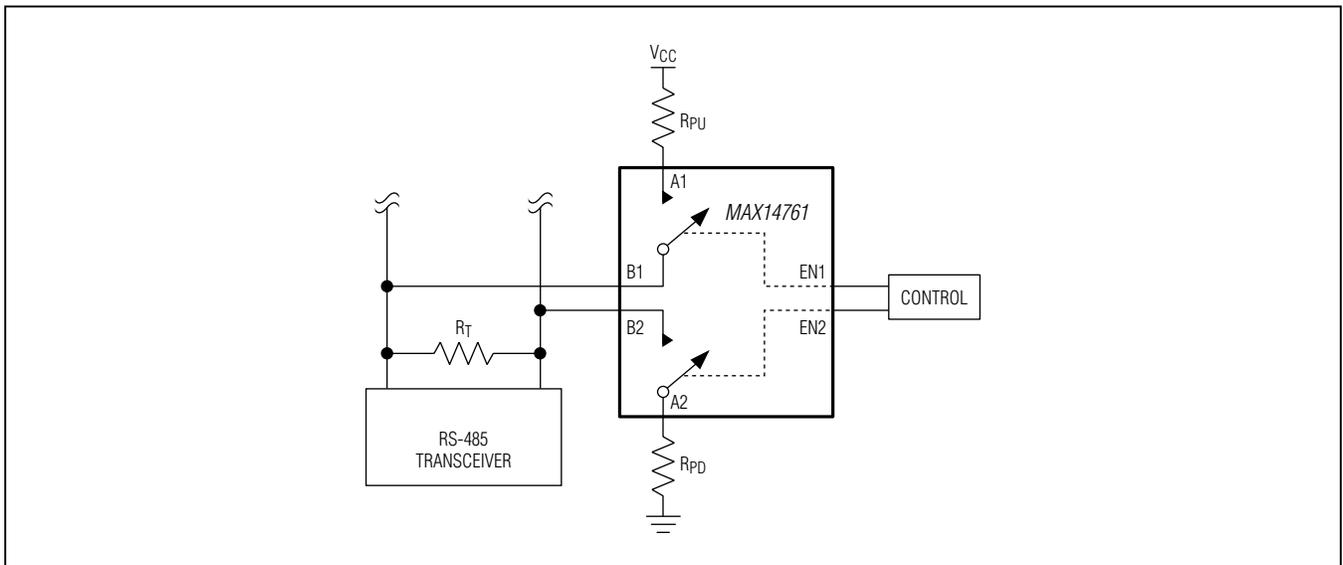


Figure 11. Pullup and Pulldown Resistance Switch

# MAX14759/MAX14761/MAX14763

## Above- and Below-the-Rails

### Low On-Resistance Analog Switches

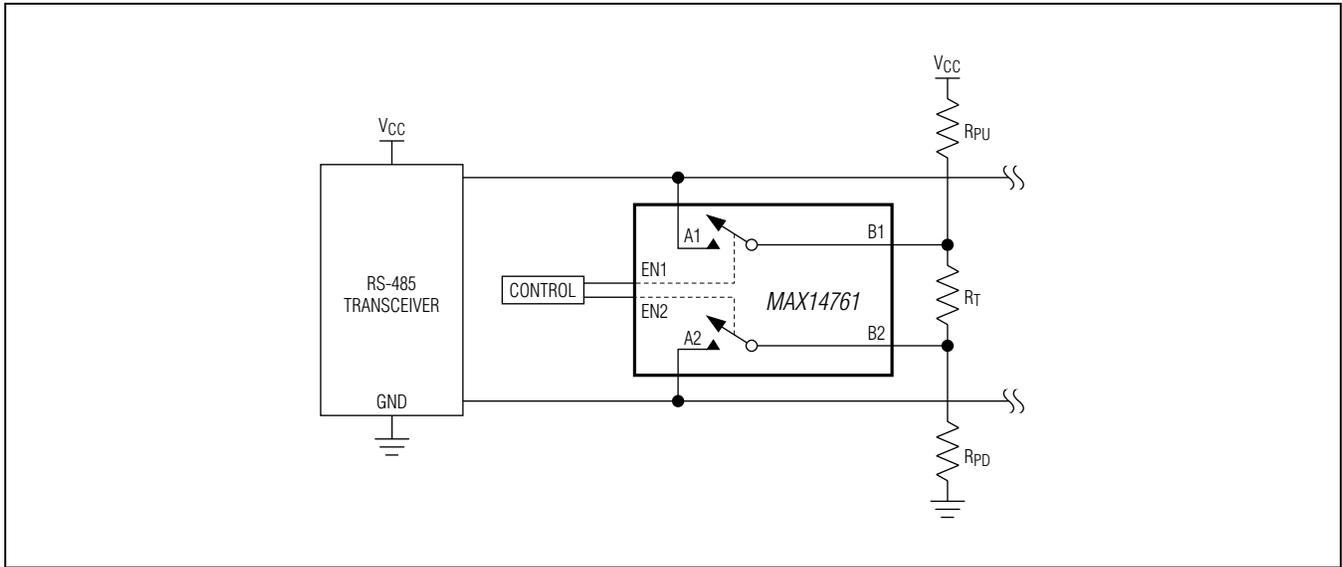


Figure 12. Fail-Safe Biasing Network Switch

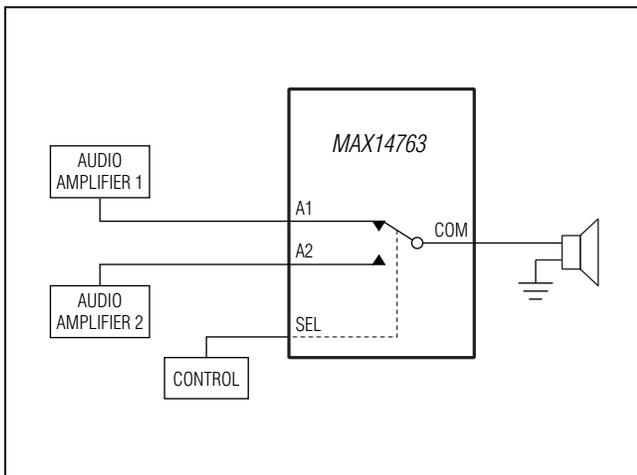


Figure 13. Single-Ended Amplifier Switching

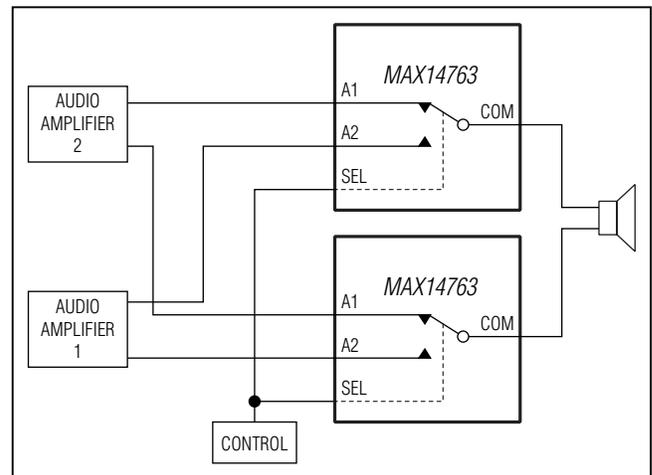


Figure 14. Differential Amplifier Switching

# MAX14759/MAX14761/MAX14763

## Above- and Below-the-Rails Low On-Resistance Analog Switches

### Ordering Information/Selector Guide

PART	TEMP RANGE	PIN-PACKAGE	FUNCTION	R <sub>ON</sub> (MAX) (Ω)
MAX14759ETA+	-40°C to +85°C	8 TDFN-EP*	1 x SPST	1
MAX14761ETB+	-40°C to +85°C	10 TDFN-EP*	2 x SPST	2
MAX14763ETA+	-40°C to +85°C	8 TDFN-EP*	1 x SPDT	2

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

\*EP = Exposed pad.

### Chip Information

PROCESS: BiCMOS

### Package Information

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
8 TDFN	T833+2	<a href="#">21-0137</a>	<a href="#">90-0059</a>
10 TDFN	T1033+1	<a href="#">21-0137</a>	<a href="#">90-0003</a>

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## Above- and Below-the-Rails Low On-Resistance Analog Switches

### *Revision History*

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/11	Initial release	—
1	8/12	Updated <i>Electrical Characteristics</i> table, updated Figures 1–7, added Switch Enabled and Switch Disabled figures, updated <i>Pin Configuration</i> table, added <i>Integrated Bias Generation</i> and <i>Nonpowered Condition</i> sections	3–7, 9–11



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[RS2117YUTQK10](#) [RS2118YUTQK10](#) [RS2227XUTQK10](#) [ADG452BRZ-REEL7](#) [MAX4066ESD+](#) [MAX391CPE+](#) [MAX4730EXT+T](#)  
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[74HC2G66DC.125](#) [DG3257DN-T1-GE4](#) [ADG619BRMZ-REEL](#) [ADG1611BRUZ-REEL7](#) [DG2535EDQ-T1-GE3](#) [LTC201ACN#PBF](#)