

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 $\pm 200\text{nA}$ (max) on-leakage current. The MAX14761/MAX14763 feature 2Ω (max) on-resistance with a $\pm 100\text{nA}$ (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 $+85^{\circ}\text{C}$ 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.

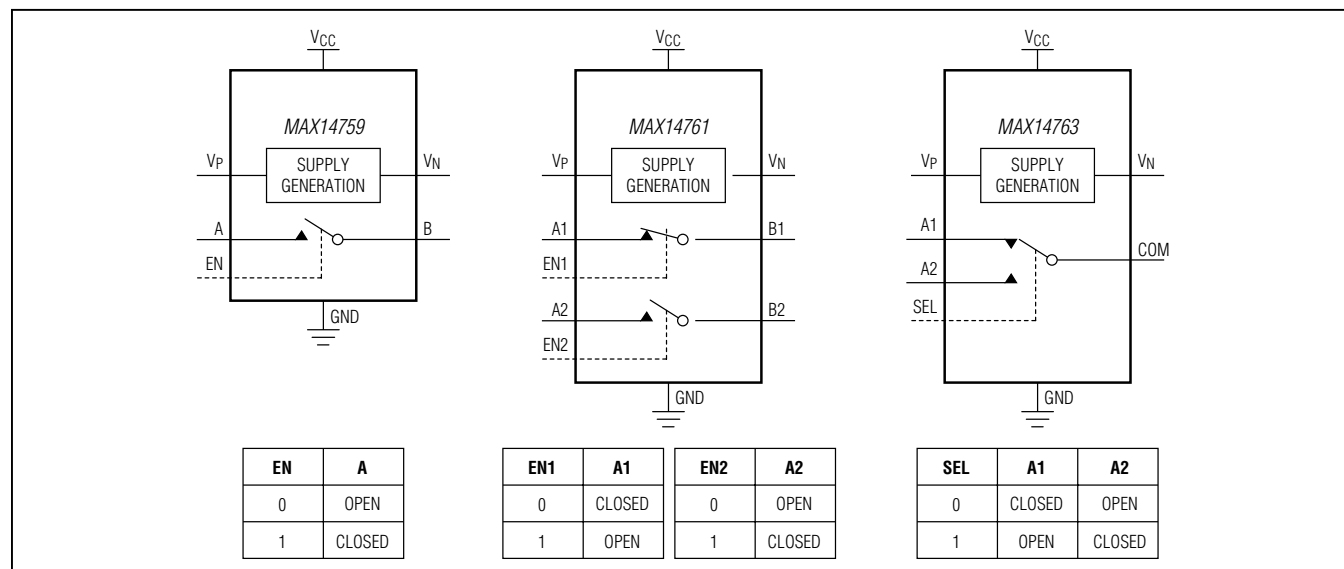
Benefits and Features

- ◆ **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 $2.4\text{m}\Omega$ (typ) and $5.1\text{m}\Omega$ (typ) R_{ON} Flatness
 - ◇ 500mA (max) Switch Current for MAX14759
 - ◇ Thermal Shutdown Protection
 - ◇ -40°C to $+85^{\circ}\text{C}$ 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.

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ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND, unless otherwise noted.)

V_{CC}	-0.3V to +6V
EN, EN1, EN2, SEL	-0.3V to + ($V_{CC} + 0.3V$)
A, B, A1, A2, B1, B2, COM	($V_N - 0.3V$) to Lesser of ($V_P + 0.3V$) or ($V_N + 52V$)
V_P	-0.3V to Lesser of (+52V) or ($V_N + 70V$)
V_N	Greater of ($V_{CC} - 40V$) or ($V_P - 70V$) to +0.3V
V_P to V_N	-0.3V to +70V
Continuous Current Through Switch (MAX14759)	±500mA

Continuous Current Through Switch

(MAX14761, MAX14763) ±250mA

Continuous Power Dissipation ($T_A = +70^\circ\text{C}$)

8-Pin TDFN Package

(derate 24.4mW/°C above +70°C) 1951.2mW

10-Pin TDFN Package

(derate 24.4mW/°C above +70°C) 1951.2mW

Operating Temperature Range -40°C to +85°C

Storage Temperature Range -65°C to +160°C

Lead Temperature (soldering, 10s) +300°C

Soldering Temperature (reflow) +260°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.

PACKAGE THERMAL CHARACTERISTICS (Note 1)

8-Pin TDFN

Junction-to-Ambient Thermal Resistance (θ_{JA}) 48°C/W

Junction-to-Case Thermal Resistance (θ_{JC}) 8°C/W

10-Pin TDFN

Junction-to-Ambient Thermal Resistance (θ_{JA}) 41°C/W

Junction-to-Case Thermal Resistance (θ_{JC}) 9°C/W

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

ELECTRICAL CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DC CHARACTERISTICS						
Power Supply Range	V_{CC}		3.0		5.5	V
Continuous Current Through Switch	$I_{A_}$	(MAX14759)	-500		+500	mA
		(MAX14761/MAX14763)	-250		+250	
Supply Current	I_{CC}	$V_{CC} \leq 4.7V$	$V_{EN_} = V_{CC}$		4.1	mA
			$V_{EN_} = V_{CC}/2$		10	
		$V_{CC} > 4.7V$	$V_{EN_} = V_{CC}$		2.5	
			$V_{EN_} = V_{CC}/2$		6	
Analog-Signal Range	V_{COM} , $V_{A_}$, $V_{B_}$	Switch open or closed	-25		+25	V
On-Resistance	R_{ON}	$I_B = \pm 500mA$, $V_A = \pm 25V$ (MAX14759)		0.6	1	Ω
		I_{COM} or $I_{B_} = \pm 250mA$, $V_{A_} = \pm 25V$ (MAX14761/MAX14763)		1.2	2	
On-Resistance Flatness	ΔR_{ON}	$-25V < V_A < +25V$, $I_B = \pm 500mA$ (MAX14759)		2.4		m Ω
		$-25V < V_{A_} < +25V$, $I_{B_}$ or $I_{COM} = \pm 250mA$ (MAX14761/MAX14763)		5.1		
A, A1, A2 Off-Leakage Current	$I_{A_}(OFF)$	$V_A = +25V$, $V_B = 0V$, Figure 1 (MAX14759)	-250		+250	nA
		$V_{A_} = +25V$, V_{COM} or $V_{B_} = 0V$, Figure 1 (MAX14761/MAX14763)	-250		+250	
COM, B, B1, B2 Off-Leakage Current	$I_{COM}(OFF)$, $I_{B_}(OFF)$	V_{COM} or $V_B = 15V$, $V_{A_} = 0V$, Figure 1 (MAX14759/MAX14763)	-100		+100	nA
		$V_{B_} = 15V$, $V_{A_} = 0V$, Figure 1 (MAX14761)	-100		+100	

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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 = ±25V, B1, B2, or COM are unconnected, Figure 1 (MAX14759)	-200		+200	nA
		V _A = ±25V, B1, B2, or COM are unconnected, Figure 1 (MAX14761)	-100		+100	
		V _A = ±25V, B1, B2, or COM are unconnected, Figure 1 (MAX14763)	-250		+250	
DIGITAL LOGIC						
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	μA
AC CHARACTERISTICS						
Power-On Time	t _{PWRON}	C _{VP} = C _{VN} = 100nF (Note 3)		50		ms
Enable Turn-On Time	t _{ON}	V _{A_} = ±10V, R _L = 10kΩ, Figure 2 (MAX14759/MAX14761)		152	300	μs
		V _{A_} = ±10V, R _L = 10kΩ, Figure 2 (MAX14763)		1.12	1.8	ms
Enable Turn-Off Time	t _{OFF}	V _{A_} = ±10V, R _L = 10kΩ, Figure 2		300	1000	μs
Break-Before-Make Interval	t _{BBM}	V _{A_} = 1V _{RMS} , R _L = 10kΩ, Figure 3 (MAX14763)		740		μs
Off-Isolation	V _{ISO}	V _{A_} = 1V _{RMS} , f = 100kHz, R _L = 50Ω, C _L = 15pF, Figure 4		-77		dB
Crosstalk	V _{CT}	R _S = R _L = 50Ω, f = 100kHz, V _{COM} = 1V _{RMS} , Figure 5 (MAX14763)		-83		dB
-3dB Bandwidth	BW	R _S = 50Ω, R _L = 50Ω , V _{A_} = 1V _{P-P} , Figure 6		100		MHz
Total Harmonic Distortion Plus Noise	THD+N	R _S = R _L = 1kΩ, 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
THERMAL PROTECTION						
Thermal Shutdown Temperature	t _{HYST}			+154		°C
Shutdown Temperature Hysteresis	t _{SHUT}			24		°C
ESD PROTECTION						
All Pins		Human Body Model		±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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Test Circuits/Timing Diagrams

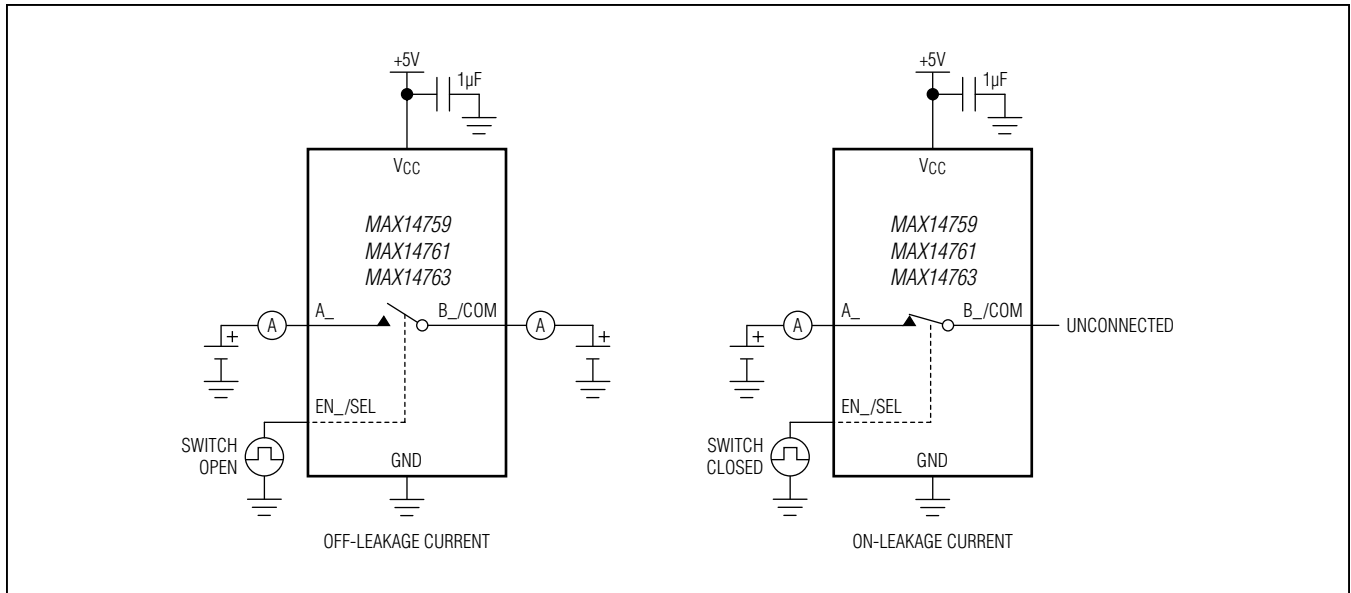


Figure 1. Leakage Current Measurement

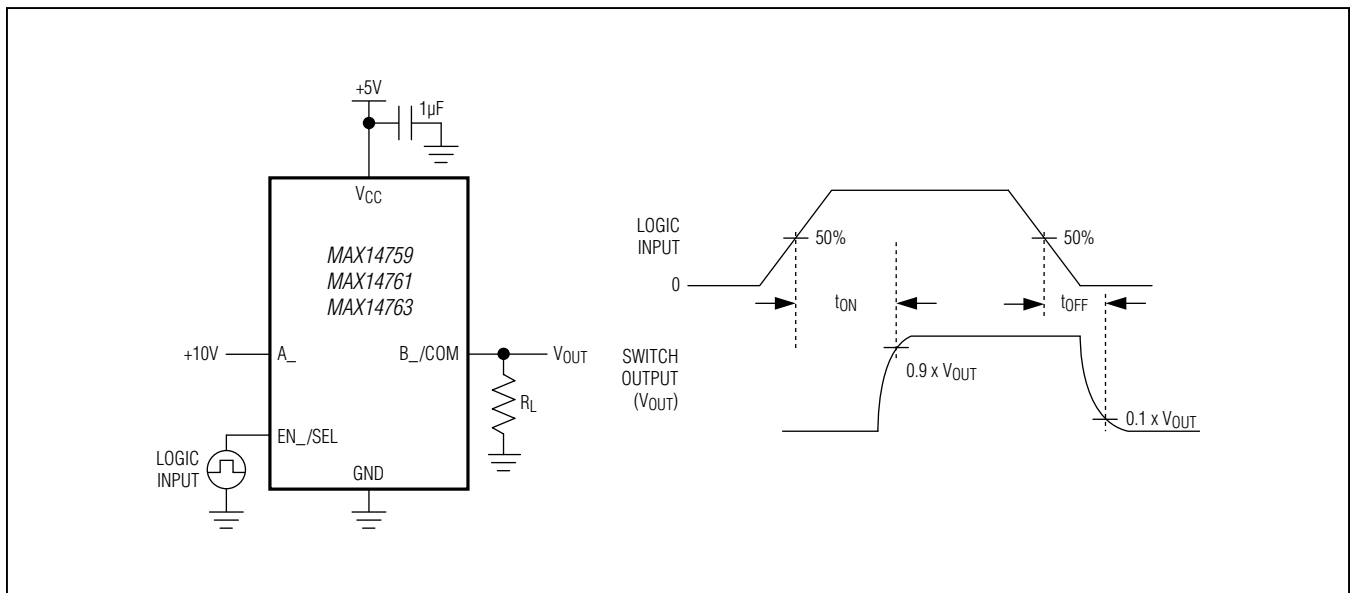


Figure 2. Switching Time

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Test Circuits/Timing Diagrams (continued)

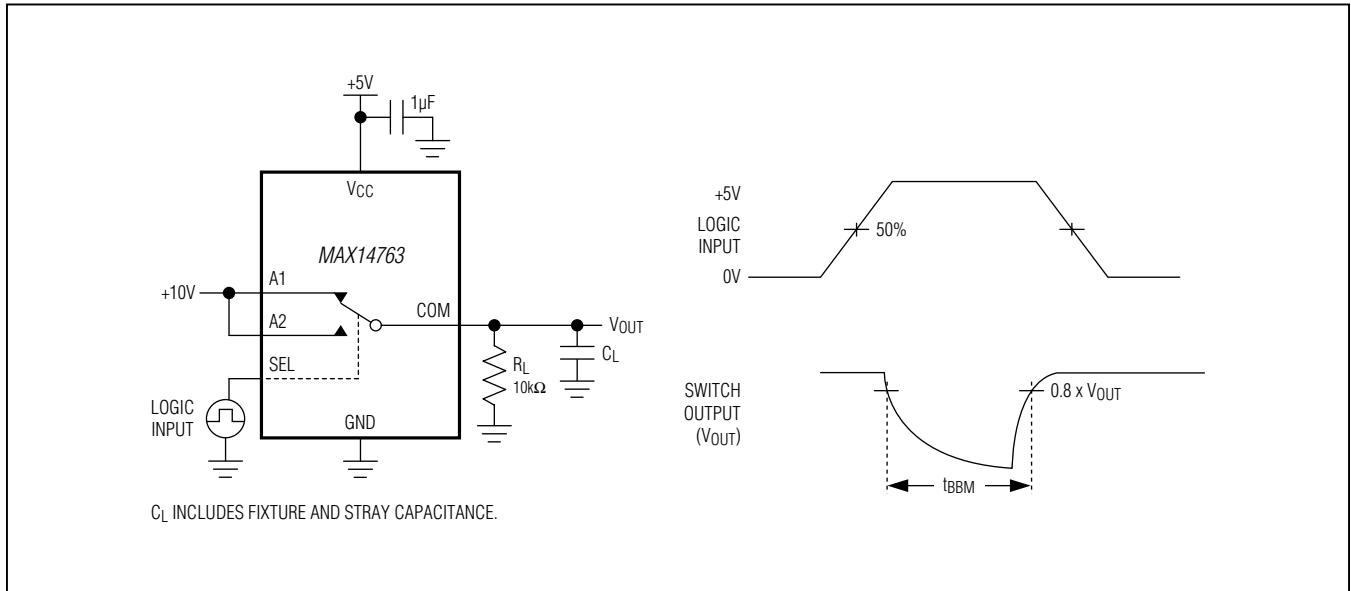


Figure 3. Break-Before-Make

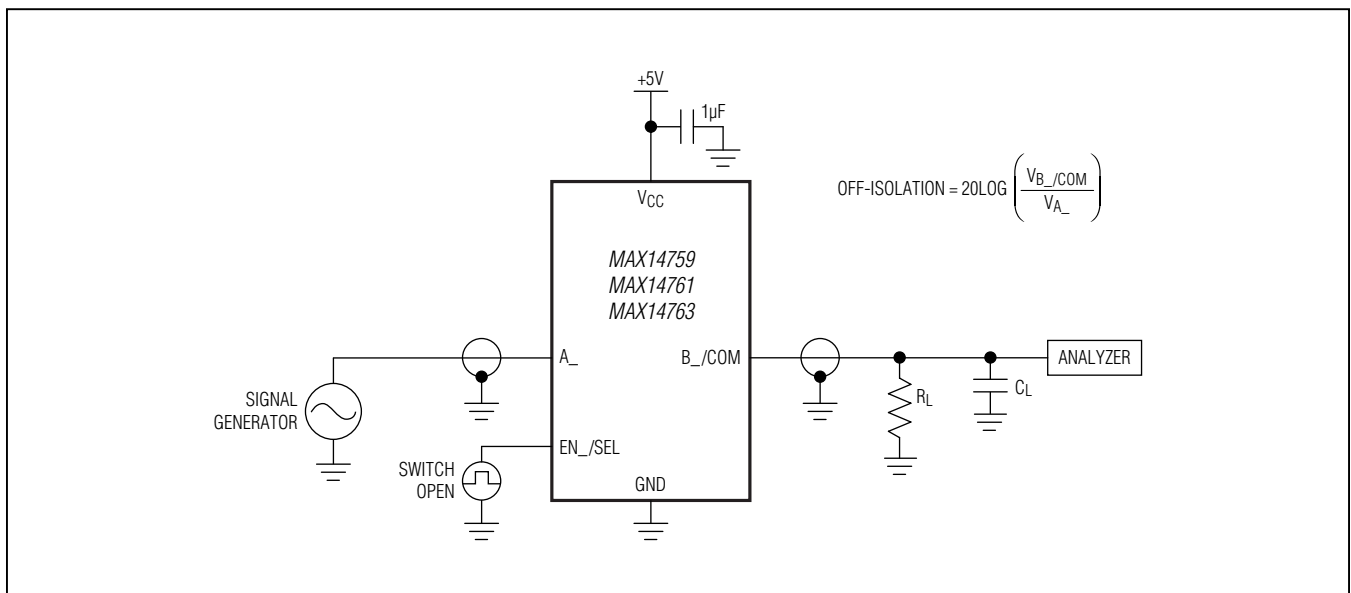


Figure 4. Off-Isolation

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Test Circuits/Timing Diagrams (continued)

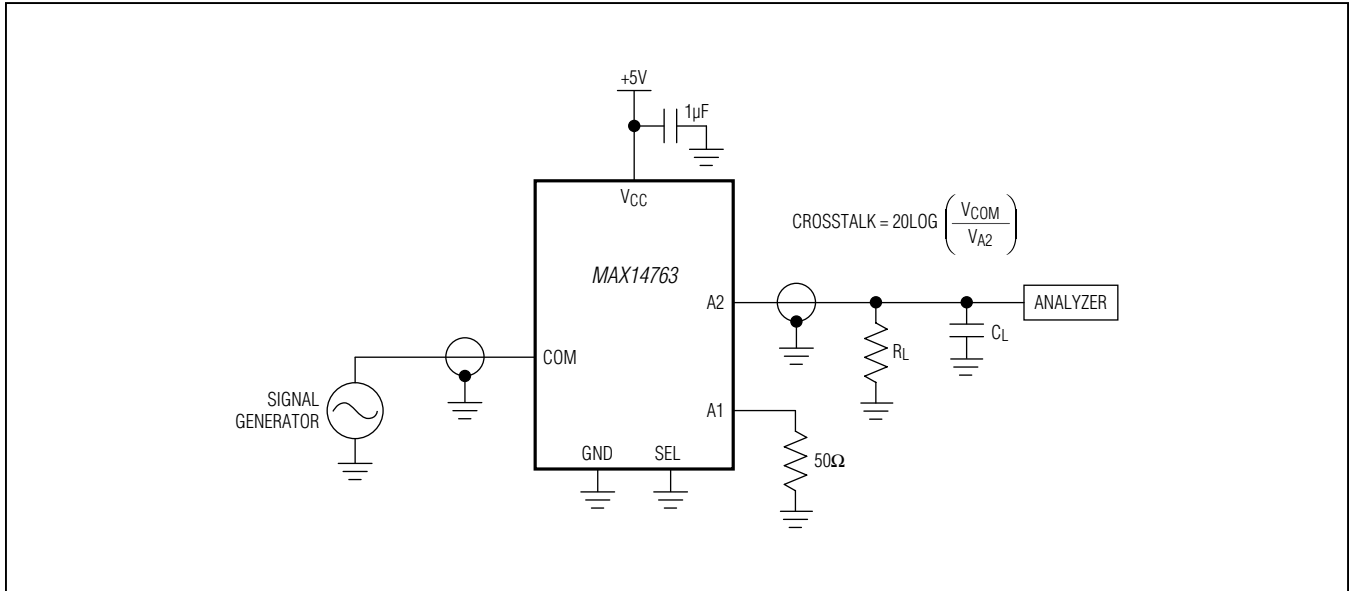


Figure 5. Crosstalk

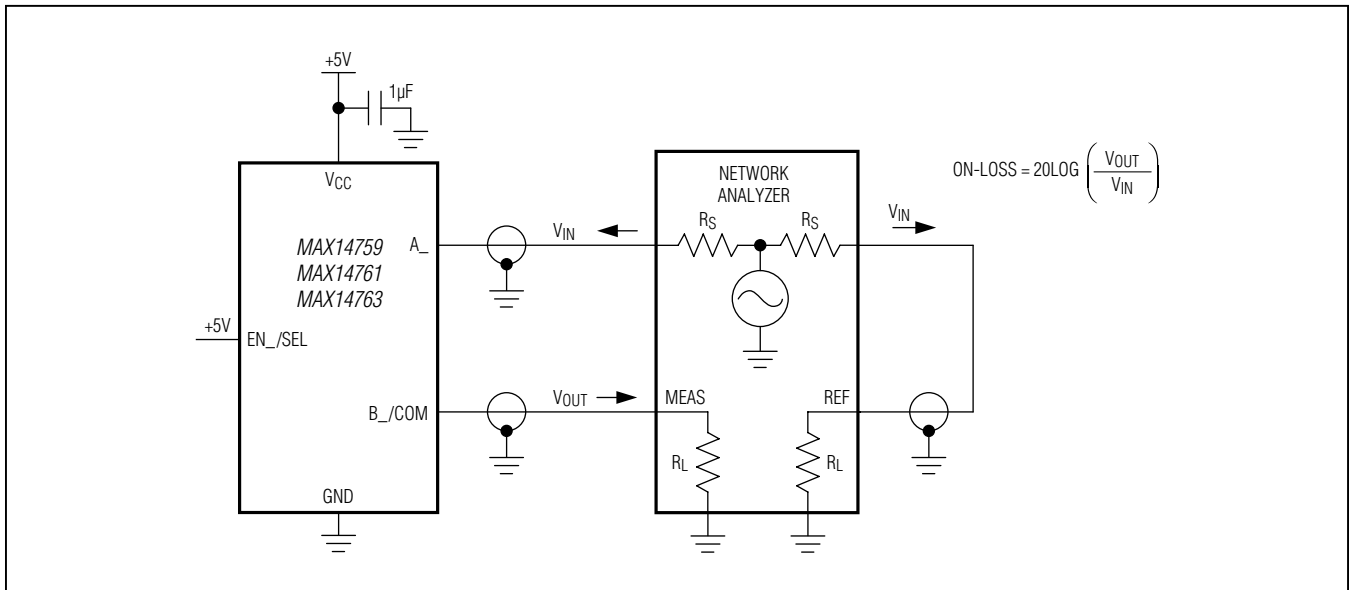


Figure 6. Insertion Loss

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Test Circuits/Timing Diagrams (continued)

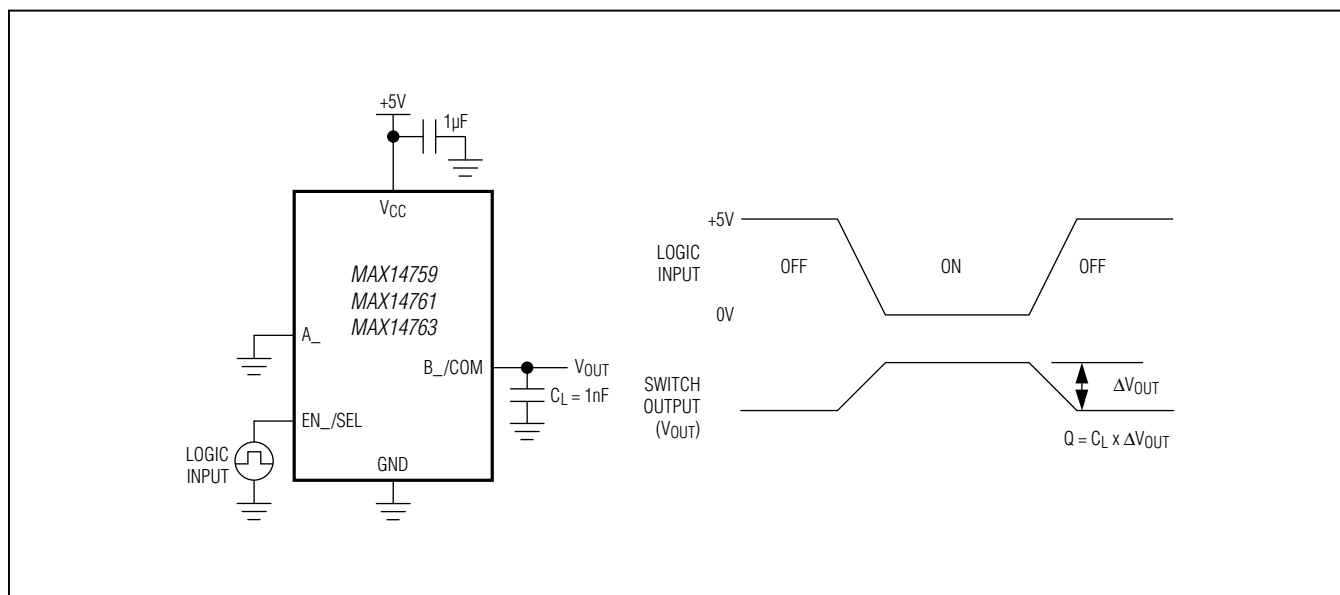
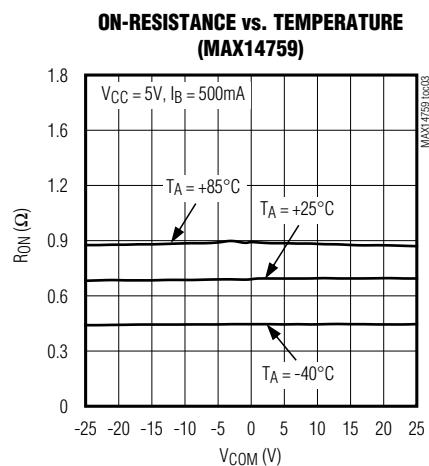
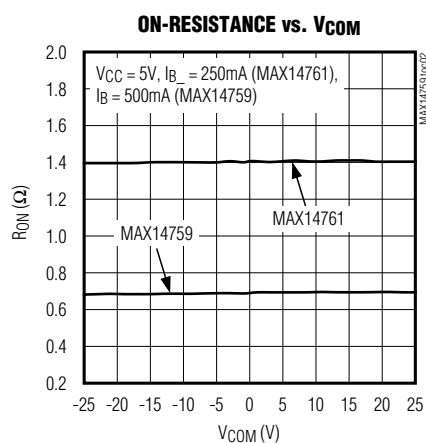
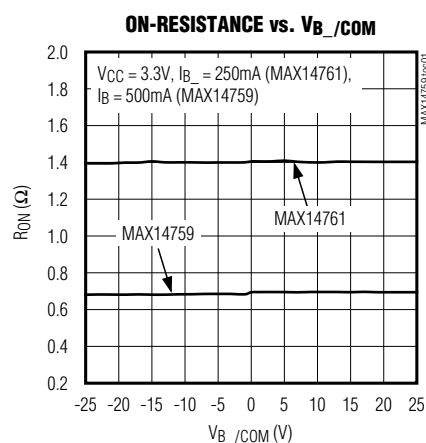


Figure 7. Charge Injection

Typical Operating Characteristics

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

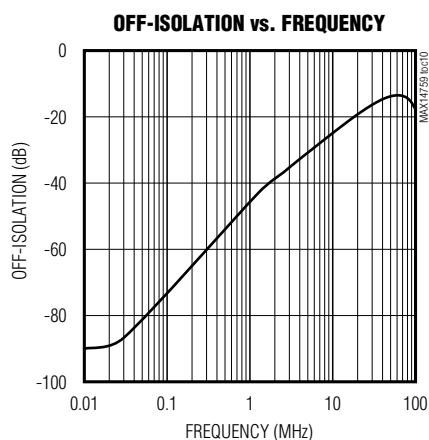
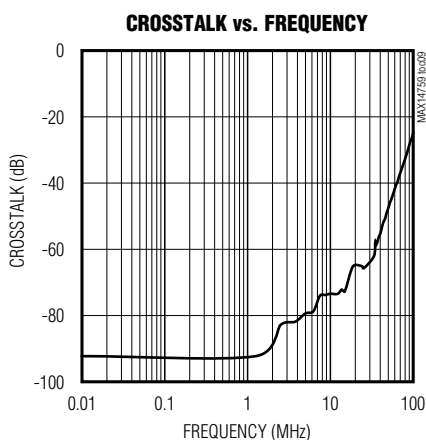
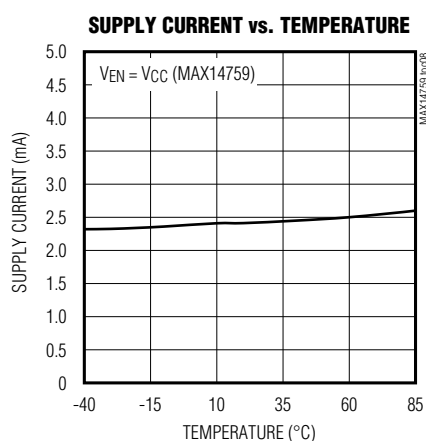
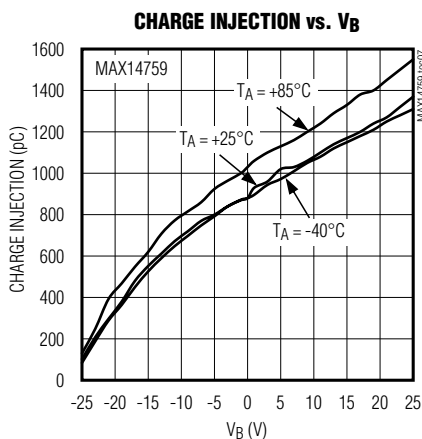
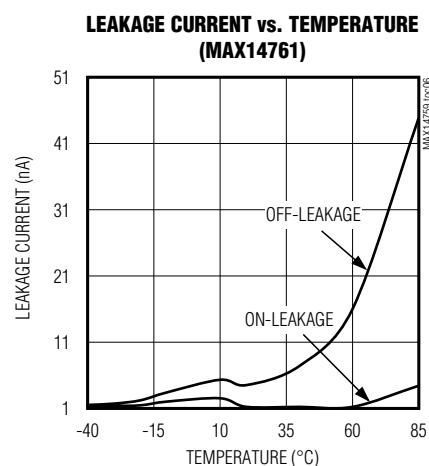
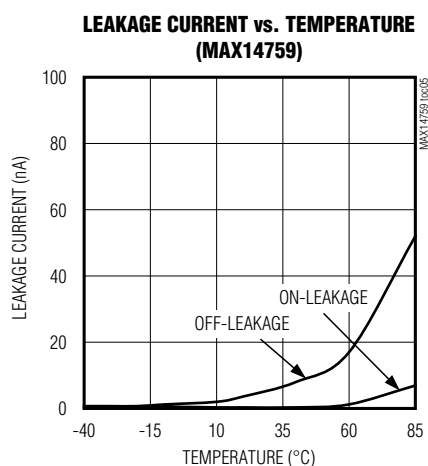
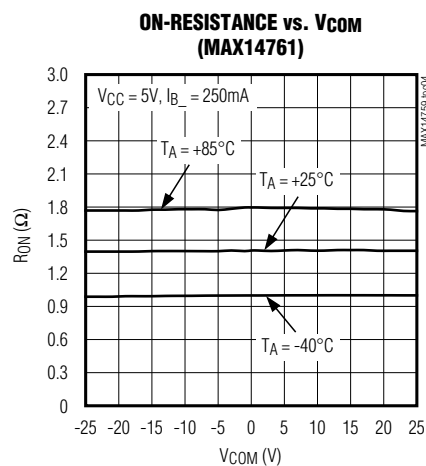


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Typical Operating Characteristics (continued)

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

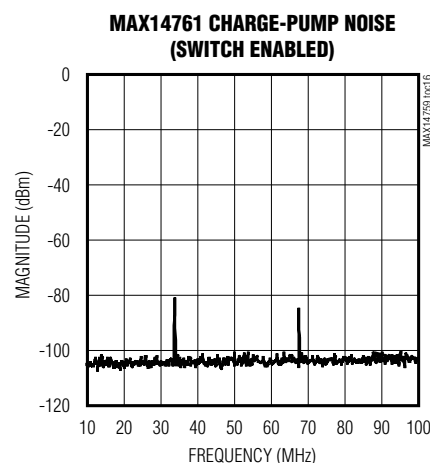
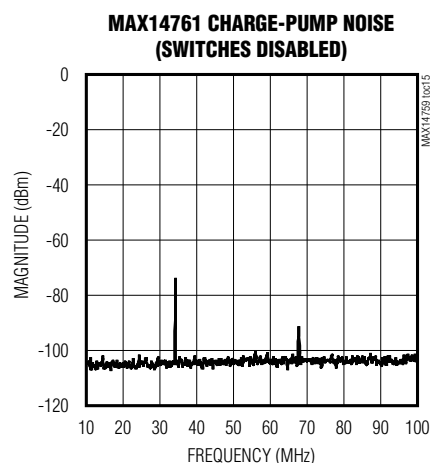
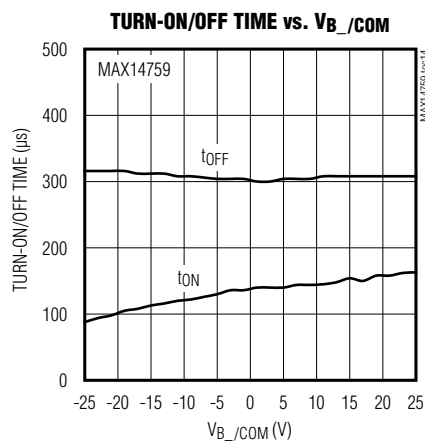
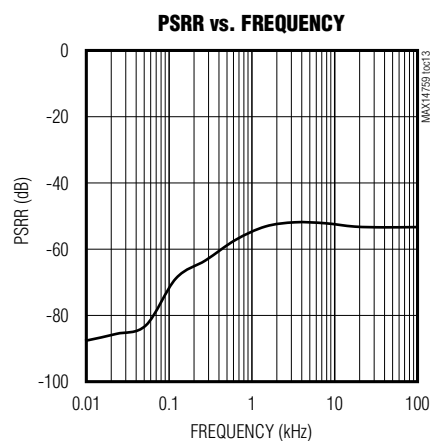
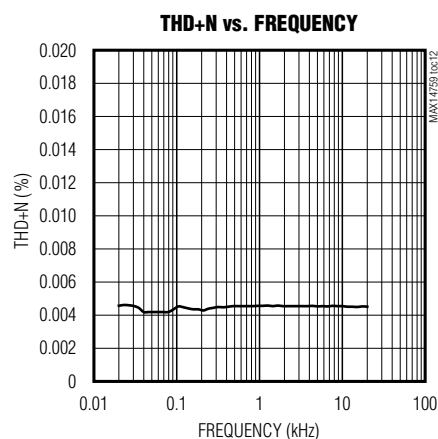
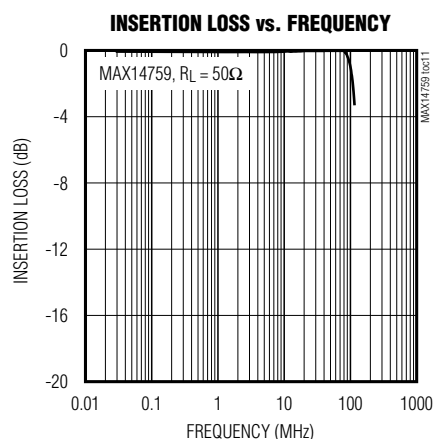


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Above- and Below-the-Rails Low On-Resistance Analog Switches

Typical Operating Characteristics (continued)

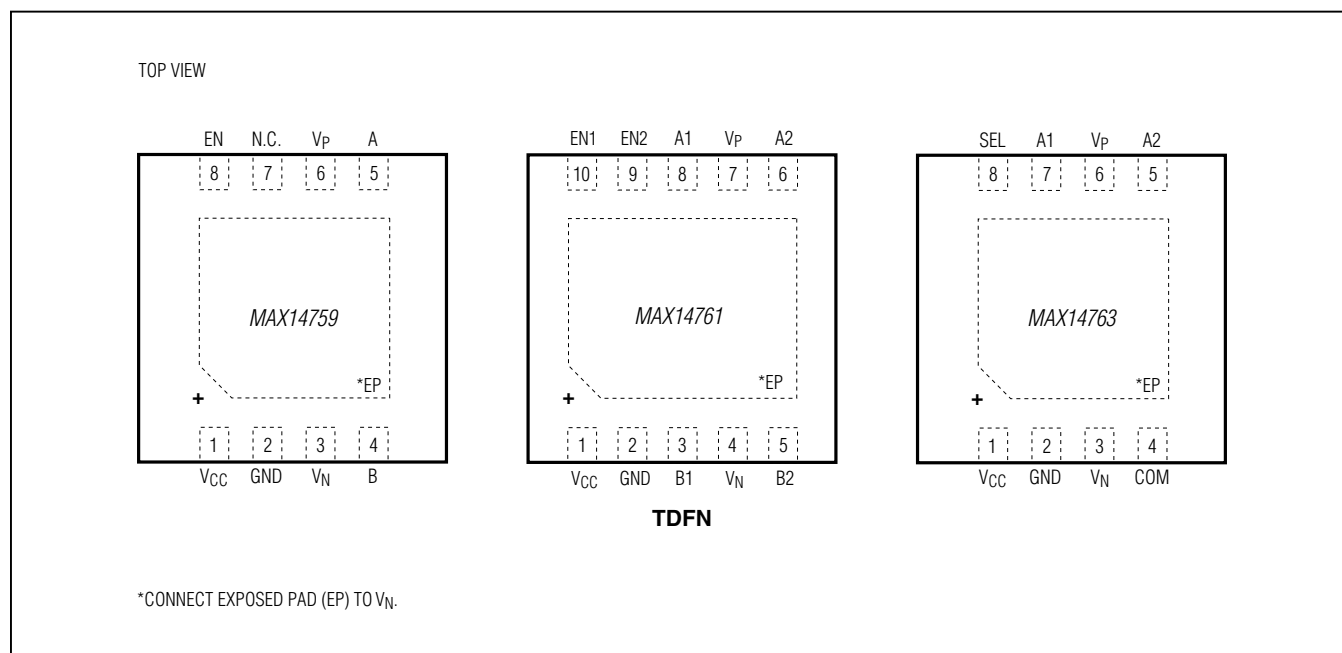
($T_A = +25^\circ\text{C}$, unless otherwise noted.)



MAX14759/MAX14761/MAX14763

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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 μ 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 μ 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 μ 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

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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 μ 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 Ω (MAX14759 typ) and 5.1m Ω (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 μ 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 ± 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 μ 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/ μ s. Once the capacitors reach their final voltage, the input current decays to the leakage current levels mentioned above.

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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](#).)

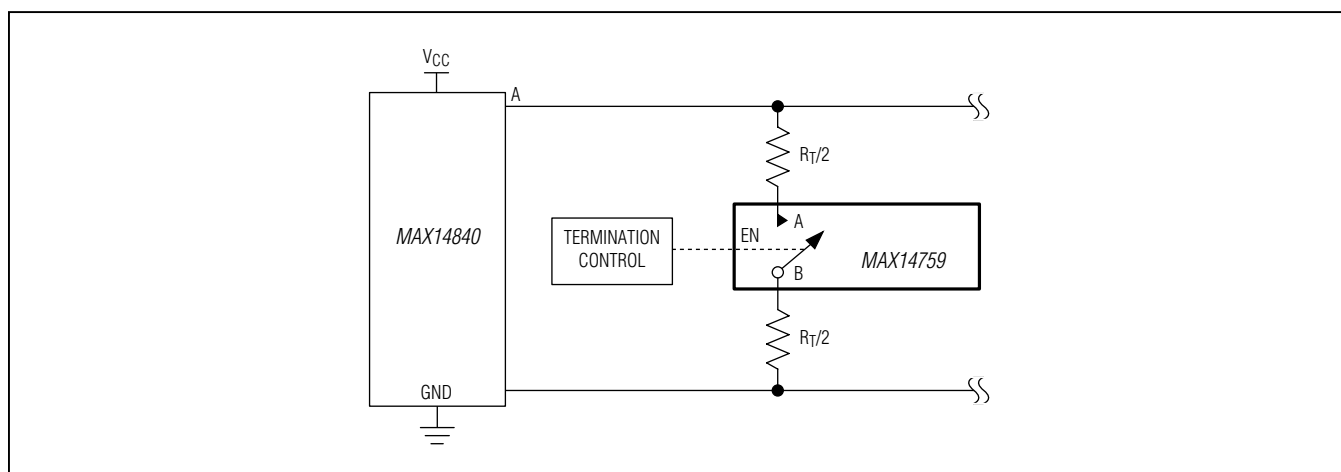


Figure 8. RS-485 Termination Switch

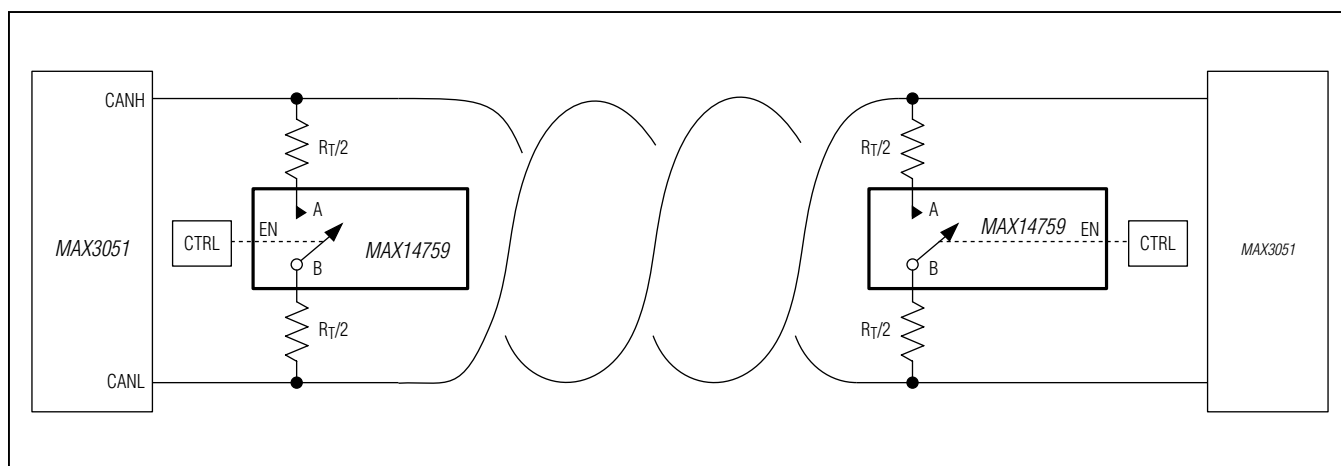


Figure 9. CAN Termination Switch

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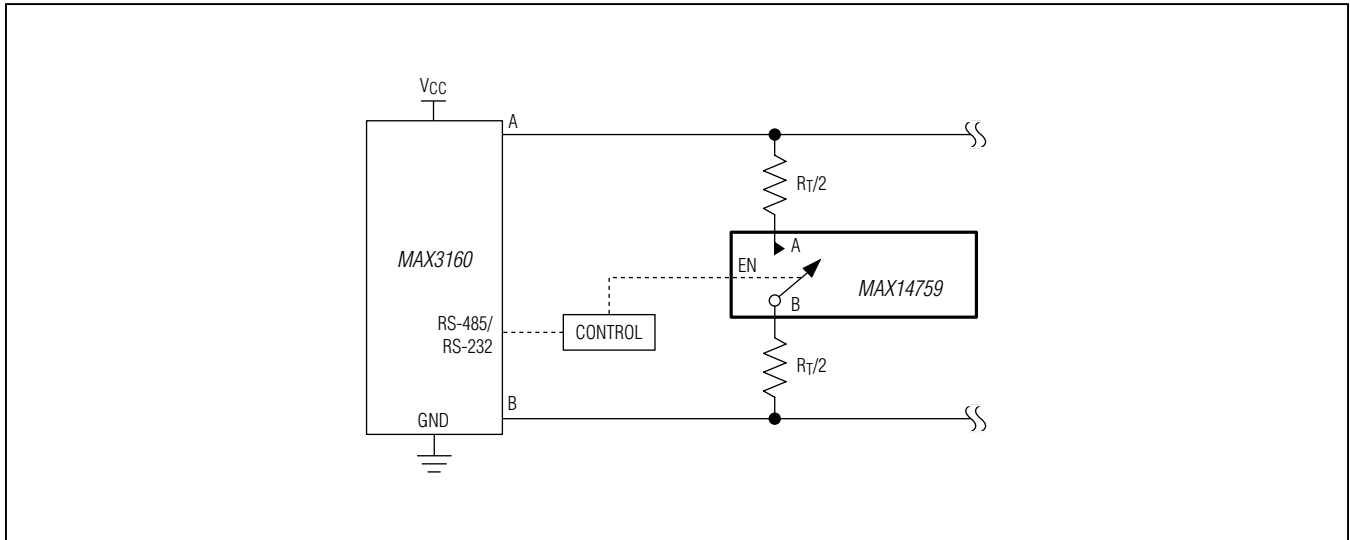


Figure 10. Multiprotocol Termination Switch

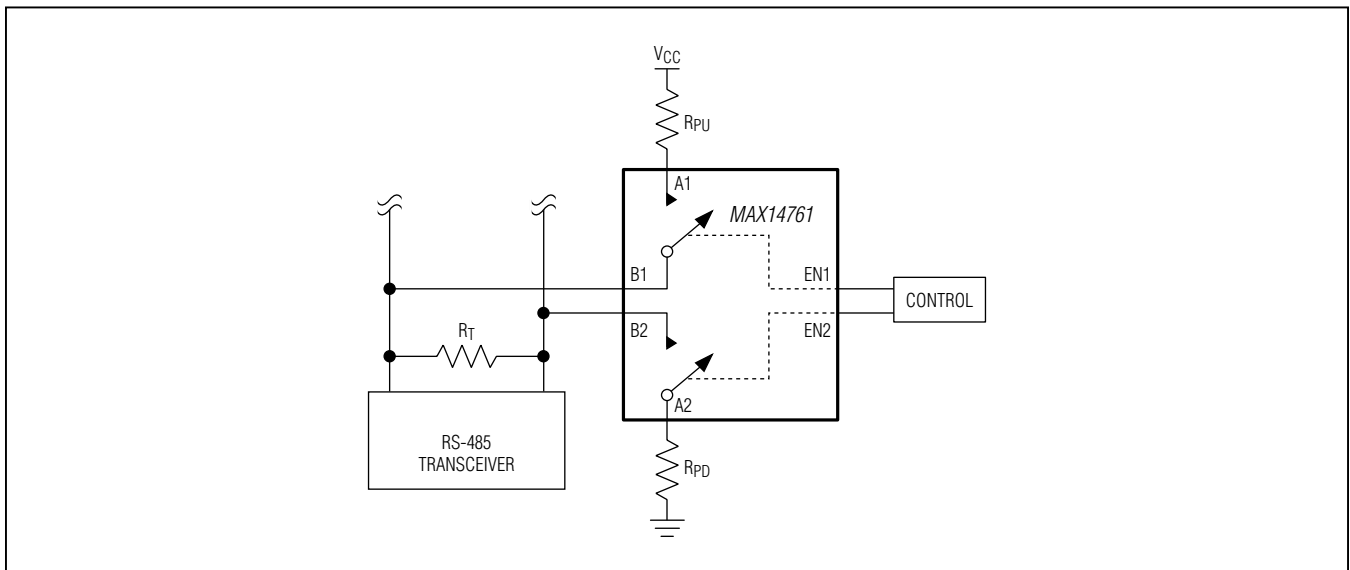


Figure 11. Pullup and Pulldown Resistance Switch

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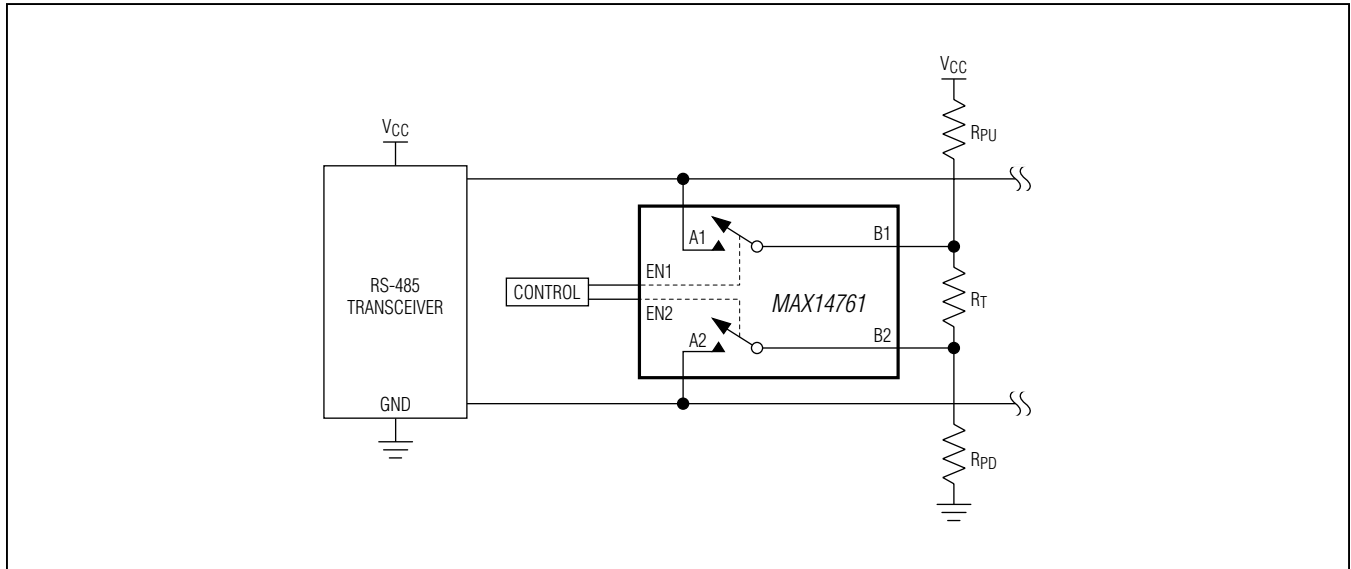


Figure 12. Fail-Safe Biasing Network Switch

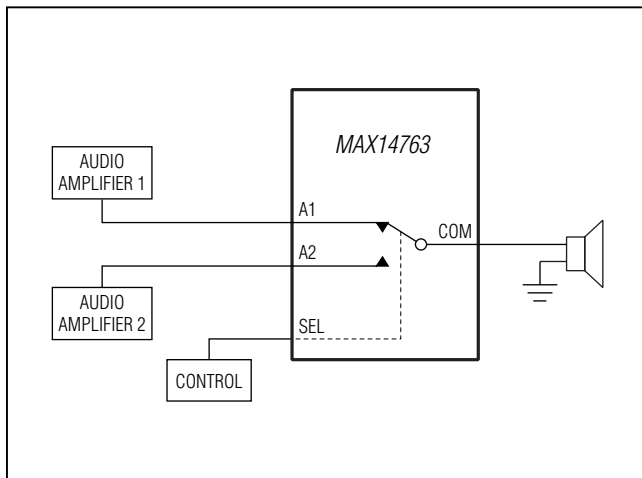


Figure 13. Single-Ended Amplifier Switching

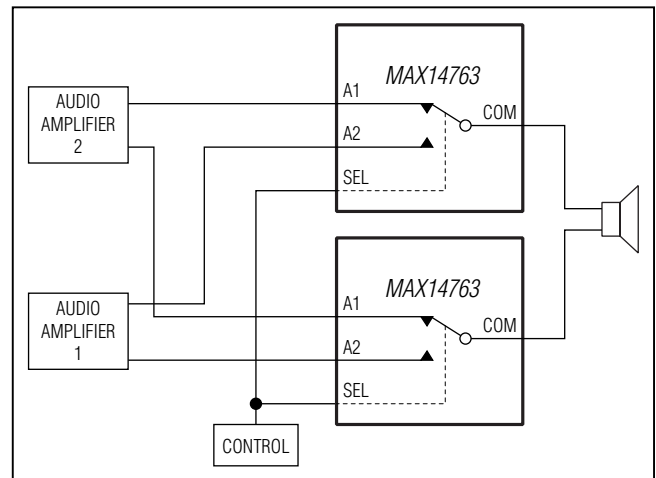


Figure 14. Differential Amplifier Switching

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Ordering Information/Selector Guide

PART	TEMP RANGE	PIN-PACKAGE	FUNCTION	R _{ON} (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. 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	21-0137	90-0059
10 TDFN	T1033+1	21-0137	90-0003

MAX14759/MAX14761/MAX14763

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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