

Above- and Below-the-Rails Low-Leakage Analog Switches

General Description

The MAX14760/MAX14762/MAX14764 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 MAX14760 is a single-pole/single-throw (SPST) analog switch, while the MAX14762 is a dual-SPST analog switch. The MAX14764 is a single-pole/double-throw (SPDT) analog switch.

The MAX14760/MAX14762/MAX14764 feature 20Ω (max) on-resistance with a ±10nA (max) on-leakage current for MAX14760/MAX14762.

The MAX14760/MAX14764 are available in 8-pin (3mm x 3mm) TDFN packages. The MAX14762 is available in a 10-pin (3mm x 3mm) TDFN package. These devices are specified over the -40°C to +85°C extended operating 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.maxim-ic.com/MAX14760.related.

Benefits and Features

- ♦ Simplify Power-Supply Requirements
 - ♦ 3.0V to 5.5V Supply Range
- **♦ High Performance**
 - MAX14762)
 - \diamond 20 Ω (max) On-Resistance
 - \diamond Low On-Resistance Flatness, 58m Ω (typ)
 - ♦ Thermal Shutdown Protection
 - ♦ -40°C to +85°C Operating Temperature Range
 - → High Bandwidth:115MHz (typ)
- ♦ Save Space on Board
 - ♦ Small 8-Pin and 10-Pin TDFN Packages

Applications

Industrial Measurement Systems

Instrumentation Systems

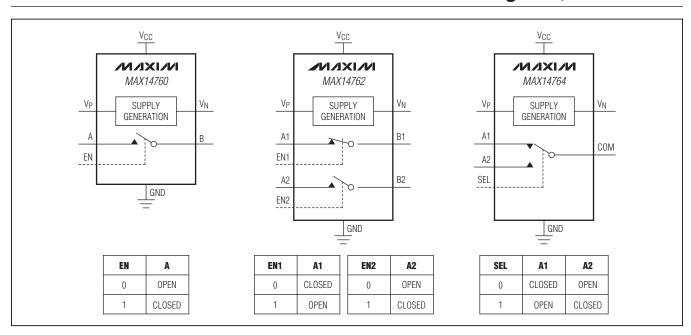
Opto-Relay Replacement

Medical Systems

ATE Systems

Audio Signal Routing and Switching

Functional Diagrams/Truth Tables



NIXIN

Maxim Integrated Products 1

Above- and Below-the-Rails Low-Leakage Analog Switches

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND, unless otherwise noted.) V_{CC} 0.3V to +6V EN, EN1, EN2, SEL0.3V to +(V_{CC} + 0.3V) A, A1, A2, B, B1, B2, COM(V_{N} - 0.3V) to Lesser of	Continuous Power Dissipation (T _A = +70°C) 8-Pin TDFN Package (derate 24.4mW/°C above +70°C)1951.2mW 10-Pin TDFN Package (derate 24.4mW/°C
$(V_{\rm P} + 0.3V)$ or $(V_{\rm N} + 52V)$	above +70°C)1951.2mW
V _P 0.3V to Lesser of (+52V) or (V _N + 70V)	Operating Temperature Range40°C to +85°C
V _N Greater of (V _{CC} - 40V) or (V _P - 70V) to +0.3V	Storage Temperature Range65°C to +160°C
V _P to V _N 0.3V to 70V	Lead Temperature (soldering, 10s)+300°C
Continuous Current ±25mA	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 TDFN	10 TDFN
Junction-to-Ambient Thermal Resistance (θ _{JA})41°C/W	Junction-to-Ambient Thermal Resistance (θ _{JA})41°C/W
Junction-to-Case Thermal Resistance (θ_{JC})8°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 fourlayer board. For detailed information on package thermal considerations, refer to www.maxim-ic.com/thermal-tutorial.

ELECTRICAL CHARACTERISTICS

 $(V_{CC} = 3.0 \text{V to } 5.5 \text{V}, T_A = -40 ^{\circ}\text{C} \text{ to } +85 ^{\circ}\text{C}, \text{ unless otherwise noted.}$ Typical values are at $V_{CC} = 5 \text{V}, \text{ and } T_A = +25 ^{\circ}\text{C}.)$ (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			-25		+25	mA		
			V _{EN} _= V _{CC}		4.1	10			
Commanda Commanda		V _{CC} ≤ 4.7V	$V_{EN} = V_{CC}/2$		4.1	10	^		
Supply Current	Icc	V _{CC} > 4.7V	V _{EN} _= V _{CC}		2.5	6	mA		
			$V_{EN} = V_{CC}/2$		2.5	6			
Analog Signal Range	V _{COM} , V _{A_} , V _{B_}	Switch open or closed		-25		+25	V		
On-Resistance	R _{ON}	I_{COM} or $I_{B} = \pm 25$ mA, $V_{A} = \pm 25$ V			8	20	Ω		
On-Resistance Flatness	ΔR _{ON}	$-25V < V_A < +25V$, I_{COM} or $I_B = \pm 25$ mA			58		mΩ		
A, A1, A2 Off-Leakage Current	I _{A_(OFF)}	$V_{A_{-}}$ = +25V, V_{COM} or $V_{B_{-}}$ = 0V, Figure 1		-30		+30	nA		
COM, B, B1, B2 Off-Leakage	I _{B_(OFF)}	V_{COM} or $V_{B_{-}} = 15$ (MAX14764)	5V, V _A _ = 0V, Figure 1	-10		+10	- A		
Current		V _B _ = 15V, V _A _ = 0V, Figure 1 (MAX14760/ MAX14762)		-10		+10	nA		

Above- and Below-the-Rails Low-Leakage Analog Switches

ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
On London Courant		V _A _ = ±25V, B/COM is unconnected, Figure 1 (MAX14760/MAX14762)	-10		+10	^	
On-Leakage Current	I _{ON}	V _A _ = ±25V, B/COM is unconnected, Figure 1 (MAX14764)	-30		+30	nA	
DIGITAL LOGIC							
		V _{CC} = 3.0V			0.7	- V	
Input-Voltage Logic-Low	VIL	$V_{CC} = 3.6V$			0.7		
Imput-voltage Logic-Low	VIL.	$V_{CC} = 4.5V$			0.8	Į v	
		V _{CC} = 5.5V		-	0.8		
		$V_{CC} = 3.0V$	1.7				
Input Voltage Legis High	\/	$V_{CC} = 3.6V$	1.9			.,	
Input-Voltage Logic-High	V _{IH}	V _{CC} = 4.5V	2.0			V	
		V _{CC} = 5.5V	2.1				
Input Current	ΙL		-1		+1	μΑ	
AC CHARACTERISTICS							
Power-On Time	tpwron	V_{A} = ±10V, C_{VP} = C_{VN} = 1 μ F (Note 3)		320		ms	
	t _{ON}	$V_{A_{-}} = \pm 10V$, $R_{L} = 10k\Omega$, Figure 2 (MAX14760/MAX14762)		100	200	μs	
Enable Turn-On Time		$V_{A_{-}} = \pm 10V$, $R_{L} = 10k\Omega$, Figure 2 (MAX14764)		1.04	1.6	ms	
Enable Turn-Off Time	t _{OFF}	(Figure 2)		110	400	μs	
Break-Before-Make Interval	t _{BBM}	$V_{A_{-}} = 1V_{RMS}$, $R_{L} = 10k\Omega$, Figure 3 (MAX14764)		740		μs	
Off-Isolation	V _{ISO}	V_{A} = 1 V_{RMS} , f = 100kHz, R_L = 50 Ω , C_L = 15pF, Figure 4		-77		dB	
Crosstalk	V _{CT}	$R_S = R_L = 50\Omega$, $f = 100$ kHz, $V_{COM} = 1V_{RMS}$, Figure 5 (MAX14764)		-92		dB	
-3dB Bandwidth	BW	$R_S = 50\Omega$, $R_L = 1k\Omega$, $V_A = 1V_{P-P}$, Figure 6		115		MHz	
Total Harmonic Distortion	THD+N	$R_S = R_L = 1k\Omega$, $f = 20Hz$ to $20kHz$		0.005		%	
Charge Injection	Q	$V_A = GND, C_L = 1nF, Figure 7$		19		рС	
Input Capacitance	C _{IN}	At A, A1, A2, B, B1, B2, and COM pins		32		pF	
THERMAL PROTECTION	1114						
Thermal Shutdown Temperature	t _{HYST}			+154		°C	
Shutdown Temperature Hysteresis	i			24		°C	
ESD PROTECTION							
All Pins		Human Body Model		±2		kV	

Note 2: All devices are 100% production tested at $T_A = +25$ °C. Specifications over operating temperature range are guaranteed

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%.

Above- and Below-the-Rails Low-Leakage Analog Switches

Test Circuits/Timing Diagrams

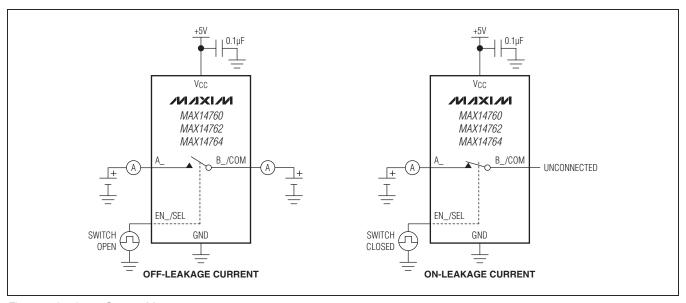


Figure 1. Leakage Current Measurement

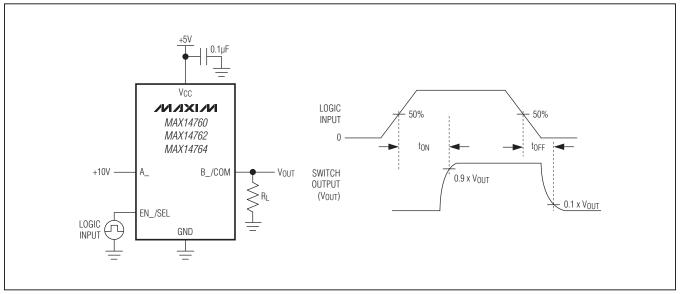


Figure 2. Switching Time

Above- and Below-the-Rails Low-Leakage Analog Switches

Test Circuits/Timing Diagrams (continued)

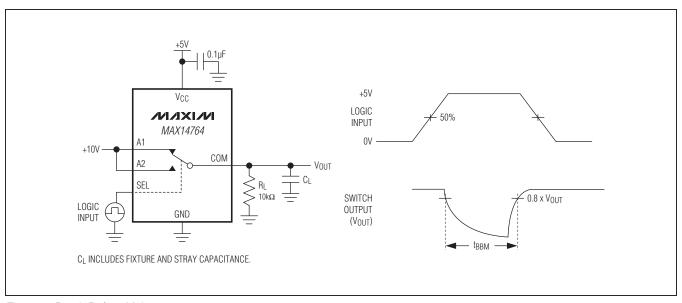


Figure 3. Break-Before-Make

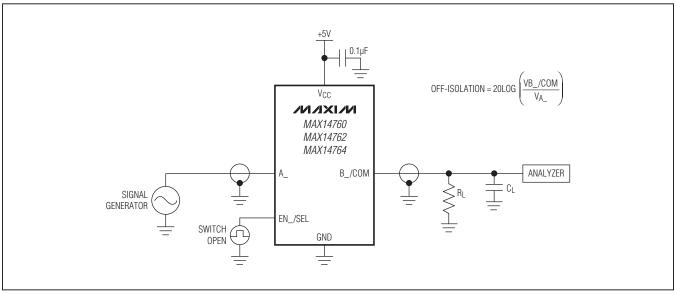


Figure 4. Off-Isolation

Above- and Below-the-Rails Low-Leakage Analog Switches

Test Circuits/Timing Diagrams (continued)

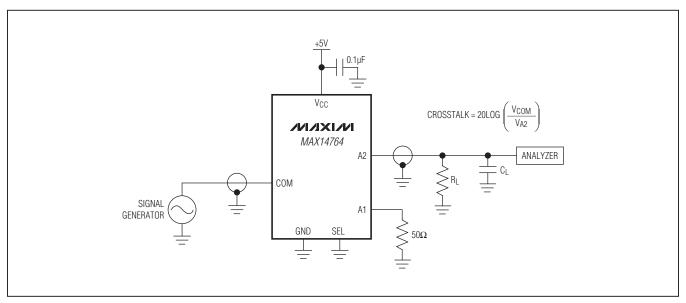


Figure 5. Crosstalk

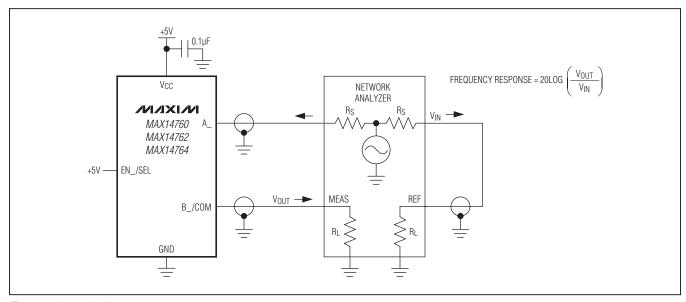


Figure 6. Insertion Loss

Above- and Below-the-Rails **Low-Leakage Analog Switches**

Test Circuits/Timing Diagrams (continued)

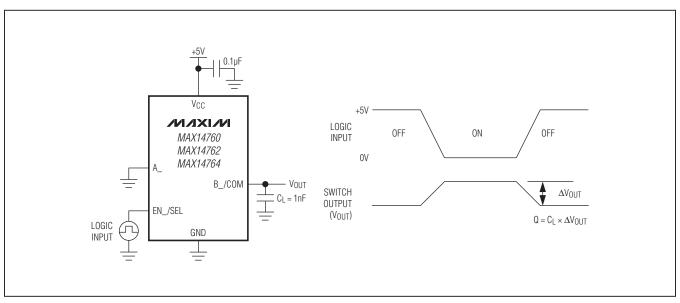
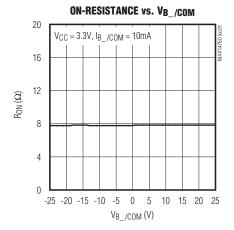
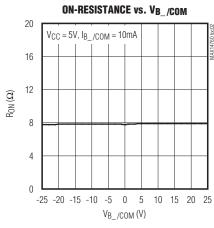


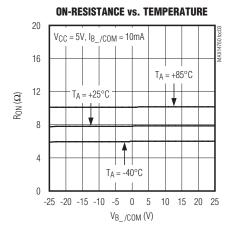
Figure 7. Charge Injection

Typical Operating Characteristics

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



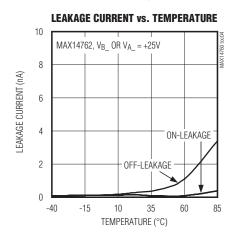


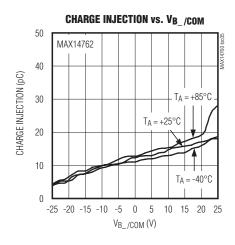


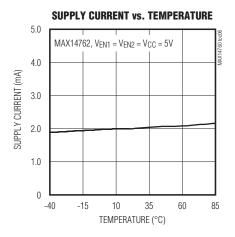
Above- and Below-the-Rails Low-Leakage Analog Switches

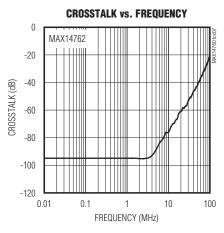
Typical Operating Characteristics (continued)

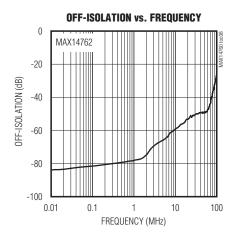
 $(T_A = +25$ °C, unless otherwise noted.)







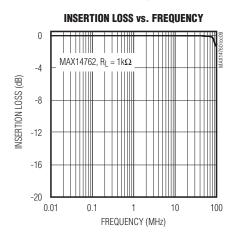


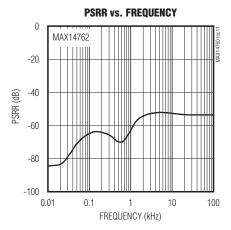


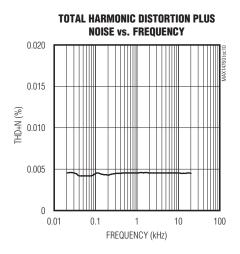
Above- and Below-the-Rails Low-Leakage Analog Switches

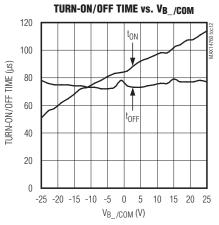
Typical Operating Characteristics (continued)

 $(T_A = +25$ °C, unless otherwise noted.)



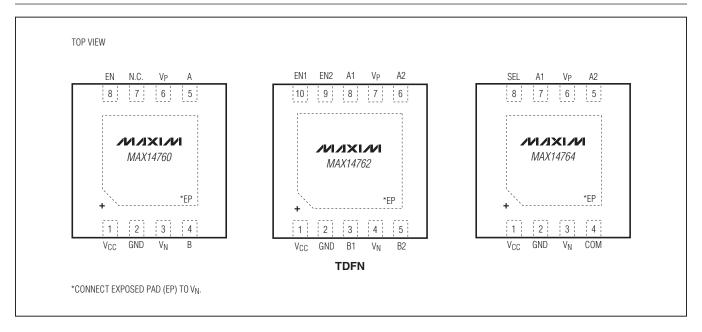






Above- and Below-the-Rails Low-Leakage Analog Switches

Pin Configurations



Pin Description

	PIN		N. A. B. A.	FUNCTION	
MAX14760	MAX14762	MAX14764	NAME	FUNCTION	
1	1	1	V _{CC}	Positive-Supply Voltage Input. Bypass V _{CC} to GND with a 0.1FF 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 1 μ F ceramic capacitor placed as close as possible to the device.	
4	_	_	В	Analog Switch Common Terminal	
_	_	4	COM	COM Analog Switch Common Terminal	
5	_	_	А	Analog Switch Normally Open Terminal	
6	7	6	V_{P}	Positive Voltage Output. Bypass V_P to GND with a 1 μ F 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 ope the switch.	
_	8	7	A1	Analog Switch 1 Normally Closed Terminal	

Above- and Below-the-Rails Low-Leakage Analog Switches

Pin Description (continued)

	PIN		NABAT	FUNCTION	
MAX14760	MAX14762	MAX14764	NAME	FUNCTION	
_	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 lov 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. Internally connected to $V_{\rm N}$; not intended as an electrical connection. Leave exposed pad unconnected.	

Detailed Description

The MAX14760/MAX14762/MAX14764 analog switches are 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.

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 exhibits a high degree of flatness $(58m\Omega)$ 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. 1µF ceramic capacitors are suggested for effective operation. V_P and V_N are not intended as a power supply for other circuitry.

Applications Information

Power-Up Conditions

Ensure that negative signals are not present on the A_, B_, or COM inputs before 1 second has passed after applying V_{CC}.

Above- and Below-the-Rails Low-Leakage Analog Switches

Ordering Information/Selector Guide

PART	TEMP RANGE	PIN-PACKAGE	FUNCTION	R_{ON} (MAX) (Ω)
MAX14760ETA+	-40°C to +85°C	8 TDFN-EP*	1 x SPST	20
MAX14762ETB+	-40°C to +85°C	10 TDFN-EP*	2 x SPST	20
MAX14764ETA+	-40°C to +85°C	8 TDFN-EP*	1 x SPDT	20

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

Chip Information

Package Information

For the latest package outline information and land patterns (footprints), go to www.maxim-ic.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	<u>21-0137</u>	90-0059
10 TDFN	T1033+1	21-0137	90-0003

PROCESS: BiCMOS

^{*}EP = Exposed pad.

Above- and Below-the-Rails Low-Leakage Analog Switches

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/11	Initial release	_

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time. The parametric values (min and max limits) shown in the Electrical Characteristics table are guaranteed. Other parametric values quoted in this data sheet are provided for guidance.