MAX4607/MAX4608/MAX4609

2.5Ω, Dual, SPST, CMOS Analog Switches

General Description

The MAX4607/MAX4608/MAX4609 dual analog switches feature low on-resistance of 2.5Ω max. On-resistance is matched between switches to 0.5Ω max and is flat (0.5Ω max) over the specified signal range. Each switch can handle rail-to-rail analog signals. The off-leakage current is only 2.5nA max at +85°C. These analog switches are ideal in low-distortion applications and are the preferred solution over mechanical relays in automatic test equipment or applications where current switching is required. They have low power requirements, require less board space, and are more reliable than mechanical relays.

The MAX4607 has two normally closed (NC) switches, the MAX4608 has two normally open (NO) switches, and the MAX4609 has one NC and one NO switch.

These switches operate from a single supply of +4.5V to +36V or from dual supplies of ±4.5V to ±20V. All digital inputs have +0.8V and +2.4V logic thresholds, ensuring TTL/CMOS-logic compatibility when using dual ±15V or a single +12V supply.

Applications

Reed Relay Replacement	PBX, PABX Systems
Test Equipment	Audio-Signal Routing
Communication Systems	Avionics

Features

- **Low On-Resistance (2.5Ω max)**
- **Guaranteed R_{ON} Match Between Channels (0.5Ω max)**
- **Guaranteed R_{ON} Flatness over Specified Signal Range (0.5Ω max)**
- **Rail-to-Rail Signal Handling**
- **Guaranteed ESD Protection > 2kV per Method 3015.7**
- **Single-Supply Operation: +4.5V to +36V Dual-Supply Operation: ±4.5V to ±20V**
- **TTL/CMOS-Compatible Control Inputs**

Ordering Information

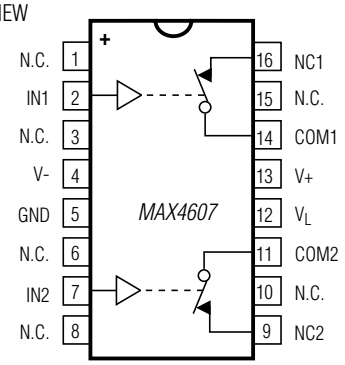
PART	TEMP RANGE	PIN-PACKAGE
MAX4607CSE	0°C to +70°C	16 Narrow SO
MAX4607CPE	0°C to +70°C	16 Plastic DIP
MAX4607ESE	-40°C to +85°C	16 Narrow SO
MAX4607EPE	-40°C to +85°C	16 Plastic DIP

Ordering Information continued at end of data sheet.

Devices are also available in a lead(Pb)-free/RoHS-compliant package. Specify lead-free by adding "+" to the part number when ordering.

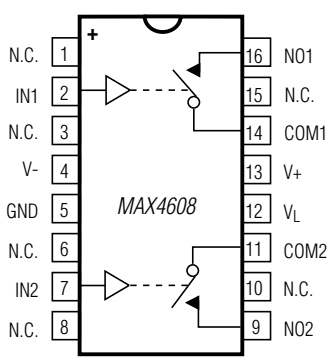
Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW



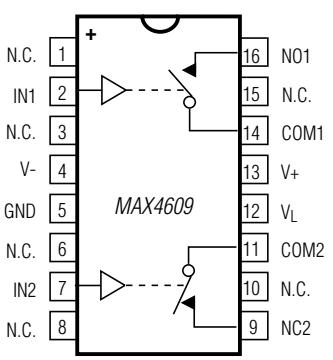
SO/DIP

LOGIC	SWITCH
0	ON
1	OFF



SO/DIP

LOGIC	SWITCH
0	OFF
1	ON



SO/DIP

LOGIC	SWITCH 1	SWITCH 2
0	OFF	ON
1	ON	OFF

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

19-1392; Rev 3; 9/12

ABSOLUTE MAXIMUM RATINGS

V+ to GND .....-0.3V to +44V
V- to GND .....+0.3V to -44V
V+ to V- .....-0.3V to +44V
V_L to GND .....(GND - 0.3V) to (V+ + 0.3V)
All Other Pins to GND (Note 1) .....(V- - 0.3V) to (V+ + 0.3V)
Continuous Current (COM_, NO_, NC_) .....±100mA
Peak Current (COM_, NO_, NC_)
(pulsed at 1ms, 10% duty cycle) ..... ±300mA
Continuous Power Dissipation (T_A = +70°C)
Narrow SO (derate 8.70mW/°C above +70°C) 696mW
Plastic DIP (derate 10.53mW/°C above +70°C) 842mW
Operating Temperature Ranges
MAX460_C_E .....0°C to +70°C
MAX460_E_E .....-40°C to +85 °C
Soldering Temperature (reflow)
Lead(Pb)-Free Packages .....+260°C
Packages Containing Lead(Pb) .....+240°C
Storage Temperature Range .....-65°C to +160°C
Lead Temperature (soldering, 10s) .....+300°C

Note 1: Signals on NC_, NO_, COM_, or IN_, exceeding V+ or V- will be clamped by internal diodes. 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—Dual Supplies

(V+ = +15V, V- = -15V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS			MIN	TYP	MAX	UNITS
ANALOG SWITCH								
Input Voltage Range (Note 3)	$V_{COM_}$, $V_{NO_}$, $V_{NC_}$				V-		V+	V
COM_ to NO_, COM_ to NC_ On-Resistance	R_{ON}	$I_{COM_}$ = 10mA, $V_{NO_}$ or $V_{NC_}$ = ±10V	T_A = +25°C			1.6	2.5	Ω
			T_A = T_{MIN} to T_{MAX}				3	
COM_ to NO_, COM_ to NC_ On-Resistance Match Between Channels (Note 4)	ΔR_{ON}	$I_{COM_}$ = 10mA, $V_{NO_}$ or $V_{NC_}$ = -5V, 0, 5V	T_A = +25°C			0.05	0.4	Ω
			T_A = T_{MIN} to T_{MAX}				0.5	
COM_ to NO_, COM_ to NC_ On-Resistance Flatness (Note 5)	$R_{FLAT(ON)}$	$I_{COM_}$ = 10mA, $V_{NO_}$ or $V_{NC_}$ = ±10V	T_A = +25°C			0.1	0.4	Ω
			T_A = T_{MIN} to T_{MAX}				0.5	
Off-Leakage Current (NO_ or NC_) (Note 6)	$I_{NO_}$, $I_{NC_}$	$V_{COM_}$ = ±10V, $V_{NO_}$ or $V_{NC_}$ = ±10V	T_A = +25°C		-0.5	+0.01	+0.5	nA
			T_A = T_{MIN} to T_{MAX}	C, E	-2.5		+2.5	
				M	-30		30	
COM_ Off-Leakage Current (Note 6)	$I_{COM_(OFF)}$	$V_{COM_}$ = ±10V, $V_{NO_}$ or $V_{NC_}$ = ±10V	T_A = +25°C		-0.5	+0.01	0.5	nA
			T_A = T_{MIN} to T_{MAX}	C, E	-2.5		+2.5	
				M	-30		30	
COM_ On-Leakage Current (Note 6)	$I_{COM_(ON)}$	$V_{COM_}$ = ±10V, $V_{NO_}$ or $V_{NC_}$ = ±10V or unconnected	T_A = +25°C		1	0.02	1	nA
			T_A = T_{MIN} to T_{MAX}	C, E	-10		10	
				M	-120		+120	
LOGIC INPUT								
Input Current with Input Voltage High	I_{IN_H}	$V_{IN_}$ = 2.4V, all others = 0.8V			-0.500	+0.001	+0.500	µA
Input Current with Input Voltage Low	I_{IN_L}	$V_{IN_}$ = 0.8V, all others = 2.4V			-0.500	+0.001	+0.500	µA

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +15V, V- = -15V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Logic Input High Voltage	V_{IN_H}			2.4	1.7		V
Logic Input Low Voltage	V_{IN_L}				1.7	0.8	V
POWER SUPPLY							
Power-Supply Range				±4.5		±20.0	V
Positive Supply Current	I+	V_{IN} = 0 or 5V	T_A = +25°C	-0.5	+0.001	+0.5	µA
			T_A = T_{MIN} to T_{MAX}	-5		+5	
Negative Supply Current	I-	V_{IN} = 0 or 5V	T_A = +25°C	-0.5	+0.001	+0.5	µA
			T_A = T_{MIN} to T_{MAX}	-5		+5	
Logic Supply Current	C	V_{IN} = 0 or 5V	T_A = +25°C	-0.5	+0.001	+0.5	µA
			T_A = T_{MIN} to T_{MAX}	-5		+5	
Ground Current	I_{GND}	V_{IN} = 0 or 5V	T_A = +25°C	-0.5	+0.001	+0.5	µA
			T_A = T_{MIN} to T_{MAX}	-5		+5	
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	T_{ON}	$V_{COM_}$ = ±10V, Figure 2, T_A = +25°C			110		ns
Turn-Off Time	T_{OFF}	$V_{COM_}$ = ±10V, Figure 2, T_A = +25°C			150		ns
Charge Injection	Q	C_L = 1.0nF, V_{GEN} = 0, R_{GEN} = 0, Figure 3, T_A = +25°C			45		pC
Off-Isolation (Note 7)	V_{ISO}	R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 4, T_A = +25°C			-60		dB
Crosstalk (Note 8)	V_{CT}	R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 5, T_A = +25°C			-66		dB
NC_ or NO_ Capacitance	C_{OFF}	F = 1MHz, Figure 6, T_A = +25°C			65		pF
COM_ Off-Capacitance	C_{COM}	F = 1MHz, Figure 6, T_A = +25°C			65		pF
On-Capacitance	C_{COM}	F = 1MHz, Figure 7, T_A = +25°C			290		pF

ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Input Voltage Range (Note 3)	$V_{COM_}$, $V_{NO_}$, $V_{NC_}$			V_{GND}		V+	V
COM_ to NO_, COM_ to NC_ On-Resistance	R_{ON}	$I_{COM_}$ = 10mA, $V_{NO_}$ or $V_{NC_}$ = 10V	T_A = +25°C		3	6	Ω
			T_A = T_{MIN} to T_{MAX}			7	
COM_ to NO_, COM_ to NC_ On-Resistance Match Between Channels (Note 4)	ΔR_{ON}	$I_{COM_}$ = 10mA, $V_{NO_}$ or $V_{NC_}$ = 10V	T_A = +25°C		0.05	0.4	Ω
			T_A = T_{MIN} to T_{MAX}			0.5	
COM_ to NO_, COM_ to NC_ On-Resistance Flatness (Note 5)	$R_{FLAT(ON)}$	$I_{COM_}$ = 10mA, $V_{NO_}$ or $V_{NC_}$ = 3V, 6V, 0V	T_A = +25°C		0.05	1.1	Ω
			T_A = T_{MIN} to T_{MAX}			1.2	
Off-Leakage Current (NO_ or NC_) (Notes 6, 9)	$I_{NO_}$ $I_{NC_}$	$V_{COM_}$ = 1V, 10V, $V_{NO_}$ or $V_{NC_}$ = 1V, 10V	T_A = +25°C	-0.5	+0.01	+0.5	nA
			T_A = T_{MIN} to T_{MAX}	-2.5		2.5	
COM Off-Leakage Current (Notes 6, 9)	$I_{COM_(OFF)}$	$V_{COM_}$ = 10V, 1V $V_{NO_}$ or $V_{NC_}$ = 1V, 10V	T_A = +25°C	-0.5	+0.01	+0.5	nA
			T_A = T_{MIN} to T_{MAX}	-2.5		+2.5	
COM On-Leakage Current (Notes 6, 9)	$I_{COM_(ON)}$	$V_{COM_}$ = 1V, 10V, $V_{NO_}$ or $V_{NC_}$= 1V, 10V, or unconnected	T_A = +25°C	-1	+0.01	+1	nA
			T_A = T_{MIN} to T_{MAX}	-10		+10	
LOGIC INPUT							
Input Current with Input Voltage High	I_{IN_H}	$V_{IN_}$ = 2.4V, all others = 0.8V		-0.500	+0.001	+0.500	µA
Input Current with Input Voltage Low	I_{IN_L}	$V_{IN_}$ = 0.8V, all others = 2.4V		-0.500	+0.001	+0.500	µA
Logic Input High Voltage	V_{IN_H}			2.4	1.7		V
Logic Input Low Voltage	V_{IN_L}				1.7	0.8	V

ELECTRICAL CHARACTERISTICS—Single Supply (continued)

(V+ = +12V, V- = 0V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
POWER SUPPLY							
Power-Supply Range				+4.5		+36.0	V
Positive Supply Current	I+	V_{IN} = 0V or 5V	T_A = +25°C	-0.5	+0.001	+0.5	µA
			T_A = T_{MIN} to T_{MAX}	-5		+5	
Logic Supply Current	I_L	V_{IN} = 0V or 5V	T_A = +25°C	-0.5	+0.001	+0.5	µA
			T_A = T_{MIN} to T_{MAX}	-5		+5	
Ground Current	I_{GND}	V_{IN} = 0V or 5V	T_A = +25°C	-0.5	+0.001	+0.5	µA
			T_A = T_{MIN} to T_{MAX}	-5		+5	
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	$V_{COM_}$ = 10V, Figure 2, T_A = +25°C			110		ns
Turn-Off Time	t_{OFF}	$V_{COM_}$ = 10V, Figure 2, T_A = +25°C			130		ns
Charge Injection	Q	C_L = 1.0nF, V_{GEN} = 0V, R_{GEN} = 0Ω, Figure 3, T_A = +25°C			50		pC
Crosstalk (Note 8)	V_{CT}	R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 5, T_A = +25°C			66		dB
NC or NO Capacitance	$C_{(OFF)}$	f = 1MHz, Figure 6, T_A = +25°C			105		pF
COM Off-Capacitance	$C_{(COM)}$	f = 1MHz, Figure 6, T_A = +25°C			105		pF
On-Capacitance	$C_{(COM)}$	f = 1MHz, Figure 7, T_A = +25°C			185		pF

Note 2: The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.

Note 3: Guaranteed by design.

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 range.

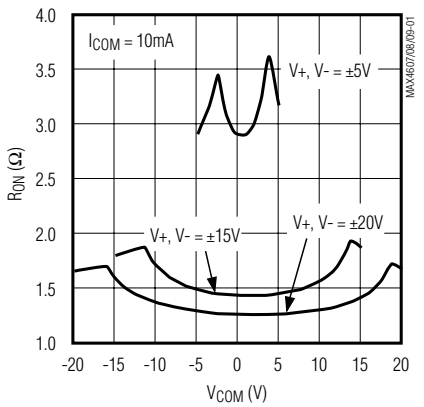
Note 6: Leakage parameters are 100% tested at maximum-rated hot temperature and guaranteed by correlation at +25°C.

Note 7: Off-isolation = $20\log_{10}$ [V_{COM} / (V_{NC} or V_{NO})], V_{COM} = output, V_{NC} or V_{NO} = input to off switch.

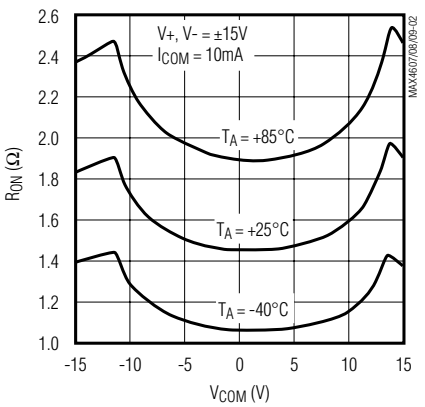
Note 8: Between any two switchesΩ.

Note 9: Leakage testing at single supply is guaranteed by testing with dual supplies.

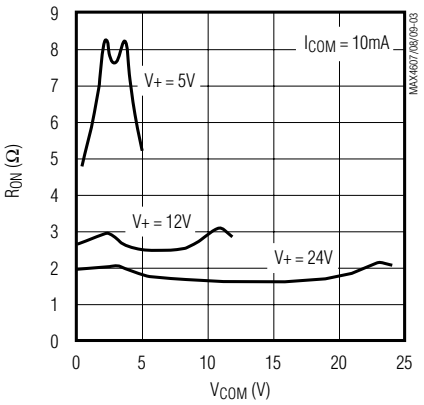
ON-RESISTANCE (DUAL SUPPLY)



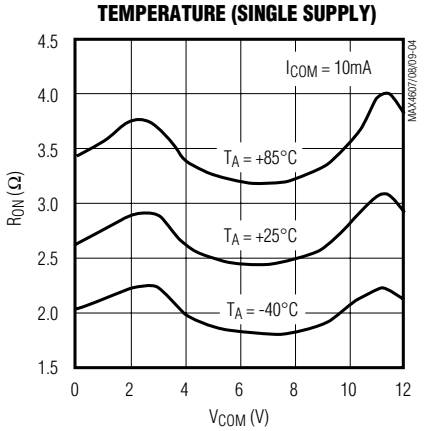
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (DUAL SUPPLY)



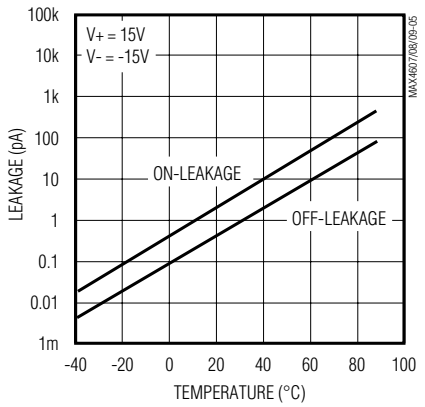
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (SINGLE SUPPLY)



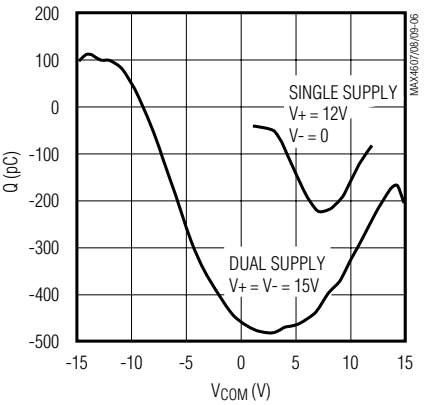
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (SINGLE SUPPLY)



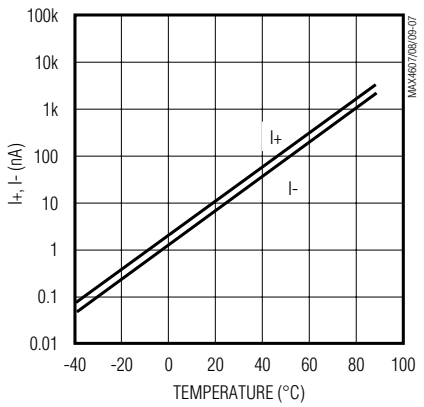
ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE



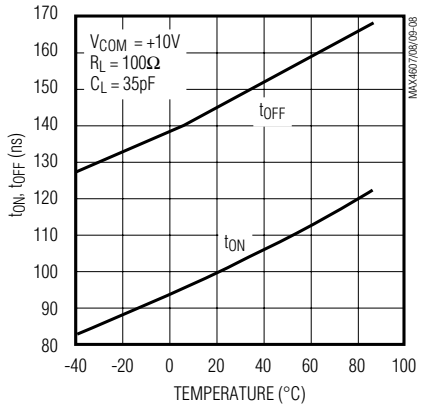
CHARGE INJECTION vs. V_{COM}



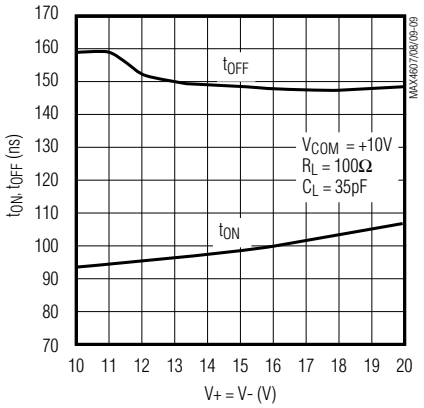
SUPPLY CURRENT vs. TEMPERATURE



ON/OFF TIME vs. TEMPERATURE

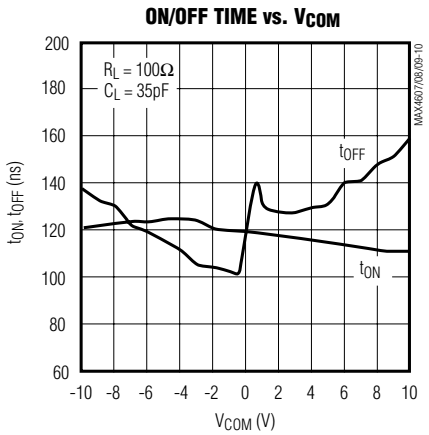


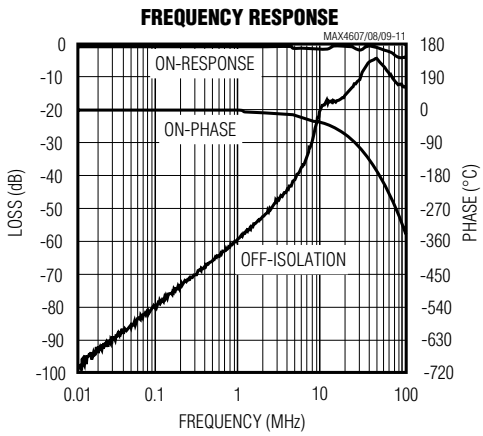
ON/OFF TIME vs. SUPPLY VOLTAGE



Typical Operating Characteristics (continued)

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





Pin Description

PIN			NAME	FUNCTION
MAX4607	MAX4608	MAX4609		
2, 7	2, 7	2, 7	IN2, IN2	Logic-Control Digital Inputs
14, 11	14, 11	14, 11	COM1, COM2	Analog Switch, Common Terminals
16, 9	—	—	NC1, NC2	Analog Switch, Normally Closed Terminals
—	16, 9	—	NO1, NO2	Analog Switch, Normally Open Terminals
—	—	9	NC1	Analog Switch, Normally Closed Terminal
—	—	16	NO1	Analog Switch, Normally Open Terminal
4	4	4	V-	Negative Analog Supply-Voltage Input. Connect to DGND for single-supply operation.
5	5	5	GND	Ground
1, 3, 6, 8, 10, 15	1, 3, 6, 8, 10, 15	1, 3, 6, 8, 10, 15	N.C.	No Connection. Not internally connected. Connect to GND as low impedance to improve on/off-isolation.
12	12	12	V_L	Logic-Supply Input
13	13	13	V+	Positive Analog-Supply Input

Applications Information

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings can cause permanent damage to the devices. Always sequence V+ on first, then V-, followed by the logic inputs, NO, or COM. If power-supply sequencing is not possible, add two small signal diodes (D1, D2) in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V. These protection diodes are not recommended when using a single supply.

Off-Isolation at High Frequencies

With the N.C. pins connected to GND, the high-frequency on-response of these parts extends from DC to above 100MHz with a typical loss of -2dB. When the switch is turned off, however, it behaves like a capacitor, and off-isolation decreases with increasing frequency. (Above 300MHz, the switch actually passes more signal turned off than turned on.) This effect is more pronounced with higher source and load impedances.

Above 5MHz, circuit-board layout becomes critical, and it becomes difficult to characterize the response of the switch independent of the circuit. The graphs shown in the *Typical Operating Characteristics* were taken using a 50Ω source and load connected with BNC connectors to a circuit board deemed "average;" that is, designed with isolation in mind, but not using strip-line or other special RF circuit techniques. For critical applications above 5MHz, use the MAX440, MAX441, and MAX442, which are fully characterized up to 160MHz.

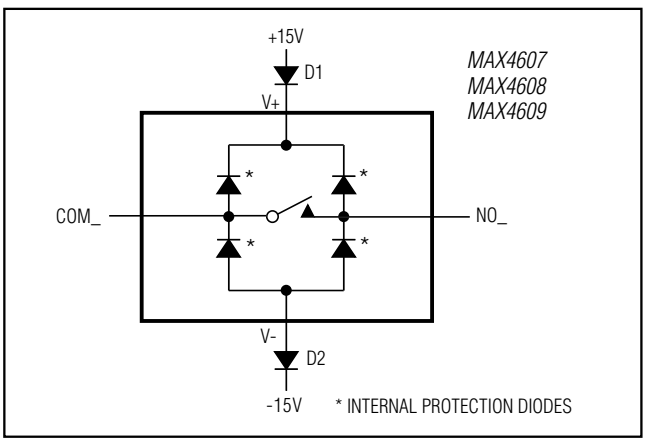


Figure 1. Overvoltage Protection Using External Blocking Diodes

Test Circuits/Timing Diagrams

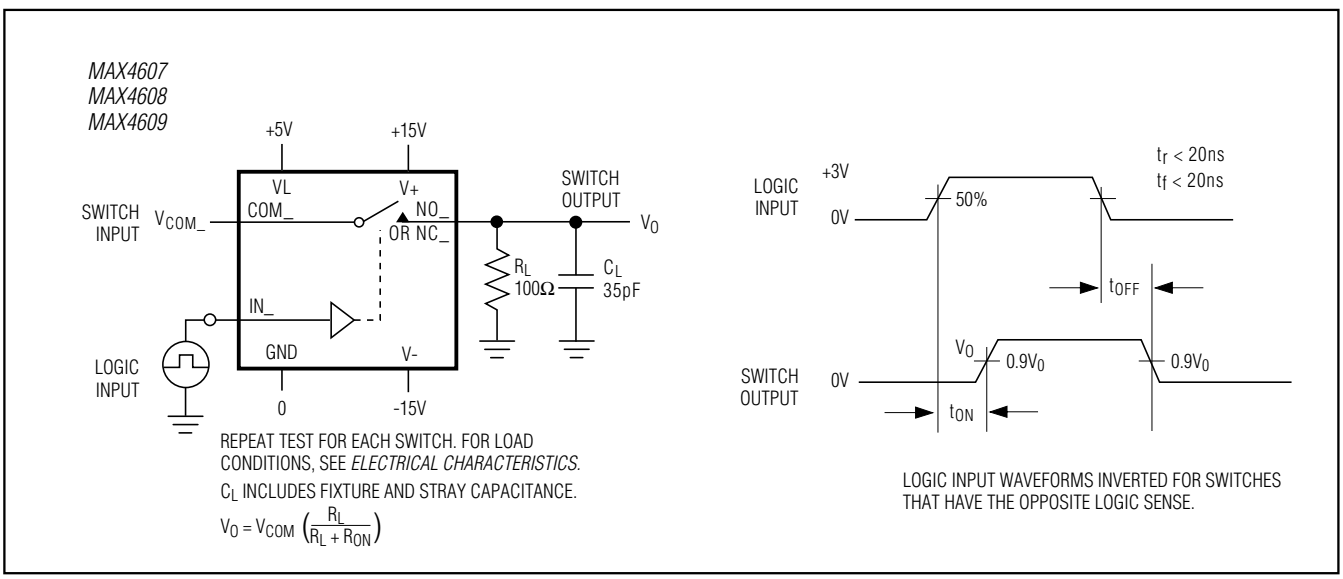


Figure 2. Switching-Time Test Circuit

Test Circuits/Timing Diagrams (continued)

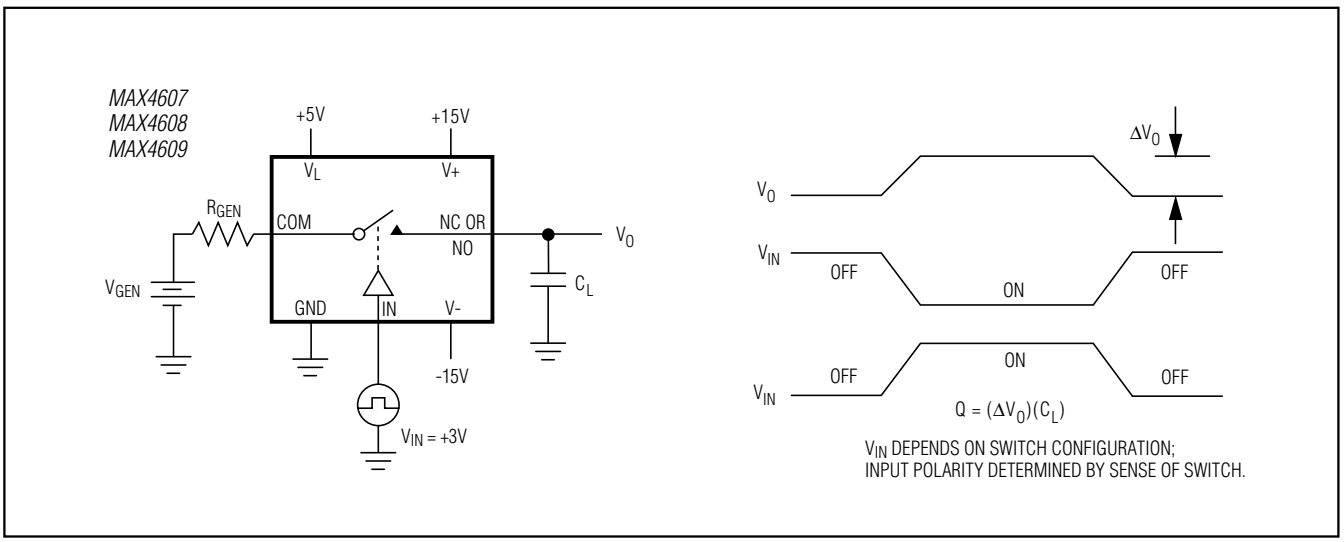


Figure 3. Charge-Injection Test Circuit

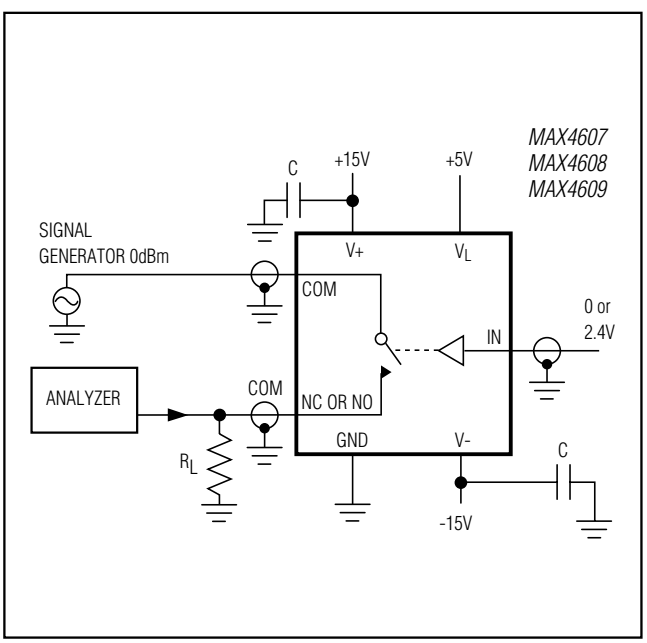


Figure 4. Off-Isolation Test Circuit

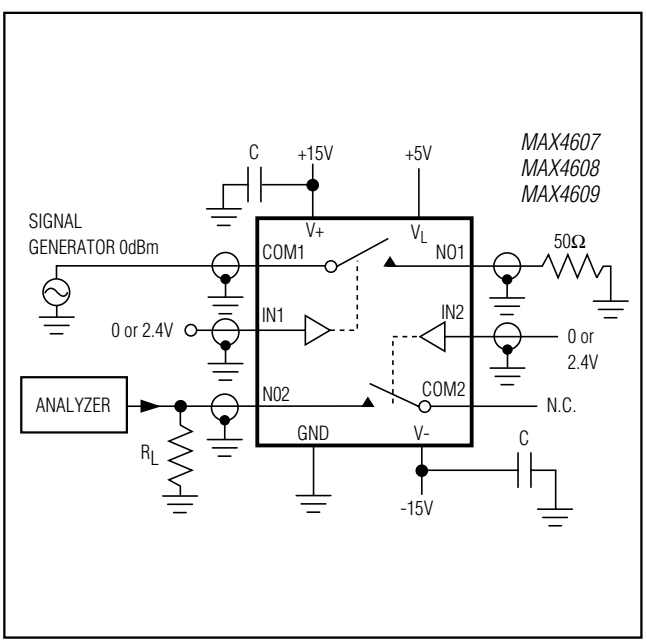


Figure 5. Crosstalk Test Circuit

Test Circuits/Timing Diagrams (continued)

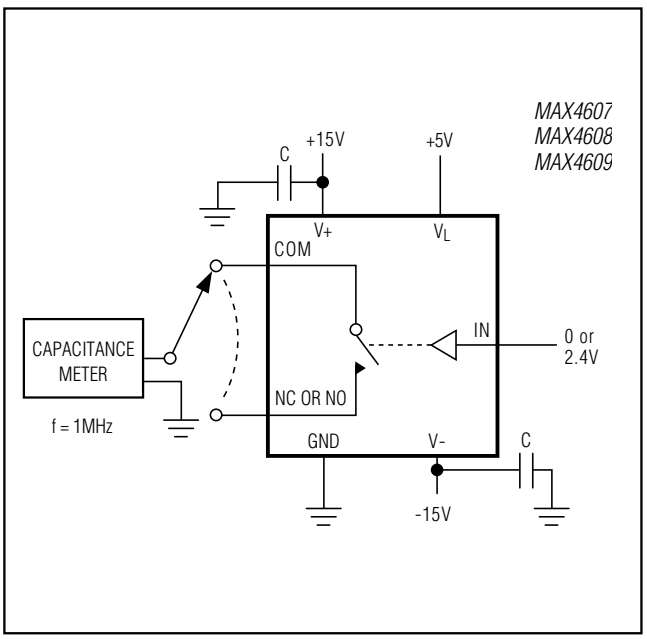


Figure 6. Switch Off-Capacitance Test Circuit

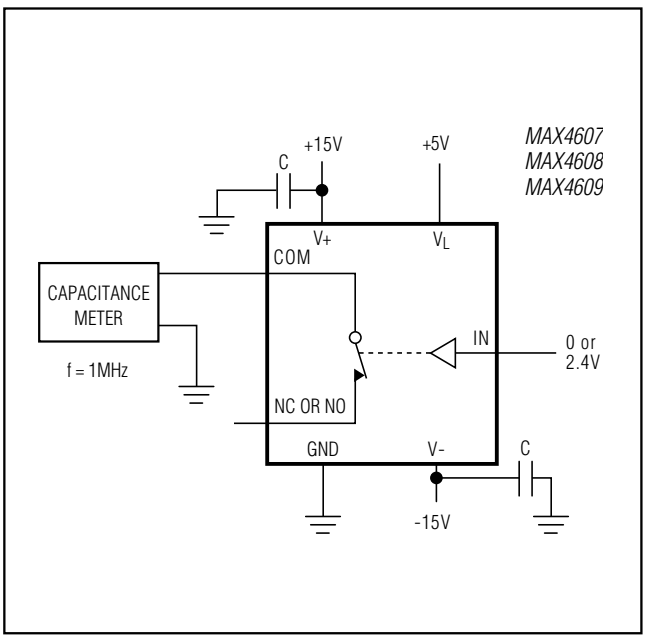


Figure 7. Switch On-Capacitance Test Circuit

Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE
MAX4608CSE	-0°C to +70°C	16 Narrow SO
MAX4608CPE	0°C to +70°C	16 Plastic DIP
MAX4608ESE	-40°C to +85°C	16 Narrow SO
MAX4608EPE	-40°C to +85°C	16 Plastic DIP
MAX4608MSE/PR3	-55°C to +125°C	16 Narrow SO
MAX4609CSE	-0°C to +70°C	16 Narrow SO
MAX4609CPE	-0°C to +70°C	16 Plastic DIP
MAX4609ESE	-40°C to +85°C	16 Narrow SO
MAX4609EPE	-40°C to +85°C	16 Plastic DIP

Devices are also available in a lead(Pb)-free/RoHS-compliant package. Specify lead-free by adding "+" to the part number when ordering.

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.
16 PDIP	P16-4	21-0043	—
16 SO	S16-8	21-0041	90-0097