

## Low-Voltage, Low $R_{ON}$ , Single SPDT Analog Switch.

### DESCRIPTION

The PA2011 is a low on-resistance, single-pole double-throw monolithic CMOS analog switch. It is designed for low voltage applications with guaranteed operation at 2 V.

The PA2011 is ideal for portable and battery powered equipment, requiring high performance and efficient use of board space. In addition to the low on-resistance ( $1.8 \Omega$  at 2.7 V), charge injection is less than 10 pC over the entire analog range.

The switch conducts equally well in both directions when on, and blocks up to the power supply level when off.

Break-before-make is guaranteed.

### FEATURES

- Low Voltage Operation (1.8 V to 3.3 V)
- Low On-Resistance -  $r_{ON}$ :  $1.8 \Omega$  at 2.7 V
- Low Charge Injection
- Low Voltage Logic Compatible
- SC-89 Package (1.6 x 1.6 mm)

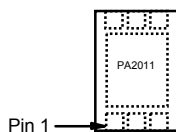
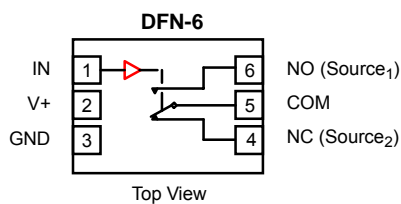
### BENEFITS

- Reduced Power Consumption
- Simple Logic Interface
- High Accuracy
- Reduce Board Space
- Guaranteed 2 V Operation

### APPLICATIONS

- Cellular Phones
- Communication Systems
- Portable Test Equipment
- Battery Operated Systems
- Sample and Hold Circuits
- ADC and DAC Applications

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Device Marking: PA2011  
xx Date Code

### TRUTH TABLE

Logic	NC	NO
0	ON	OFF
1	OFF	ON

### ORDERING INFORMATION

Temp Range	Package	Part Number
- 40 to 85 °C	SC-89 Tape and Reel	PA2011- T7
	SC-89 Lead (Pb)-free with Tape and Reel	PA2011-LF PA2011-LF-T7

**ABSOLUTE MAXIMUM RATINGS**  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted

Parameter	Symbol	Limit	Unit
Reference $V_+$ to GND		- 0.3 to + 3.3	V
IN, COM, NC, NO <sup>1</sup>		- 0.3 to ( $V_+ + 0.3\text{ V}$ )	
Continuous Current (NO, NC, COM pins)		$\pm 150$	mA
Peak Current (Pulsed at 1 ms, 10 % duty cycle)		$\pm 300$	
Storage Temperature	D Suffix	- 65 to 150	$^\circ\text{C}$
Power Dissipation (Packages) <sup>2</sup>	SC-89 <sup>3</sup>	172	mW

Notes:

1. Signals on NC, NO, or COM or IN exceeding  $V_+$  will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
2. All leads welded or soldered to PC Board.
3. Derate 2.15 mW/ $^\circ\text{C}$  above 70 $^\circ\text{C}$ .

**SPECIFICATIONS ( $V_+ = 2.0\text{ V}$ )**

Parameter	Symbol	Test Conditions Otherwise Unless Specified $V_+ = 2.0\text{ V}$ , $V_{IN} = 0.4\text{ V}$ or $1.6\text{ V}$ <sup>5</sup>	Temp <sup>1</sup>	Limits - 40 to 85 $^\circ\text{C}$			Unit
				Min <sup>2</sup>	Typ <sup>3</sup>	Max <sup>2</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>4</sup>	$V_{NO}, V_{NC}, V_{COM}$		Full	0		$V_+$	V
On-Resistance	$r_{ON}$	$V_+ = 2.0\text{ V}$ , $V_{COM} = 0.2\text{ V}/0.9\text{ V}$ $I_{NO}, I_{NC} = 20\text{ mA}$	Room Full		3.5	5.5 5.5	$\Omega$
Switch Off Leakage Current <sup>5</sup>	$I_{NO(off)}$ $I_{NC(off)}$	$V_+ = 2.2\text{ V}$ , $V_{NO}, V_{NC} = 0.5\text{ V}/1.5\text{ V}$ , $V_{COM} = 1.5\text{ V}/0.5\text{ V}$	Room Full	- 1 - 10		1 10	nA
	$I_{COM(off)}$		Room Full	- 1 - 10		1 10	
Channel-On Leakage Current <sup>6</sup>	$I_{COM(on)}$	$V_+ = 2.2\text{ V}$ , $V_{NO}, V_{NC} = V_{COM} = 0.5\text{ V}/1.5\text{ V}$	Room	- 1 - 10		1 10	
<b>Digital Control</b>							
Input High Voltage	$V_{INH}$		Full	1.5			V
Input Low Voltage	$V_{INL}$		Full			0.4	
Input Capacitance	$C_{in}$		Full		4		pF
Input Current	$I_{INL}$ or $I_{INH}$	$V_{IN} = 0$ or $V_+$	Full	1		1	$\mu\text{A}$
<b>Dynamic Characteristics</b>							
Turn-On Time	$t_{ON}$	$V_{NO}$ or $V_{NC} = 1.5\text{ V}$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$	Room Full		25	36 40	ns
Turn-Off Time	$t_{OFF}$		Room Full		10	15 16	
Break-Before-Make Time	$t_{BBM}$		Room	9	15		
Charge Injection <sup>4</sup>	$Q_{INJ}$	$C_L = 1\text{ nF}$ , $V_{GEN} = 0\text{ V}$ , $R_{GEN} = 0\ \Omega$	Room		7		pC
Off-Isolation <sup>4</sup>	OIRR	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$	Room		- 113		dB
Crosstalk <sup>4</sup>	$X_{TALK}$		Room		- 112		
$N_O, N_C$ Off Capacitance <sup>4</sup>	$C_{NO(off)}$ $C_{NC(off)}$	$V_{IN} = 0$ or $V_+$ , $f = 1\text{ MHz}$	Room		26		pF
Channel-On Capacitance <sup>4</sup>	$C_{ON}$		Room		85		
<b>Power Supply</b>							
Positive Supply Range	$V_+$	$V_{IN} = 0$ or $V_+$		1.8		3.3	V
Negative Supply Current	$I_+$				0.01		1.0

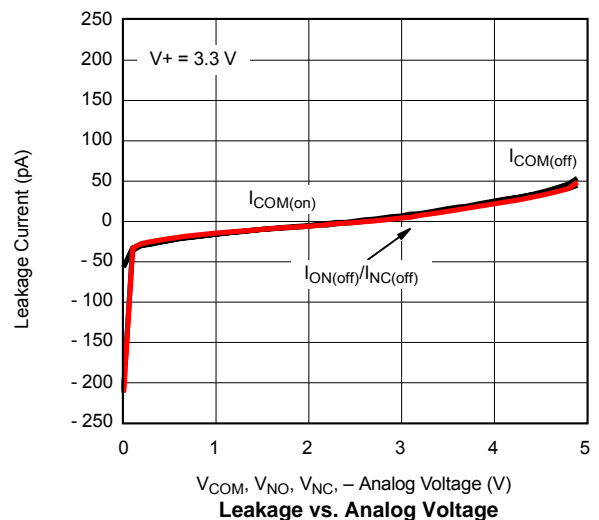
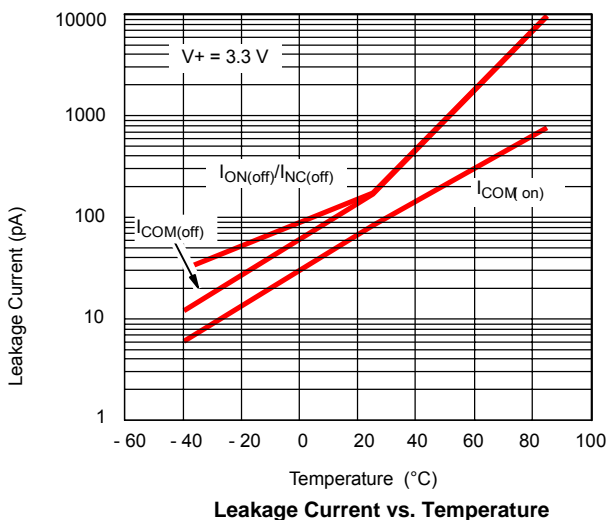
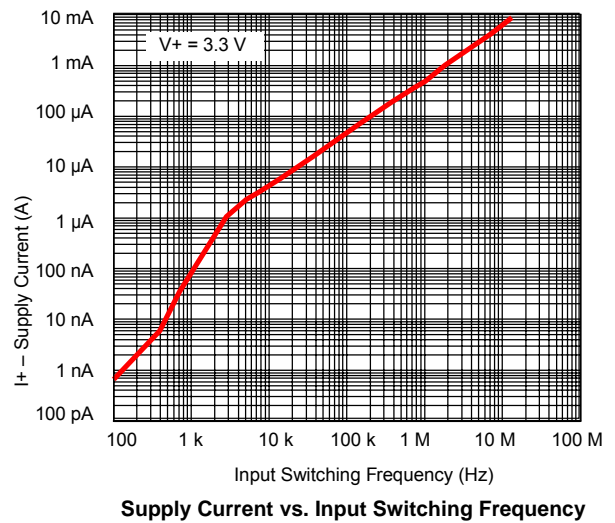
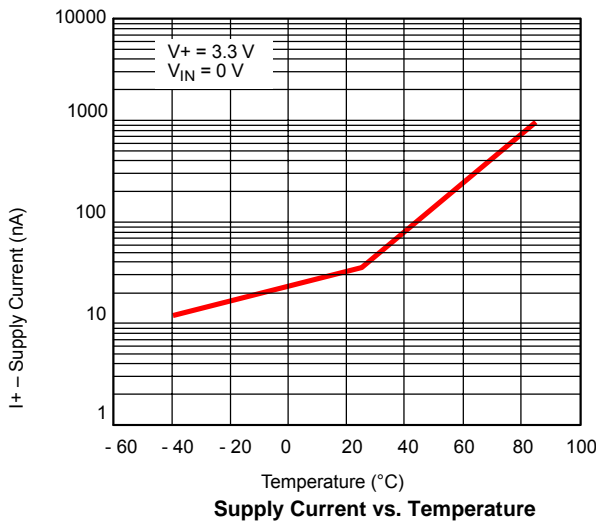
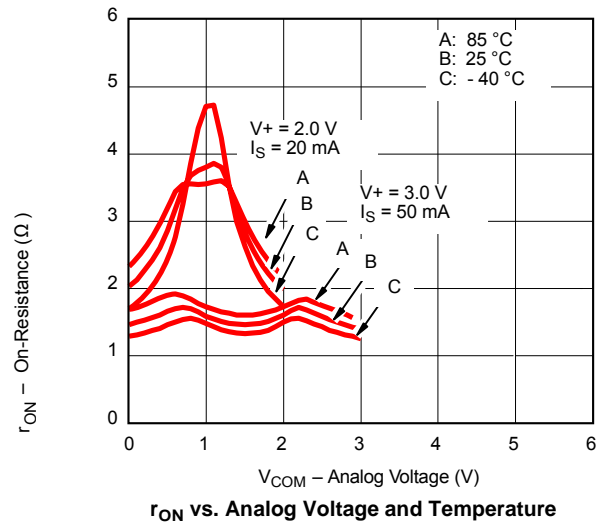
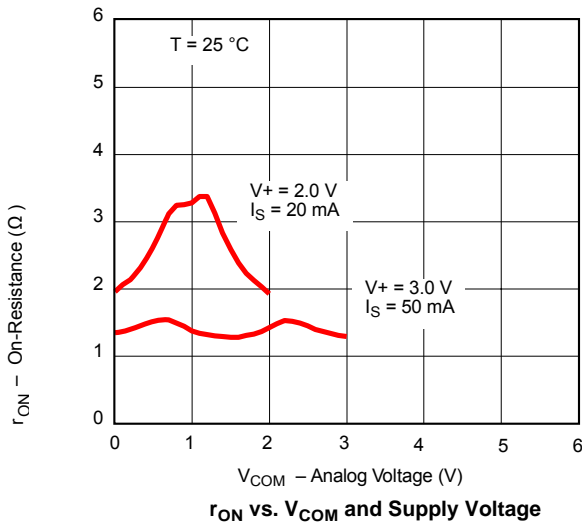
**SPECIFICATIONS (V+ = 3 V)**

Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ±10 %, V <sub>IN</sub> = 0.4 V or 2.0 V <sup>5</sup>	Temp <sup>1</sup>	Limits -40 to 85 °C			Unit
				Min <sup>2</sup>	Typ <sup>3</sup>	Max <sup>2</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>4</sup>	V <sub>NO</sub> , V <sub>NC</sub> , V <sub>COM</sub>		Full	0		V+	V
On-Resistance	r <sub>ON</sub>	V+ = 2.7 V, V <sub>COM</sub> = 0.9 V/1.5 V I <sub>NO</sub> , I <sub>NC</sub> = 50 mA	Room		1.8	2.7	Ω
r <sub>ON</sub> Match	Δr <sub>ON</sub>		Full			2.9	
r <sub>ON</sub> Flatness	r <sub>ON</sub> Flatness		Room		0.2	0.5	
Switch Off Leakage Current	I <sub>NO(off)</sub> I <sub>NC(off)</sub>	V+ = 3.3 V, V <sub>NO</sub> , V <sub>NC</sub> = 1 V/3 V, V <sub>COM</sub> = 3 V/1 V	Room	- 1		1	nA
	I <sub>COM(off)</sub>		Full	- 10		10	
Channel-On Leakage Current <sup>6</sup>	I <sub>COM(on)</sub>	V+ = 3.3 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 1 V/3 V	Room	- 1		1	
			Full	- 10		10	
<b>Digital Control</b>							
Input High Voltage	V <sub>INH</sub>		Full	1.6			V
Input Low Voltage	V <sub>INL</sub>		Full			0.4	
Input Capacitance	C <sub>in</sub>		Full		4		pF
Input Current	I <sub>INL</sub> or I <sub>INH</sub>	V <sub>IN</sub> = 0 or V+	Full	1		1	μA
<b>Dynamic Characteristics</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 2.0 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room		16	24	ns
Turn-Off Time	t <sub>OFF</sub>		Full		7	9	
Break-Before-Make Time	t <sub>BBM</sub>		Full		7	9	
Charge Injection <sup>4</sup>	Q <sub>INJ</sub>	C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω	Room		2		pC
Off-Isolation <sup>4</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 107		dB
Crosstalk <sup>4</sup>	X <sub>TALK</sub>		Room		- 107		
N <sub>O</sub> , N <sub>C</sub> Off Capacitance <sup>4</sup>	C <sub>NO(off)</sub> C <sub>NC(off)</sub>	V <sub>IN</sub> = 0 or V+, f = 1 MHz	Room		26		pF
Channel-On Capacitance <sup>4</sup>	C <sub>ON</sub>		Room		84		
<b>Power Supply</b>							
Power Supply Range	V+			1.8		3.3	V
Power Supply Current	I+	V <sub>IN</sub> = 0 or V+			0.01	1.0	μA
Power Consumption	P <sub>C</sub>						3.3

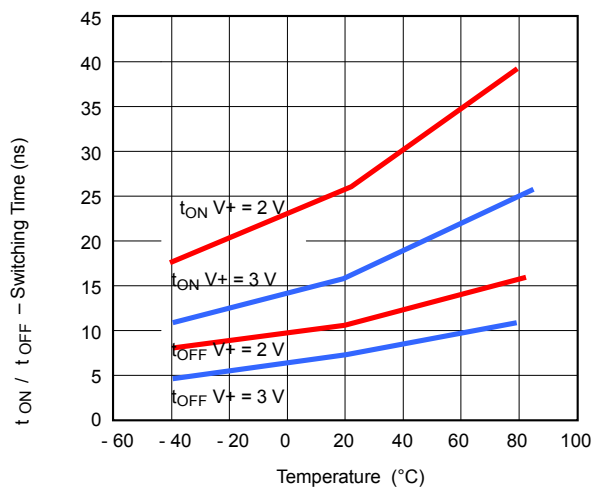
Notes:

1. Room = 25 °C, Full = as determined by the operating suffix.
2. Typical values are for design aid only, not guaranteed nor subject to production testing.
3. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
4. Guarantee by design, nor subjected to production test.
5. V<sub>IN</sub> = input voltage to perform proper function.
6. Guaranteed by 3.3V leakage testing, not production tested.

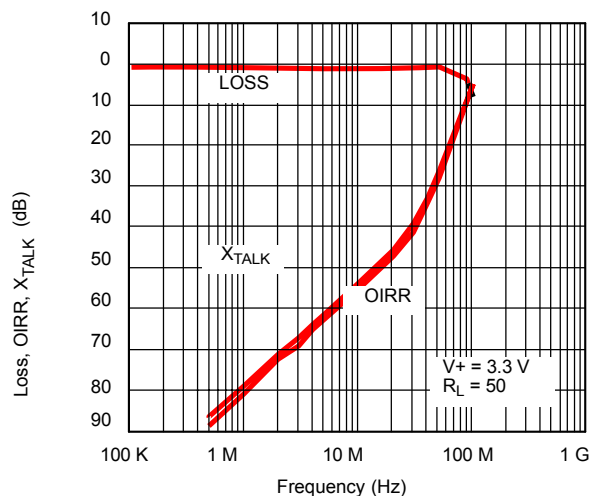
TYPICAL CHARACTERISTICS  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted



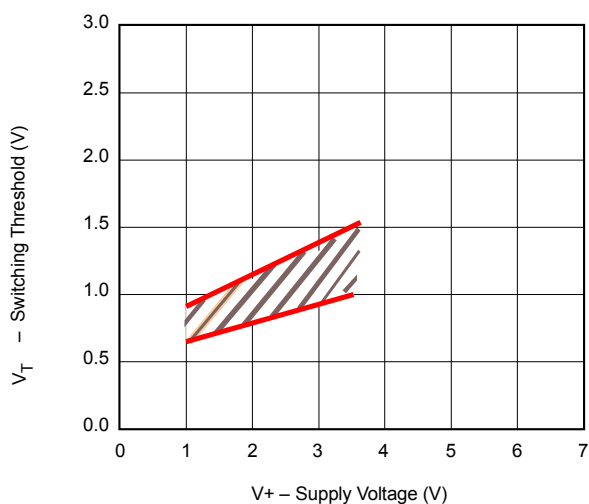
TYPICAL CHARACTERISTICS  $T_A = 25^\circ\text{C}$ , unless otherwise noted



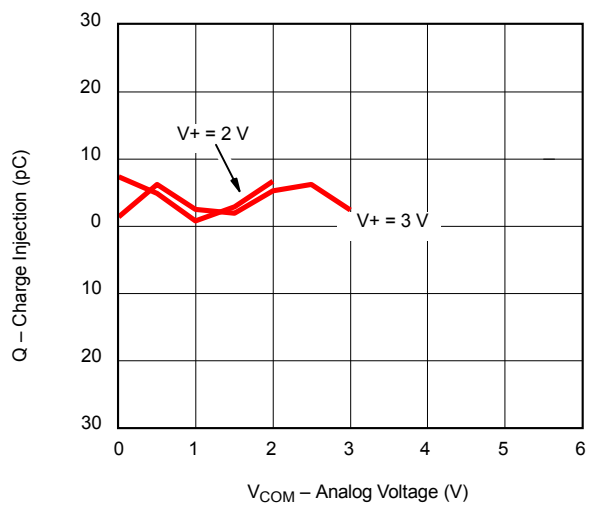
Switching Time vs. Temperature and Supply Voltage



Insertion Loss, Off-Isolation, Crosstalk vs. Frequency



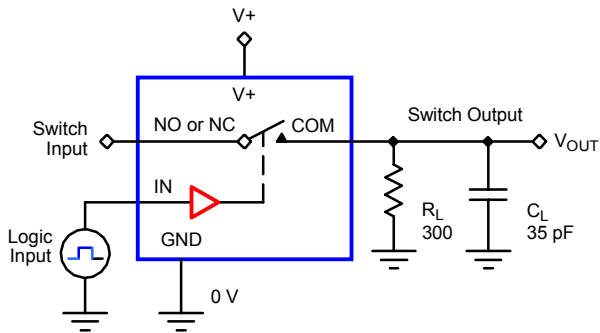
Switching Threshold vs. Supply Voltage



Charge Injection vs. Analog Voltage

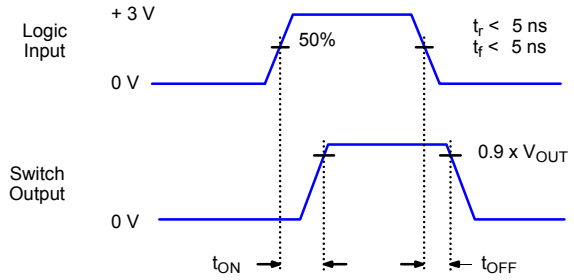


TEST CIRCUITS



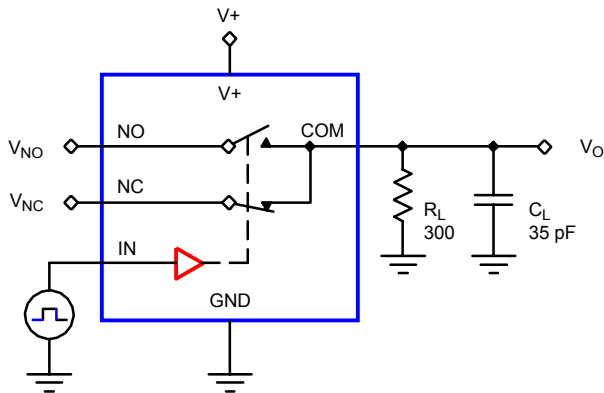
$C_L$  (includes fixture and stray capacitance)

$$V_{OUT} = V_{COM} \left( \frac{R_L}{R_L + R_{ON}} \right)$$



Logic "1" = Switch On  
 Logic input waveforms inverted for switches that have the opposite logic sense.

Figure 1. Switching Time



$C_L$  (includes fixture and stray capacitance)

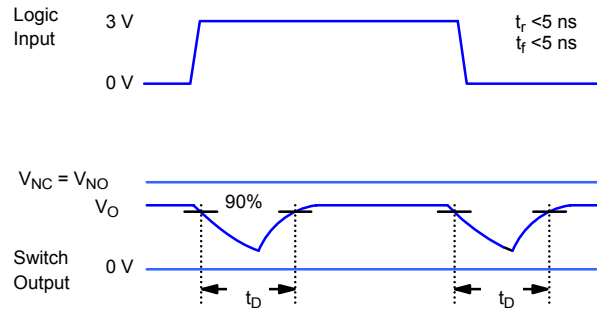


Figure 2. Break-Before-Make Interval

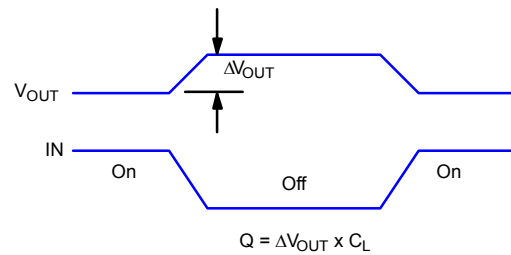
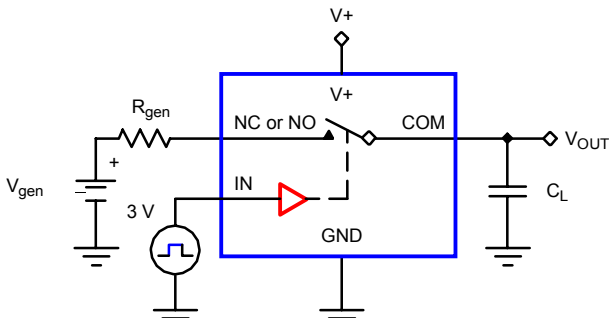


Figure 3. Charge Injection

IN depends on switch configuration: input polarity determined by sense of switch.

TEST CIRCUITS

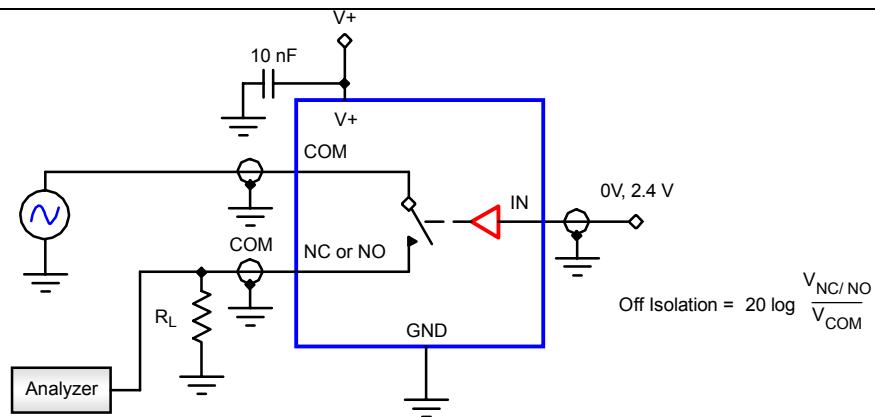


Figure 4. Off-Isolation

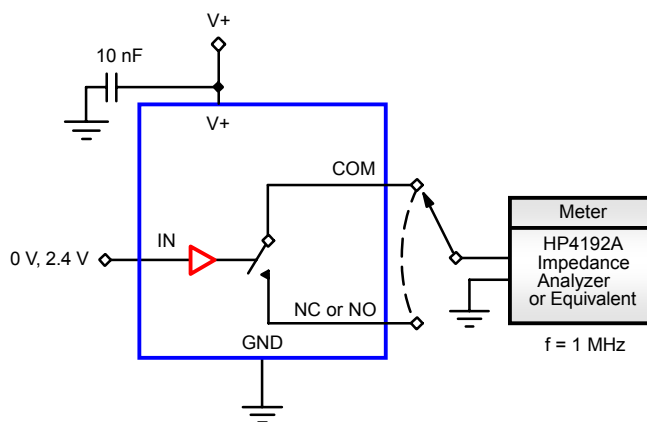


Figure 5. Channel Off/On Capacitance

TYPICAL APPLICATIONS

