



# Low-Voltage, Low $r_{ON}$ , Single SPDT Analog Switch In SC-89 Package

## FEATURES

- Low Voltage Operation (1.8 V to 5.5 V)
- Low On-Resistance -  $r_{ON}$ : 1.8  $\Omega$  @ 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
- Low Voltage Data Acquisition Systems

## DESCRIPTION

The DG2011 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 DG2011 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  $\Omega$  @ 2.7 V), charge injection is less than 10 pC over the entire analog range.

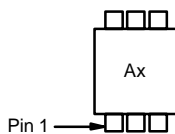
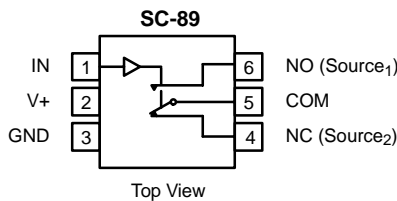
The switch conducts equally well in both directions when on, and blocks up to the power supply level when off.

The DG2011 is built on Vishay Siliconix's low voltage J12 process. An epitaxial layer prevents latchup.

Break-before-make is guaranteed.

The DG2011 represents a breakthrough in packaging development for analog switching products. The SC-89 package (1.6 x 1.6 mm<sup>2</sup>) – also known as SOT-666 in the industry – reduces board spacing by approximately 40% while obtaining performance comparable to SC-70 analog switch devices available today.

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Device Marking: Ax  
x = Date/Lot Traceability 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 (SOT-666)	DG2011DX

**ABSOLUTE MAXIMUM RATINGS**

Reference to GND

V+ .....	-0.3 to +6 V
IN, COM, NC, NO <sup>a</sup> .....	-0.3 to (V+ + 0.3 V)
Continuous Current (NO, NC, COM pins) .....	± 150 mA
Peak Current .....	± 300 mA
(Pulsed at 1 ms, 10% duty cycle)	
Storage Temperature (D Suffix) .....	-65 to 150°C

Power Dissipation (Packages)<sup>b</sup>

SC-89 <sup>c</sup> .....	172 mW
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- Notes:
- Signals on NC, NO, or COM or IN exceeding V+ will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
  - All leads welded or soldered to PC Board.
  - Derate 2.15 mW/°C above 70°C

SPECIFICATIONS (V+ = 2.0 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 2.0 V, V <sub>IN</sub> = 0.4 or 1.6 V <sup>e</sup>	Temp <sup>a</sup>	Limits -40 to 85°C			Unit
				Min <sup>b</sup>	Typ <sup>c</sup>	Max <sup>b</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</sup>	V <sub>NO</sub> , V <sub>NC</sub> , V <sub>COM</sub>		Full	0		V+	V
On-Resistance	r <sub>ON</sub>	V+ = 2.0 V, V <sub>COM</sub> = 0.2 V/0.9 V I <sub>NO</sub> , I <sub>NC</sub> = 20 mA	Room Full		3.5	5.5 5.5	Ω
Switch Off Leakage Current <sup>f</sup>	I <sub>NO(off)</sub> , I <sub>NC(off)</sub>	V+ = 2.2 V V <sub>NO</sub> , V <sub>NC</sub> = 0.5 V/1.5 V, V <sub>COM</sub> = 1.5 V/0.5 V	Room Full	-1 -10		1 10	nA
	I <sub>COM(off)</sub>		Room Full	-1 -10		1 10	
Channel-On Leakage Current <sup>f</sup>	I <sub>COM(on)</sub>	V+ = 2.2 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 0.5 V/1.5 V	Room Full	-1 -10		1 10	
<b>Digital Control</b>							
Input High Voltage	V <sub>INH</sub>		Full	1.5			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> = 1.5 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room Full		75	110 113	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full		37	71 76	
Break-Before-Make Time	t <sub>BBM</sub>		Room	1	37		
Charge Injection <sup>d</sup>	Q <sub>INJ</sub>	C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω	Room		7		pC
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		-62		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		-69		
N <sub>O</sub> , N <sub>C</sub> Off Capacitance <sup>d</sup>	C <sub>N<sub>O</sub>(off)</sub> , C <sub>N<sub>C</sub>(off)</sub>	V <sub>IN</sub> = 0 or V+, f = 1 MHz	Room		29		pF
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		85		
<b>Power Supply</b>							
Power Supply Range	V+			1.8		5.5	V
Power Supply Current	I+	V <sub>IN</sub> = 0 or V+			0.01	1.0	μA



SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ±10%, VIN = 0.4 or 2.0 V <sup>e</sup>	Temp <sup>a</sup>	Limits -40 to 85°C			Unit
				Min <sup>b</sup>	Typ <sup>c</sup>	Max <sup>b</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</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 Full		1.8	2.7 2.9	Ω
r <sub>ON</sub> Match	Δr <sub>ON</sub>		Room			0.2	
r <sub>ON</sub> Flatness	r <sub>ON</sub> Flatness		Room		0.2	0.5	
Switch Off Leakage Current <sup>f</sup>	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 Full	-1 -10		1 10	nA
	I <sub>COM(off)</sub>		Room Full	-1 -10		1 10	
Channel-On Leakage Current <sup>f</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 Full	-1 -10		1 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 Full		45	75 77	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full		29	59 62	
Break-Before-Make Time	t <sub>BBM</sub>		Room	1	16		
Charge Injection <sup>d</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>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		-62		dB
Crosstalk <sup>d</sup>	XTALK		Room		-68		
N <sub>O</sub> , N <sub>C</sub> Off Capacitance <sup>d</sup>	C <sub>NO(off)</sub> , C <sub>NC(off)</sub>	V <sub>IN</sub> = 0 or V+, f = 1 MHz	Room		28		pF
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		84		
<b>Power Supply</b>							
Power Supply Range	V+			1.8		5.5	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

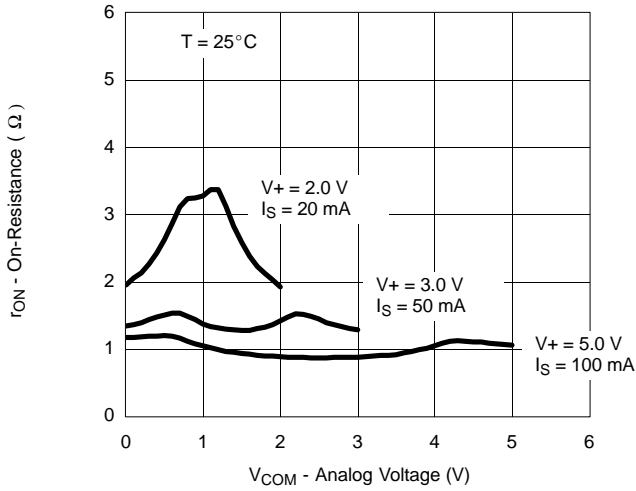
SPECIFICATIONS (V+ = 5 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 5 V, ± 10%, VIN = 0.8 or 2.4 V <sup>e</sup>	Temp <sup>a</sup>	Limits -40 to 85°C			Unit
				Min <sup>b</sup>	Typ <sup>c</sup>	Max <sup>b</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</sup>	V <sub>NO</sub> , V <sub>NC</sub> , V <sub>COM</sub>		Full	0		V+	V
On-Resistance	r <sub>ON</sub>	V+ = 4.5 V, V <sub>COM</sub> = 2.5 V I <sub>NO</sub> , I <sub>NC</sub> = 100 mA	Room		1.3	2.0	Ω
r <sub>ON</sub> Match	Δr <sub>ON</sub>		Room			0.15	
Switch Off Leakage Current	I <sub>NO(off)</sub> , I <sub>NC(off)</sub>	V+ = 5.5 V V <sub>NO</sub> , V <sub>NC</sub> = 1 V/4.5 V, V <sub>COM</sub> = 4.5 V/1 V	Room	-1		1	nA
	I <sub>COM(off)</sub>		Full	-10		10	
Channel-On Leakage Current	I <sub>COM(on)</sub>	V+ = 5.5 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 1 V/4.5 V	Room	-1		1	
Full			Full	-10		10	
<b>Digital Control</b>							
Input High Voltage	V <sub>INH</sub>		Full	2			V
Input Low Voltage	V <sub>INL</sub>		Full			0.8	
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> = 3 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room		45	75	ns
Turn-Off Time	t <sub>OFF</sub>		Full		20	47	
Break-Before-Make Time	t <sub>BBM</sub>		Room	1	19		
Charge Injection <sup>d</sup>	Q <sub>INJ</sub>	C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω	Room		9		pC
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		-62		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		-68		
Source-Off Capacitance <sup>d</sup>	C <sub>NO(off)</sub> , C <sub>NC(off)</sub>	V <sub>IN</sub> = 0 or V+, f = 1 MHz	Room		27		pF
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		82		
<b>Power Supply</b>							
Power Supply Range	V+			1.8		5.5	V
Power Supply Current	I+	V <sub>IN</sub> = 0 or V+			0.01	1.0	μA

Notes:

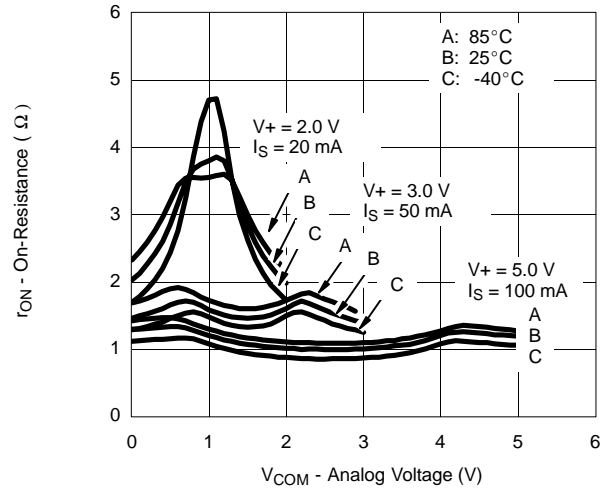
- Room = 25°C, Full = as determined by the operating suffix.
- Typical values are for design aid only, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guarantee by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

**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**

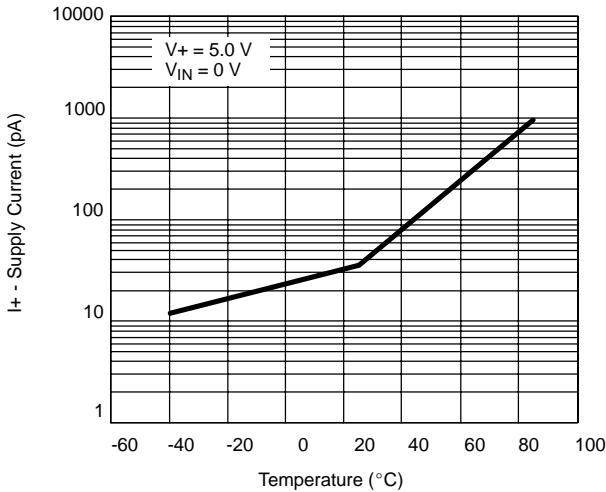
**$r_{ON}$  vs.  $V_{COM}$  and Supply Voltage**



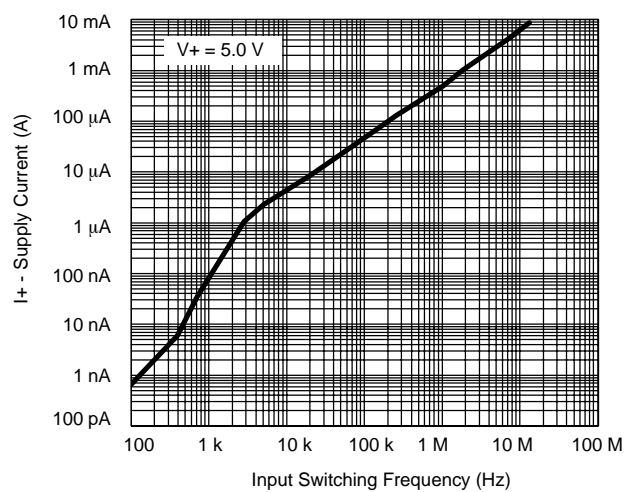
**$r_{ON}$  vs. Analog Voltage and Temperature**



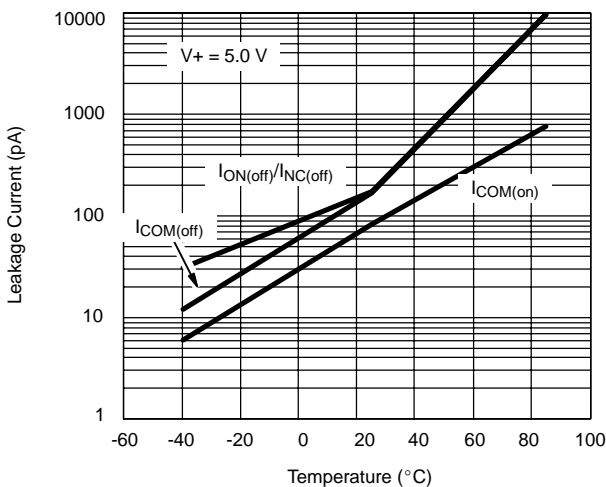
**Supply Current vs. Temperature**



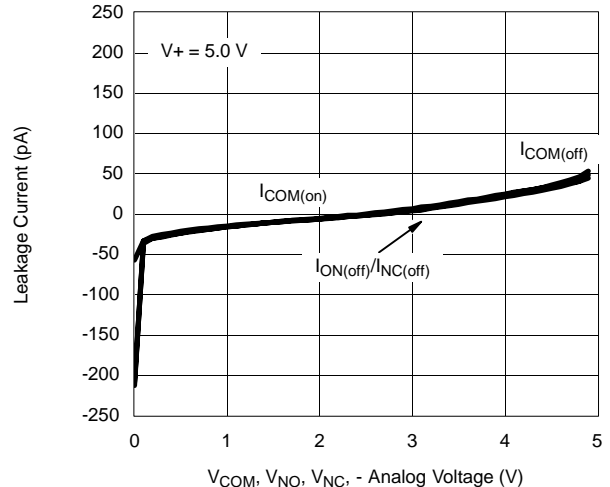
**Supply Current vs. Input Switching Frequency**



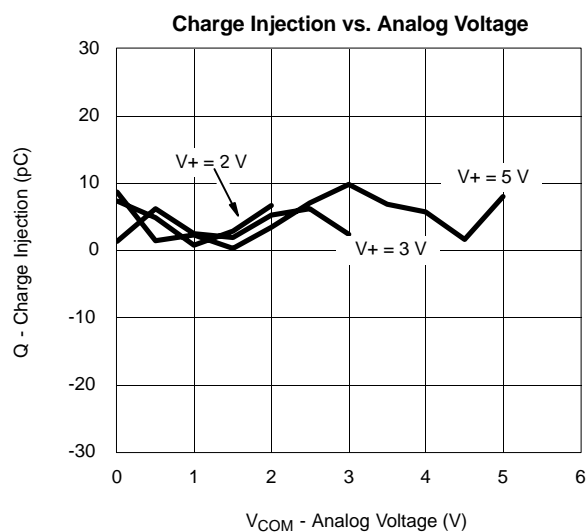
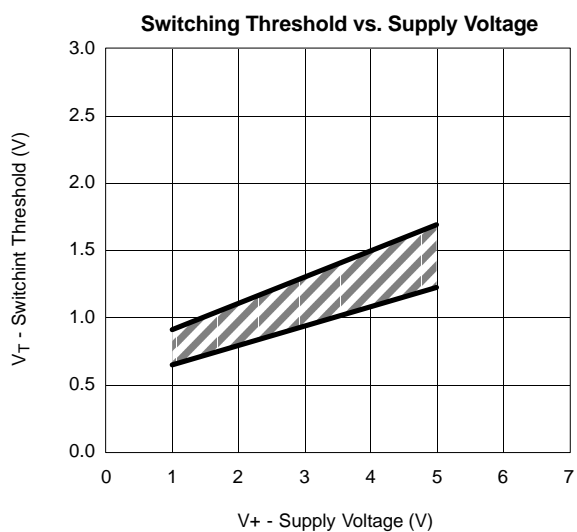
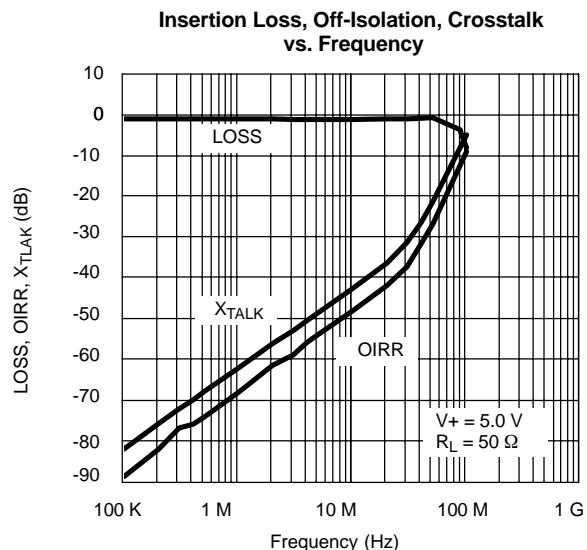
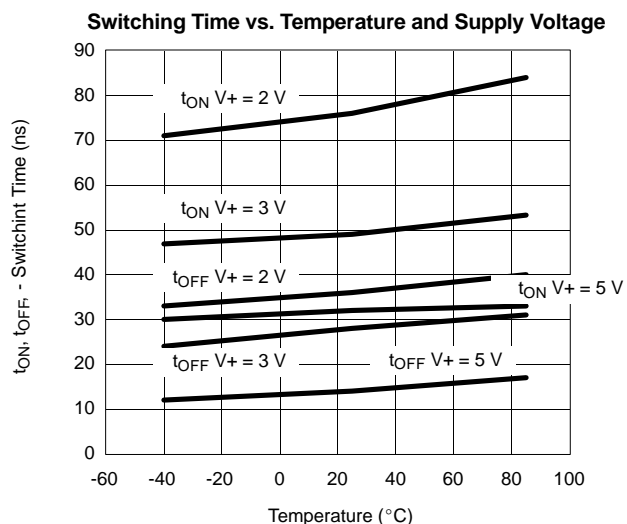
**Leakage Current vs. Temperature**



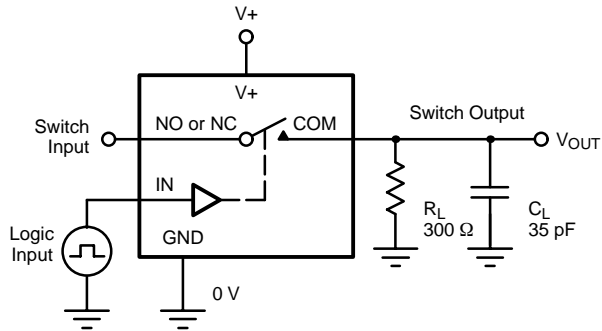
**Leakage vs. Analog Voltage**



**TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)**

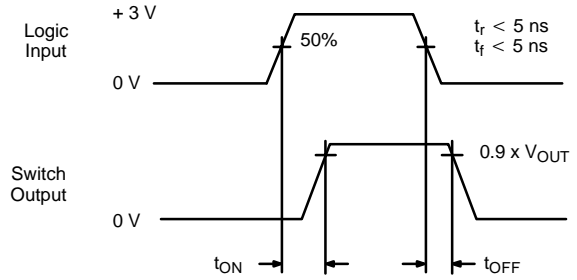


TEST CIRCUITS



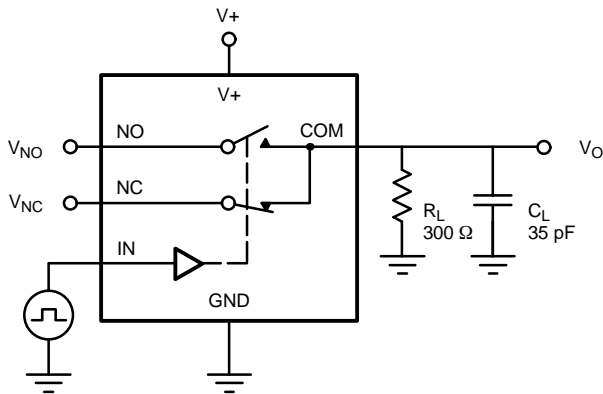
$C_L$  (includes fixture and stray capacitance)

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



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)

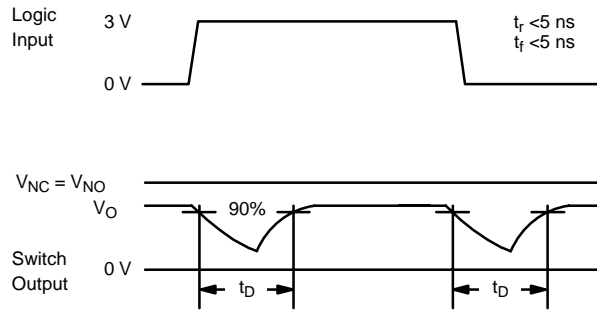
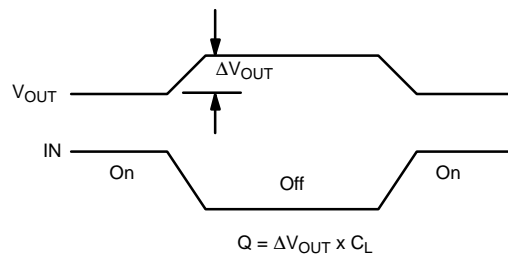
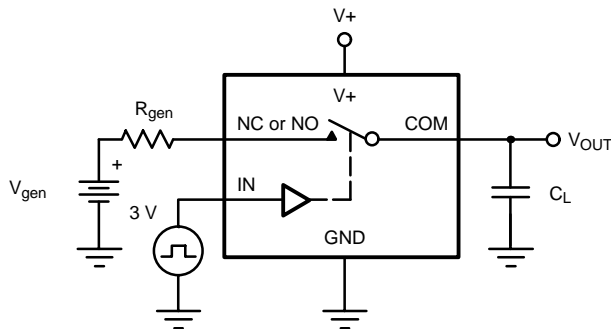


FIGURE 2. Break-Before-Make Interval



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

FIGURE 3. Charge Injection

TEST CIRCUITS

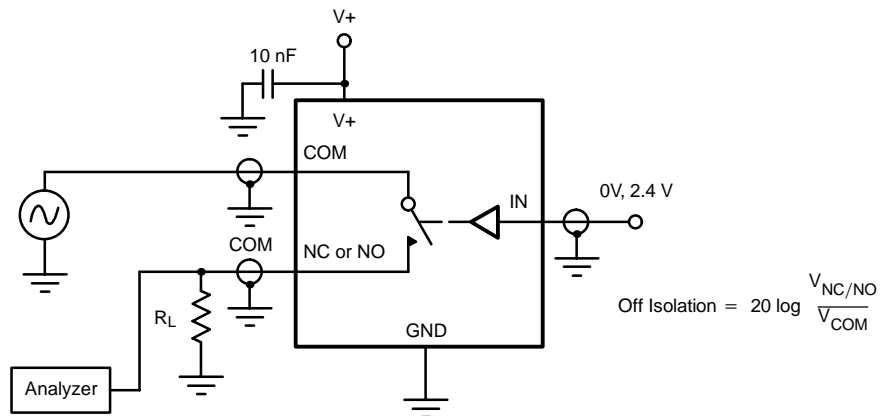


FIGURE 4. Off-Isolation

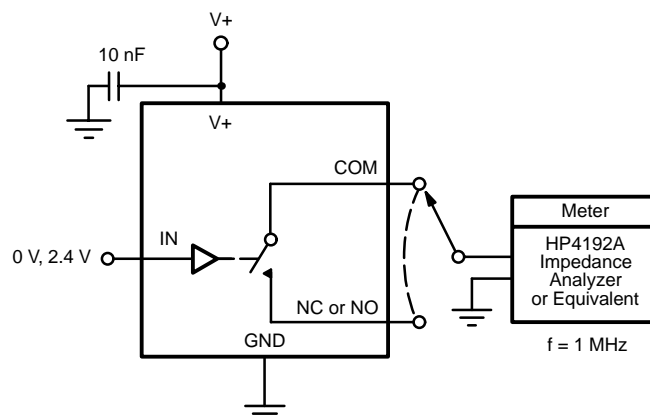


FIGURE 5. Channel Off/On Capacitance