

## Low-Voltage Single SPDT Analog Switch

### DESCRIPTION

The DG2012 is a single-pole/double-throw monolithic CMOS analog switch designed for high performance switching of analog signals. Combining low power, high speed ( $t_{ON}$ : 17 ns,  $t_{OFF}$ : 13 ns), low on-resistance ( $r_{DS(on)}$ : 1  $\Omega$ ) and small physical size (SC70), the DG2012 is ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2012 is built on Vishay Siliconix's low voltage submicron CMOS process. An epitaxial layer prevents latchup. Break-before -make is guaranteed for DG2012.

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

### FEATURES

- Low Voltage Operation (1.8 V to 5.5 V)
- Low On-Resistance -  $r_{DS(on)}$ : 1  $\Omega$  Typ.
- Fast Switching -  $t_{ON}$ : 17 ns,  $t_{OFF}$ : 13 ns
- Low Leakage
- TTL/CMOS Compatible
- 6-Pin SC-70 Package



**RoHS\***  
COMPLIANT

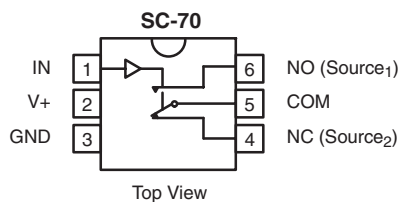
### BENEFITS

- Reduced Power Consumption
- Simple Logic Interface
- High Accuracy
- Reduce Board Space

### APPLICATIONS

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

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Device Marking: E7xx

TRUTH TABLE		
Logic	NC	NO
0	ON	OFF
1	OFF	ON

ORDERING INFORMATION		
Temp Range	Package	Part Number
- 40 to 85 °C	SC70-6	DG2012DL-T1 DG2012DL-T1-E3

\* Pb containing terminations are not RoHS compliant, exemptions may apply



ABSOLUTE MAXIMUM RATINGS			
Parameter	Limit	Unit	
Referenced V+ to GND	- 0.3 to + 6	V	
IN, COM, NC, NO <sup>a</sup>	- 0.3 to (V+ + 0.3)		
Continuous Current (NO, NC and COM Pins)	± 100	mA	
Peak Current (Pulsed at 1 ms, 10 % duty cycle)	± 300		
Storage Temperature (D Suffix)	- 65 to 150	°C	
Power Dissipation (Packages) <sup>b</sup>	6-Pin SO70 <sup>c</sup>	250	mW

Notes:

- a. Signals on NC, NO, or COM or IN exceeding V+ will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- b. All leads welded or soldered to PC Board.
- c. Derate 3.1 mW/°C above 70 °C.

SPECIFICATIONS (V+ = 2.0 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 2.0 V, ± 10 %, 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+ = 1.8 V, V <sub>COM</sub> = 0.2 V/0.9 V I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room Full <sup>d</sup>		2.7 2.7	5.3 5.3	Ω
r <sub>ON</sub> Flatness <sup>d</sup>	r <sub>ON</sub> Flatness	V+ = 1.8 V, V <sub>COM</sub> = 0 to V+, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room			3	
r <sub>ON</sub> Match <sup>d</sup>	Δr <sub>ON</sub>		Room				
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	- 0.5 - 5.0		0.5 5.0	nA
	I <sub>COM(off)</sub>		Room Full <sup>d</sup>	- 0.5 - 5.0		0.5 5.0	
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 <sup>d</sup>	- 0.5 - 5.0		0.5 5.0	
<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 <sup>d</sup>	C <sub>in</sub>		Full		3		pF
Input Current <sup>f</sup>	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 <sup>d</sup>	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 Figures 1 and 2	Room Full <sup>d</sup>		43	63 65	ns
Turn-Off Time <sup>d</sup>	t <sub>OFF</sub>		Room Full <sup>d</sup>		23	45 46	
Break-Before-Make Time <sup>d</sup>	t <sub>d</sub>		Room	2			
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, Figure 3	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		- 63		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		- 64		
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		22		pF
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		58		



SPECIFICATIONS (V+ = 3.0 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, VIN = 0.6 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> = 0.2 V/1.5 V, I <sub>NO</sub> I <sub>NC</sub> = 10 mA	Room Full		1.4 1.6	2.1 2.3	Ω
r <sub>ON</sub> Flatness	r <sub>ON</sub> Flatness	V+ = 2.7 V, V <sub>COM</sub> = 0 to V+, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room			0.85	
r <sub>ON</sub> MatchFlat	Δr <sub>ON</sub>		Room				
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	- 0.5 - 5.0		0.5 5.0	nA
	I <sub>COM(off)</sub>		Room Full	- 0.5 - 5.0		0.5 5.0	
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	- 0.5 - 5.0		0.5 5.0	
<b>Digital Control</b>							
Input High Voltage	V <sub>INH</sub>		Full	2			V
Input Low Voltage	V <sub>INL</sub>		Full			0.6	
Input Capacitance <sup>d</sup>	C <sub>in</sub>		Full		3		pF
Input Current <sup>f</sup>	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 Figures 1 and 2	Room Full		27	47 48	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full		17	37 38	
Break-Before-Make Time	t <sub>d</sub>		Room	1			
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, Figure 3	Room		10		pC
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		- 64		
NO, NC 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		21		pF
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		57		
<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



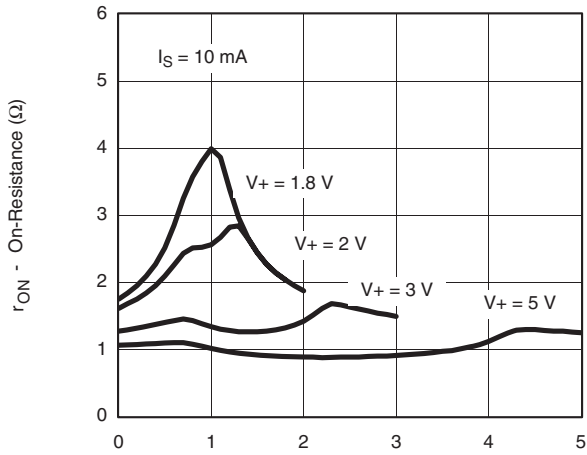
SPECIFICATIONS (V+ = 5.0 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 5 V, ± 10 %, VIN = 0.8 or 2.4 V <sup>e</sup>	Temp <sup>a</sup>	Limits - 40 to 85 °C			Unit
				Min <sup>b</sup>	Typ <sup>c</sup>	Max <sup>b</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</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> = 0.5 V/2.5 V I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room Full		1.0 1.2	1.8 1.9	Ω
r <sub>ON</sub> Flatness <sup>d</sup>	r <sub>ON</sub> Flatness	V+ = 4.5 V, V <sub>COM</sub> = 0 to V+, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room			0.55	
r <sub>ON</sub> Match <sup>d</sup>	Δr <sub>ON</sub>		Room				
Switch Off Leakage Current	I <sub>NO(off)</sub> I <sub>NC(off)</sub>	V+ = 5.0 V V <sub>NO</sub> , V <sub>NC</sub> = 0.5 V/4.5 V, V <sub>COM</sub> = 4.5 V/0.5 V	Room Full	- 0.5 - 5.0		0.5 5.0	nA
	I <sub>COM(off)</sub>		Room Full	- 0.5 - 5.0		0.5 5.0	
Channel-On Leakage Current	I <sub>COM(on)</sub>	V+ = 5.0 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 0.5 V/4.5 V	Room Full	- 0.5 - 5.0		0.5 5.0	
<b>Digital Control</b>							
Input High Voltage	V <sub>INH</sub>		Full	2.4			V
Input Low Voltage	V <sub>INL</sub>		Full			0.8	
Input Capacitance	C <sub>in</sub>		Full		3		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 <sup>d</sup>	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 Figures 1 and 2	Room Full		17	38 39	ns
Turn-Off Time <sup>d</sup>	t <sub>OFF</sub>		Room Full		13	32 33	
Break-Before-Make Time <sup>d</sup>	t <sub>d</sub>		Room	1			
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, Figure 3	Room		20		pC
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		- 64		
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		20		pF
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		56		

Notes:

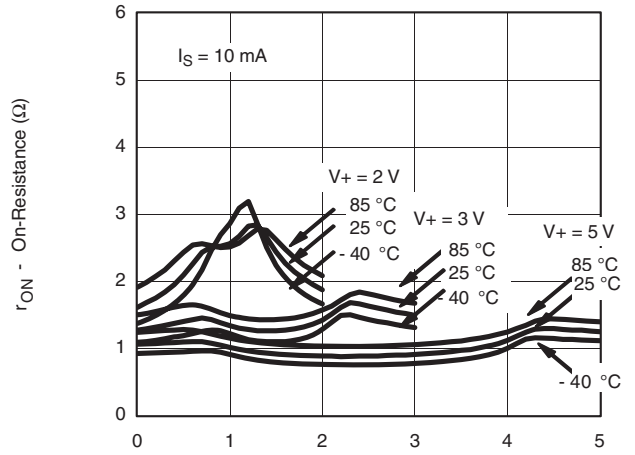
- a. Room = 25 °C, Full = as determined by the operating suffix.
- b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- c. Typical values are for design aid only, not guaranteed nor subject to production testing.
- d.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

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.

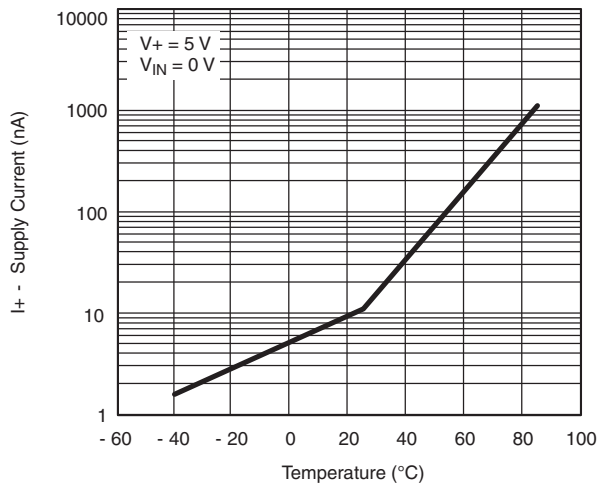
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



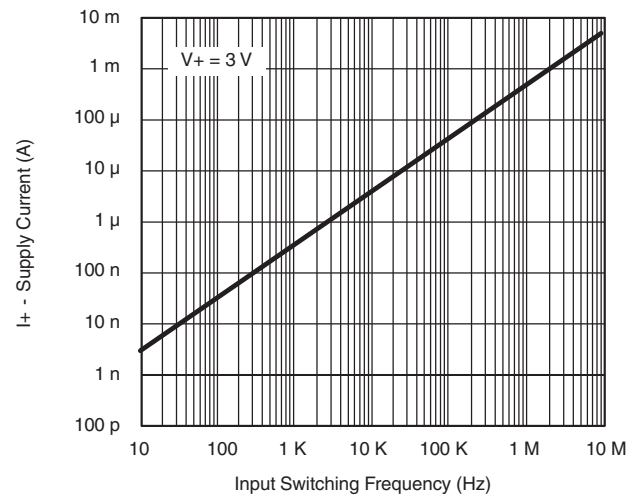
**r<sub>ON</sub> vs. V<sub>COM</sub> and Supply Voltage**



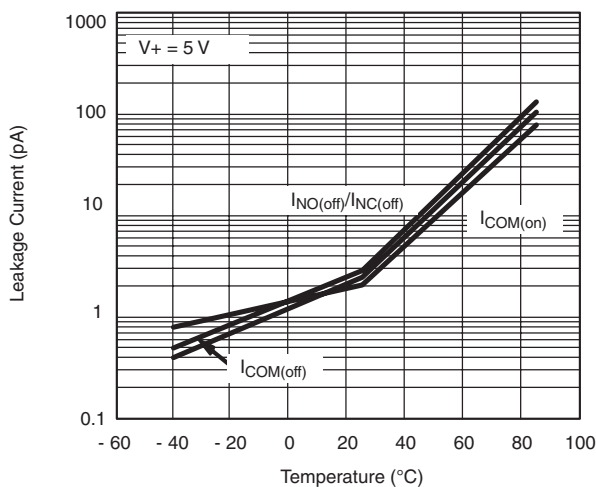
**r<sub>ON</sub> vs. Analog Voltage and Temperature**



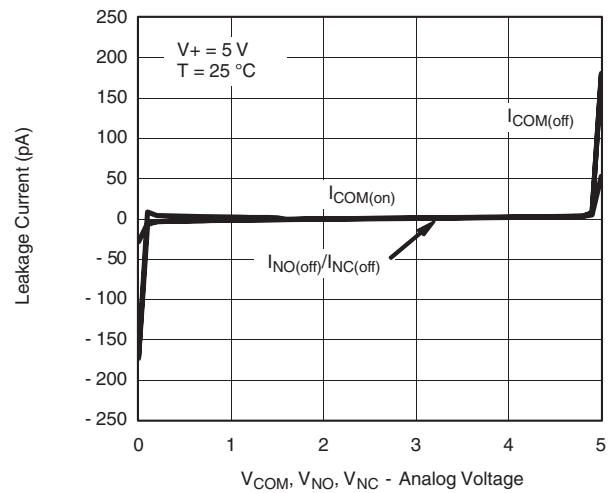
**Supply Current vs. Temperature**



**Supply Current vs. Input Switching Frequency**

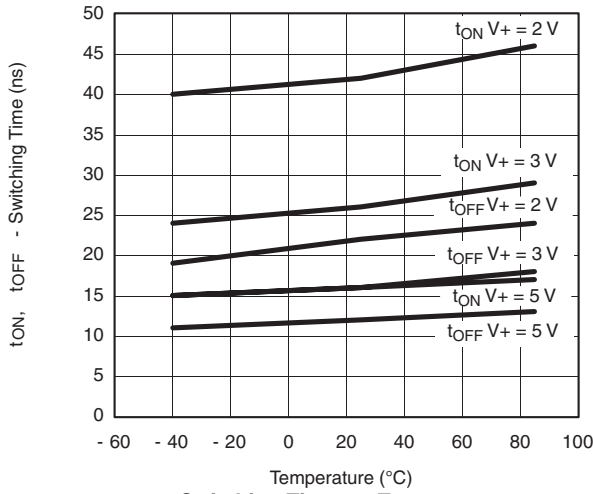


**Leakage Current vs. Temperature**

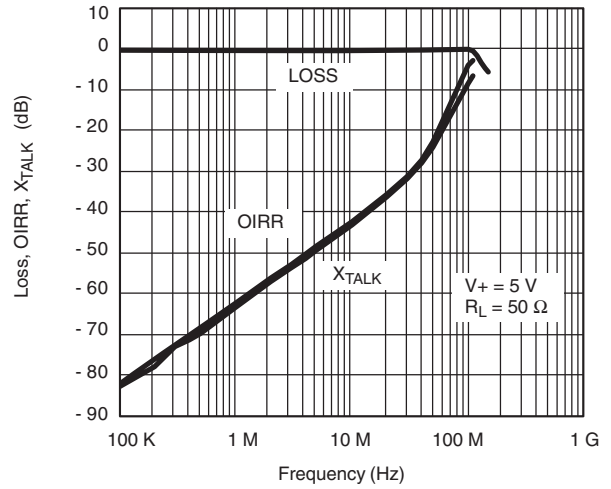


**Leakage vs. Analog Voltage**

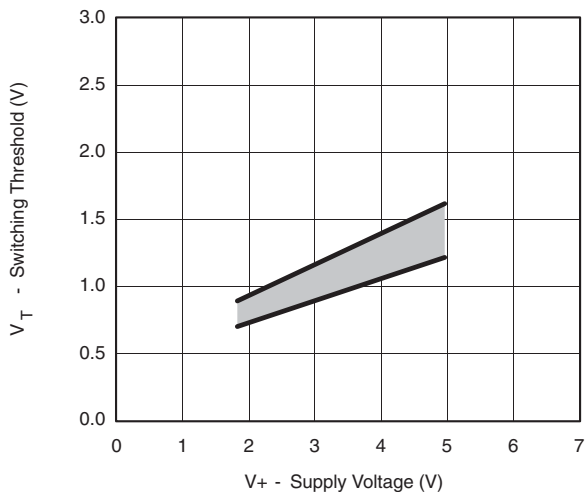
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



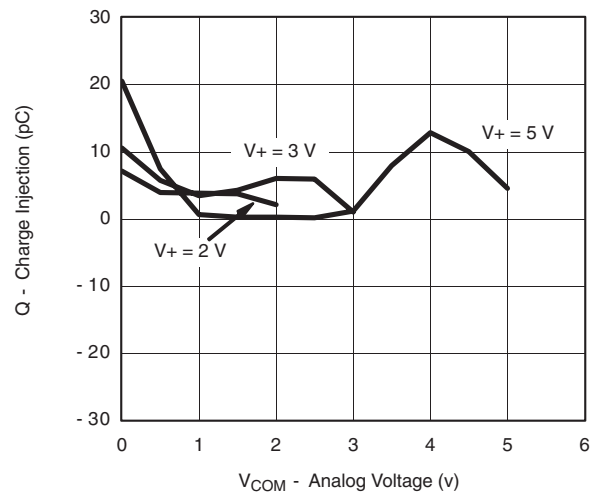
**Switching Time vs. Temperature and Supply Voltage**



**Insertion Loss, Off-Isolation Crosstalk vs. Frequency**

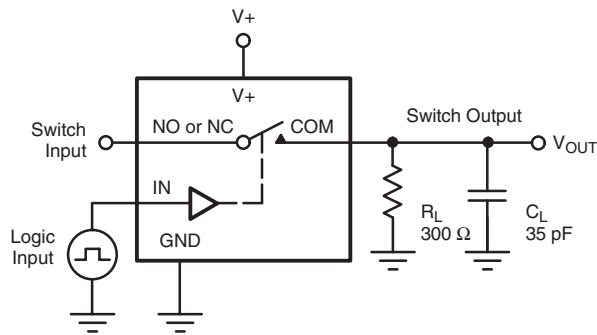


**Switching Threshold vs. Supply Voltage**



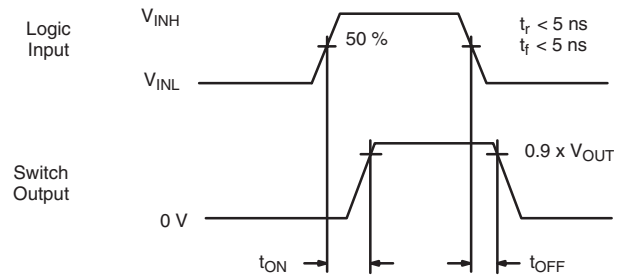
**Charge Injection vs. Analog Voltage**

**TEST CIRCUITS**



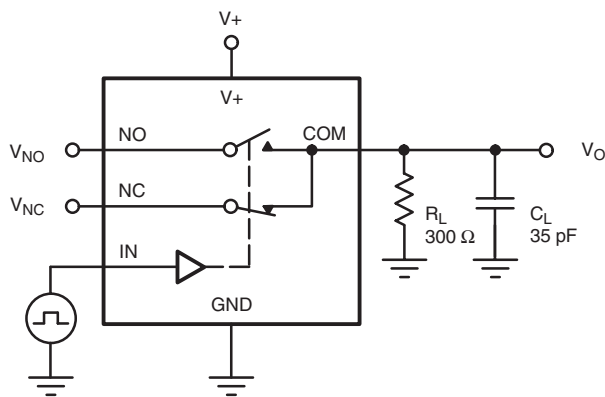
$C_L$  (includes fixture and stray capacitance)

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

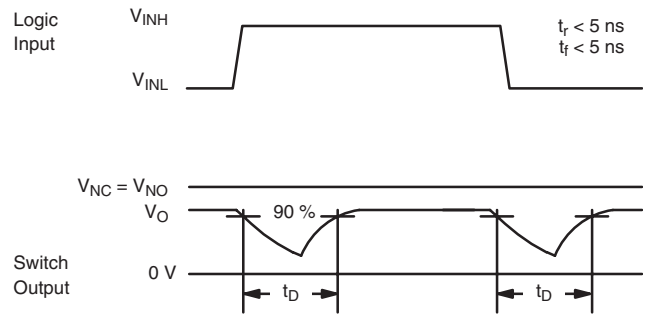


Logic "1" = Switch On  
Logic input waveforms inverted for switches that have the opposite logic sense.

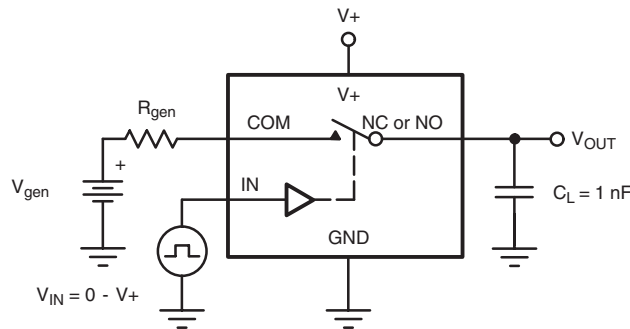
**Figure 1. Switching Time**



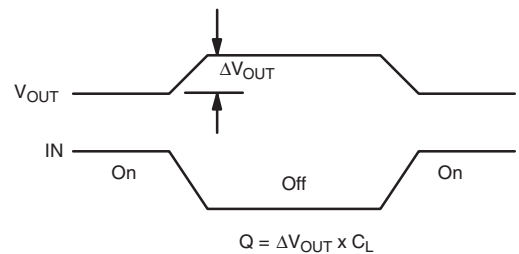
$C_L$  (includes fixture and stray capacitance)



**Figure 2. Break-Before-Make Interval**



$V_{IN} = 0 - V+$



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

**Figure 3. Charge Injection**

TEST CIRCUITS

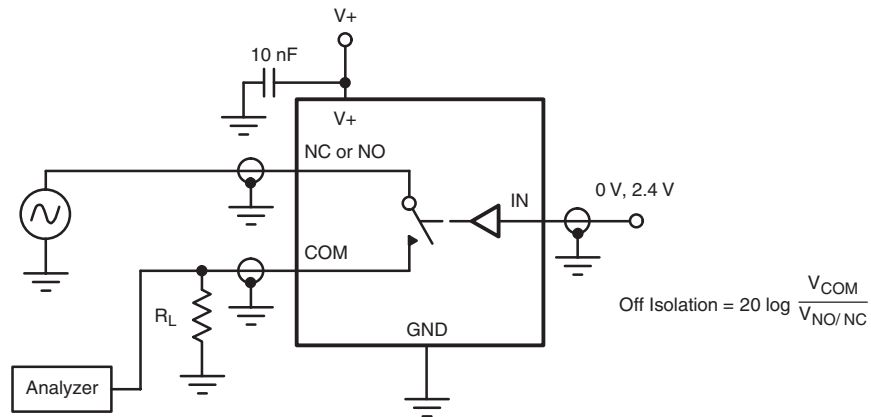


Figure 4. Off-Isolation

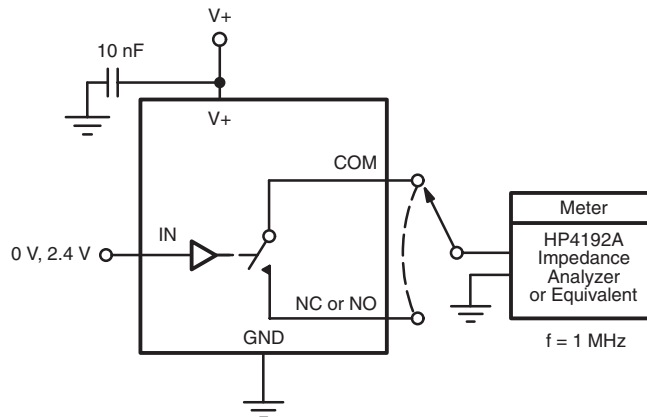


Figure 5. Channel Off/On Capacitance

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