

## Low-Voltage Single SPDT Analog Switch

### DESCRIPTION

The DG2002 is a single-pole/double-throw monolithic CMOS analog switch designed for high performance switching of analog signals. Combining low power, high speed ( $t_{ON}$ : 8 ns,  $t_{OFF}$ : 6 ns), low on-resistance ( $r_{DS(on)}$ : 7  $\Omega$ ) and small physical size (SC70), the DG2002 is ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2002 is built on Vishay Siliconix's low voltage J12 process. An epitaxial layer prevents latchup. Break-before-make is guaranteed for DG2002.

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 -  $r_{DS(on)}$ : 7  $\Omega$
- Fast switching -  $t_{ON}$ : 8 ns,  $t_{OFF}$ : 6 ns
- Low charge injection -  $Q_{INJ}$ : 5 pC
- Low power consumption
- TTL/CMOS compatible
- 6-pin SC70 package



Available  
**RoHS\***  
COMPLIANT

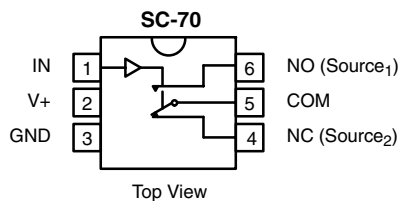
### BENEFITS

- 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: E2xx

TRUTH TABLE		
Logic	NC	NO
0	ON	OFF
1	OFF	ON

ORDERING INFORMATION		
Temp Range	Package	Part Number
- 40 to 85 °C	SC70-6	DG2002DL-T1 DG2002DL-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 (Any Terminal)	± 50		mA
Peak Current (Pulsed at 1 ms, 10 % duty cycle)	± 200		
Storage Temperature	- 65 to + 150		°C
Power Dissipation (Packages) <sup>b</sup>	6-Pin SC70 <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 Unless Otherwise Specified V+ = 2.0 V, ± 10 % VIN = 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> = 1.0 V, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room Full <sup>d</sup>		38 39.3	46.1 47.1	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		21		
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 <sup>d</sup>	- 250 - 3.0		250 3.0	pA nA
	I <sub>COM(off)</sub>		Room Full <sup>d</sup>	- 250 - 3.0		250 3.0	pA nA
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>	- 250 - 3.0		250 3.0	pA nA
<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	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 Figures 1 and 2	Room Full <sup>d</sup>		22	31 32	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full <sup>d</sup>		10	17 18	
Break-Before-Make Time	t <sub>d</sub>		Room	1	12		
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		5	10	pC
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 67		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		- 71		
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		5		pF
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		29		
<b>Power Supply</b>							
Power Supply Range	V+			1.8		2.2	V
Power Supply Current <sup>d</sup>	I+	V <sub>IN</sub> = 0 or V+			0.01	1.0	μA
Power Consumption	P <sub>C</sub>						2.2



SPECIFICATIONS $V_+ = 3.0\text{ V}$							
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 3\text{ V}, \pm 10\%$ $V_{IN} = 0.4\text{ or }2.0\text{ V}^e$	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>	$V_{NO}, V_{NC}$ $V_{COM}$		Full	0		$V_+$	V
On-Resistance <sup>d</sup>	$r_{ON}$	$V_+ = 2.7\text{ V}, V_{COM} = 1.5\text{ V}, I_{NO}, I_{NC} = 10\text{ mA}$	Room Full		12.2 13	14.8 15.8	Ω
$r_{ON}$ Flatness <sup>d</sup>	$r_{ON}$ Flatness	$V_+ = 2.7\text{ V}, V_{COM} = 0\text{ to }V_+, I_{NO}, I_{NC} = 10\text{ mA}$	Room		5		
Switch Off Leakage Current <sup>f</sup>	$I_{NO(off)}$ $I_{NC(off)}$	$V_+ = 3.3\text{ V}$ $V_{NO}, V_{NC} = 1\text{ V}/3\text{ V}, V_{COM} = 3\text{ V}/1\text{ V}$	Room Full	- 500 - 4.0		500 4.0	pA nA
	$I_{COM(off)}$		Room Full	- 500 - 4.0		500 4.0	pA nA
Channel-On Leakage Current <sup>f</sup>	$I_{COM(on)}$	$V_+ = 3.3\text{ V}, V_{NO}, V_{NC} = V_{COM} = 1\text{ V}/3\text{ V}$	Room Full	- 500 - 4.0		500 4.0	pA nA
<b>Digital Control</b>							
Input High Voltage	$V_{INH}$		Full	2			V
Input Low Voltage	$V_{INL}$		Full			0.4	
Input Capacitance <sup>d</sup>	$C_{in}$		Full		3		pF
Input Current	$I_{INL}$ or $I_{INH}$	$V_{IN} = 0\text{ or }V_+$	Full	- 1		1	μA
<b>Dynamic Characteristics</b>							
Turn-On Time <sup>d</sup>	$t_{ON}$	$V_{NO}$ or $V_{NC} = 2.0\text{ V}, R_L = 300\ \Omega, C_L = 35\text{ pF}$ Figures 1 and 2	Room Full		12	21 22	ns
Turn-Off Time <sup>d</sup>	$t_{OFF}$		Room Full		7	14 15	
Break-Before-Make Time <sup>d</sup>	$t_d$		Room	1	6		
Charge Injection <sup>d</sup>	$Q_{INJ}$	$C_L = 1\text{ nF}, V_{GEN} = 0\text{ V}, R_{GEN} = 0\ \Omega$ , Figure 3	Room		5	10	pC
Off-Isolation <sup>d</sup>	OIRR	$R_L = 50\ \Omega, C_L = 5\text{ pF}, f = 1\text{ MHz}$	Room		- 67		dB
Crosstalk <sup>d</sup>	$X_{TALK}$		Room		- 69		
NO, NC Off Capacitance <sup>d</sup>	$C_{NO(off)}$ $C_{NC(off)}$	$V_{IN} = 0\text{ or }V_+, f = 1\text{ MHz}$	Room		5		pF
Channel-On Capacitance <sup>d</sup>	$C_{ON}$		Room		29		
<b>Power Supply</b>							
Power Supply Range	$V_+$			2.7		3.3	V
Power Supply Current	$I_+$	$V_{IN} = 0\text{ or }V_+$			0.01	1.0	μA
Power Consumption	$P_C$						3.3



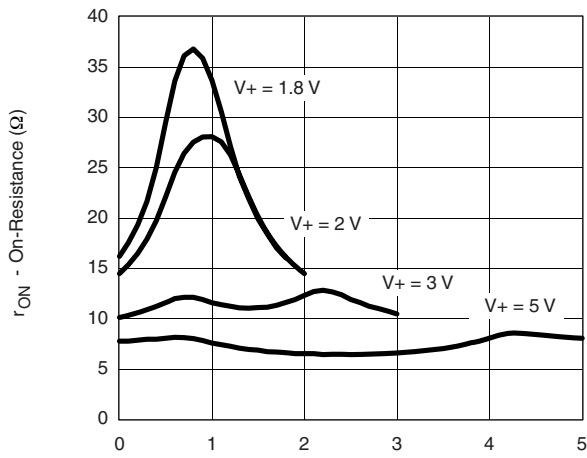
SPECIFICATIONS $V_+ = 5.0\text{ V}$							
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 5\text{ V}, \pm 10\%$ $V_{IN} = 0.8\text{ or }2.4\text{ V}^e$	Temp <sup>a</sup>	Limits - 40 to 85 °C			Unit
				Min <sup>b</sup>	Typ <sup>c</sup>	Max <sup>b</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</sup>	$V_{NO}, V_{NC}, V_{COM}$		Full	0		$V_+$	V
On-Resistance	$r_{ON}$	$V_+ = 4.5\text{ V}, V_{COM} = 3\text{ V}, I_{NO}, I_{NC} = 10\text{ mA}$	Room Full		6.4 7.4	7.8 8.8	Ω
$r_{ON}$ Flatness <sup>d</sup>	$r_{ON}$ Flatness	$V_+ = 4.5\text{ V}, V_{COM} = 0\text{ to }V_+, I_{NO}, I_{NC} = 10\text{ mA}$	Room		3		
Switch Off Leakage Current	$I_{NO(off)}, I_{NC(off)}$	$V_+ = 5.5\text{ V}$ $V_{NO}, V_{NC} = 1\text{ V}/4.5\text{ V}, V_{COM} = 4.5\text{ V}/1\text{ V}$	Room Full	- 1.0 - 4.0		1.0 4.0	nA
	$I_{COM(off)}$		Room Full	- 1.0 - 4.0		1.0 4.0	
Channel-On Leakage Current	$I_{COM(on)}$	$V_+ = 5.5\text{ V}, V_+ = 5.5\text{ V}$ $V_{NO}, V_{NC} = V_{COM} = 1\text{ V}/4.5\text{ V}$	Room Full	- 1.0 - 4.0		1.0 4.0	
<b>Digital Control</b>							
Input High Voltage	$V_{INH}$		Full	2.4			V
Input Low Voltage	$V_{INL}$		Full			0.8	
Input Capacitance	$C_{in}$		Full		3		pF
Input Current	$I_{INL}$ or $I_{INH}$	$V_{IN} = 0\text{ or }V_+$	Full	- 1		1	μA
<b>Dynamic Characteristics</b>							
Turn-On Time <sup>d</sup>	$t_{ON}$	$V_{NO}$ or $V_{NC} = 3\text{ V}, R_L = 300\text{ Ω}, C_L = 35\text{ pF}$ Figures 1 and 2	Room Full		8	15 16	ns
Turn-Off Time <sup>d</sup>	$t_{OFF}$		Room Full		6	13 14	
Break-Before-Make Time <sup>d</sup>	$t_d$		Room	1	4		
Charge Injection <sup>d</sup>	$Q_{INJ}$	$C_L = 1\text{ nF}, V_{GEN} = 0\text{ V}, R_{GEN} = 0\text{ Ω}$ , Figure 3	Room		5	10	pC
Off-Isolation <sup>d</sup>	OIRR	$R_L = 50\text{ Ω}, C_L = 5\text{ pF}, f = 1\text{ MHz}$	Room		- 69		dB
Crosstalk <sup>d</sup>	$X_{TALK}$		Room		- 69		
Source-Off Capacitance <sup>d</sup>	$C_{NO(off)}, C_{NC(off)}$	$V_{IN} = 0\text{ or }V_+, f = 1\text{ MHz}$	Room		5		pF
Channel-On Capacitance <sup>d</sup>	$C_{ON}$		Room		29		
<b>Power Supply</b>							
Power Supply Range	$V_+$			4.5		5.5	V
Power Supply Current	$I_+$	$V_{IN} = 0\text{ or }V_+$			0.01	1.0	μA
Power Consumption	$P_C$						5.5

Notes:

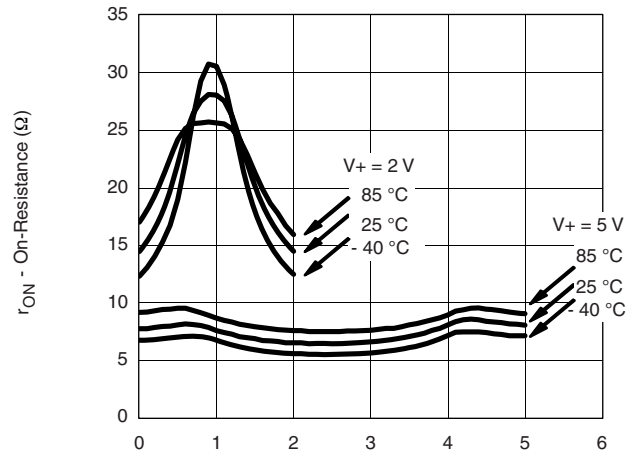
- a. Room = 25 °C, Full = as determined by the operating suffix.
- b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- c. Typical values are for design aid only, not guaranteed nor subject to production testing.
- d. Guarantee by design, nor subjected to production test.
- e.  $V_{IN}$  = 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.

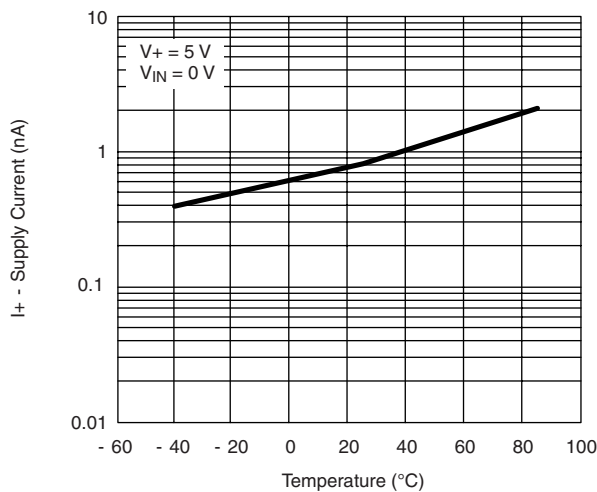
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



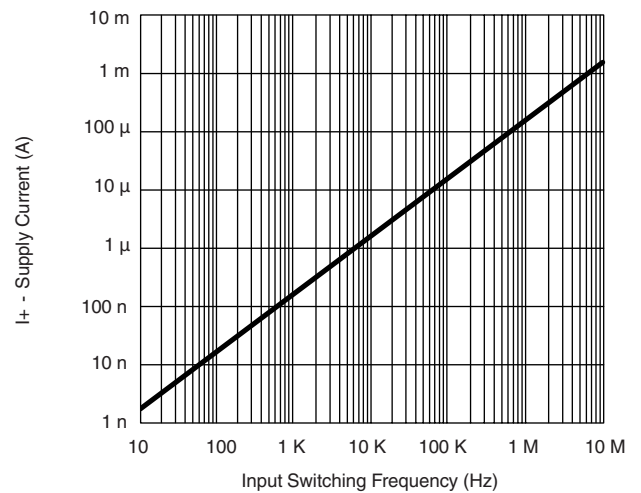
$r_{ON}$  vs.  $V_{COM}$  and Supply Voltage



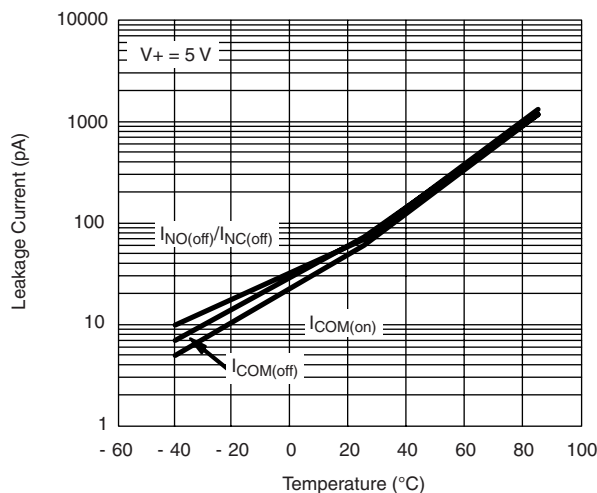
$r_{ON}$  vs. Analog Voltage and Temperature



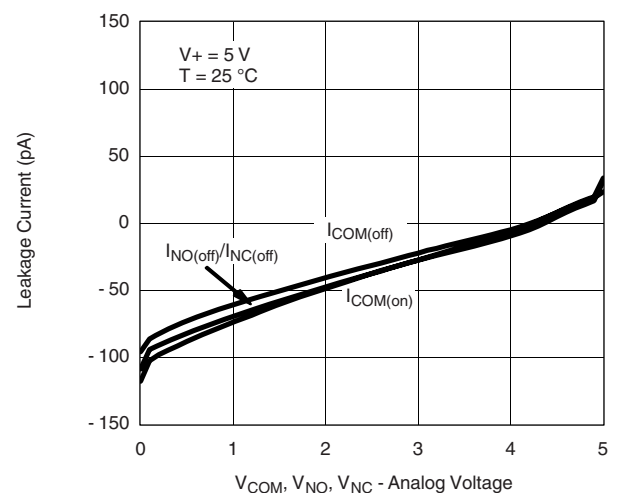
Supply Current vs. Temperature



Supply Current vs. Input Switching Frequency

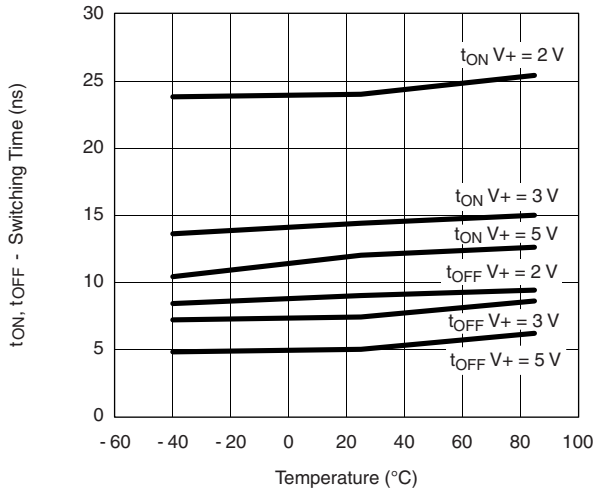


Leakage Current vs. Temperature

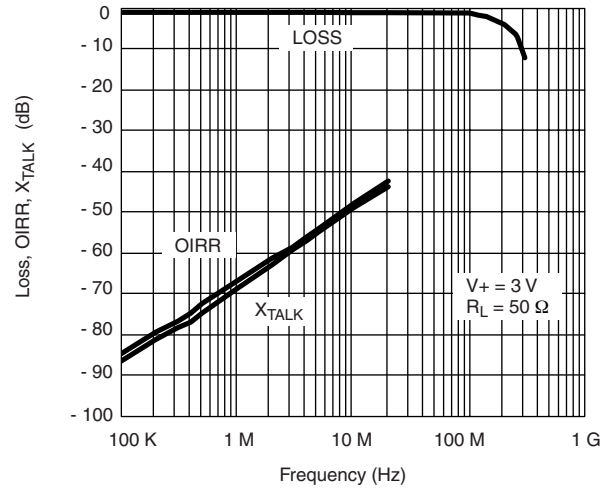


Leakage vs. Analog Voltage

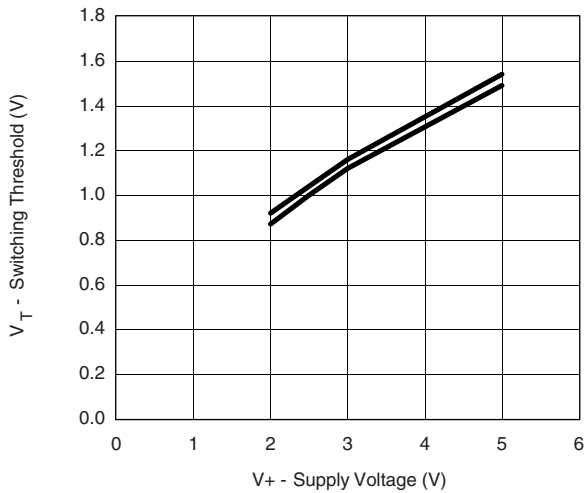
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



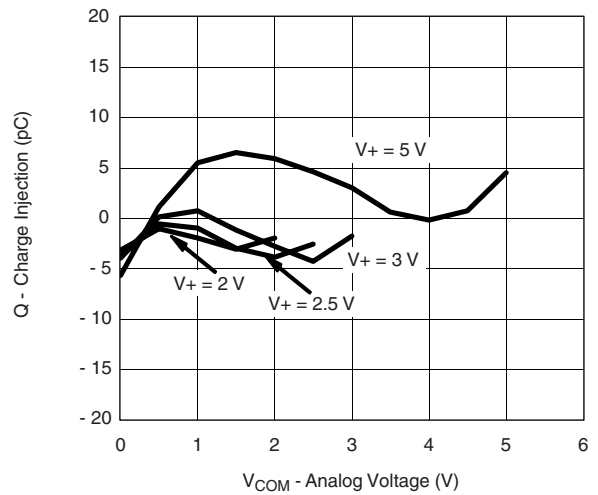
**Switching Time vs. Temperature and Supply Voltage**



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

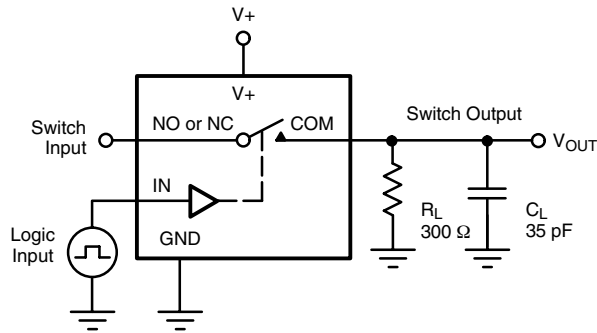


**Switching Threshold vs. Supply Voltage**



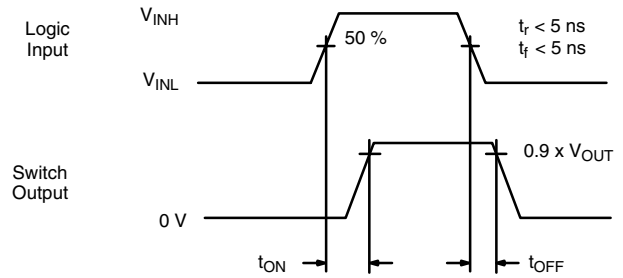
**Charge Injection vs. Analog Voltage**

**TEST CIRCUITS**



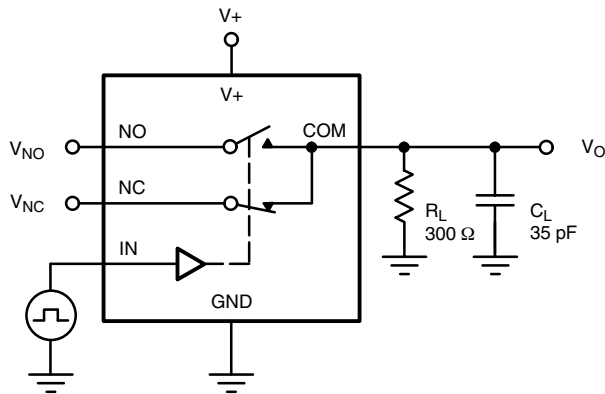
$C_L$  (includes fixture and stray capacitance)

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

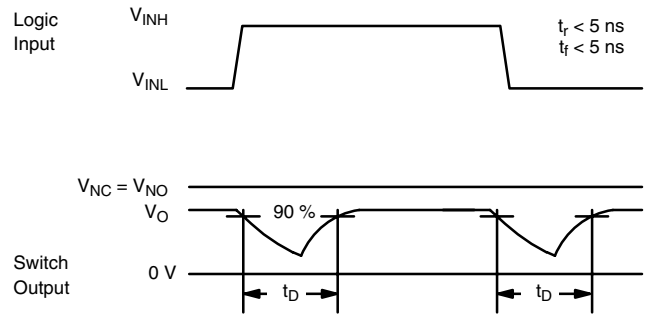


Logic "1" = Switch On  
Logic input waveforms inverted for switches that have the opposite logic sense.

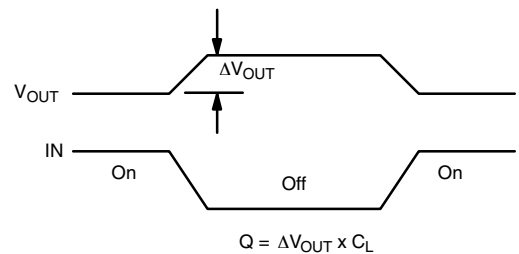
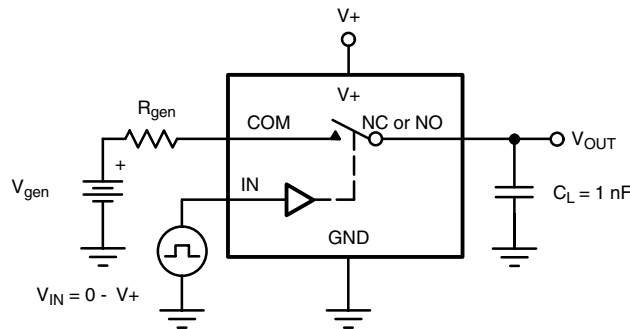
**Figure 1. Switching Time**



$C_L$  (includes fixture and stray capacitance)



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



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

**Figure 3. Charge Injection**

TEST CIRCUITS

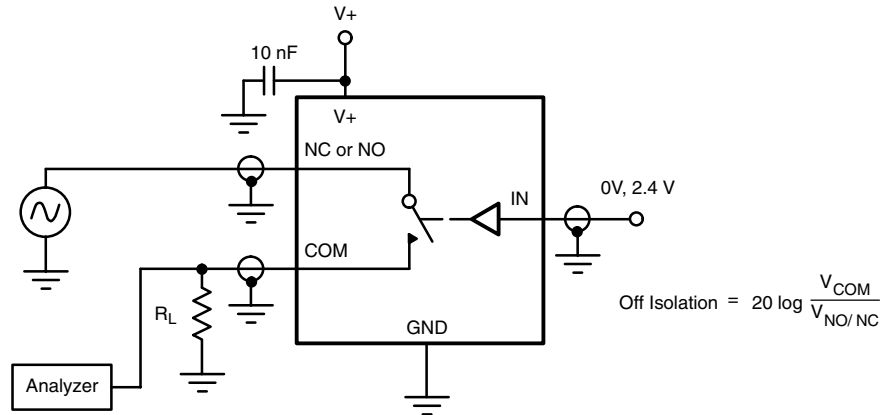


Figure 4. Off-Isolation

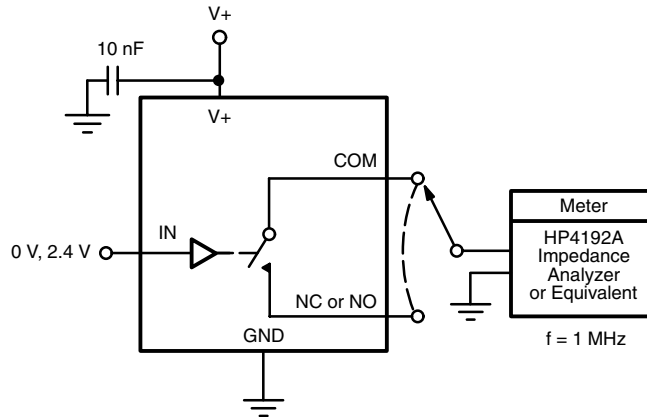


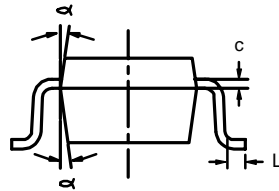
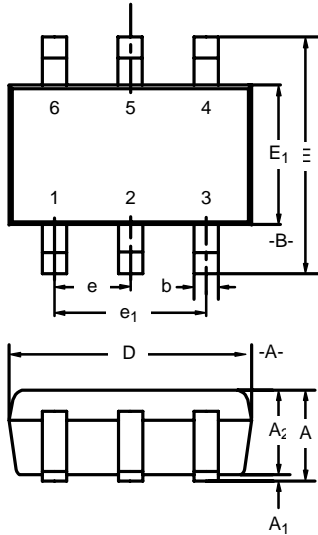
Figure 5. Channel Off/On Capacitance

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see <http://www.vishay.com/ppg?71448>.





**SC-70: 6-LEADS**



Dim	MILLIMETERS			INCHES		
	Min	Nom	Max	Min	Nom	Max
A	0.90	-	1.10	0.035	-	0.043
A <sub>1</sub>	-	-	0.10	-	-	0.004
A <sub>2</sub>	0.80	-	1.00	0.031	-	0.039
b	0.15	-	0.30	0.006	-	0.012
c	0.10	-	0.25	0.004	-	0.010
D	1.80	2.00	2.20	0.071	0.079	0.087
E	1.80	2.10	2.40	0.071	0.083	0.094
E <sub>1</sub>	1.15	1.25	1.35	0.045	0.049	0.053
e	0.65BSC			0.026BSC		
e <sub>1</sub>	1.20	1.30	1.40	0.047	0.051	0.055
L	0.10	0.20	0.30	0.004	0.008	0.012
α	7°Nom			7°Nom		

ECN: S-03946—Rev. B, 09-Jul-01  
DWG: 5550



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