

## Low-Voltage Single SPDT Analog Switch

### DESCRIPTION

The DG9431 is a single-pole/double-throw monolithic CMOS analog device designed for high performance switching of analog signals. Combining low power, high speed ( $t_{ON}$ : 35 ns,  $t_{OFF}$ : 20 ns), low on-resistance ( $r_{DS(on)}$ : 20  $\Omega$ ) and small physical size (TSOP-6), the DG9431 is ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG9431 is built on Vishay Siliconix's low voltage BCD-15 process. Minimum ESD protection, per Method 3015.7, is 2000 V. An epitaxial layer prevents latchup. Break-before -make is guaranteed for DG9431.

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

As a committed partner to the community and the environment, Vishay Siliconix manufactures this product with the lead (Pb)-free device terminations. For analog switching products manufactured with 100 % matte tin device terminations, the lead (Pb)-free "-E3" suffix is being used as a designator.

### FEATURES

- Low Voltage Operation (+ 2.7 to + 5 V)
- Low On-Resistance -  $r_{DS(on)}$ : 20  $\Omega$
- Fast Switching -  $t_{ON}$ : 35 ns,  $t_{OFF}$ : 20 ns
- Low Leakage -  $I_{COM(on)}$ : 200-pA max
- Low Charge Injection -  $Q_{INJ}$ : 1 pC
- Low Power Consumption
- TTL/CMOS Compatible
- ESD Protection > 2000 V (Method 3015.7)
- Available in TSOP-6 and SOIC-8
- Lead (Pb)-Free Version is RoHS Compliant



**RoHS\***  
COMPLIANT

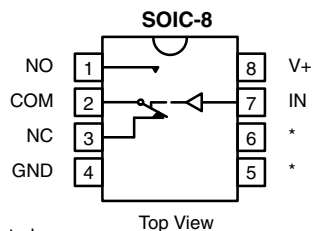
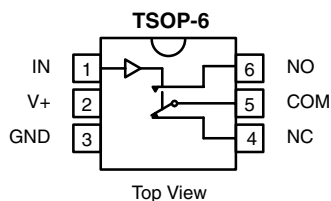
### BENEFITS

- Reduced Power Consumption
- Simple Logic Interface
- High Accuracy
- Reduce Board Space (TSOP-6)

### APPLICATIONS

- Battery Operated Systems
- Portable Test Equipment
- Sample and Hold Circuits
- Cellular Phones
- Communication Systems
- Military Radio
- PBX, PABX Guidance and Control Systems

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



\*Not Connected

TRUTH TABLE		
Logic	NC	NO
0	ON	OFF
1	OFF	ON

Logic "0"  $\leq$  0.8 V

Logic "1"  $\geq$  2.4 V

ORDERING INFORMATION		
Temp Range	Package	Part Number
- 40 to 85 $^{\circ}$ C	TSOP-6	DG9431DV-T1
		DG9431DV-T1-E3 (Lead (Pb)-free)
	SOIC-8	DG9431DY-T1
		DG9431DY-T1-E3 (Lead (Pb)-free)

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



ABSOLUTE MAXIMUM RATINGS			
Parameter		Limit	Unit
Reference V+ to GND		- 0.3 to + 13	V
IN, COM, NC, NO <sup>a</sup>		- 0.3 to (V+ + 0.3)	
Continuous Current (Any Terminal)		± 20	mA
Peak Current (Pulsed at 1 ms, 10 % duty cycle)		± 40	
ESD (Method 3015.7)		> 2000	V
Storage Temperature (D Suffix)		- 65 to 125	°C
Power Dissipation (Packages) <sup>b</sup>	8-Pin Narrow Body SOIC <sup>c</sup>	400	mW

Notes:

- a. Signals on S<sub>X</sub>, D<sub>X</sub>, or IN<sub>X</sub> exceeding V+ or 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 6.5 mW/°C above 75 °C.

SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 3 V, ± 10 %, V <sub>IN</sub> = 0.8 or 2.4 V <sup>e</sup>	Temp <sup>a</sup>	D Suffix - 40 to 85 °C			Unit
				Min <sup>c</sup>	Typ <sup>b</sup>	Max <sup>c</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</sup>	V <sub>ANALOG</sub>		Full	0		3	V
Drain-Source On-Resistance	r <sub>DS(on)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V, V+ = 2.7 V I <sub>COM</sub> = 5 mA	Room Full		30	50 80	Ω
r <sub>DS(on)</sub> Match <sup>d</sup>	Δr <sub>DS(on)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V	Room		0.4	2	
r <sub>DS(on)</sub> Flatness <sup>f</sup>	r <sub>DS(on)</sub> Flatness	V <sub>NO</sub> or V <sub>NC</sub> = 1 and 2 V	Room		4	8	
NO or NC Off Leakage Current <sup>g</sup>	I <sub>NO/NC(off)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1 V/2 V, V <sub>COM</sub> = 2 V/1 V	Room Full	- 100 - 5000	5	100 5000	pA
COM Off Leakage Current <sup>g</sup>	I <sub>COM(off)</sub>	V <sub>COM</sub> = 1 V/2 V, V <sub>NO</sub> or V <sub>NC</sub> = 2 V/1 V	Room Full	- 100 - 5000	5	100 5000	
Channel-On Leakage Current <sup>g</sup>	I <sub>COM(on)</sub>	V <sub>COM</sub> = V <sub>NO</sub> or V <sub>NC</sub> = 1 V/2 V	Room Full	- 200 - 10000	10	200 10000	
<b>Digital Control</b>							
Input Current	I <sub>INL</sub> or I <sub>INH</sub>		Full		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	Room Full		50	120 200	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full		20	50 120	
Break-Before-Make Time	t <sub>d</sub>		Room	3	20		
Charge Injection	Q <sub>INJ</sub>	C <sub>L</sub> = 1 nF, V <sub>gen</sub> = 0 V, R <sub>gen</sub> = 0 Ω	Room		1	5	pC
Off-Isolation	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 74		dB
Source Off Capacitance	C <sub>S(off)</sub>	f = 1 MHz	Room		7		pF
Channel-On Capacitance	C <sub>D(on)</sub>		Room		32		
<b>Power Supply</b>							
Power Supply Range	V+			2.7		12	V
Power Supply Current	I+	V+ = 3.3 V, V <sub>IN</sub> = 0 or 3.3 V				1	μA



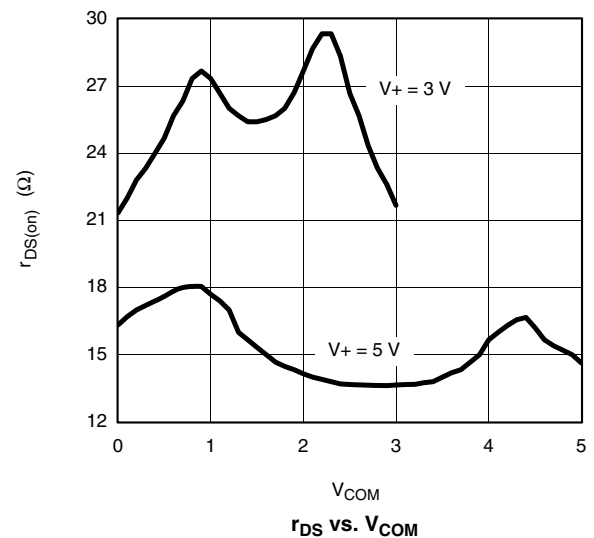
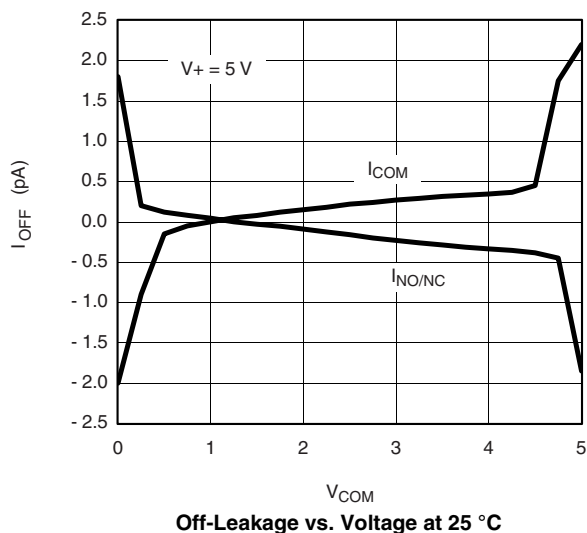
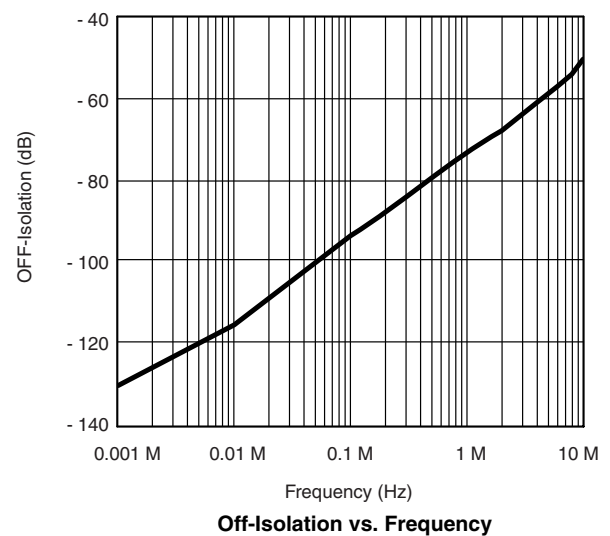
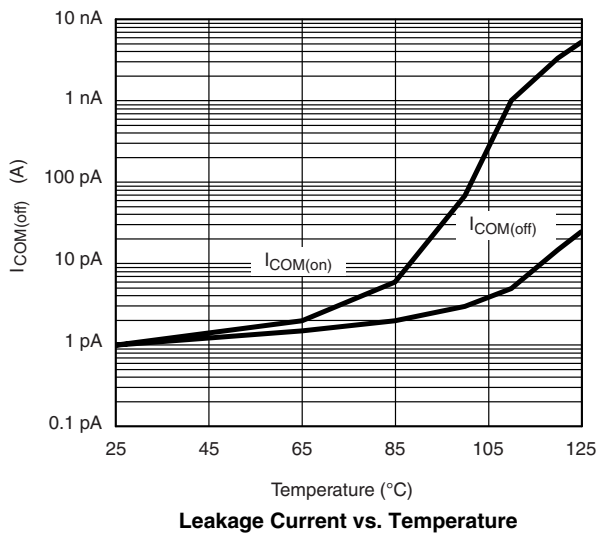
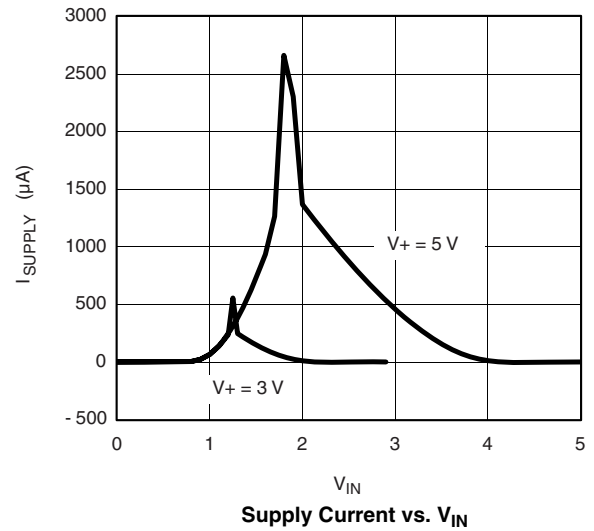
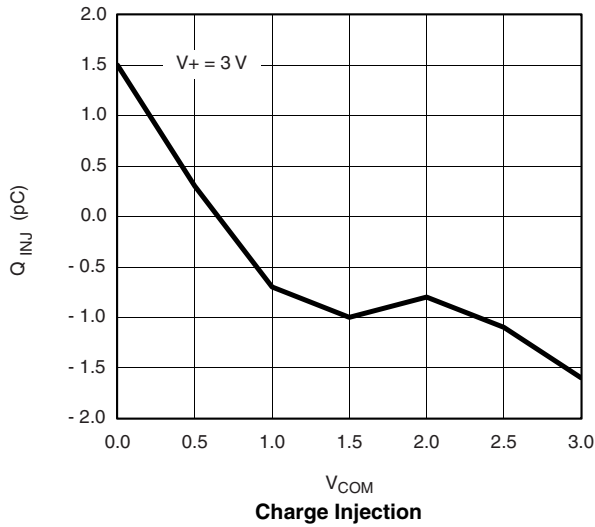
SPECIFICATIONS (V+ = 5 V)							
Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 5 V, ± 10 %, VIN = 0.8 or 2.4 V <sup>e</sup>	Temp <sup>a</sup>	D Suffix - 40 to 85 °C			Unit
				Min <sup>c</sup>	Typ <sup>b</sup>	Max <sup>c</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</sup>	V <sub>ANALOG</sub>		Full	0		5	V
Drain-Source On-Resistance	r <sub>DS(on)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 3.5 V, V+ = 4.5 V I <sub>COM</sub> = 5 mA	Room Full		20	30 50	Ω
r <sub>DS(on)</sub> Match <sup>d</sup>	Δr <sub>DS(on)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V	Room		0.4	2	
r <sub>DS(on)</sub> Flatness <sup>f</sup>	r <sub>DS(on)</sub> Flatness	V <sub>NO</sub> or V <sub>NC</sub> = 1, 2 and 3 V	Room		2	6	
NO or NC Off Leakage Current	I <sub>NO/NC(off)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1 V/4 V, V <sub>COM</sub> = 4 V/1 V	Room Full	- 100 - 5000	10	100 5000	pA
COM Off Leakage Current	I <sub>COM(off)</sub>	V <sub>COM</sub> = 1 V/4 V, V <sub>NO</sub> or V <sub>NC</sub> = 4 V/1 V	Room Full	- 100 - 5000	10	100 5000	
Channel-On Leakage Current	I <sub>COM(on)</sub>	V <sub>COM</sub> = V <sub>NO</sub> or V <sub>NC</sub> = 1 V/4 V	Room Full	- 200 - 10000		200 10000	
<b>Digital Control</b>							
Input Current	I <sub>INL</sub> or I <sub>INH</sub>		Full		1		μA
<b>Dynamic Characteristics</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 3.0 V	Room Full		35	75 150	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full		20	50 100	
Break-Before-Make Time	t <sub>d</sub>		Room	3	10		
Charge Injection	Q <sub>INJ</sub>	C <sub>L</sub> = 1 nF, V <sub>gen</sub> = 0 V, R <sub>gen</sub> = 0 Ω	Room		2	5	pC
Off-Isolation	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 74		dB
NC and NO Capacitance	C <sub>(off)</sub>	f = 1 MHz	Room		- 7		pF
Channel-On Capacitance	C <sub>D(on)</sub>		Room		32		
<b>Power Supply</b>							
Power Supply Range	V+			2.7		12	V
Power Supply Current	I+	V+ = 5.5 V, VIN = 0 or 5.5 V				1	μA

Notes:

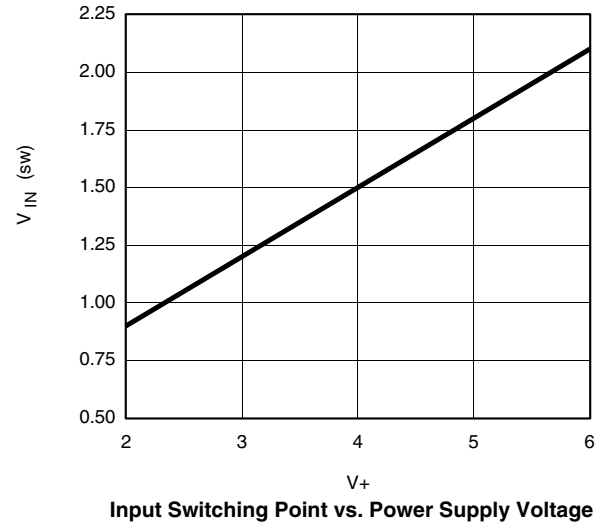
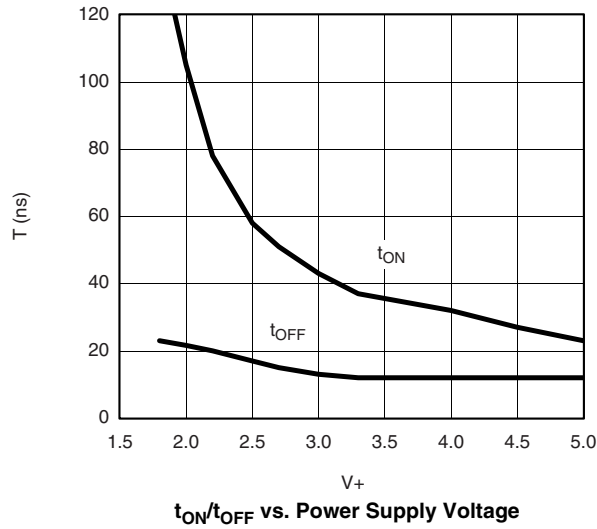
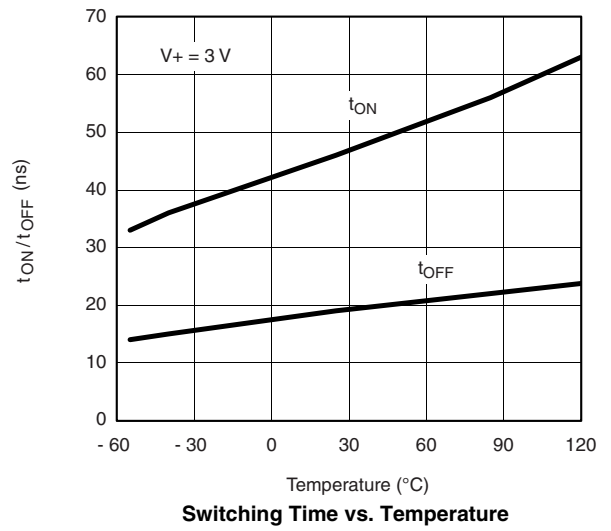
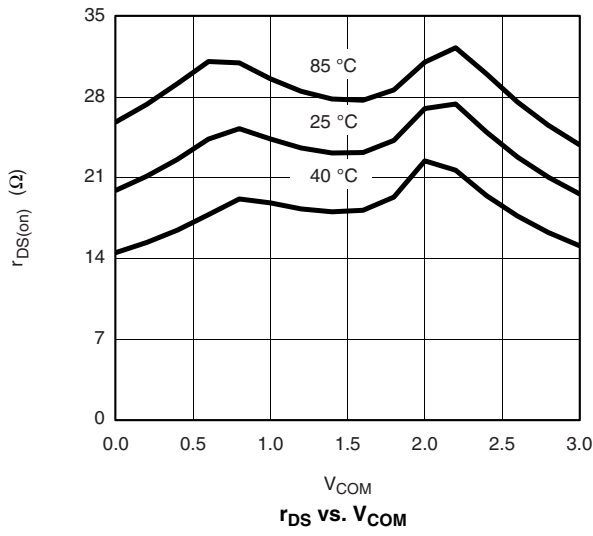
- a. Room = 25 °C, Full = as determined by the operating suffix.
- b. Typical values are for design aid only, not guaranteed nor subject to production testing.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- d. Guarantee by design, nor subjected to production test.
- e. VIN = input voltage to perform proper function.
- f. Difference of min and max values.
- g. Guraranteed 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.

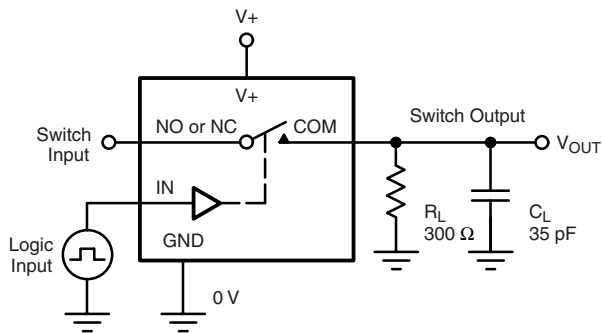
### TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



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

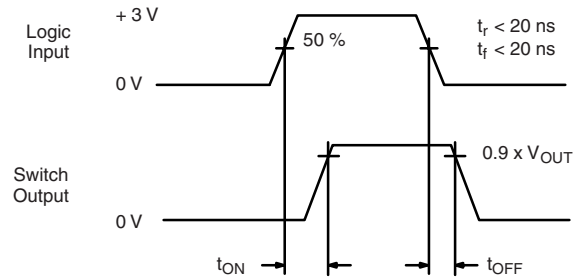


**TEST CIRCUITS**



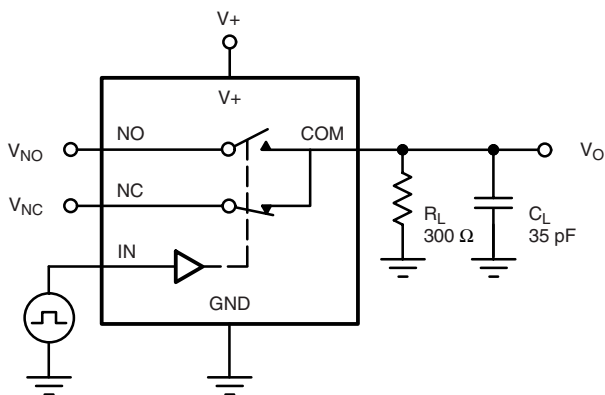
$C_L$  (includes fixture and stray capacitance)

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

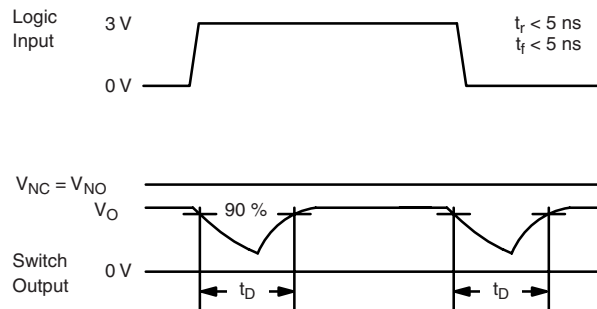


Logic "1" = Switch On  
Logic input waveforms inverted for switches that have the opposite logic sense.

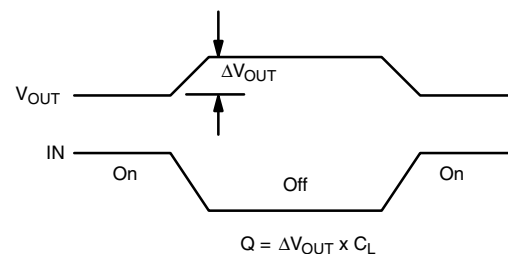
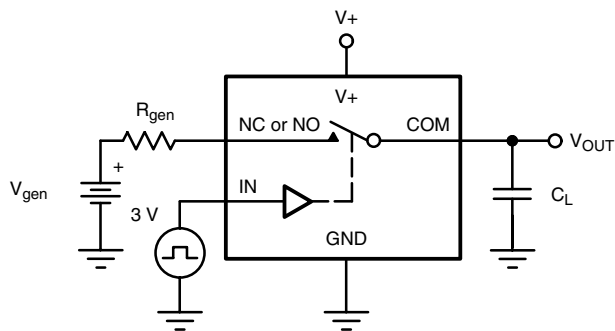
**Figure 1. Switching Time**



$C_L$  (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

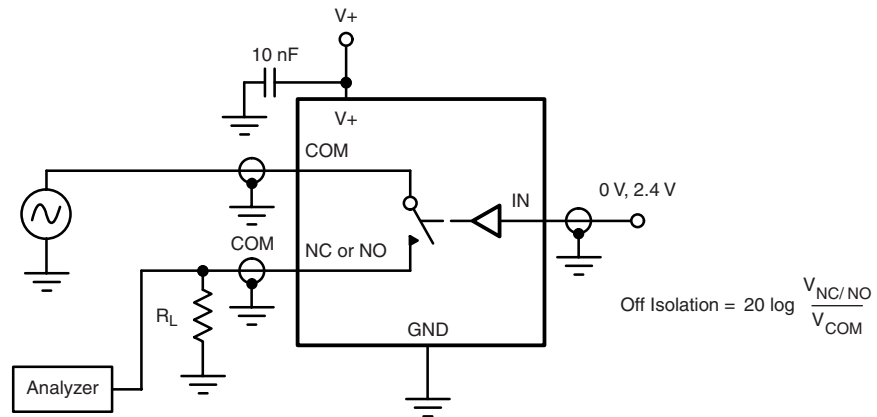


Figure 4. Off-Isolation

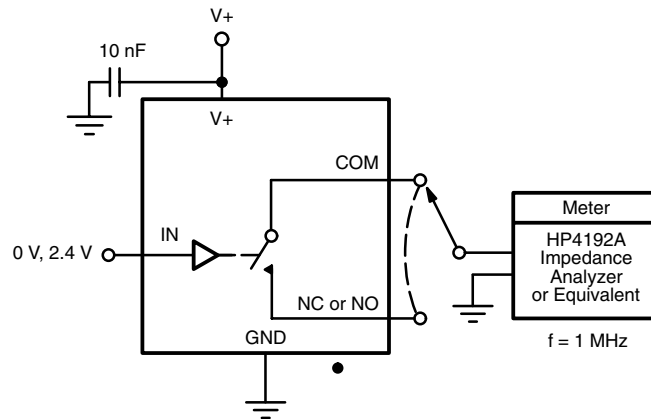


Figure 5. Channel Off/On Capacitance

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