

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

## 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 ( $1.8 \Omega$  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.

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 ( $1.6 \times 1.6 \text{ mm}^2$ ) – 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.

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 (1.8 V to 5.5 V)
- Low On-Resistance -  $r_{ON}$ :  $1.8 \Omega$  at 2.7 V
- Low Charge Injection
- Low Voltage Logic Compatible
- SC-89 Package ( $1.6 \times 1.6 \text{ mm}$ )



**RoHS\***  
COMPLIANT

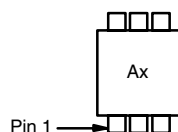
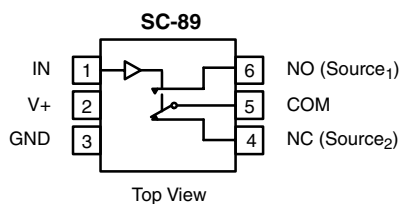
## BENEFITS

- 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

## 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  |

| COMMERCIAL ORDERING INFORMATION |                                                         |                                     |
|---------------------------------|---------------------------------------------------------|-------------------------------------|
| Temp Range                      | Package                                                 | Part Number                         |
| - 40 to 85 °C                   | SC-89 (SOT-666)<br>with Tape and Reel                   | DG2011DX-T1**                       |
|                                 | SC-89 (SOT-666)<br>Lead (Pb)-free<br>with Tape and Reel | DG2011DX-T1-E3**<br>DG2011DXA-T1-E3 |

\*\* Note:  
DG2011DX-T1 and DG2011DX-T1-E3 are not recommended for new designs.

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

| <b>ABSOLUTE MAXIMUM RATINGS</b> $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted |                    |        |                                   |                    |
|---------------------------------------------------------------------------------------------|--------------------|--------|-----------------------------------|--------------------|
| Parameter                                                                                   |                    | Symbol | Limit                             | Unit               |
| Reference $V_+$ to GND                                                                      |                    |        | - 0.3 to + 6                      | V                  |
| IN, COM, NC, NO <sup>a</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>b</sup>                                                   | SC-89 <sup>c</sup> |        | 172                               | 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 2.15 mW/ $^{\circ}\text{C}$  above 70  $^{\circ}\text{C}$ .

| SPECIFICATIONS (V+ = 2.0 V)             |                      |                                                                                                |                   |                         |                  |                  |      |
|-----------------------------------------|----------------------|------------------------------------------------------------------------------------------------|-------------------|-------------------------|------------------|------------------|------|
| Parameter                               | Symbol               | Test Conditions<br>Otherwise Unless Specified<br>V+ = 2.0 V, VIN = 0.4 V or 1.6 V <sup>e</sup> | Temp <sup>a</sup> | Limits<br>- 40 to 85 °C |                  |                  | Unit |
|                                         |                      |                                                                                                |                   | Min <sup>b</sup>        | Typ <sup>c</sup> | Max <sup>b</sup> |      |
| Analog Switch                           |                      |                                                                                                |                   |                         |                  |                  |      |
| Analog Signal Range <sup>d</sup>        | VNO, VNC,<br>VCOM    |                                                                                                | Full              | 0                       |                  | V+               | V    |
| On-Resistance                           | rON                  | V+ = 2.0 V, VCOM = 0.2 V/0.9 V<br>INO, INC = 20 mA                                             | Room<br>Full      |                         | 3.5              | 5.5<br>5.5       | Ω    |
| Switch Off Leakage Current <sup>f</sup> | INO(off)<br>INC(off) | V+ = 2.2 V,<br>VNO, VNC= 0.5 V/1.5 V, VCOM = 1.5 V/0.5 V                                       | Room<br>Full      | - 1<br>- 10             |                  | 1<br>10          | nA   |
|                                         | ICOM(off)            |                                                                                                | Room<br>Full      | - 1<br>- 10             |                  | 1<br>10          |      |
| Channel-On Leakage Current <sup>f</sup> | ICOM(on)             | V+ = 2.2 V, VNO, VNC= VCOM = 0.5 V/1.5 V                                                       | Room<br>Full      | - 1<br>- 10             |                  | 1<br>10          |      |
| Digital Control                         |                      |                                                                                                |                   |                         |                  |                  |      |
| Input High Voltage                      | VINH                 |                                                                                                | Full              | 1.5                     |                  |                  | V    |
| Input Low Voltage                       | VINL                 |                                                                                                | Full              |                         |                  | 0.4              |      |
| Input Capacitance                       | Cin                  |                                                                                                | Full              |                         | 4                |                  | pF   |
| Input Current                           | IINL or IINH         | VIN = 0 or V+                                                                                  | Full              | 1                       |                  | 1                | μA   |
| Dynamic Characteristics                 |                      |                                                                                                |                   |                         |                  |                  |      |
| Turn-On Time                            | tON                  | VNO or VNC = 1.5 V, RL = 300 Ω, CL = 35 pF                                                     | Room<br>Full      |                         | 75               | 110<br>113       | ns   |
| Turn-Off Time                           | tOFF                 |                                                                                                | Room<br>Full      |                         | 37               | 71<br>76         |      |
| Break-Before-Make Time                  | tBBM                 |                                                                                                | Room              | 1                       | 37               |                  |      |
| Charge Injection <sup>d</sup>           | QINJ                 | CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω                                                              | Room              |                         | 7                |                  | pC   |
| Off-Isolation <sup>d</sup>              | OIRR                 | RL = 50 Ω, CL = 5 pF, f = 1 MHz                                                                | Room              |                         | - 62             |                  | dB   |
| Crosstalk <sup>d</sup>                  | XTALK                |                                                                                                | Room              |                         | - 69             |                  |      |
| NO, NC Off Capacitance <sup>d</sup>     | CNO(off)<br>CNC(off) | VIN = 0 or V+, f = 1 MHz                                                                       | Room              |                         | 29               |                  | pF   |
| Channel-On Capacitance <sup>d</sup>     | CON                  |                                                                                                | Room              |                         | 85               |                  |      |
| Power Supply                            |                      |                                                                                                |                   |                         |                  |                  |      |
| Positive Supply Range                   | V+                   | VIN = 0 or V+                                                                                  |                   | 1.8                     |                  | 5.5              | V    |
| Negative Supply Current                 | I+                   |                                                                                                |                   |                         | 0.01             | 1.0              | μA   |



| SPECIFICATIONS (V+ = 3 V)               |                      |                                                                                                     |                   |                        |                  |                  |      |
|-----------------------------------------|----------------------|-----------------------------------------------------------------------------------------------------|-------------------|------------------------|------------------|------------------|------|
| Parameter                               | Symbol               | Test Conditions<br>Otherwise Unless Specified<br>V+ = 3 V, ±10 %, VIN = 0.4 V or 2.0 V <sup>e</sup> | Temp <sup>a</sup> | Limits<br>–40 to 85 °C |                  |                  | Unit |
|                                         |                      |                                                                                                     |                   | Min <sup>b</sup>       | Typ <sup>c</sup> | Max <sup>b</sup> |      |
| Analog Switch                           |                      |                                                                                                     |                   |                        |                  |                  |      |
| Analog Signal Range <sup>d</sup>        | VNO, VNC,<br>VCOM    |                                                                                                     | Full              | 0                      |                  | V+               | V    |
| On-Resistance                           | rON                  | V+ = 2.7 V, VCOM = 0.9 V/1.5 V<br>INO, INC = 50 mA                                                  | Room<br>Full      |                        | 1.8              | 2.7<br>2.9       | Ω    |
| rON Match                               | ΔrON                 |                                                                                                     | Room              |                        |                  | 0.2              |      |
| rON Flatness                            | rON<br>Flatness      |                                                                                                     | Room              |                        | 0.2              | 0.5              |      |
| Switch Off Leakage Current              | INO(off)<br>INC(off) | V+ = 3.3 V,<br>VNO, VNC= 1 V/3 V, VCOM = 3 V/1 V                                                    | Room<br>Full      | - 1<br>- 10            |                  | 1<br>10          | nA   |
|                                         | ICOM(off)            |                                                                                                     | Room<br>Full      | - 1<br>- 10            |                  | 1<br>10          |      |
| Channel-On Leakage Current <sup>f</sup> | ICOM(on)             | V+ = 3.3 V, VNO, VNC = VCOM = 1 V/3 V                                                               | Room<br>Full      | - 1<br>- 10            |                  | 1<br>10          |      |
| Digital Control                         |                      |                                                                                                     |                   |                        |                  |                  |      |
| Input High Voltage                      | VINH                 |                                                                                                     | Full              | 1.6                    |                  |                  | V    |
| Input Low Voltage                       | VINL                 |                                                                                                     | Full              |                        |                  | 0.4              |      |
| Input Capacitance                       | Cin                  |                                                                                                     | Full              |                        | 4                |                  | pF   |
| Input Current                           | IINL or IINH         | VIN = 0 or V+                                                                                       | Full              | 1                      |                  | 1                | μA   |
| Dynamic Characteristics                 |                      |                                                                                                     |                   |                        |                  |                  |      |
| Turn-On Time                            | tON                  | VNO or VNC = 2.0 V, RL = 300 Ω, CL = 35 pF                                                          | Room<br>Full      |                        | 45               | 75<br>77         | ns   |
| Turn-Off Time                           | tOFF                 |                                                                                                     | Room<br>Full      |                        | 29               | 59<br>62         |      |
| Break-Before-Make Time                  | tBBM                 |                                                                                                     | Room              | 1                      | 16               |                  |      |
| Charge Injection <sup>d</sup>           | QINJ                 | CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω                                                                   | Room              |                        | 2                |                  | pC   |
| Off-Isolation <sup>d</sup>              | OIRR                 | RL = 50 Ω, CL = 5 pF, f = 1 MHz                                                                     | Room              |                        | - 62             |                  | dB   |
| Crosstalk <sup>d</sup>                  | XTALK                |                                                                                                     | Room              |                        | - 68             |                  |      |
| NO, NC Off Capacitance <sup>d</sup>     | CNO(off)<br>CNC(off) | VIN = 0 or V+, f = 1 MHz                                                                            | Room              |                        | 28               |                  | pF   |
| Channel-On Capacitance <sup>d</sup>     | CON                  |                                                                                                     | Room              |                        | 84               |                  |      |
| Power Supply                            |                      |                                                                                                     |                   |                        |                  |                  |      |
| Power Supply Range                      | V+                   |                                                                                                     |                   | 1.8                    |                  | 5.5              | V    |
| Power Supply Current                    | I+                   | VIN = 0 or V+                                                                                       |                   |                        | 0.01             | 1.0              | μA   |
| Power Consumption                       | PC                   |                                                                                                     |                   |                        |                  | 3.3              | μW   |

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.

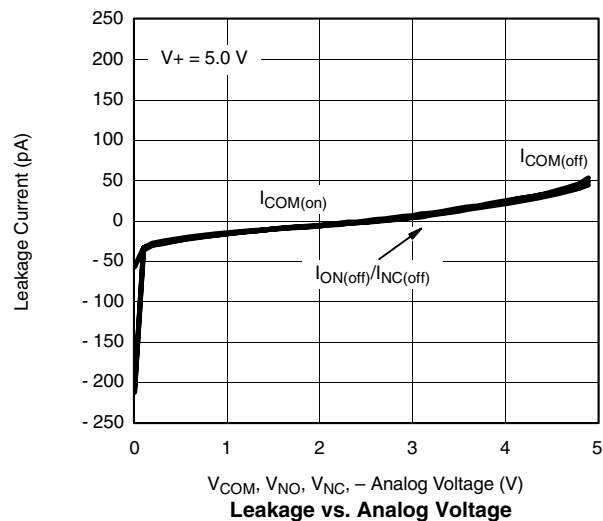
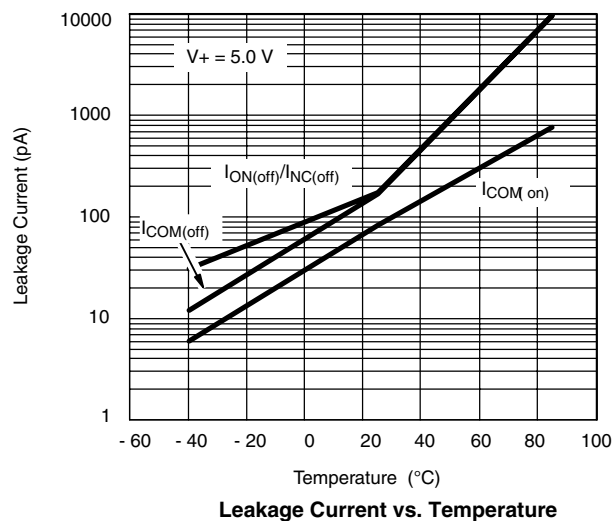
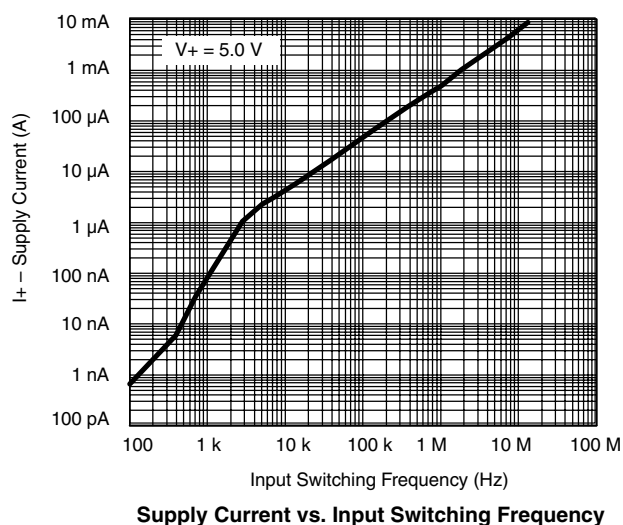
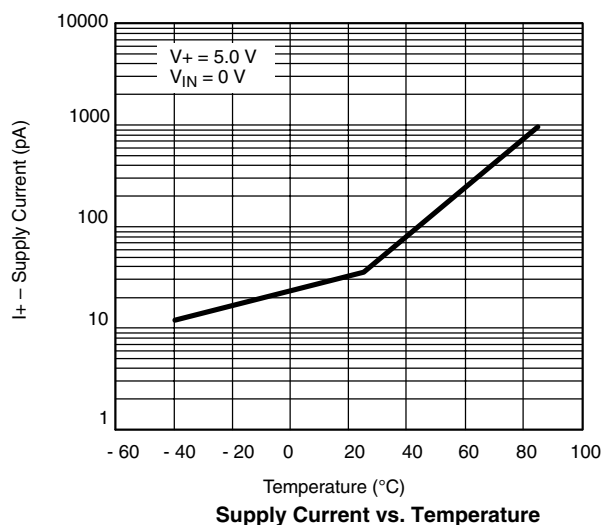
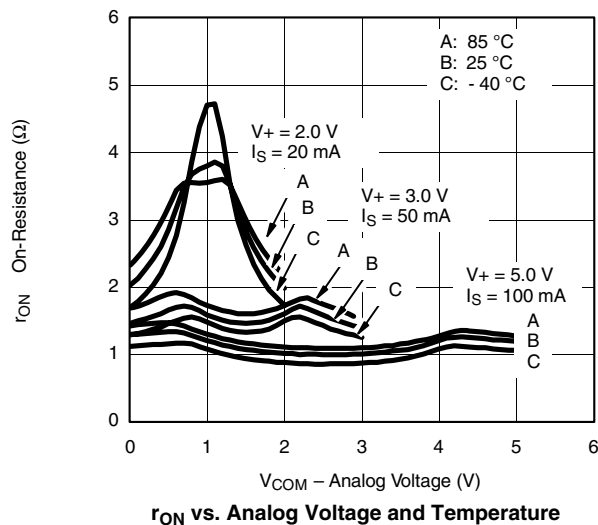
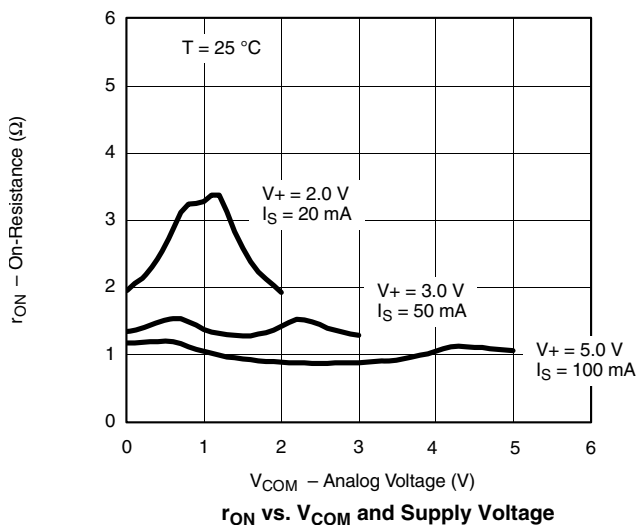
d. Guarantee by design, nor subjected to production test.

e. V<sub>IN</sub> = input voltage to perform proper function.

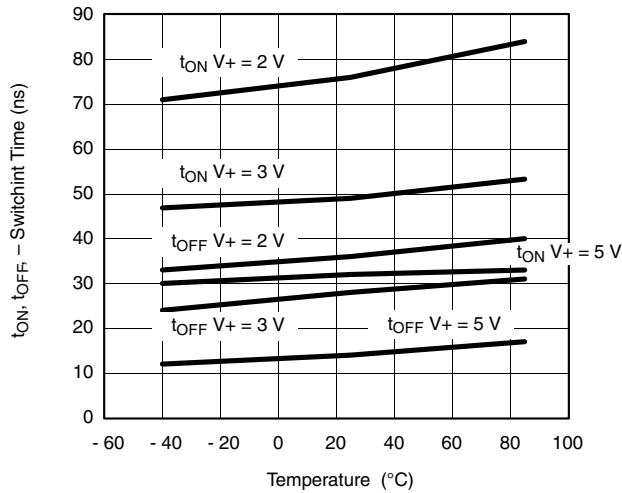
f. Guaranteed by 5 V leakage testing, not production tested.

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.

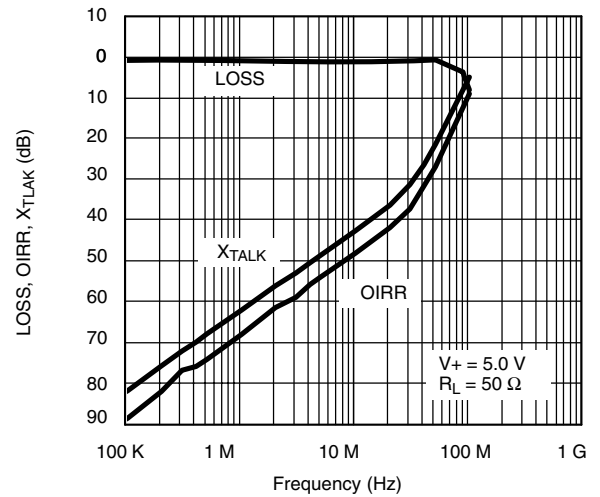
**TYPICAL CHARACTERISTICS**  $T_A = 25^\circ\text{C}$ , unless otherwise noted



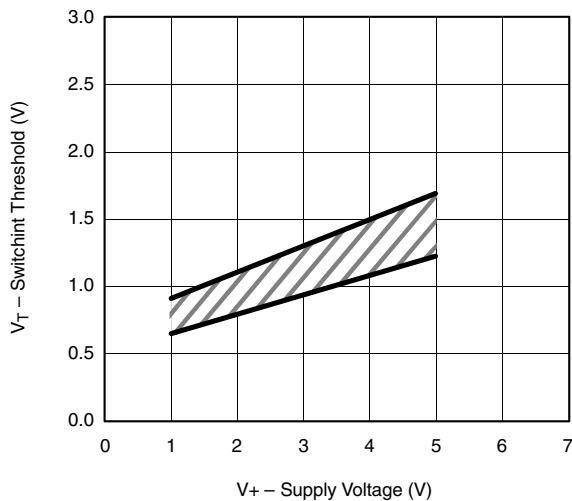
**TYPICAL CHARACTERISTICS**  $T_A = 25^\circ\text{C}$ , unless otherwise noted



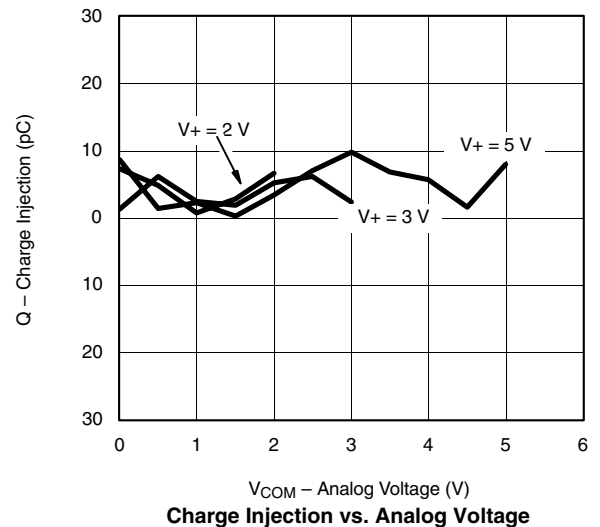
**Switching Time vs. Temperature and Supply Voltage**



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



**Switching Threshold vs. Supply Voltage**



**Charge Injection vs. Analog Voltage**

TEST CIRCUITS

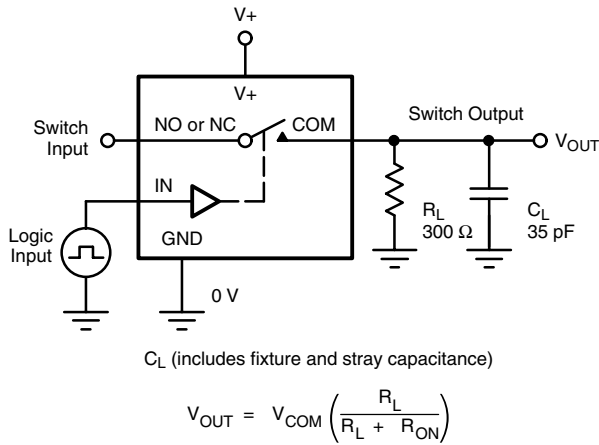
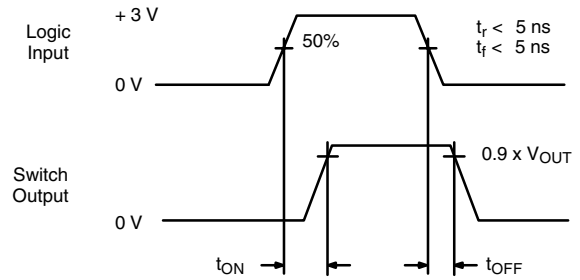


Figure 1. Switching Time



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

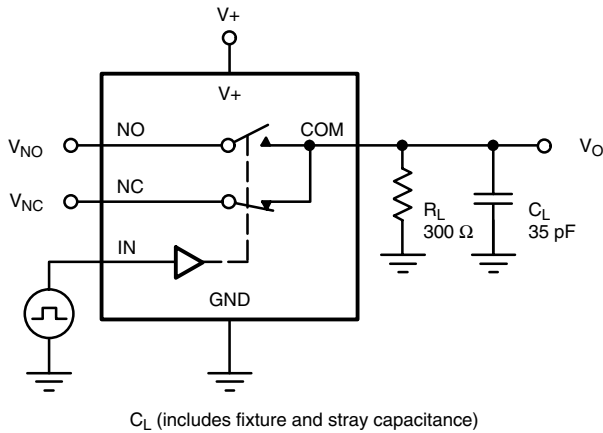


Figure 2. Break-Before-Make Interval

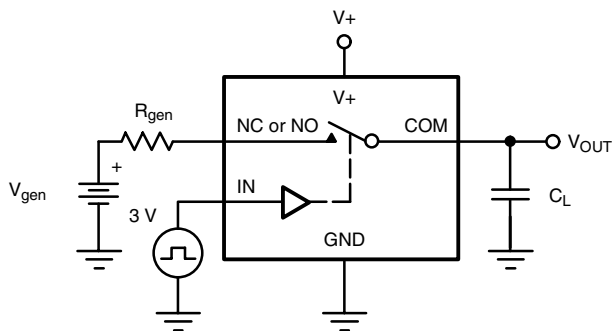
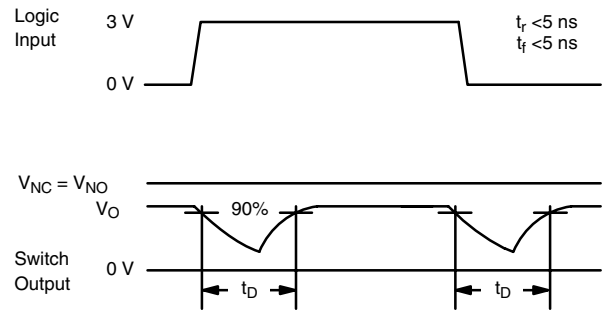
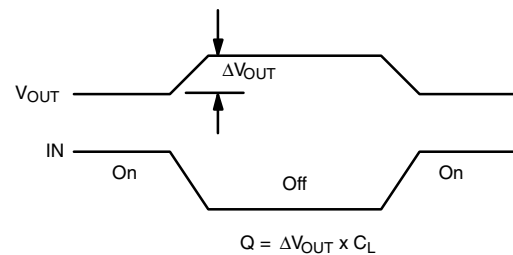
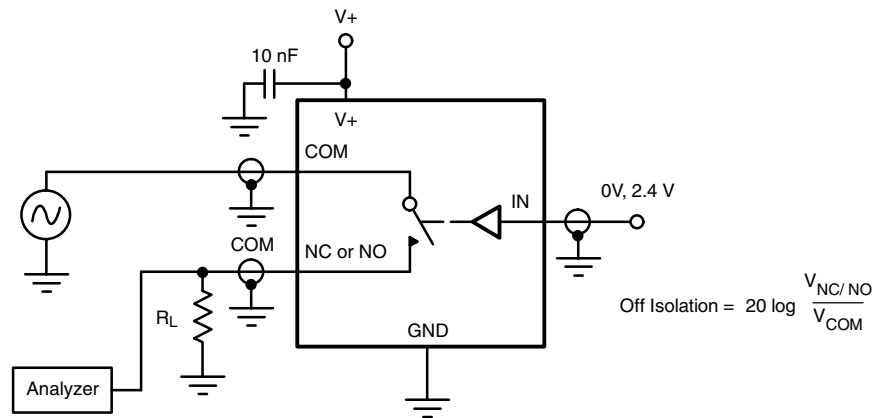
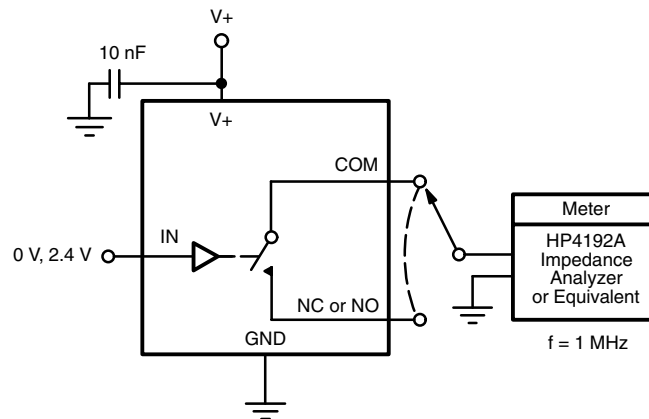


Figure 3. Charge Injection



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

**TEST CIRCUITS**

**Figure 4. Off-Isolation**

**Figure 5. Channel Off/On Capacitance**

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