

## 0.35-Ω Low-Voltage Dual SPDT Analog Switch

### DESCRIPTION

The DG2535/DG2536 is a sub 1 Ω (0.35 Ω at 2.7 V) dual SPDT analog switches designed for low voltage applications.

The DG2535/DG2536 has on-resistance matching (less than 0.05 Ω at 2.7 V) and flatness (less than 0.2 Ω at 2.7 V) that are guaranteed over the entire voltage range. Additionally, low logic thresholds make the DG2535/DG2536 an ideal interface to low voltage DSP control signals.

The DG2535/DG2536 has fast switching speed with break-before-make guaranteed. In the On condition, all switching elements conduct equally in both directions. Off-isolation and crosstalk is - 69 dB at 100 kHz.

The DG2535/DG2536 is built on Vishay Siliconix's high-density low voltage CMOS process. An eptiaxial layer is built in to prevent latchup. The DG2535/DG2536 contains the additional benefit of 2,000 V ESD protection.

In space saving MSOP-10 and DFN-10 lead (Pb)-free packages, the DG2535/DG2536 are high performance, low  $r_{ON}$  switches for battery powered applications. No lead (Pb) is used in the manufacturing process either inside the device/package or on the external terminations. 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 in DFN packages, the lead (Pb)-free "-E3/E4" suffix is being used as a designator. Lead (Pb)-free DFN products purchased at any time will have either a nickel-palladium-gold device termination or a 100 % matte tin device termination. The different lead (Pb)-free materials are interchangeable and meet all JEDEC standards for reflow and MSL rating.

### FEATURES

- Low Voltage Operation
- Low On-Resistance -  $r_{ON}$ : 0.35 Ω at 2.7 V
- - 69 dB OIRR at 2.7 V, 100 kHz
- MSOP-10 and DFN-10 Packages
- ESD Protection > 2000 V
- Latch-Up Current > 300 mA (JESD 78)


**RoHS**  
COMPLIANT

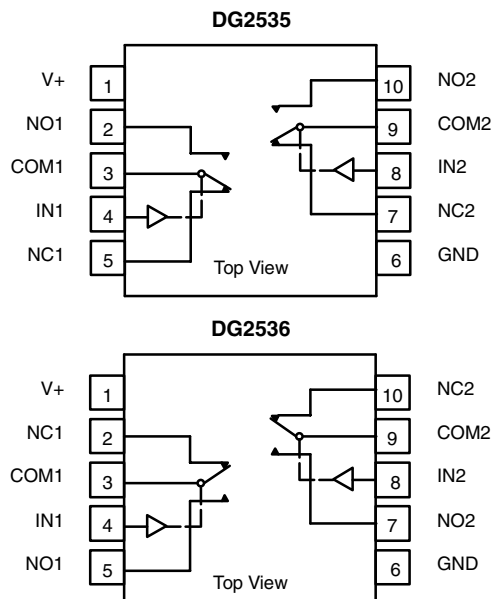
### BENEFITS

- Reduced Power Consumption
- High Accuracy
- Reduce Board Space
- 1.8 V Logic Compatible
- High Bandwidth

### APPLICATIONS

- Cellular Phones
- Speaker Headset Switching
- Audio and Video Signal Routing
- PCMCIA Cards
- Battery Operated Systems
- Relay Replacement

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



### TRUTH TABLE

| Logic | NC1 and NC2 | NO1 and NO2 |
|-------|-------------|-------------|
| 0     | ON          | OFF         |
| 1     | OFF         | ON          |

### ORDERING INFORMATION

| Temp Range    | Package | Part Number                      |
|---------------|---------|----------------------------------|
| - 40 to 85 °C | MSOP-10 | DG2535DQ-T1-E3<br>DG2536DQ-T1-E3 |
|               | DFN-10  | DG2535DN-T1-E4<br>DG2536DN-T1-E4 |



| 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, COM)               | ± 300                | mA   |    |
| Peak Current (Pulsed at 1 ms, 10 % duty cycle) | ± 500                |      |    |
| Storage Temperature (D Suffix)                 | - 65 to 150          | °C   |    |
| ESD per Method 3015.7                          | > 2                  | kV   |    |
| Power Dissipation (Packages) <sup>b</sup>      | MSOP-10 <sup>c</sup> | 320  | mW |
|  | DFN-10 <sup>d</sup>  | 1191 |    |

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 4.0 mW/°C above 70 °C
- d. Derate 14.9 mW/°C above 70 °C.

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.

| SPECIFICATIONS (V+ = 3 V)                            |   |  |                   |                         |                  |                  |      |
|--|---|--|-------------------|-------------------------|------------------|------------------|------|
| Parameter  | Symbol  | Test Conditions<br>Otherwise Unless Specified<br>V+ = 3 V, ± 10 %, V <sub>IN</sub> = 0.5 or 1.4 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> |      |
| <b>Analog Switch</b>                                 |   |  |                   |                         |                  |                  |      |
| Analog Signal Range <sup>d</sup>                     | V <sub>NO</sub> , V <sub>NC</sub><br>V <sub>COM</sub> |  | Full              | 0                       |                  | V+               | V    |
| On-Resistance  | r <sub>ON</sub>                                       | V+ = 2.7 V, V <sub>COM</sub> = 0.6 V/1.5 V, I <sub>NO</sub> , I <sub>NC</sub> = 100 mA                         | Room<br>Full      |                         | 0.35             | 0.5<br>0.6       | Ω    |
| r <sub>ON</sub> Flatness <sup>d</sup>                | r <sub>ON</sub><br>Flatness                           |  | Room              |                         | 0.09             | 0.2              |      |
| On-Resistance<br>Match Between Channels <sup>d</sup> | Δr <sub>DS(on)</sub>                                  |  | Room              |                         |                  | 0.05             |      |
| Switch Off<br>Leakage Current                        | I <sub>NO(off)</sub><br>I <sub>NC(off)</sub>          | V+ = 3.3 V<br>V <sub>NO</sub> , V <sub>NC</sub> = 0.3 V/3 V, V <sub>COM</sub> = 3 V/0.3 V                      | Room<br>Full      | - 1<br>- 10             |                  | 1<br>10          | nA   |
|  | I <sub>COM(off)</sub>                                 |  | Room<br>Full      | - 1<br>- 10             |                  | 1<br>10          |      |
| Channel-On<br>Leakage Current                        | I <sub>COM(on)</sub>                                  | V+ = 3.3 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 0.3 V/3 V                                   | Room<br>Full      | - 1<br>- 10             |                  | 1<br>10          |      |
| <b>Digital Control</b>                               |   |  |                   |                         |                  |                  |      |
| Input High Voltage <sup>d</sup>                      | V <sub>INH</sub>                                      |  | Full              | 1.4                     |                  |                  | V    |
| Input Low Voltage                                    | V <sub>INL</sub>                                      |  | Full              |                         |                  | 0.5              |      |
| Input Capacitance                                    | C <sub>in</sub>                                       |  | Full              |                         | 10               |                  | pF   |
| Input Current  | I <sub>INL</sub> or I <sub>INH</sub>                  | V <sub>IN</sub> = 0 or V+  | Full              | 1                       |                  | 1                | μA   |

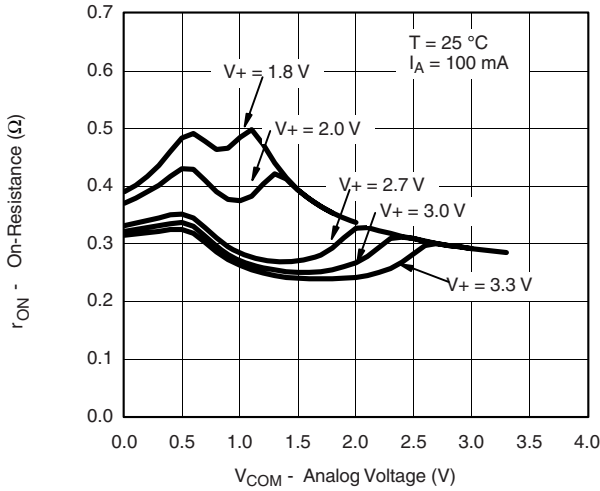


| SPECIFICATIONS (V+ = 3 V)                                    |                      |  |                   |                         |                  |                  |      |
|--|----------------------|--|-------------------|-------------------------|------------------|------------------|------|
| Parameter  | Symbol               | Test Conditions<br>Otherwise Unless Specified<br>V+ = 3 V, ± 10 %, VIN = 0.4 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> |      |
| <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> = 50 Ω, C <sub>L</sub> = 35 pF          | Room              |                         | 52               | 82               | ns   |
| Turn-Off Time  | t <sub>OFF</sub>     |  | Full              |                         | 43               | 73               |      |
| Break-Before-Make Time                                       | t <sub>d</sub>       |  | Full              | 1                       | 6                |                  |      |
| Charge Injection <sup>d</sup>                                | Q <sub>INJ</sub>     | C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 1.5 V, R <sub>GEN</sub> = 0 Ω                            | Room              |                         | 21               |                  | pC   |
| Off-Isolation <sup>d</sup>                                   | OIRR                 | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 100 kHz  | Room              |                         | - 69             |                  | 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>NO(off)</sub> | V <sub>IN</sub> = 0 or V+, f = 1 MHz   | Room              |                         | 145              |                  | pF   |
|  | C <sub>NC(off)</sub> |  | Room              |                         | 145              |                  |      |
| Channel-On Capacitance <sup>d</sup>                          | C <sub>NO(on)</sub>  | V <sub>IN</sub> = 0 or V+, f = 1 MHz   | Room              |                         | 406              |                  |      |
|  | C <sub>NC(on)</sub>  |  | Room              |                         | 406              |                  |      |
| <b>Power Supply</b>  |                      |  |                   |                         |                  |                  |      |
| Power Supply Current   | I+                   | V <sub>IN</sub> = 0 or V+  | Full              |                         |                  | 1.0              | μA   |

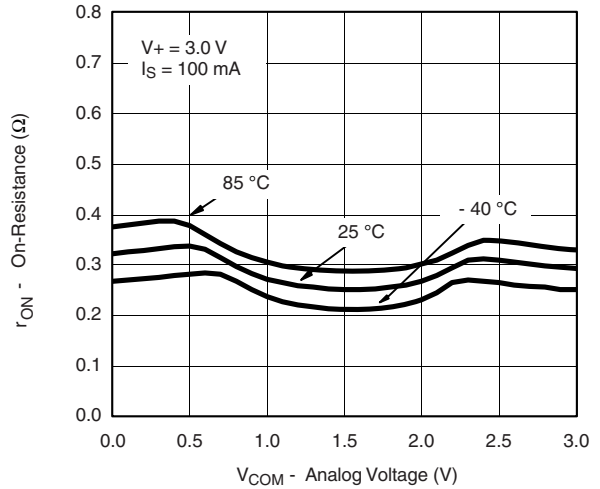
Notes:

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

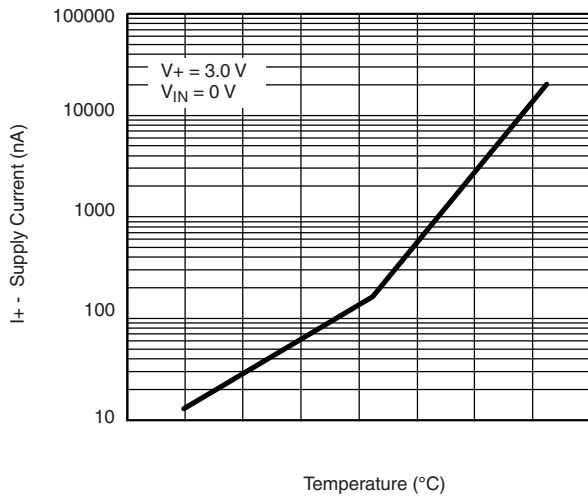
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



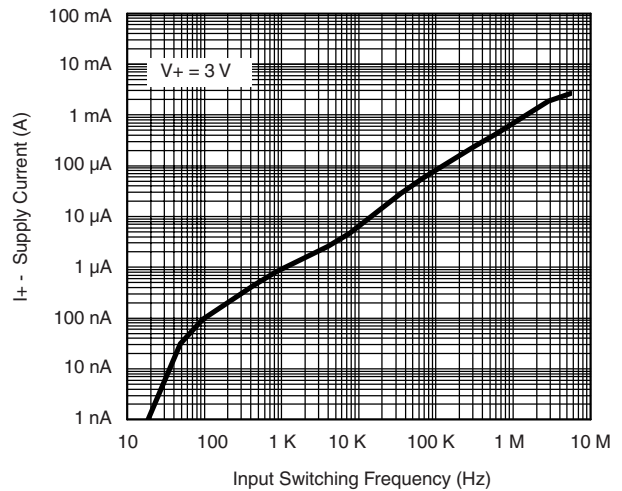
**r<sub>ON</sub> vs. V<sub>COM</sub> and Supply Voltage**



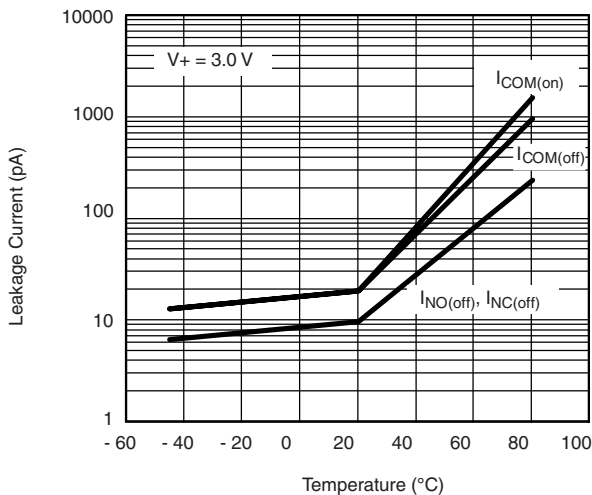
**r<sub>ON</sub> vs. Analog Voltage and Temperature (NC1)**



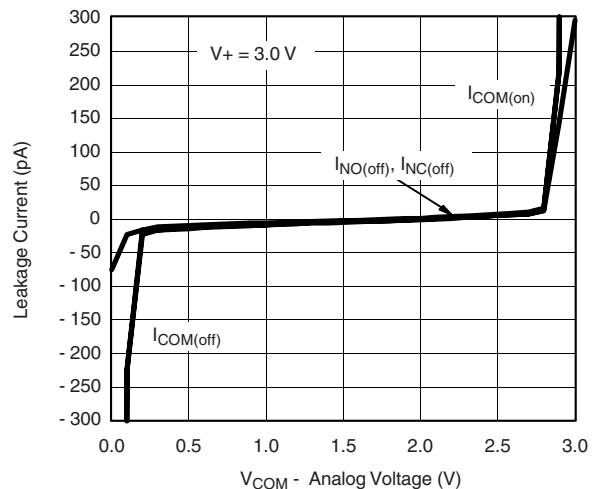
**Supply Current vs. Temperature**



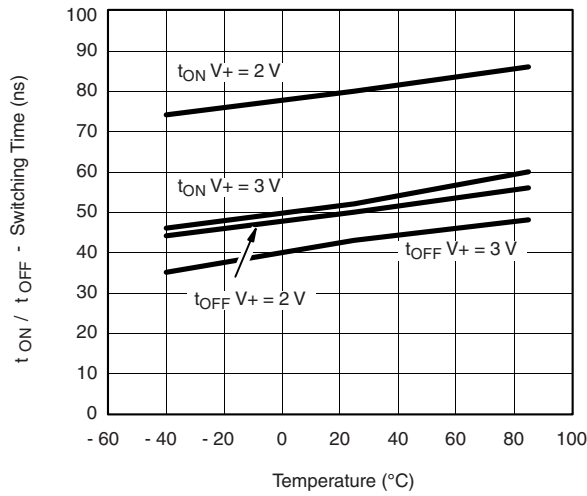
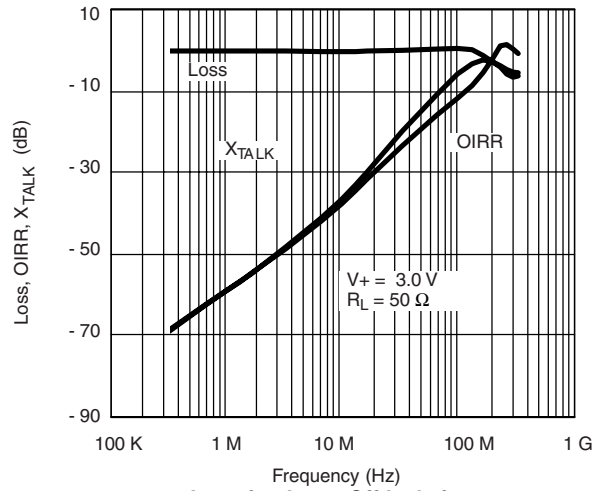
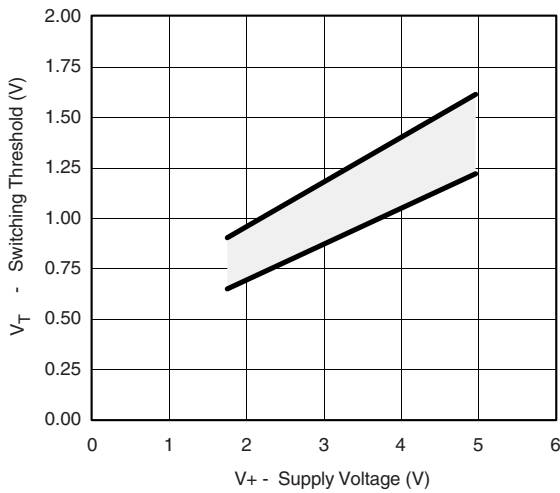
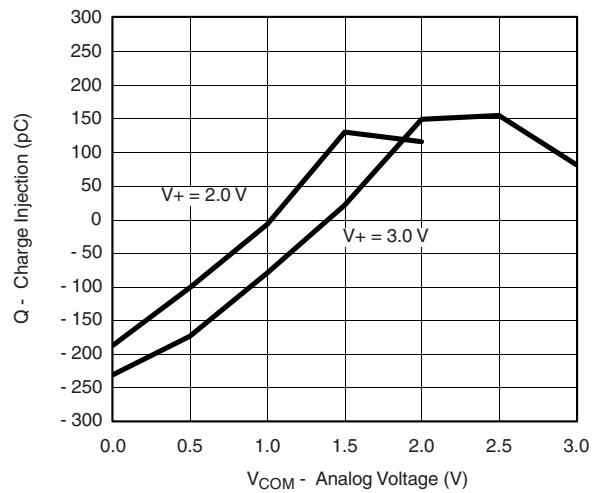
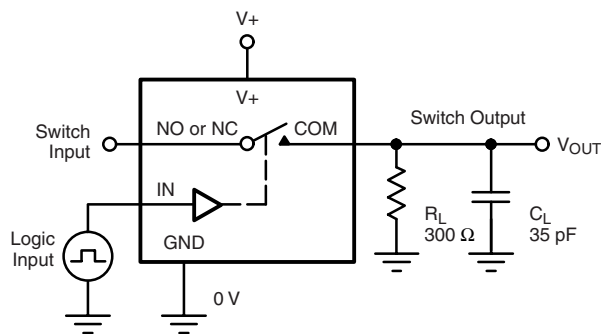
**Supply Current vs. Input Switching Frequency**



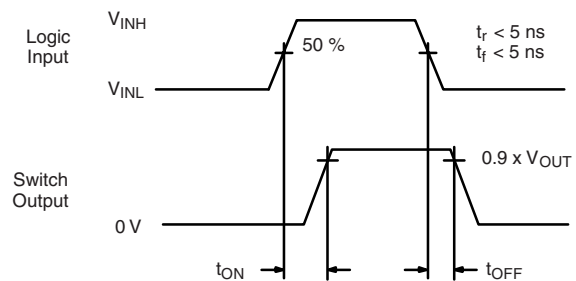
**Leakage Current vs. Temperature**



**Leakage vs. Analog Voltage**

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

**Switching Time vs. Temperature**

**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**

TEST CIRCUITS

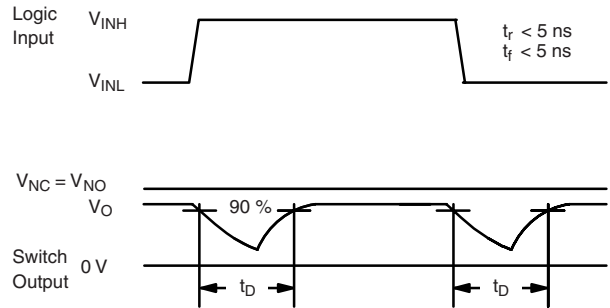
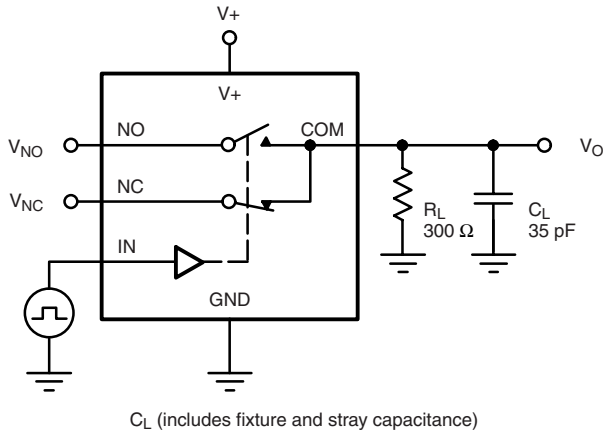
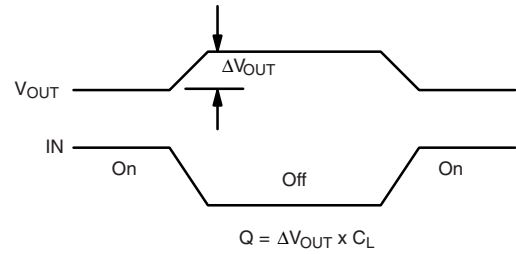
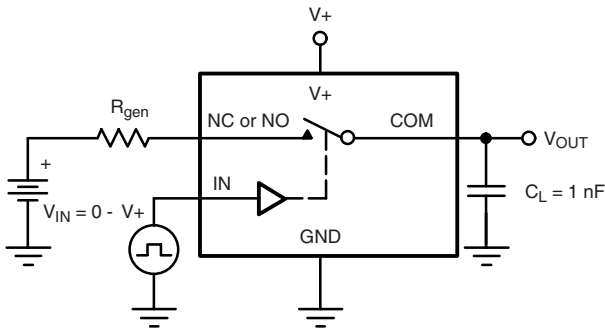


Figure 2. Break-Before-Make Interval



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

Figure 3. Charge Injection

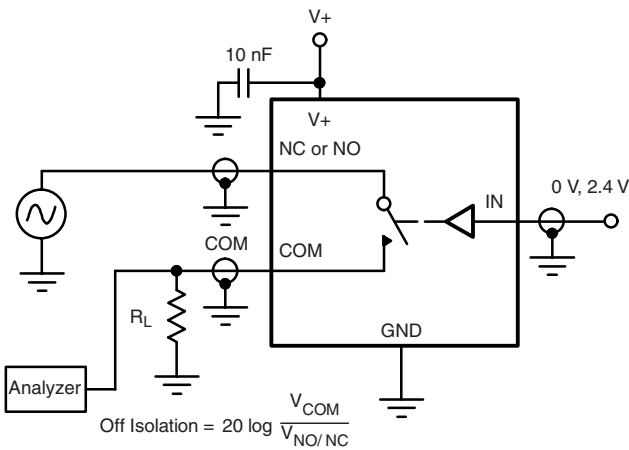


Figure 4. Off-Isolation

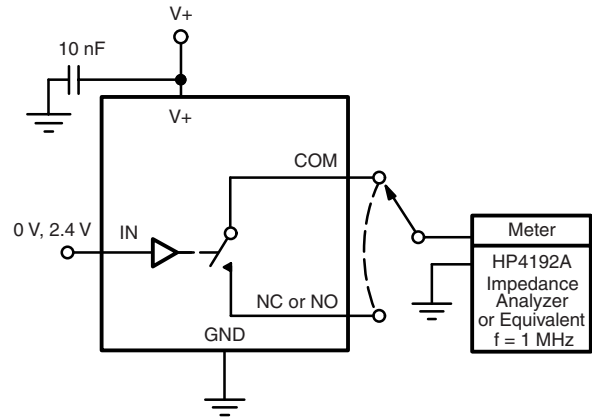


Figure 5. Channel Off/On Capacitance

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