

# 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

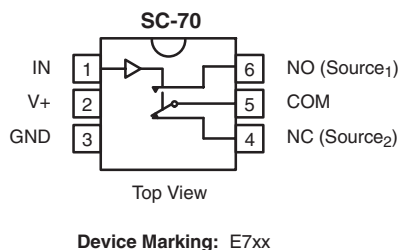
## BENEFITS

- 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



## 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<br>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> | 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<br>Otherwise Unless Specified<br>V+ = 2.0 V, ± 10 %, V <sub>IN</sub> = 0.4 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>                             | V <sub>NO</sub> , V <sub>NC</sub><br>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<br>I <sub>NO</sub> , I <sub>NC</sub> = 10 mA                          | Room<br>Full <sup>d</sup> |                         | 2.7<br>2.7       | 5.3<br>5.3       | Ω    |
| r <sub>ON</sub> Flatness <sup>d</sup>                        | r <sub>ON</sub><br>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                      |                         |                  | 0.25             |      |
| Switch Off Leakage Current <sup>f</sup>                      | I <sub>NO(off)</sub><br>I <sub>NC(off)</sub>          | V+ = 2.2 V<br>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<br>Full              | - 0.5<br>- 5.0          |                  | 0.5<br>5.0       | nA   |
|                                                              | I <sub>COM(off)</sub>                                 |                                                                                                                  | Room<br>Full <sup>d</sup> | - 0.5<br>- 5.0          |                  | 0.5<br>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<br>Full <sup>d</sup> | - 0.5<br>- 5.0          |                  | 0.5<br>5.0       |      |
| Digital Control                                              |                                                       |                                                                                                                  |                           |                         |                  |                  |      |
| 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   |
| Dynamic Characteristics                                      |                                                       |                                                                                                                  |                           |                         |                  |                  |      |
| 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<br>Figures 1 and 2    | Room<br>Full <sup>d</sup> |                         | 43               | 63<br>65         | ns   |
| Turn-Off Time <sup>d</sup>                                   | t <sub>OFF</sub>                                      |                                                                                                                  | Room<br>Full <sup>d</sup> |                         | 23               | 45<br>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><br>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               |                  |      |



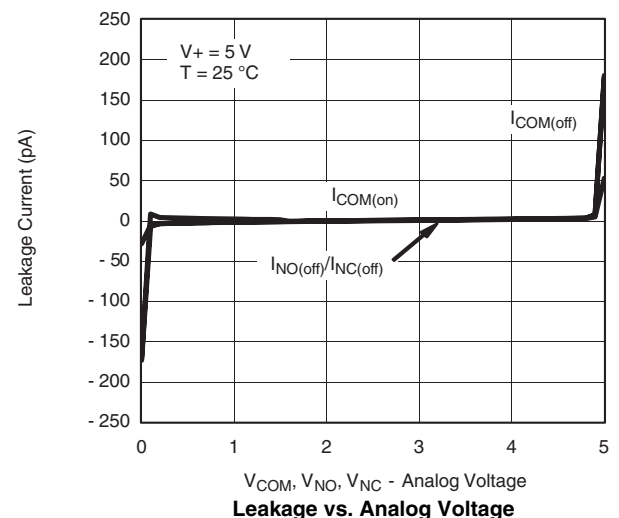
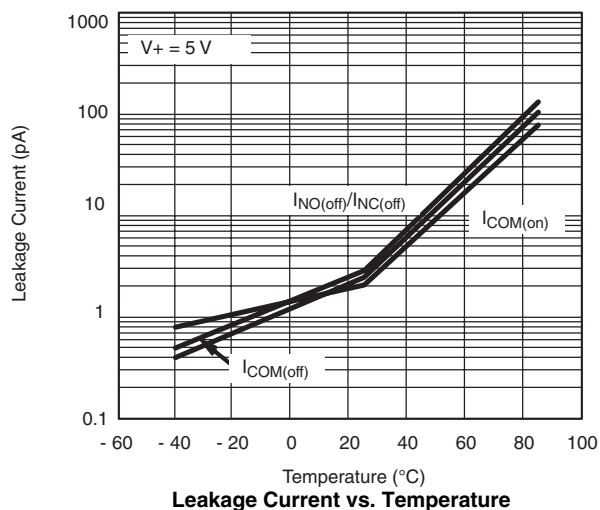
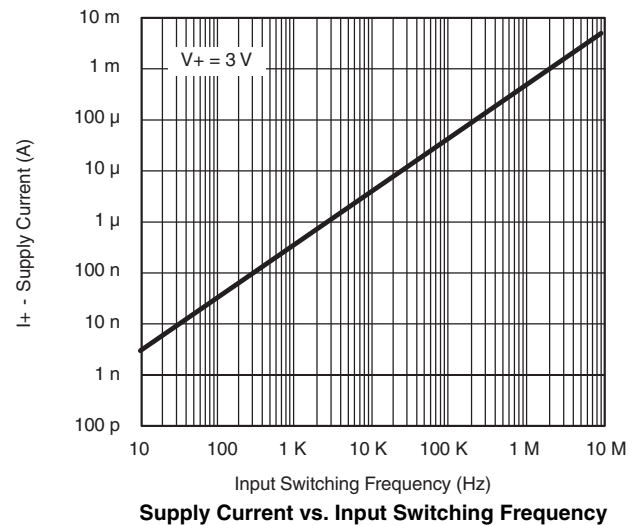
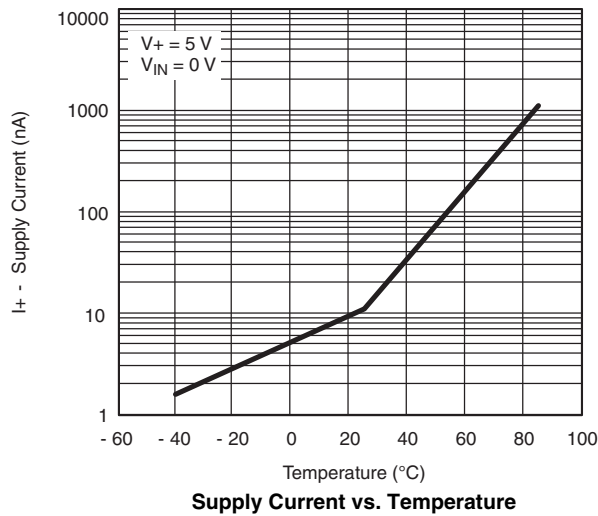
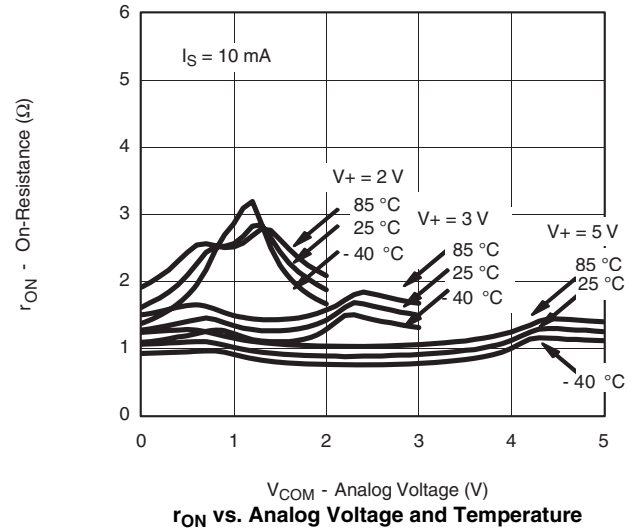
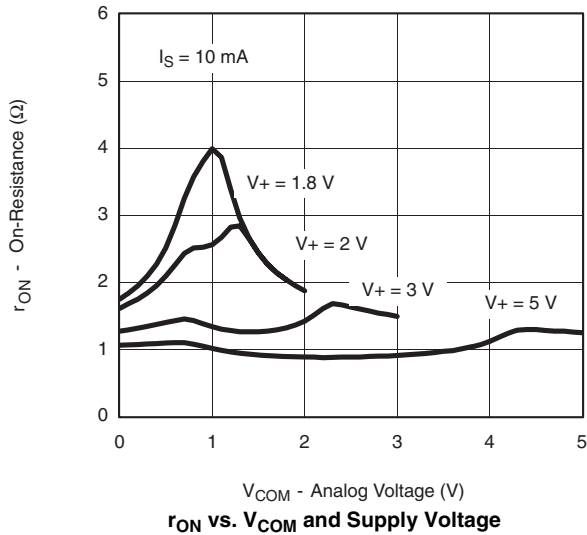
| SPECIFICATIONS (V+ = 3.0 V)             |                                                       |                                                                                                                |                   |                         |                  |                  |      |
|-----------------------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-------------------|-------------------------|------------------|------------------|------|
| Parameter                               | Symbol                                                | Test Conditions<br>Otherwise Unless Specified<br>V+ = 3 V, ± 10 %, V <sub>IN</sub> = 0.6 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>        | 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> = 0.2 V/1.5 V, I <sub>NO</sub><br>I <sub>NC</sub> = 10 mA                         | Room<br>Full      |                         | 1.4<br>1.6       | 2.1<br>2.3       | Ω    |
| r <sub>ON</sub> Flatness                | r <sub>ON</sub><br>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              |                         |                  | 0.25             |      |
| Switch Off Leakage Current <sup>f</sup> | I <sub>NO(off)</sub><br>I <sub>NC(off)</sub>          | V+ = 3.3 V<br>V <sub>NO</sub> , V <sub>NC</sub> = 1 V/3 V, V <sub>COM</sub> = 3 V/1 V                          | Room<br>Full      | - 0.5<br>- 5.0          |                  | 0.5<br>5.0       | nA   |
|                                         | I <sub>COM(off)</sub>                                 |                                                                                                                | Room<br>Full      | - 0.5<br>- 5.0          |                  | 0.5<br>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<br>Full      | - 0.5<br>- 5.0          |                  | 0.5<br>5.0       |      |
| Digital Control                         |                                                       |                                                                                                                |                   |                         |                  |                  |      |
| 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   |
| Dynamic Characteristics                 |                                                       |                                                                                                                |                   |                         |                  |                  |      |
| 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<br>Figures 1 and 2  | Room<br>Full      |                         | 27               | 47<br>48         | ns   |
| Turn-Off Time                           | t <sub>OFF</sub>                                      |                                                                                                                | Room<br>Full      |                         | 17               | 37<br>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><br>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               |                  |      |
| Power Supply                            |                                                       |                                                                                                                |                   |                         |                  |                  |      |
| 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<br>Otherwise Unless Specified<br>V+ = 5 V, ± 10 %, V <sub>IN</sub> = 0.8 or 2.4 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> |      |
| Analog Switch                         |                                                       |                                                                                                                |                   |                         |                  |                  |      |
| 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+ = 4.5 V, V <sub>COM</sub> = 0.5 V/2.5 V<br>I <sub>NO</sub> , I <sub>NC</sub> = 10 mA                        | Room<br>Full      |                         | 1.0<br>1.2       | 1.8<br>1.9       | Ω    |
| r <sub>ON</sub> Flatness <sup>d</sup> | r <sub>ON</sub><br>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              |                         |                  | 0.25             |      |
| Switch Off Leakage Current            | I <sub>NO(off)</sub><br>I <sub>NC(off)</sub>          | V+ = 5.0 V<br>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<br>Full      | - 0.5<br>- 5.0          |                  | 0.5<br>5.0       | nA   |
|                                       | I <sub>COM(off)</sub>                                 |                                                                                                                | Room<br>Full      | - 0.5<br>- 5.0          |                  | 0.5<br>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<br>Full      | - 0.5<br>- 5.0          |                  | 0.5<br>5.0       |      |
| Digital Control                       |                                                       |                                                                                                                |                   |                         |                  |                  |      |
| 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   |
| Dynamic Characteristics               |                                                       |                                                                                                                |                   |                         |                  |                  |      |
| 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<br>Figures 1 and 2    | Room<br>Full      |                         | 17               | 38<br>39         | ns   |
| Turn-Off Time <sup>d</sup>            | t <sub>OFF</sub>                                      |                                                                                                                | Room<br>Full      |                         | 13               | 32<br>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><br>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               |                  |      |

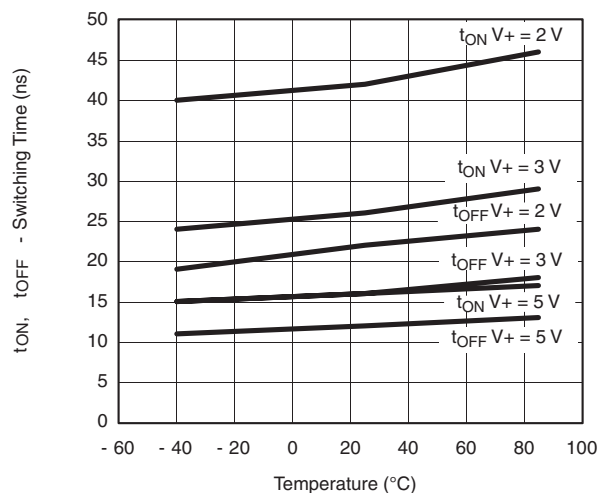
## Notes:

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

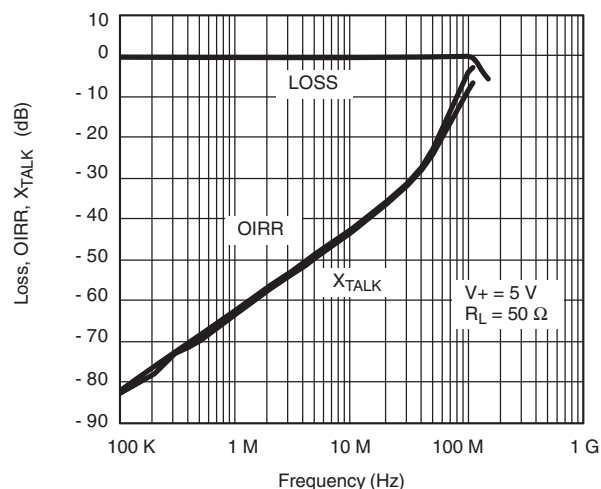
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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


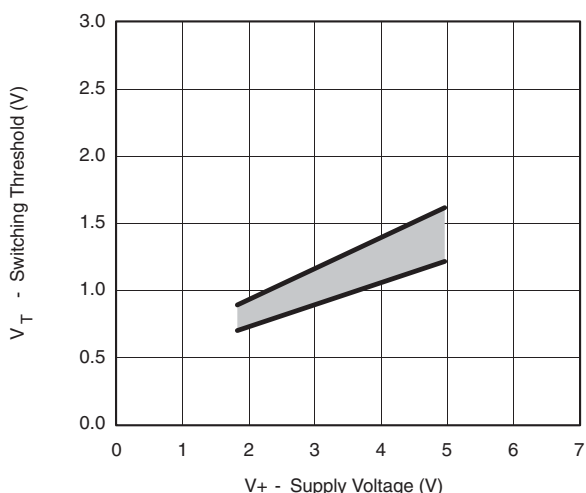
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



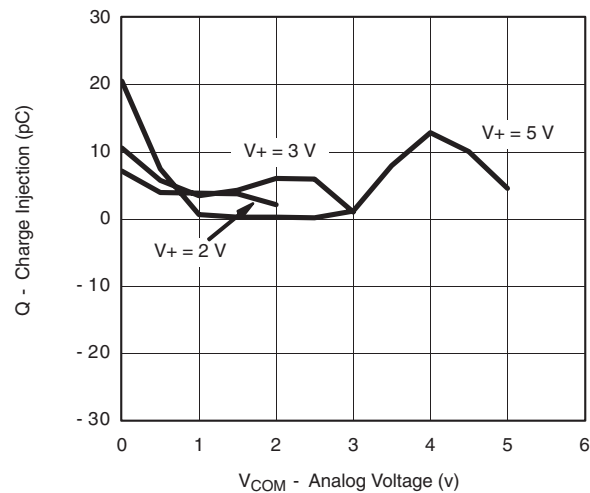
**Switching Time vs. Temperature and Supply Voltage**



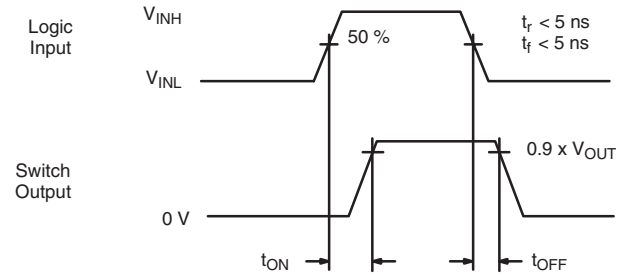
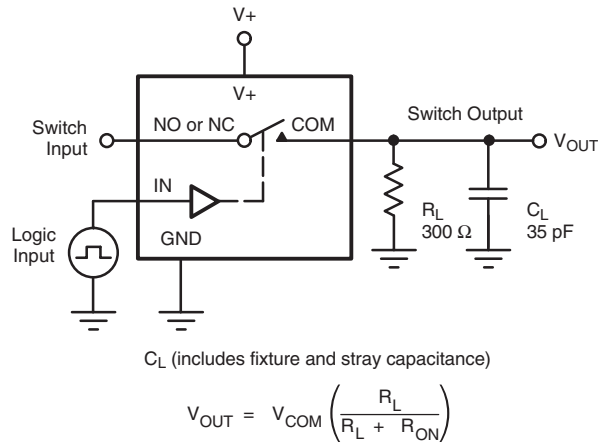
**Insertion Loss, Off-Isolation Crosstalk vs. Frequency**



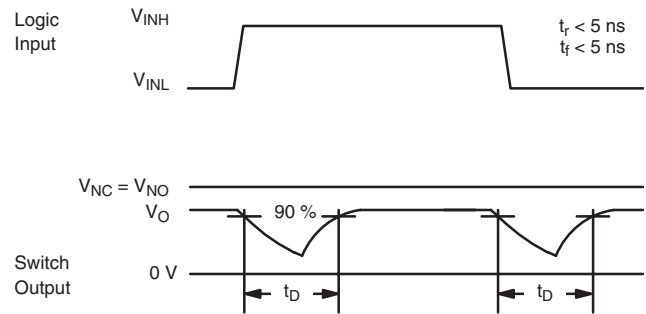
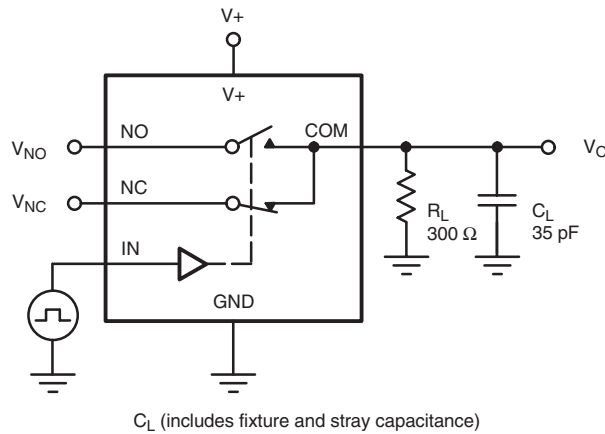
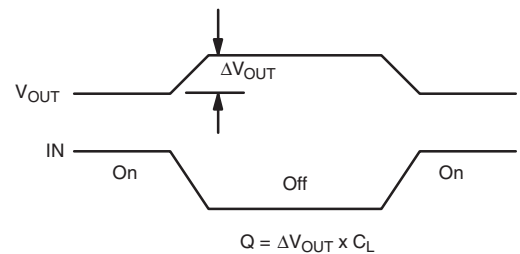
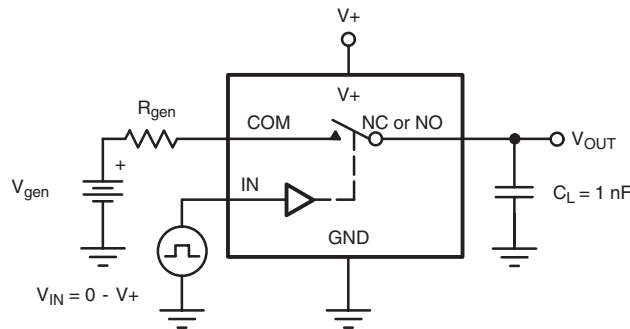
**Switching Threshold vs. Supply Voltage**



**Charge Injection vs. Analog Voltage**

**TEST CIRCUITS**


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

**Figure 1. Switching Time**

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


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

**Figure 3. Charge Injection**

TEST CIRCUITS

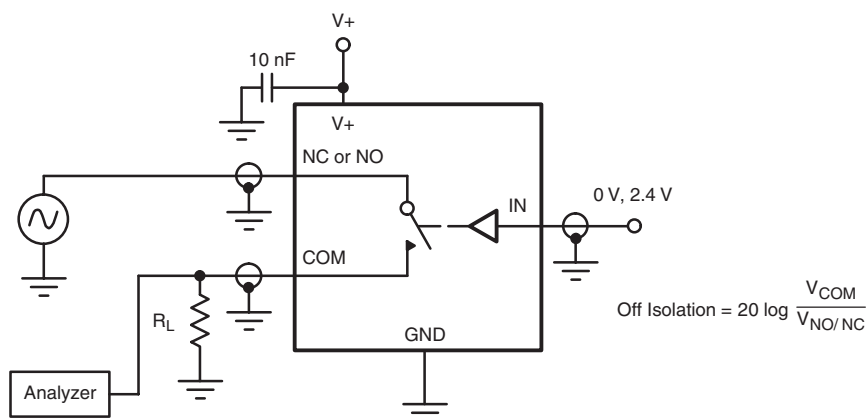


Figure 4. Off-Isolation

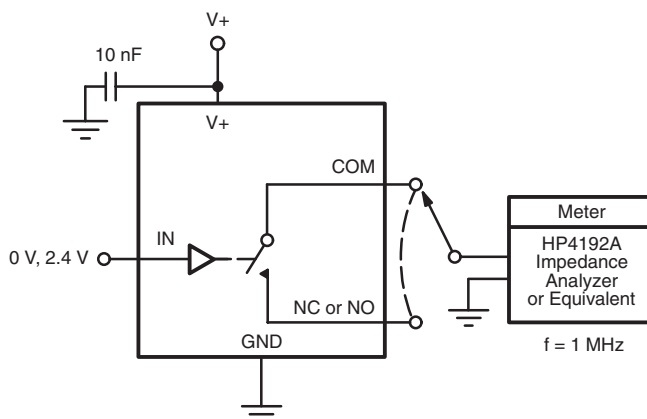


Figure 5. Channel Off/On Capacitance

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