



## Low-Voltage Dual SPST Analog Switch

### FEATURES

- Low Voltage Operation (1.8 V to 5.5 V)
- Low On-Resistance -  $r_{DS(on)}$ : 1.2  $\Omega$
- Fast Switching - 14 ns
- Low Charge Injection -  $Q_{INJ}$ : 1 pC
- Low Power Consumption
- TTL/CMOS Compatible
- MSOP-8 Package

### 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

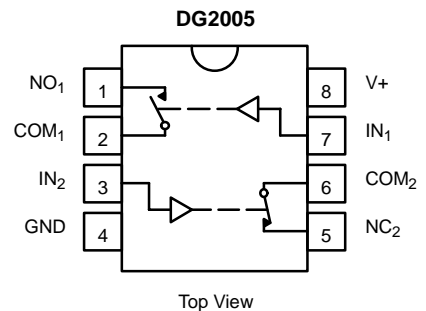
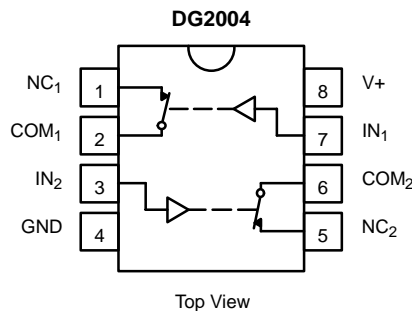
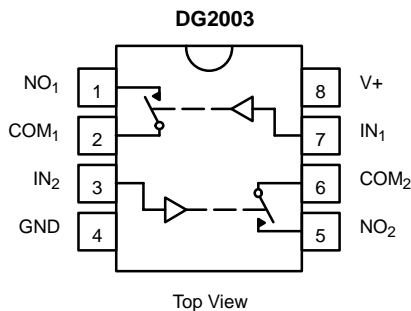
### DESCRIPTION

The DG2003/2004/2005 are dual single-pole/single-throw monolithic CMOS analog switch designed for high performance switching of analog signals. Combining low power, fast switching, low on-resistance ( $r_{DS(on)}$ : 1.2  $\Omega$ ) and small physical size (MSOP-8), the DG2003/2004/2005 are ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2003/2004/2005 are built on Vishay Siliconix's low voltage J12 process. An epitaxial layer prevents latchup.

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

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



| TRUTH TABLE - DG2003 |     |
|----------------------|-----|
| Logic                | NO  |
| 0                    | Off |
| 1                    | On  |

| TRUTH TABLE - DG2004 |     |
|----------------------|-----|
| Logic                | NC  |
| 0                    | On  |
| 1                    | Off |

| TRUTH TABLE - DG2005 |                 |                 |
|----------------------|-----------------|-----------------|
| Logic                | NO <sub>1</sub> | NC <sub>2</sub> |
| 0                    | Off             | On              |
| 1                    | On              | Off             |

| ORDERING INFORMATION |         |             |
|----------------------|---------|-------------|
| Temp Range           | Package | Part Number |
| -40 to 85°C          | MSOP-8  | DG2003DQ    |
|                      |         | DG2004DQ    |
|                      |         | DG2005DQ    |



**ABSOLUTE MAXIMUM RATINGS**

Reference to GND

|   |       |                      |
|---|-------|----------------------|
| V+  | ..... | -0.3 to +6 V         |
| IN, COM, NC, NO <sup>3</sup>                  | ..... | -0.3 to (V+ + 0.3 V) |
| Continuous Current (Any terminal)             | ..... | ±50 mA               |
| Peak Current (Pulsed at 1 ms, 10% duty cycle) | ..... | ±200 mA              |
| Storage Temperature (D Suffix)                | ..... | -65 to 150°C         |

Power Dissipation (Packages)<sup>b</sup>

|                     |       |        |
|---------------------|-------|--------|
| MSOP-8 <sup>c</sup> | ..... | 320 mW |
|---------------------|-------|--------|

- Notes:
- Signals on NC, NO, or COM or IN exceeding V+ will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
  - All leads welded or soldered to PC Board.
  - Derate 6.5 mW/°C above 25°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> |          |
| <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+ = 2.0 V, V <sub>COM</sub> = 1.0 V, I <sub>NO</sub> , I <sub>NC</sub> = 1 mA                                 | Room<br>Full <sup>d</sup> |                       | 7.0<br>12.5      | 10.0<br>16.0     | Ω        |
| r <sub>ON</sub> Flatness <sup>d</sup>   | r <sub>ON</sub><br>Flatness                             | V+ = 2.0 V, V <sub>COM</sub> = 0 to V+, I <sub>NO</sub> , I <sub>NC</sub> = 1 mA                               | Room                      |                       | 5                |                  |          |
| 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 <sup>d</sup> | -500<br>-4.0          |                  | 500<br>4.0       | pA<br>nA |
|   | I <sub>COM(off)</sub>                                   |  | Room<br>Full <sup>d</sup> | -500<br>-4.0          |                  | 500<br>4.0       | pA<br>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<br>Full <sup>d</sup> | -500<br>-4.0          |                  | 500<br>4.0       | pA<br>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                      |                       | 5                |                  | 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<br>Figures 1 and 2  | Room<br>Full <sup>d</sup> |                       | 30               | 47<br>48         | ns       |
| Turn-Off Time                           | t <sub>OFF</sub>  |  | Room<br>Full <sup>d</sup> |                       | 22               | 37<br>48         |          |
| 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                      |                       | 2                |                  | pC       |
| Off-Isolation <sup>d</sup>              | OIRR  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz  | Room                      |                       | -61              |                  | dB       |
| Crosstalk <sup>d</sup>                  | X <sub>TALK</sub>                                       |  | Room                      |                       | -67              |                  |          |
| 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                      |                       | 53               |                  | pF       |
| Channel-On Capacitance <sup>d</sup>     | C <sub>ON</sub>   |  | Room                      |                       | 110              |                  |          |
| <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+  |                           |                       | 0.02             | 1.0              | μA       |
| Power Consumption                       | P <sub>C</sub>  |  |                           |                       |                  |                  | 2.2      |



| SPECIFICATIONS (V+ = 3.0 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>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> = 1.5 V, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA                              | Room<br>Full      |                       | 2.2<br>2.4       | 3.5<br>3.7       | Ω        |
| r <sub>ON</sub> Flatness <sup>d</sup>   | 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              |                       | 0.5              |                  |          |
| 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      | -500<br>-6.0          |                  | 500<br>6.0       | pA<br>nA |
|   | I <sub>COM(off)</sub>                                   |  | Room<br>Full      | -500<br>-6.0          |                  | 500<br>6.0       | pA<br>nA |
| 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      | -500<br>-6.0          |                  | 500<br>6.0       | pA<br>nA |
| <b>Digital Control</b>                  |   |  |                   |                       |                  |                  |          |
| Input High Voltage                      | V <sub>INH</sub>  |  | Full              | 2                     |                  |                  | V        |
| Input Low Voltage                       | V <sub>INL</sub>  |  | Full              |                       |                  | 0.4              |          |
| Input Capacitance <sup>d</sup>          | C <sub>in</sub>   |  | Full              |                       | 5                |                  | 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 <sup>d</sup>               | 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>Figure 1 and 2 | Room<br>Full      |                       | 19               | 35<br>36         | ns       |
| Turn-Off Time <sup>d</sup>              | t <sub>OFF</sub>  |  | Room<br>Full      |                       | 17               | 31<br>34         |          |
| 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              |                       | 1                |                  | pC       |
| Off-Isolation <sup>d</sup>              | OIRR  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz  | Room              |                       | -61              |                  | dB       |
| Crosstalk <sup>d</sup>                  | X <sub>TALK</sub>                                       |  | Room              |                       | -67              |                  |          |
| 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              |                       | 53               |                  | pF       |
| Channel-On Capacitance <sup>d</sup>     | C <sub>ON</sub>   |  | Room              |                       | 110              |                  |          |
| <b>Power Supply</b>                     |   |  |                   |                       |                  |                  |          |
| Power Supply Range                      | V+  |  |                   | 2.7                   |                  | 3.3              | V        |
| Power Supply Current                    | I+  | V <sub>IN</sub> = 0 or V+  |                   |                       | 0.02             | 1.0              | μA       |
| Power Consumption                       | P <sub>C</sub>  |  |                   |                       |                  |                  | 3.3      |

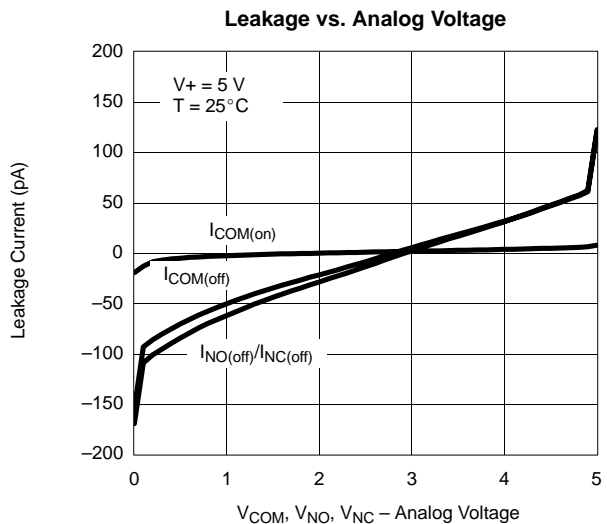
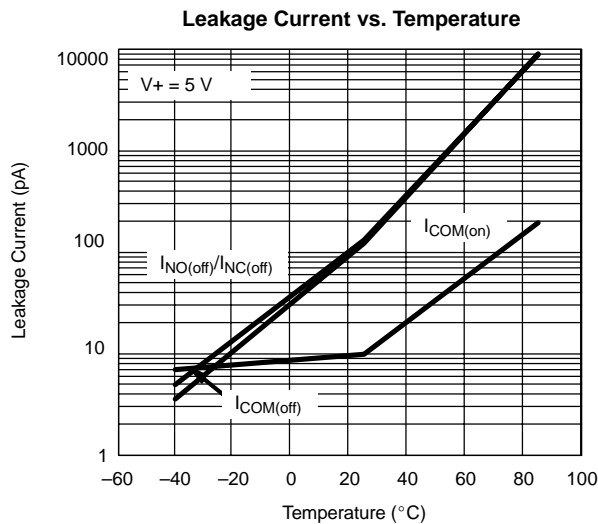
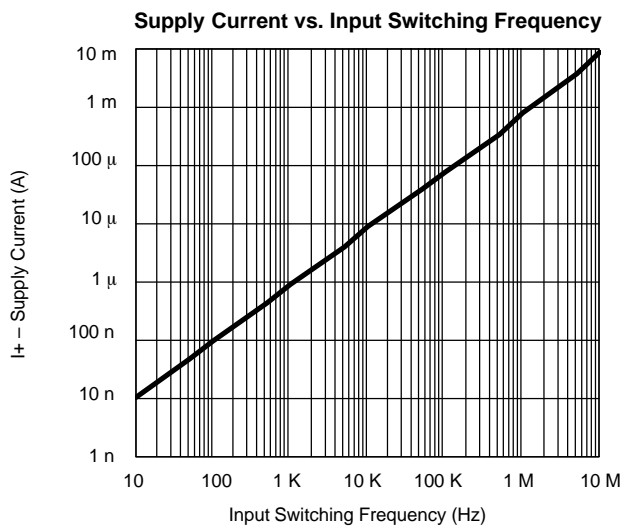
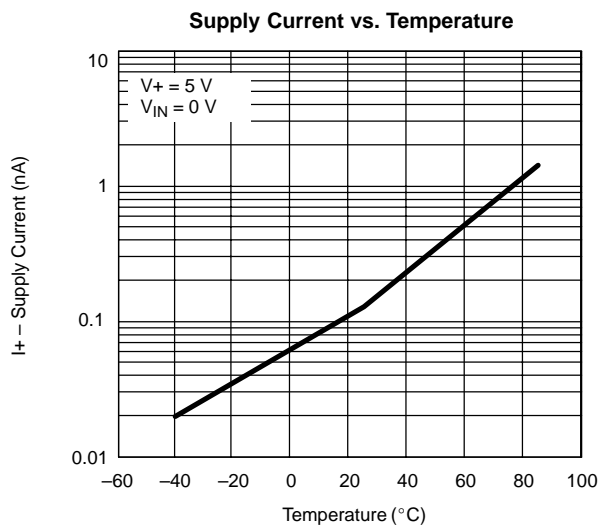
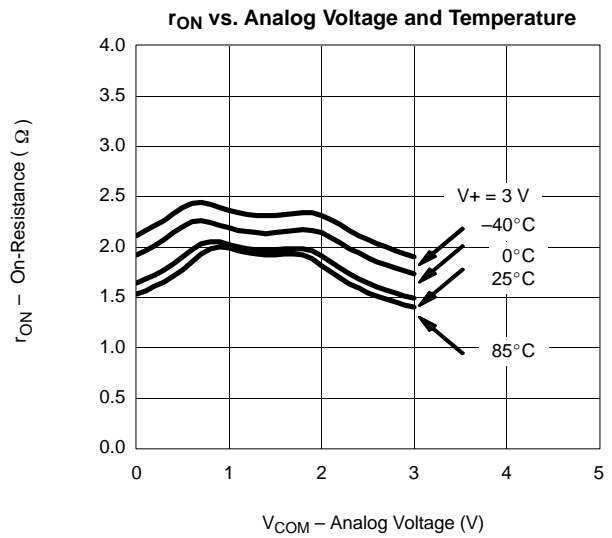
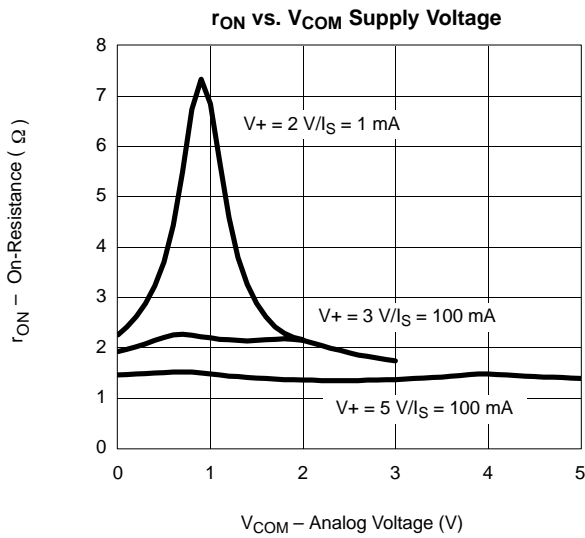


| SPECIFICATIONS (V+ = 5.0 V)           |   |  |                   |                       |                  |                  |      |
|---------------------------------------|---|--|-------------------|-----------------------|------------------|------------------|------|
| Parameter                             | Symbol  | Test Conditions<br>Otherwise Unless Specified<br>V+ = 5 V, ± 10%, VIN = 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> |      |
| <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+ = 4.5 V, V <sub>COM</sub> = 3 V, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA                              | Room<br>Full      |                       | 1.2<br>1.6       | 2.5<br>2.7       | 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              |                       | 0.2              |                  |      |
| Switch Off Leakage Current            | I <sub>NO(off)</sub> ,<br>I <sub>NC(off)</sub>          | V+ = 5.5 V<br>V <sub>NO</sub> , V <sub>NC</sub> = 1 V/4.5 V, V <sub>COM</sub> = 4.5 V/1 V                  | Room<br>Full      | -1.0<br>-8.0          |                  | 1.0<br>8.0       | nA   |
|                                       | I <sub>COM(off)</sub>                                   |  | Room<br>Full      | -1.0<br>-8.0          |                  | 1.0<br>8.0       |      |
| Channel-On Leakage Current            | I <sub>COM(on)</sub>                                    | V+ = 5.5 V, V+ = 5.5 V<br>V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 1 V/4.5 V                 | Room<br>Full      | -1.0<br>-8.0          |                  | 1.0<br>8.0       |      |
| <b>Digital Control</b>                |   |  |                   |                       |                  |                  |      |
| 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              |                       | 5                |                  | 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 <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>Figure 1 and 2 | Room<br>Full      |                       | 13               | 28<br>31         | ns   |
| Turn-Off Time <sup>d</sup>            | t <sub>OFF</sub>  |  | Room<br>Full      |                       | 19               | 22<br>31         |      |
| 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              |                       | 1                |                  | pC   |
| Off-Isolation <sup>d</sup>            | OIRR  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz  | Room              |                       | -61              |                  | dB   |
| Crosstalk <sup>d</sup>                | X <sub>TALK</sub>                                       |  | Room              |                       | -67              |                  |      |
| 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              |                       | 51               |                  | pF   |
| Channel-On Capacitance <sup>d</sup>   | C <sub>ON</sub>   |  | Room              |                       | 110              |                  |      |
| <b>Power Supply</b>                   |   |  |                   |                       |                  |                  |      |
| Power Supply Range                    | V+  |  |                   | 4.5                   |                  | 5.5              | V    |
| Power Supply Current                  | I+  | V <sub>IN</sub> = 0 or V+  |                   |                       | 0.02             | 1.0              | μA   |
| Power Consumption                     | P <sub>C</sub>  |  |                   |                       |                  |                  | 5.5  |

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.

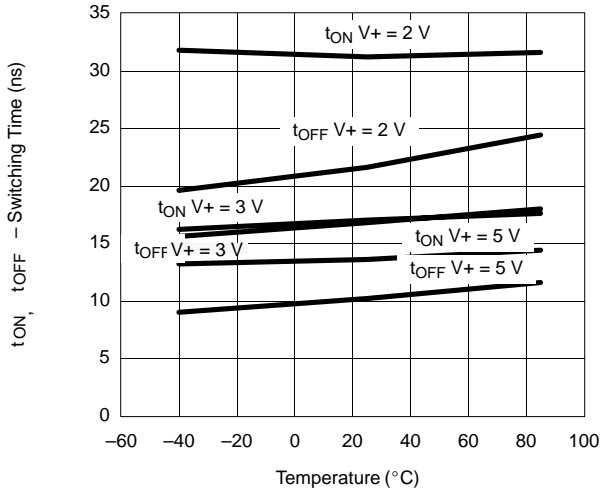
**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**



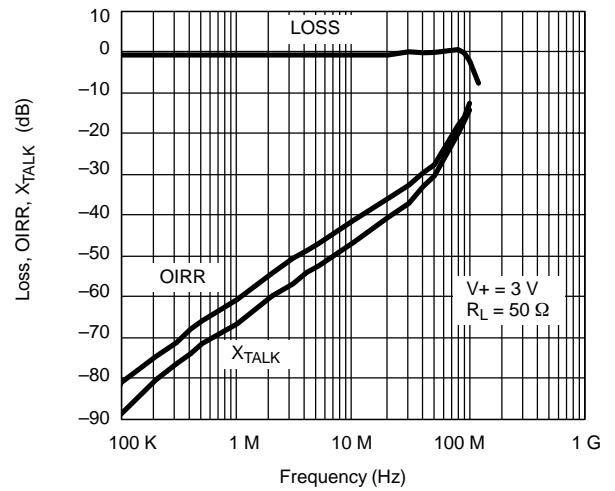


**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**

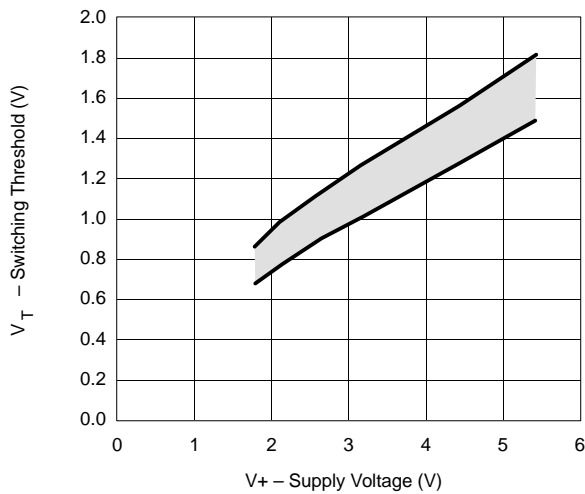
Switching Time vs. Temperature and Supply Voltage



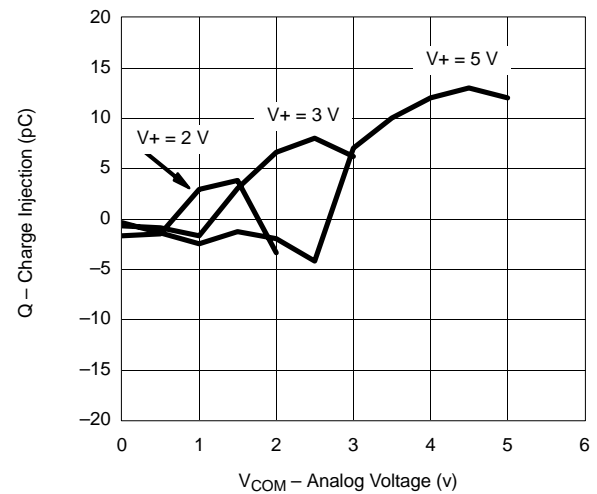
Insertion Loss, Off-Isolation, Crosstalk vs. Frequency

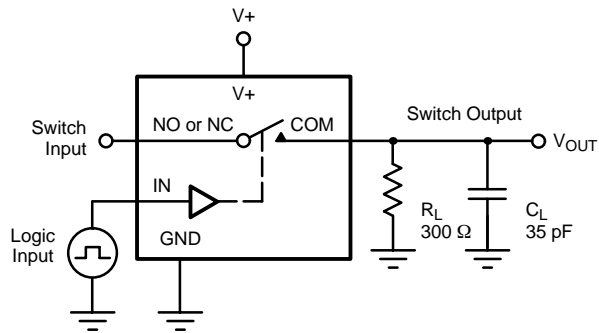


Switching Threshold vs. Supply Voltage



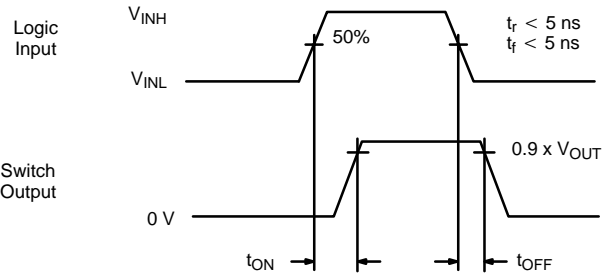
Charge Injection vs. Analog Voltage



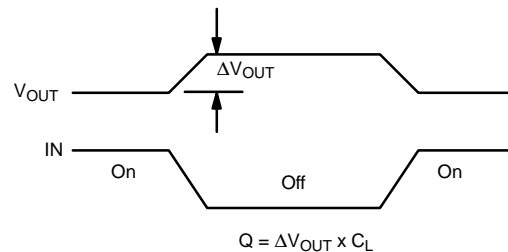
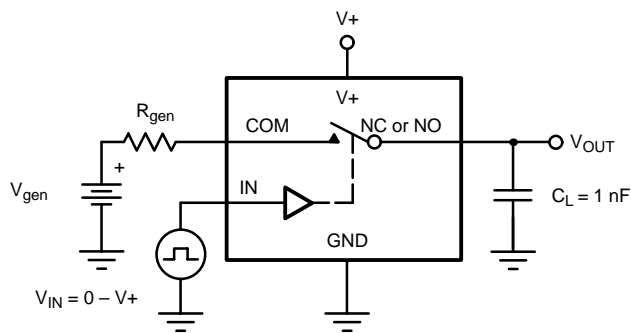
**TEST CIRCUITS**


$C_L$  (includes fixture and stray capacitance)

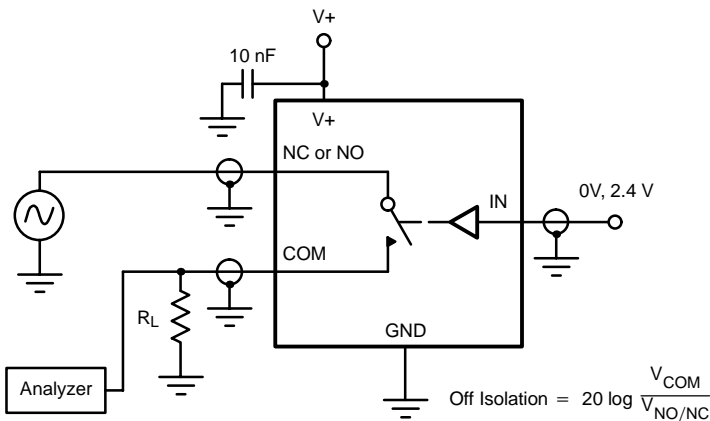
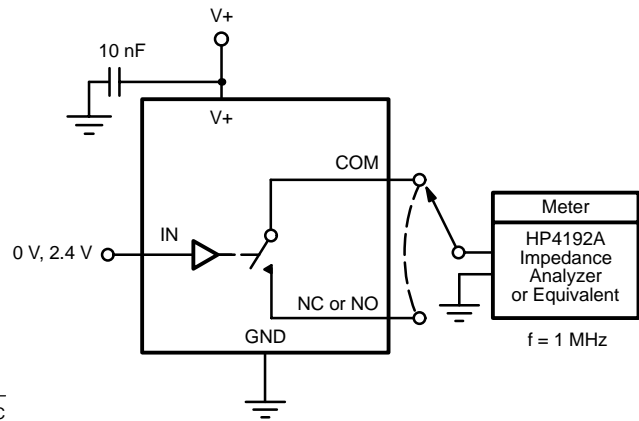
$$V_{OUT} = V_{COM} \left( \frac{R_L}{R_L + R_{ON}} \right)$$



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

**FIGURE 1. Switching Time**


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

**FIGURE 2. Charge Injection**

**FIGURE 3. Off-Isolation**

**FIGURE 4. Channel Off/On Capacitance**



## Disclaimer

All product specifications and data are subject to change without notice.

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