



## High-Bandwidth, Low Voltage, Dual SPDT Analog Switch

### FEATURES

- Single Supply (1.8 V to 5.5 V)
- Low On-Resistance -  $r_{ON}$ : 2.4  $\Omega$
- Crosstalk and Off Isolation: -81 dB @ 1 MHz
- MSOP-10 Package

### BENEFITS

- Reduced Power Consumption
- High Accuracy
- Reduce Board Space
- Low-Voltage Logic Compatible
- High Bandwidth

### APPLICATIONS

- Cellular Phones
- Speaker Headset Switching
- Audio and Video Signal Routing
- PCMCIA Cards
- Low-Voltage Data Acquisition
- ATE

### DESCRIPTION

The DG2016 is a monolithic CMOS dual single-pole/double-throw (SPDT) analog switch. It is specifically designed for low-voltage, high bandwidth applications.

The DG2016's on-resistance (3  $\Omega$  @ 2.7 V), matching and flatness are guaranteed over the entire analog voltage range. Wide dynamic performance is achieved with better than -80 dB for both cross-talk and off-isolation at 1 MHz.

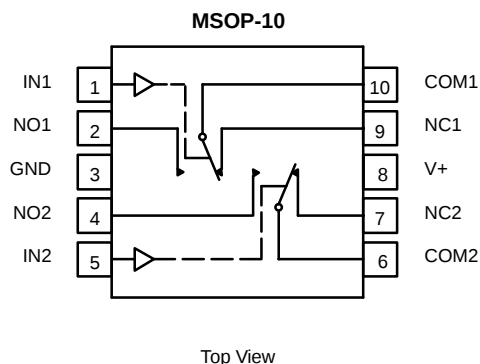
Both SPDT's operate with independent control logic, conduct equally well in both directions and block signals up to the

power supply level when off. Break-before-make is guaranteed.

With fast switching speeds, low on-resistance, high bandwidth, and low charge injection, the DG2016 is ideally suited for audio and video switching with high linearity.

Built on Vishay Siliconix's low voltage CMOS technology, the DG2016 contains an epitaxial layer which prevents latch-up.

### 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 | DG2016DQ    |

## ABSOLUTE MAXIMUM RATINGS

Reference to GND

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

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

|                      |       |        |
|----------------------|-------|--------|
| MSOP-10 <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 4.0 mW/°C above 70°C

| 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> |      |
| Analog Switch                           |                       |                                                                                                  |                   |                       |                  |                  |      |
| Analog Signal Range <sup>d</sup>        | VNO, VNC,<br>VCOM     |                                                                                                  | Full              | 0                     |                  | V+               | V    |
| On-Resistance                           | rON                   | V+ = 2.7 V, VCOM = 0.2 V/1.5 V<br>INO, INC = 10 mA                                               | Room<br>Full      |                       | 3.0              | 4.8<br>5.3       | Ω    |
| rON Flatness                            | rON<br>Flatness       | V+ = 2.7 V<br>VCOM = 0 to V+, INO, INC = 10 mA                                                   | Room              |                       |                  | 1.6              |      |
| rON Match Between Channels              | ΔrON                  |                                                                                                  | Room              |                       |                  | 0.2              |      |
| Switch Off Leakage Current <sup>f</sup> | INO(off),<br>INC(off) | V+ = 3.3 V, VNO, VNC = 1 V/3 V<br>VCOM = 3 V/1 V                                                 | Room<br>Full      | -0.25<br>-2.5         | 0.01             | 0.25<br>2.5      | nA   |
|                                         | ICOM(off)             |                                                                                                  | Room<br>Full      | -0.25<br>-2.5         | 0.01             | 0.25<br>2.5      |      |
| Channel-On Leakage Current <sup>f</sup> | ICOM(on)              | V+ = 3.3 V, VNO, VNC = VCOM = 1 V/3 V                                                            | Room<br>Full      | -0.25<br>-2.5         | 0.01             | 0.25<br>2.5      |      |
| Digital Control                         |                       |                                                                                                  |                   |                       |                  |                  |      |
| Input High Voltage <sup>d</sup>         | VINH                  |                                                                                                  | Full              | 1.6                   |                  |                  | V    |
| Input Low Voltage                       | VINL                  |                                                                                                  | Full              |                       |                  | 0.4              |      |
| Input Capacitance                       | Cin                   |                                                                                                  | Full              |                       | 5                |                  | pF   |
| Input Current                           | INL or INH            | VIN = 0 or V+                                                                                    | Full              | 1                     |                  | 1                | μA   |
| Dynamic Characteristics                 |                       |                                                                                                  |                   |                       |                  |                  |      |
| Turn-On Time                            | tON                   | VNO or VNC = 2.0 V, RL = 50 Ω, CL = 35 pF                                                        | Room<br>Full      |                       | 28               | 53<br>59         | ns   |
| Turn-Off Time                           | tOFF                  |                                                                                                  | Room<br>Full      |                       | 13               | 38<br>38         |      |
| Break-Before-Make Time                  | td                    | VNO or VNC = 2.0 V, RL = 50 Ω, CL = 35 pF                                                        | Full              | 1                     |                  |                  |      |
| Charge Injection <sup>d</sup>           | QINJ                  | CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω                                                                | Room              |                       | 38               |                  | pC   |
| Off-Isolation <sup>d</sup>              | OIRR                  | RL = 50 Ω, CL = 5 pF, f = 1 MHz                                                                  | Room              |                       | -78              |                  | dB   |
| Crosstalk <sup>d</sup>                  | XTALK                 |                                                                                                  | Room              |                       | -82              |                  |      |
| NO, NC Off Capacitance <sup>d</sup>     | CNO(off)              | VIN = 0 or V+, f = 1 MHz                                                                         | Room              |                       | 15               |                  | pF   |
|                                         | CNC(off)              |                                                                                                  | Room              |                       | 15               |                  |      |
| Channel-On Capacitance <sup>d</sup>     | CNO(on)               |                                                                                                  | Room              |                       | 49               |                  |      |
|                                         | CNC(on)               |                                                                                                  | Room              |                       | 45               |                  |      |
| Power Supply                            |                       |                                                                                                  |                   |                       |                  |                  |      |
| Power Supply Current                    | I+                    | VIN = 0 or V+                                                                                    | Full              |                       | 0.01             | 1.0              | μA   |

Notes:

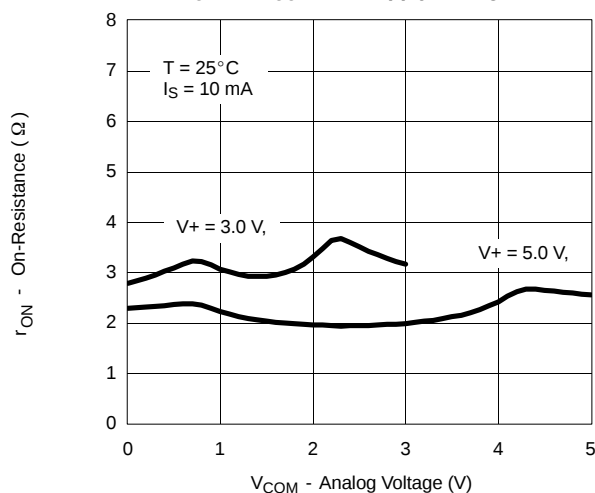
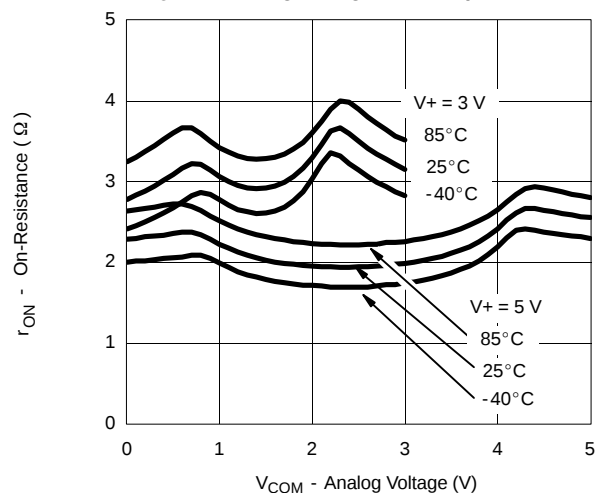
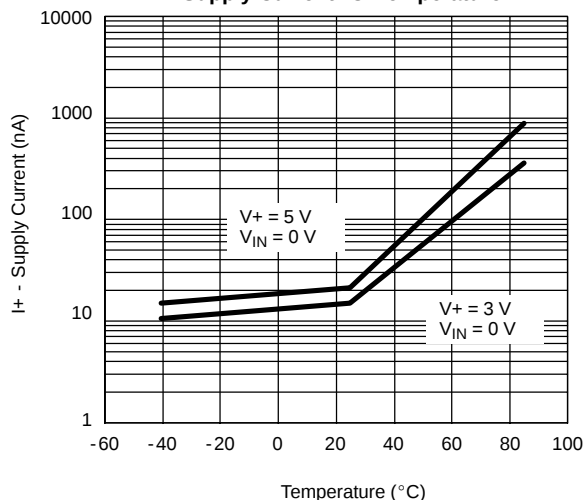
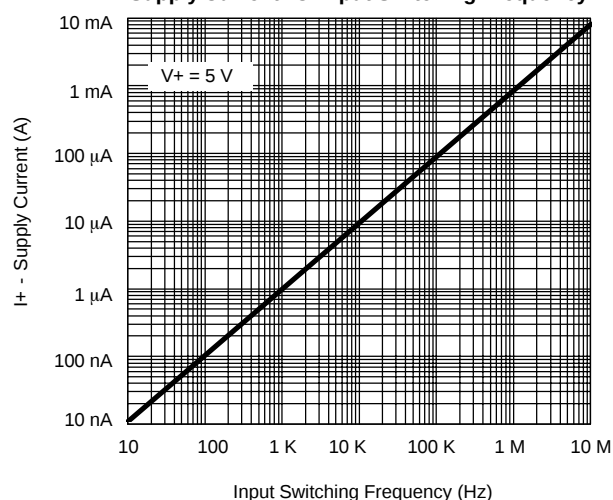
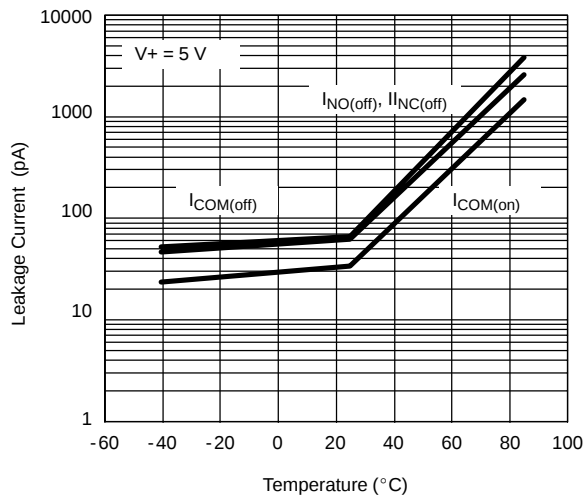
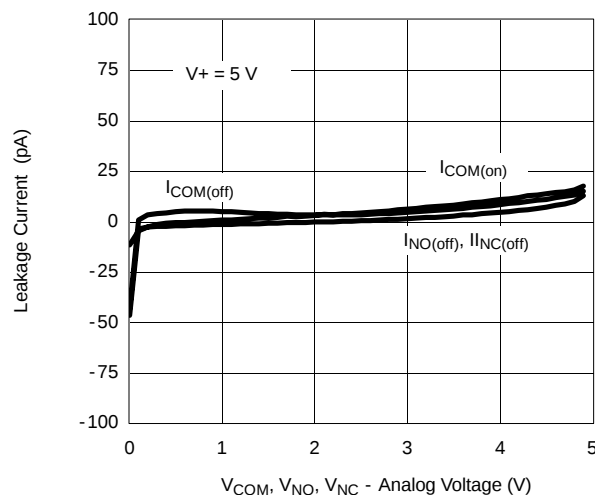
- Room = 25°C, Full = as determined by the operating suffix.
- Typical values are for design aid only, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guarantee by 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.



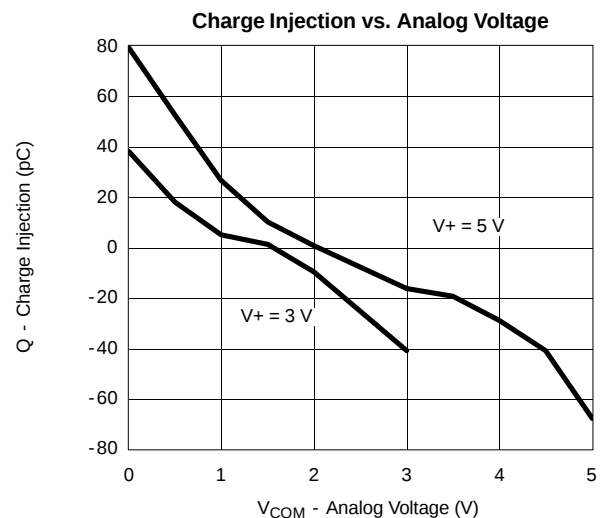
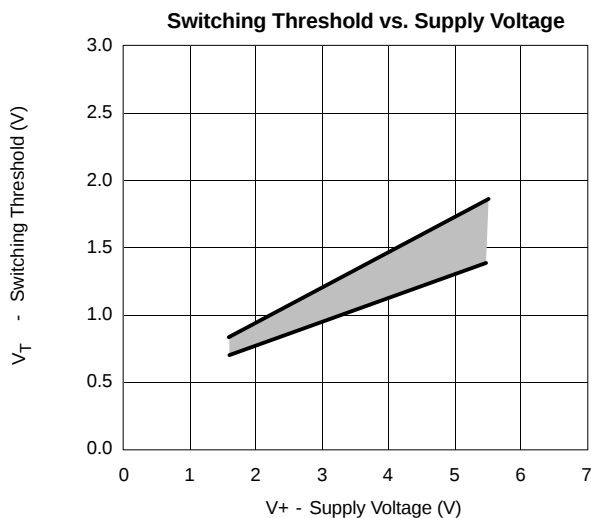
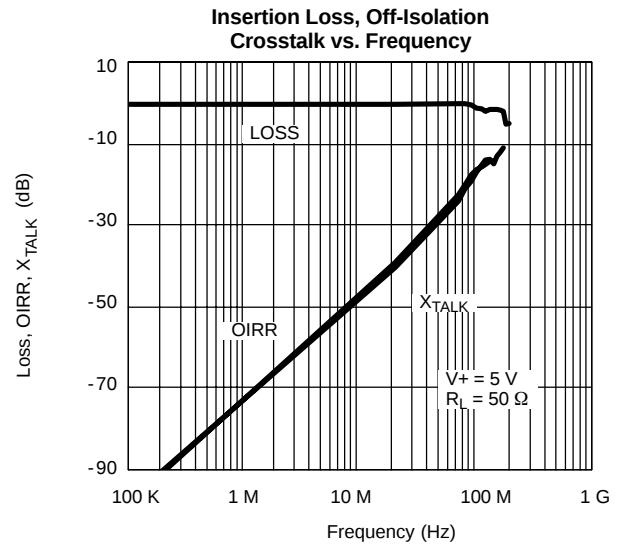
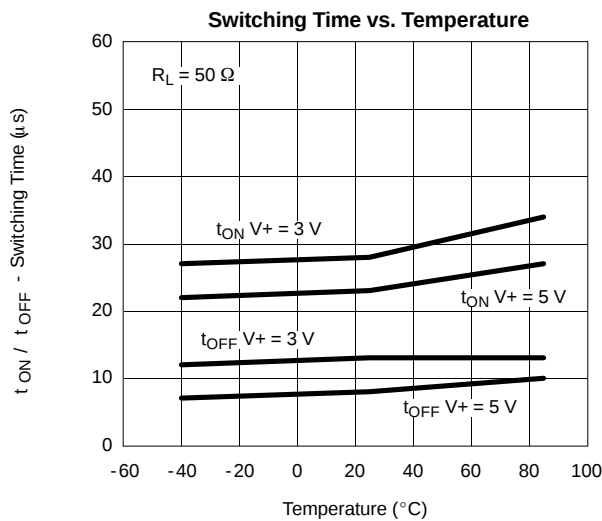
| SPECIFICATIONS (V+ = 5 V)           |                       |                                                                                                  |                   |                       |                  |                  |      |
|-------------------------------------|-----------------------|--------------------------------------------------------------------------------------------------|-------------------|-----------------------|------------------|------------------|------|
| 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> |      |
| Analog Switch                       |                       |                                                                                                  |                   |                       |                  |                  |      |
| Analog Signal Range <sup>d</sup>    | VNO, VNC,<br>VCOM     |                                                                                                  | Full              | 0                     |                  | V+               | V    |
| On-Resistance                       | rON                   | V+ = 4.5 V, VCOM = 3 V, INO, INC = 10 mA                                                         | Room<br>Full      |                       | 2.4              | 4.0<br>4.3       | Ω    |
| rON Flatness                        | rON<br>Flatness       | V+ = 4.5 V, VCOM = 0 to V+, INO, INC = 10 mA                                                     | Room              |                       |                  | 1.2              |      |
| rON Match Between Channels          | ΔrON                  |                                                                                                  | Room              |                       |                  | 0.2              |      |
| Switch Off Leakage Current          | INO(off),<br>INC(off) | V+ = 5.5 V<br>VNO, VNC = 1 V/4.5 V, VCOM = 4.5 V/1 V                                             | Room<br>Full      | -0.25<br>-2.5         | 0.01             | 0.25<br>2.5      | nA   |
|                                     | ICOM(off)             |                                                                                                  | Room<br>Full      | -0.25<br>-2.5         | 0.01             | 0.25<br>2.5      |      |
| Channel-On Leakage Current          | ICOM(on)              | V+ = 5.5 V, VNO, VNC = VCOM = 1 V/4.5 V                                                          | Room<br>Full      | -0.25<br>-2.5         | 0.01             | 0.25<br>2.5      |      |
| Digital Control                     |                       |                                                                                                  |                   |                       |                  |                  |      |
| Input High Voltage <sup>d</sup>     | VINH                  |                                                                                                  | Full              | 2.0                   |                  |                  | V    |
| Input Low Voltage                   | VINL                  |                                                                                                  | Full              |                       |                  | 0.8              |      |
| Input Capacitance                   | Cin                   |                                                                                                  | Full              |                       | 5                |                  | pF   |
| Input Current                       | IINL or IINH          | VIN = 0 or V+                                                                                    | Full              | 1                     |                  | 1                | μA   |
| Dynamic Characteristics             |                       |                                                                                                  |                   |                       |                  |                  |      |
| Turn-On Time                        | tON                   | VNO or VNC = 3 V, RL = 50 Ω, CL = 35 pF                                                          | Room<br>Full      |                       | 23               | 48<br>52         | ns   |
| Turn-Off Time                       | tOFF                  |                                                                                                  | Room<br>Full      |                       | 8                | 33<br>35         |      |
| Break-Before-Make Time              | td                    | VNO or VNC = 3 V, RL = 50 Ω, CL = 35 pF                                                          | Full              | 1                     |                  |                  |      |
| Charge Injection <sup>d</sup>       | QINJ                  | CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω                                                                | Room              |                       | 79               |                  | pC   |
| Off-Isolation <sup>d</sup>          | OIRR                  | RL = 50 Ω, CL = 5 pF, f = 1 MHz                                                                  | Room              |                       | -81              |                  | dB   |
| Crosstalk <sup>d</sup>              | XTALK                 |                                                                                                  | Room              |                       | -82              |                  |      |
| Source-Off Capacitance <sup>d</sup> | CNO(off)              | VIN = 0 or V+, f = 1 MHz                                                                         | Room              |                       | 14               |                  | pF   |
|                                     | CNC(off)              |                                                                                                  | Room              |                       | 14               |                  |      |
| Channel-On Capacitance <sup>d</sup> | CNO(on)               |                                                                                                  | Room              |                       | 48               |                  |      |
|                                     | CNC(on)               |                                                                                                  | Room              |                       | 44               |                  |      |
| Power Supply                        |                       |                                                                                                  |                   |                       |                  |                  |      |
| Power Supply Range                  | V+                    |                                                                                                  |                   | 1.8                   |                  | 5.5              | V    |
| Power Supply Current                | I+                    | VIN = 0 or V+                                                                                    | Full              |                       | 0.01             | 1.0              | μA   |

## Notes:

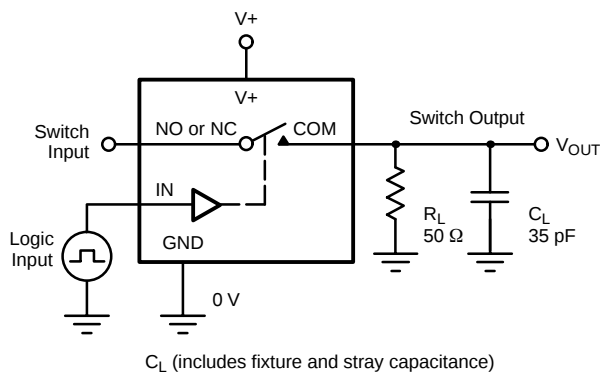
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- $V_{IN}$  = input voltage to perform proper function.
- Guaranteed by 5-V leakage testing, not production tested.

**TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)**
 **$r_{ON}$  vs.  $V_{COM}$  and Supply Voltage**

 **$r_{ON}$  vs. Analog Voltage and Temperature**

**Supply Current vs. Temperature**

**Supply Current vs. Input Switching Frequency**

**Leakage Current vs. Temperature**

**Leakage vs. Analog Voltage**


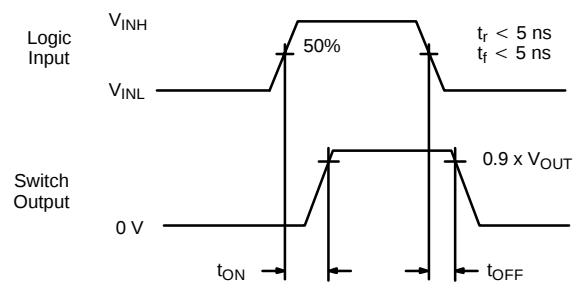
**TYPICAL CHARACTERISTICS (25 °C UNLESS NOTED)**



**TEST CIRCUITS**



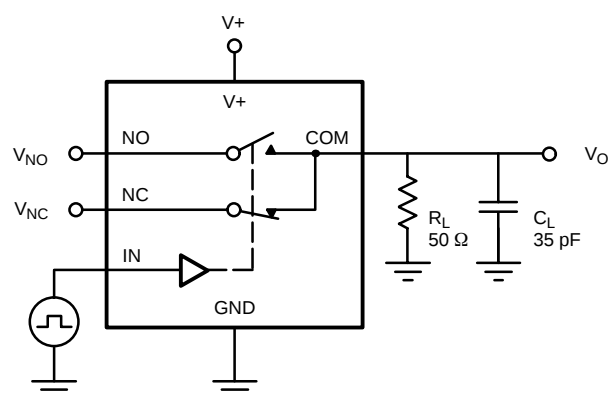
$$V_{OUT} = V_{COM} \left( \frac{R_L}{R_L + R_{ON}} \right)$$



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

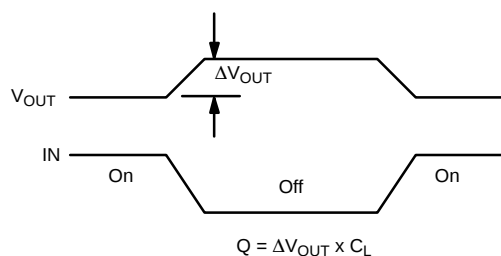
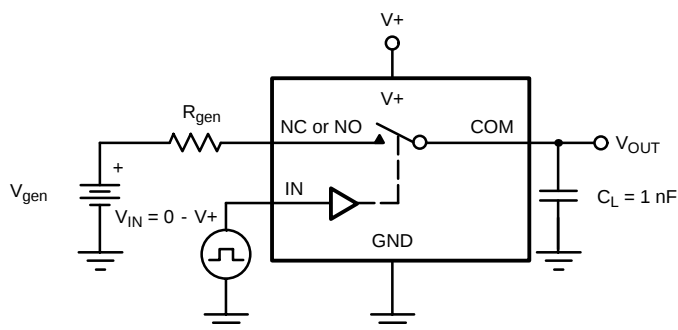
**FIGURE 1. Switching Time**

TEST CIRCUITS



$C_L$  (includes fixture and stray capacitance)

FIGURE 5. Break-Before-Make Interval



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

FIGURE 2. Charge Injection

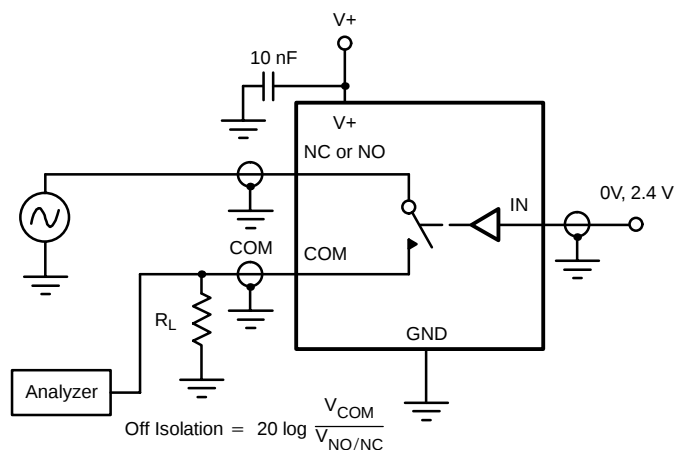


FIGURE 3. Off-Isolation

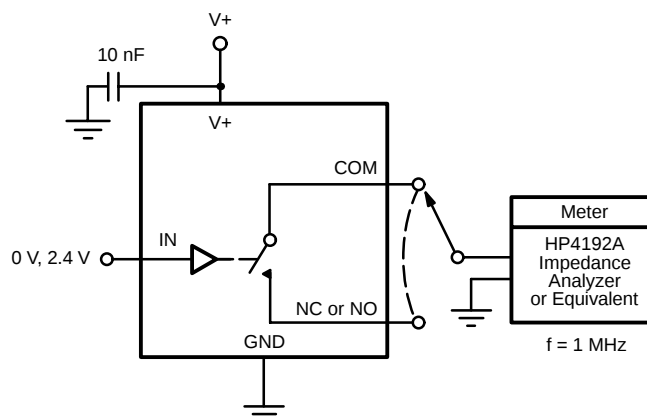


FIGURE 4. Channel Off/On Capacitance