

# Low-Voltage, 0.4 $\Omega$ $R_{ON}$ , Single SPST Analog Switch

## DESCRIPTION

The DG2715, DG2716 are low voltage, single supply, dual SPST analog switches. Designed for high performance switching of analog signals, the DG2715/2716 provide low on-resistance (0.4  $\Omega$  at + 2.7 V), fast speed ( $t_{ON}$ ,  $t_{OFF}$  at 17 ns and 14 ns) and the ability to handle signals over the entire analog voltage range.

When operated on a + 3 V supply, control pins are compatible with 1.8 V digital logic. Additionally, on-resistance flatness and matching (0.05  $\Omega$  and 0.1  $\Omega$ ) offer high accuracy between channels.

Built on Vishay Siliconix's low voltage submicron CMOS process, the DG2715, DG2716 were designed to offer solutions that extend beyond audio/video functions, to providing the performance required for today's demanding mixed-signal switching in portable applications.

The DG2715 contains a normally open (NO) switch, and the DG2716 contains a normally closed switch. An epitaxial layer prevents latch-up. All switches conduct equally well in both directions when on, and block up to the power supply level when off.

As a committed partner to the community and the environment, Vishay Siliconix manufactures this product with the lead (Pb)-free device terminations. For analog switching products manufactured with 100 % matte tin device terminations, the lead (Pb)-free "E3" suffix is being used as a designator.

## FEATURES

- Low voltage operation (1.6 V to 3.6 V)
- Low on-resistance -  $R_{DS(on)}$ : 0.4  $\Omega$  at 2.7 V
- Off-isolation: - 57 dB at 1 MHz
- Fast switching: 25 ns  $t_{ON}$
- Low charge injection -  $Q_{INJ}$ : 9 pC
- Low power consumption: < 1  $\mu$ W
- SC-70 5-lead package


**RoHS**  
COMPLIANT

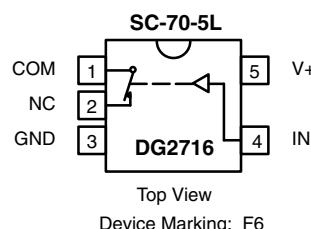
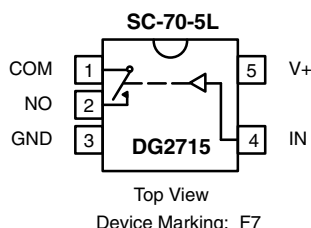
## BENEFITS

- High accuracy
- High bandwidth
- TTL and low voltage logic compatibility
- Low power consumption
- Reduced PCB space

## APPLICATIONS

- Mixed signal routing
- Portable and battery operated systems
- Low voltage data acquisition
- Modems
- PCMCIA cards

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION


**TRUTH TABLE (DG2715)**

| Logic | Switch |
|-------|--------|
| 0     | OFF    |
| 1     | ON     |

**TRUTH TABLE (DG2716)**

| Logic | Switch |
|-------|--------|
| 0     | ON     |
| 1     | OFF    |

**ORDERING INFORMATION**

| Temp. Range      | Package | Part Number    |
|------------------|---------|----------------|
| - 40 °C to 85 °C | SC70-5  | DG2715DL-T1-E3 |
|                  |         | DG2716DL-T1-E3 |

**ABSOLUTE MAXIMUM RATINGS**

| Parameter                                      | Limit                    | Unit |
|------------------------------------------------|--------------------------|------|
| Reference V+ to GND                            | - 0.3 to + 4             | V    |
| IN, COM, NC, NO <sup>a</sup>                   | - 0.3 to (V+ + 0.3 V)    |      |
| Continuous Current (NO, NC and COM Pins)       | ± 200                    | mA   |
| Peak Current (Pulsed at 1 ms, 10 % duty cycle) | ± 300                    |      |
| Storage Temperature                            | (D Suffix)               | °C   |
| Power Dissipation (Packages) <sup>b</sup>      | 5-Pin SC-70 <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+ = 1.8 V)**

| Parameter                                                    | Symbol                                                  | Test Conditions<br>Otherwise Unless Specified<br>V+ = 1.8 V, ± 10 %, V <sub>IN</sub> = 0.4 V or 1.0 V <sup>e</sup> | Temp. <sup>a</sup>        | Limits<br>- 40 °C 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> = 0.9 V<br>I <sub>NO</sub> , I <sub>NC</sub> = 10 mA                                  | Room<br>Full <sup>d</sup> |                            | 0.7               | 1.5<br>2.0        | Ω    |
| Switch Off Leakage Current <sup>f</sup>                      | I <sub>NO(off)</sub><br>I <sub>NC(off)</sub>            | V+ = 2.0 V,<br>V <sub>NO</sub> , V <sub>NC</sub> = 0.2 V/1.8 V, V <sub>COM</sub> = 1.8 V/0.2 V                     | Room<br>Full <sup>d</sup> | - 1<br>- 10                |                   | 1<br>10           | nA   |
|                                                              | I <sub>COM(off)</sub>                                   |                                                                                                                    | Room<br>Full <sup>d</sup> | - 1<br>- 10                |                   | 1<br>10           |      |
| Channel-On Leakage Current <sup>f</sup>                      | I <sub>COM(on)</sub>                                    | V+ = 2.0 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 0.2 V/1.8 V                                     | Room<br>Full <sup>d</sup> | - 1<br>- 10                |                   | 1<br>10           |      |
| Digital Control                                              |                                                         |                                                                                                                    |                           |                            |                   |                   |      |
| Input High Voltage                                           | V <sub>INH</sub>                                        |                                                                                                                    | Full                      | 1.0                        |                   |                   | V    |
| Input Low Voltage                                            | V <sub>INL</sub>                                        |                                                                                                                    | Full                      |                            |                   | 0.4               |      |
| Input Capacitance <sup>d</sup>                               | C <sub>in</sub>                                         |                                                                                                                    | Full                      |                            | 4                 |                   | 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> = 50 Ω, C <sub>L</sub> = 35 pF<br>figures1 and 2        | Room<br>Full <sup>d</sup> |                            | 24                | 36                | ns   |
| Turn-Off Time <sup>d</sup>                                   | t <sub>OFF</sub>                                        |                                                                                                                    | Room<br>Full <sup>d</sup> |                            | 21                | 33                |      |
| 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                      |                            | 13                |                   | pC   |
| Off-Isolation <sup>d</sup>                                   | OIRR                                                    | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz                                                            | Room                      |                            | - 57              |                   | dB   |
| 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                      |                            | 78                |                   | pF   |
| Channel-On Capacitance <sup>d</sup>                          | C <sub>ON</sub>                                         |                                                                                                                    | Room                      |                            | 93                |                   |      |



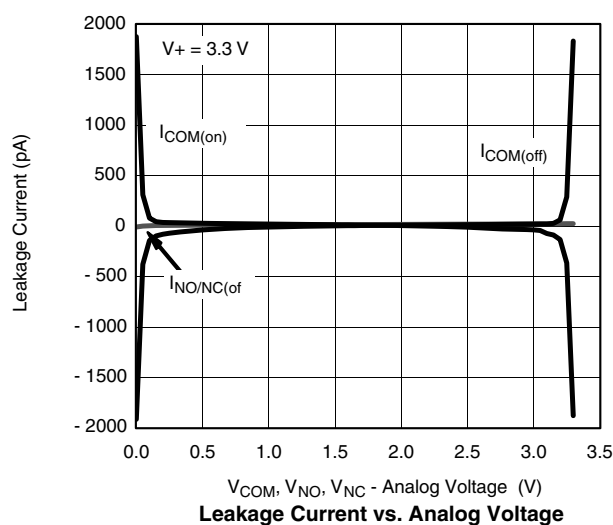
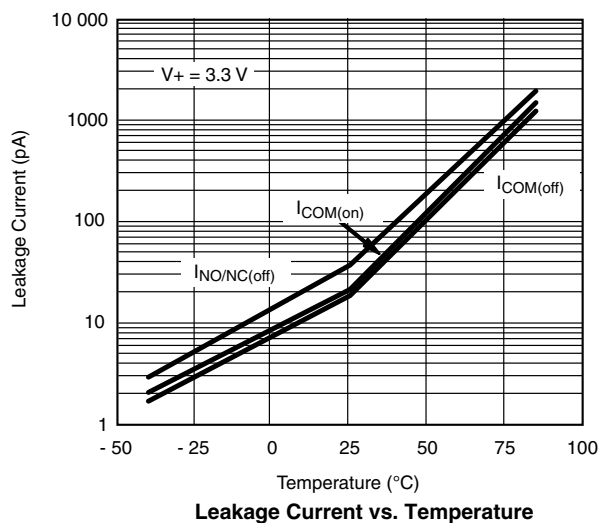
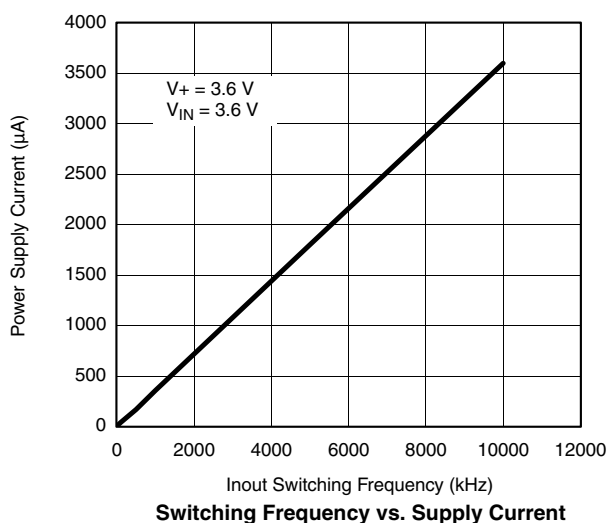
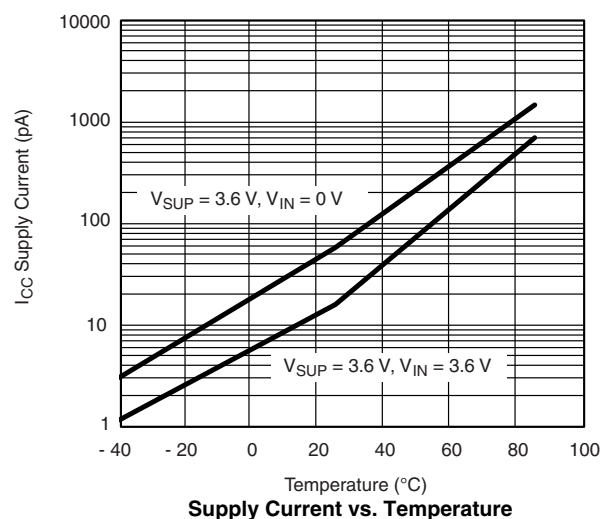
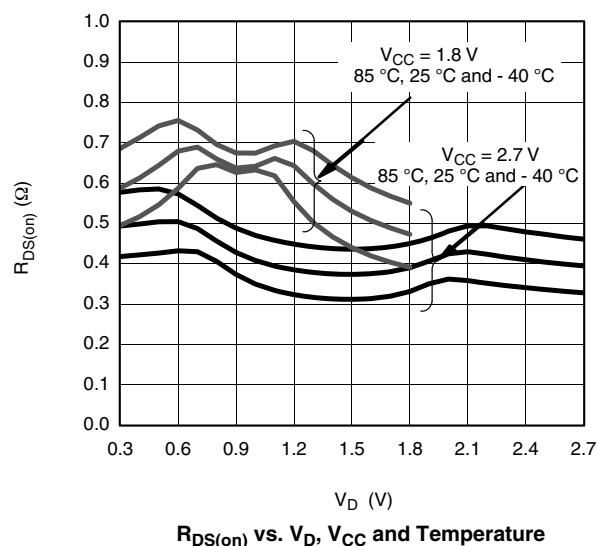
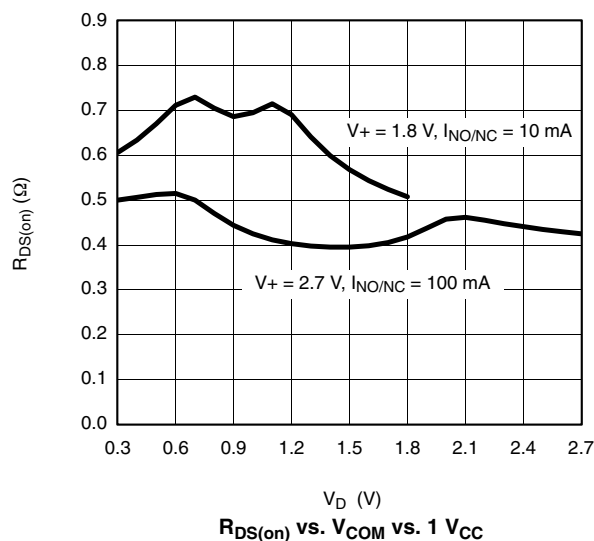
| SPECIFICATIONS (V+ = 3.0 V)         |                      |                                                                                                     |                    |                            |                   |                   |      |
|-------------------------------------|----------------------|-----------------------------------------------------------------------------------------------------|--------------------|----------------------------|-------------------|-------------------|------|
| Parameter                           | Symbol               | Test Conditions<br>Otherwise Unless Specified<br>V+ = 3 V, ± 10 %,VIN = 0.5 V or 1.4 V <sup>e</sup> | Temp. <sup>a</sup> | Limits<br>- 40 °C 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 = 1.5 V<br>INO, INC = 100 mA                                                       | Room<br>Full       |                            | 0.4               | 0.6               | Ω    |
| RON Flatness                        | RON<br>Flatness      | V+ = 2.7 V, VCOM = 0.6 V, 1.5 V, 2.1 V<br>INO, INC = 100 mA                                         | Room               |                            | 0.1               | 0.2               |      |
| Switch Off Leakage Current          | INO(off)<br>INC(off) | V+ = 3.3 V,<br>VNO, VNC = 0.3 V/3 V, VCOM = 3 V/0.3 V                                               | Room<br>Full       | - 1<br>- 10                |                   | 1<br>10           | nA   |
|                                     | ICOM(off)            |                                                                                                     | Room<br>Full       | - 1<br>- 10                |                   | 1<br>10           |      |
| Channel-On Leakage Current          | ICOM(on)             | V+ = 3.3 V, VNO, VNC = VCOM = 0.3 V/3 V                                                             | Room<br>Full       | - 1<br>- 10                |                   | 1<br>10           |      |
| Digital Control                     |                      |                                                                                                     |                    |                            |                   |                   |      |
| Input High Voltage                  | VINH                 |                                                                                                     | Full               | 1.4                        |                   |                   | V    |
| Input Low Voltage                   | VINL                 |                                                                                                     | Full               |                            |                   | 0.5               |      |
| Input Capacitance <sup>d</sup>      | 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 = 1.5 V, RL = 50 Ω, CL = 35 pF<br>Figure 1                                               | Room<br>Full       |                            | 17                | 29                | ns   |
| Turn-Off Time                       | tOFF                 |                                                                                                     | Room<br>Full       |                            | 14                | 26                |      |
| Charge Injection <sup>d</sup>       | QINJ                 | CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω, figure 3                                                         | Room               |                            | 9                 |                   | pC   |
| Off-Isolation <sup>d</sup>          | OIRR                 | RL = 50 Ω, CL = 5 pF, f = 1 MHz                                                                     | Room               |                            | - 57              |                   | dB   |
| NO, NC Off Capacitance <sup>d</sup> | CNO(off)<br>CNC(off) | VIN = 0 or V+, f = 1 MHz                                                                            | Room               |                            | 72                |                   | pF   |
| Channel-On Capacitance <sup>d</sup> | CON                  |                                                                                                     | Room               |                            | 92                |                   |      |
| Power Supply                        |                      |                                                                                                     |                    |                            |                   |                   |      |
| Power Supply Range                  | V+                   |                                                                                                     |                    | 1.5                        |                   | 3.6               | V    |
| Power Supply Current                | I+                   | V+ = 3.6 V, VIN = 0 or V+                                                                           |                    |                            | 0.01              | 1.0               | μA   |

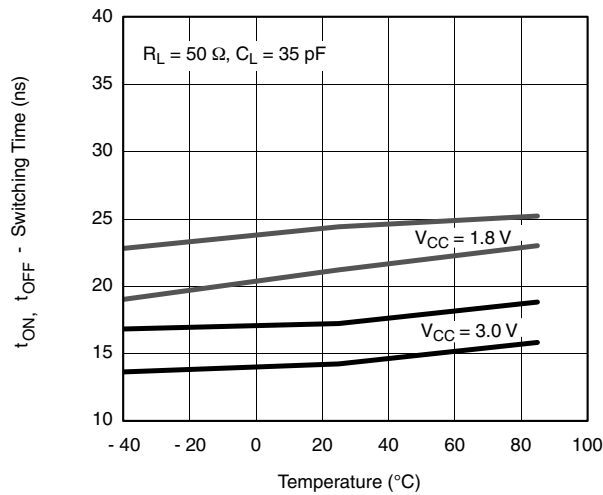
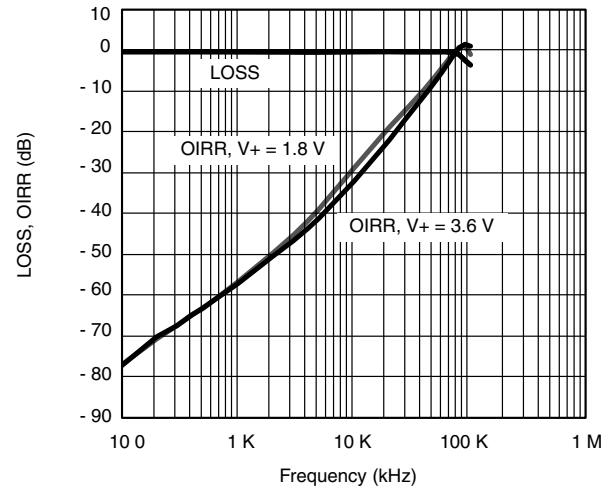
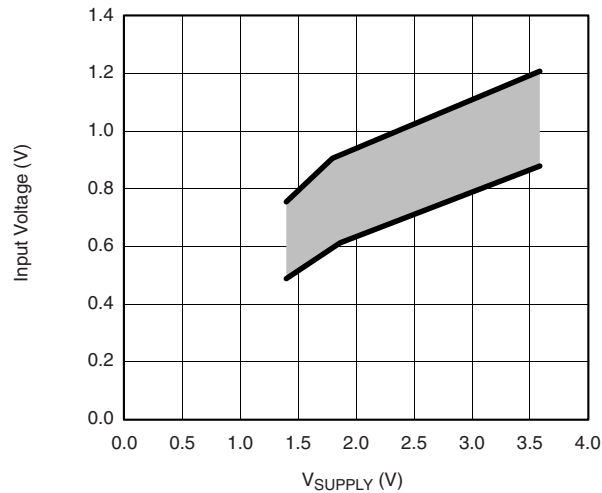
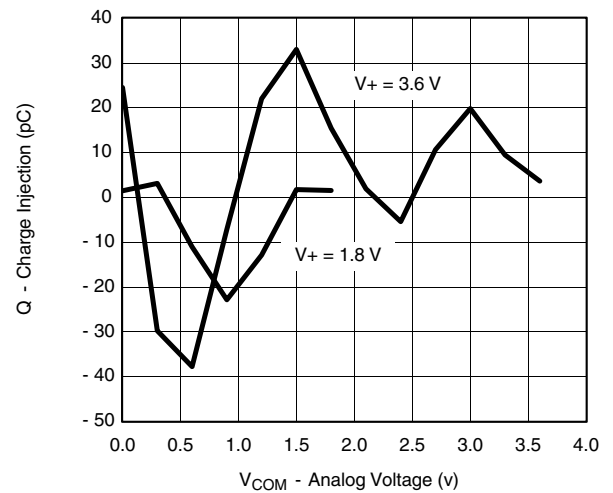
Notes:

- 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.
- $V_{IN}$  = input voltage to perform proper function.
- Guaranteed by 3 V leakage testing, not production tested.

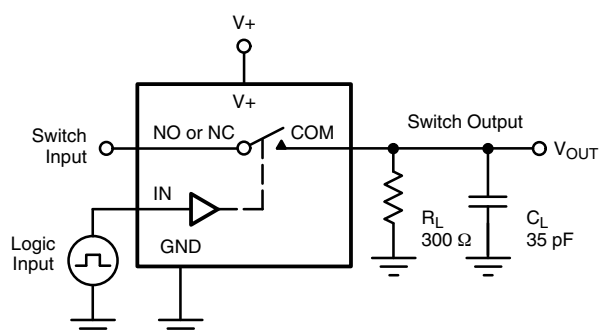
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

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



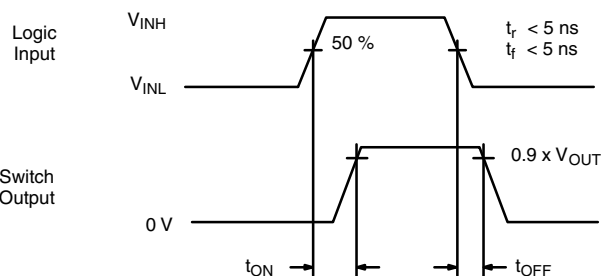
**TYPICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)

**Switching Time vs.  $V_{CC}$  and Temperature**

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

**Threshold vs. Supply Voltage**

**Charge Injection vs. Analog Voltage**

## TEST CIRCUITS



$C_L$  (includes fixture and stray capacitance)

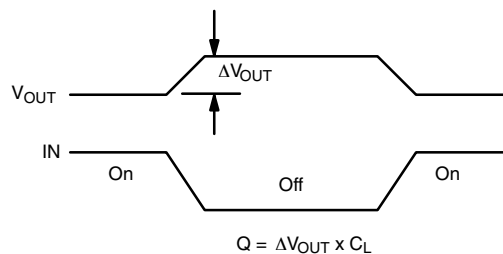
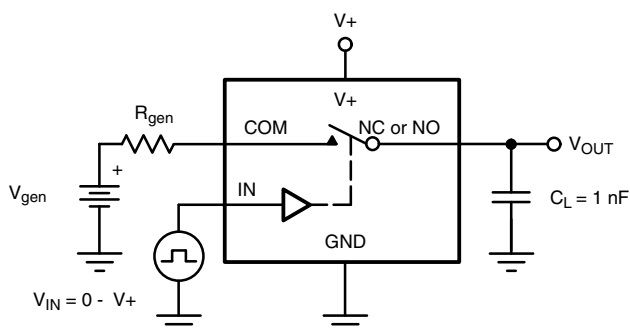
$$V_{OUT} = V_{COM} \left( \frac{R_L}{R_L + R_{ON}} \right)$$



Logic "1" = Switch On

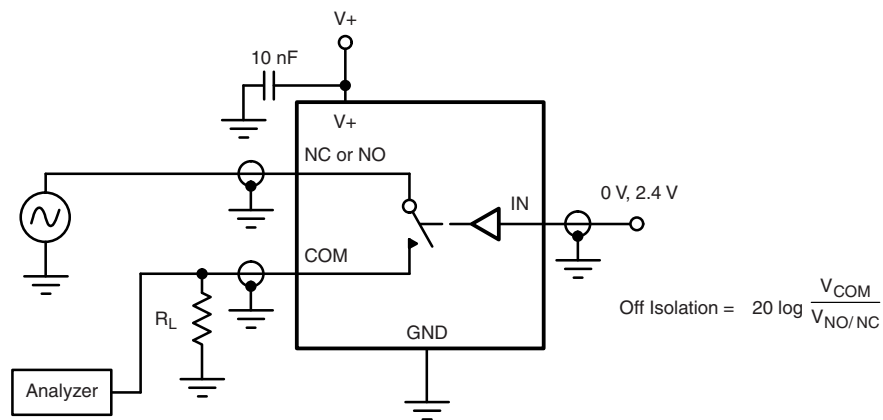
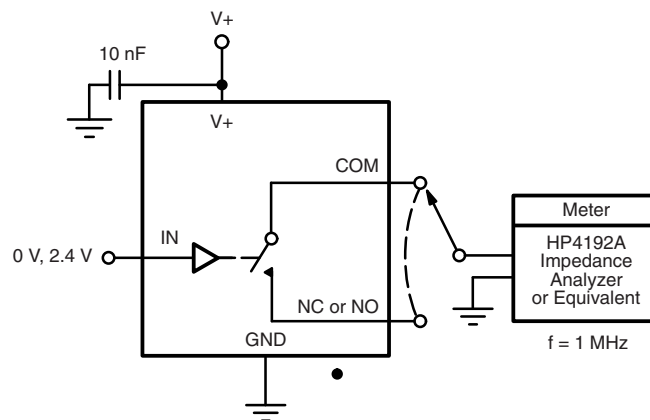
Logic input waveforms inverted for switches that have the opposite logic sense.

Figure 1. Switching Time



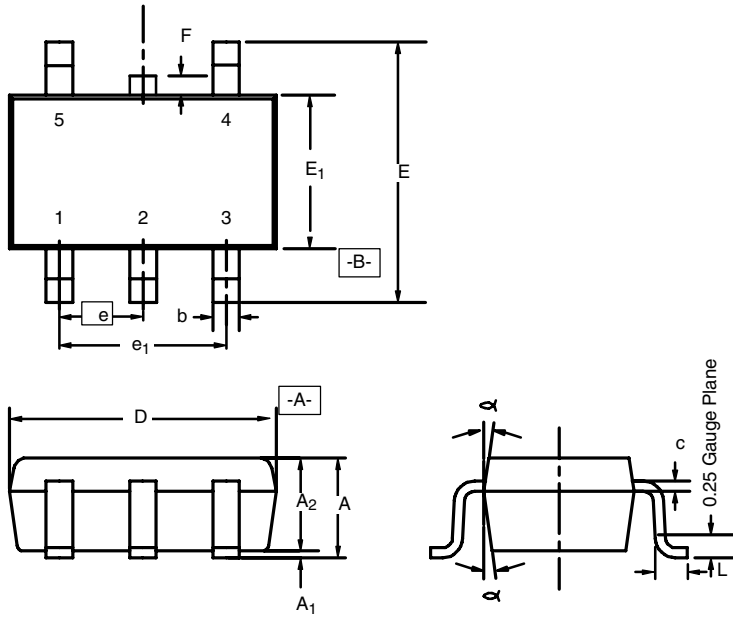
IN depends on switch configuration: input polarity determined by sense of switch.

Figure 2. Charge Injection

**TEST CIRCUITS**

**Figure 3. Off-Isolation**

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

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see [www.vishay.com/ppg?72740](http://www.vishay.com/ppg?72740).

### SC-70: 5-LEAD



|                                             | MILLIMETERS |      |      | INCHES   |       |       |
|---------------------------------------------|-------------|------|------|----------|-------|-------|
| Dim                                         | Min         | Nom  | Max  | Min      | Nom   | Max   |
| A                                           | 0.90        | —    | 1.10 | 0.035    | —     | 0.043 |
| A <sub>1</sub>                              | —           | —    | 0.10 | —        | —     | 0.004 |
| A <sub>2</sub>                              | 0.80        | —    | 1.00 | 0.031    | —     | 0.039 |
| b                                           | 0.15        | —    | 0.30 | 0.006    | —     | 0.012 |
| c                                           | 0.10        | —    | 0.25 | 0.004    | —     | 0.010 |
| D                                           | 1.80        | 2.00 | 2.20 | 0.071    | 0.079 | 0.087 |
| E                                           | 1.80        | 2.10 | 2.40 | 0.071    | 0.083 | 0.094 |
| E <sub>1</sub>                              | 1.15        | 1.25 | 1.35 | 0.045    | 0.049 | 0.053 |
| e                                           | 0.65BSC     |      |      | 0.026BSC |       |       |
| e <sub>1</sub>                              | 1.20        | 1.30 | 1.40 | 0.047    | 0.051 | 0.055 |
| F                                           | 0           | —    | 0.15 | 0        | —     | 0.006 |
| L                                           | 0.10        | 0.20 | 0.30 | 0.004    | 0.008 | 0.012 |
| α                                           | 7°Nom       |      |      | 7°Nom    |       |       |
| ECN: S-60035—Rev. C, 16-Jan-06<br>DWG: 5861 |             |      |      |          |       |       |



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