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DG2002

Vishay Siliconix

Low-Voltage Single SPDT Analog Switch

DESCRIPTION

The DG2002 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} : 8 ns, t_{OFF} : 6 ns), low on-resistance ($r_{DS(on)}$: 7 Ω) and small physical size (SC70), the DG2002 is ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2002 is built on Vishay Siliconix's low voltage J12 process. An epitaxial layer prevents latchup. Break-before-make is guaranteed for DG2002.

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 - $r_{DS(on)}$: 7 Ω
- Fast switching - t_{ON} : 8 ns, t_{OFF} : 6 ns
- Low charge injection - Q_{INJ} : 5 pC
- Low power consumption
- TTL/CMOS compatible
- 6-pin SC70 package



RoHS*
COMPLIANT

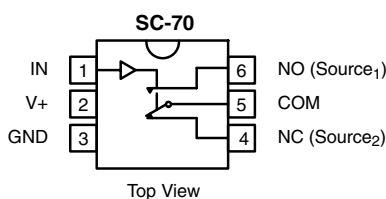
BENEFITS

- 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



Device Marking: E2xx

TRUTH TABLE

| Logic | NC | NO |
|-------|-----|-----|
| 0 | ON | OFF |
| 1 | OFF | ON |

ORDERING INFORMATION

| Temp Range | Package | Part Number |
|---------------|---------|-------------------------------|
| - 40 to 85 °C | SC70-6 | DG2002DL-T1 DG2002DL-T1-E3 |

* Pb containing terminations are not RoHS compliant, exemptions may apply.

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| ABSOLUTE MAXIMUM RATINGS | | |
|--|-------------------------|------|
| Parameter | Limit | Unit |
| Referenced V+ to GND | - 0.3 to +6 | V |
| IN, COM, NC, NO ^a | - 0.3 to (V+ + 0.3) | |
| Continuous Current (Any Terminal) | ± 50 | mA |
| Peak Current (Pulsed at 1 ms, 10 % duty cycle) | ± 200 | |
| Storage Temperature | - 65 to + 150 | °C |
| Power Dissipation (Packages) ^b | 6-Pin SC70 ^c | 250 |
| | | 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 Unless Otherwise Specified V+ = 2.0 V, ± 10 % VIN = 0.4 or 1.6 V ^e | Temp ^a | Limits - 40 to 85 °C | | | Unit |
| | | | | Min ^b | Typ ^c | Max ^b | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^d | V _{NO} , V _{NC} V _{COM} | | Full | 0 | | V+ | V |
| On-Resistance | r _{ON} | V+ = 1.8 V, V _{COM} = 1.0 V, I _{NO} , I _{NC} = 10 mA | Room Full ^d | | 38 39.3 | 46.1 47.1 | Ω |
| r _{ON} Flatness ^d | r _{ON} Flatness | V+ = 1.8 V, V _{COM} = 0 to V+, I _{NO} , I _{NC} = 10 mA | Room | | 21 | | |
| Switch Off Leakage Current ^f | I _{NO(off)} I _{NC(off)} | V+ = 2.2 V V _{NO} , V _{NC} = 0.5 V/1.5 V, V _{COM} = 1.5 V/0.5 V | Room Full ^d | - 250 - 3.0 | | 250 3.0 | pA nA |
| | I _{COM(off)} | | Room Full ^d | - 250 - 3.0 | | 250 3.0 | pA nA |
| Channel-On Leakage Current ^f | I _{COM(on)} | V+ = 2.2 V, V _{NO} , V _{NC} = V _{COM} = 0.5 V/1.5 V | Room Full ^d | - 250 - 3.0 | | 250 3.0 | pA nA |
| Digital Control | | | | | | | |
| Input High Voltage | V _{INH} | | Full | 1.6 | | | V |
| Input Low Voltage | V _{INL} | | Full | | | 0.4 | |
| Input Capacitance ^d | C _{in} | | Full | | 3 | | pF |
| Input Current | I _{INL} or I _{INH} | V _{IN} = 0 or V+ | Full | - 1 | | 1 | μA |
| Dynamic Characteristics | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO} or V _{NC} = 1.5 V, R _L = 300 Ω, C _L = 35 pF Figures 1 and 2 | Room Full ^d | | 22 | 31 32 | ns |
| Turn-Off Time | t _{OFF} | | Room Full ^d | | 10 | 17 18 | |
| Break-Before-Make Time | t _d | | Room | 1 | 12 | | |
| Charge Injection ^d | Q _{INJ} | C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω, Figure 3 | Room | | 5 | 10 | pC |
| Off-Isolation ^d | OIRR | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz | Room | | - 67 | | dB |
| Crosstalk ^d | X _{TALK} | | Room | | - 71 | | |
| NO, NC Off Capacitance ^d | C _{NO(off)} C _{NC(off)} | V _{IN} = 0 or V+, f = 1 MHz | Room | | 5 | | pF |
| Channel-On Capacitance ^d | C _{ON} | | Room | | 29 | | |
| Power Supply | | | | | | | |
| Power Supply Range | V+ | | | 1.8 | | 2.2 | V |
| Power Supply Current ^d | I+ | V _{IN} = 0 or V+ | | | 0.01 | 1.0 | μA |
| Power Consumption | P _C | | | | | | 2.2 |



| SPECIFICATIONS $V_+ = 3.0\text{ V}$ | | | | | | | |
|---|--------------------------------|--|-------------------|-------------------------|------------------|------------------|----------|
| Parameter | Symbol | Test Conditions Unless Otherwise Specified $V_+ = 3\text{ V}, \pm 10\%$ $V_{IN} = 0.4\text{ or }2.0\text{ V}^e$ | Temp ^a | Limits - 40 to 85 °C | | | Unit |
| | | | | Min ^b | Typ ^c | Max ^b | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^d | V_{NO}, V_{NC} V_{COM} | | Full | 0 | | V_+ | V |
| On-Resistance ^d | r_{ON} | $V_+ = 2.7\text{ V}, V_{COM} = 1.5\text{ V}, I_{NO}, I_{NC} = 10\text{ mA}$ | Room Full | | 12.2 13 | 14.8 15.8 | Ω |
| r_{ON} Flatness ^d | r_{ON} Flatness | $V_+ = 2.7\text{ V}, V_{COM} = 0\text{ to }V_+, I_{NO}, I_{NC} = 10\text{ mA}$ | Room | | 5 | | |
| Switch Off Leakage Current ^f | $I_{NO(off)}$ $I_{NC(off)}$ | $V_+ = 3.3\text{ V}$ $V_{NO}, V_{NC} = 1\text{ V}/3\text{ V}, V_{COM} = 3\text{ V}/1\text{ V}$ | Room Full | - 500 - 4.0 | | 500 4.0 | pA nA |
| | $I_{COM(off)}$ | | Room Full | - 500 - 4.0 | | 500 4.0 | pA nA |
| Channel-On Leakage Current ^f | $I_{COM(on)}$ | $V_+ = 3.3\text{ V}, V_{NO}, V_{NC} = V_{COM} = 1\text{ V}/3\text{ V}$ | Room Full | - 500 - 4.0 | | 500 4.0 | pA nA |
| Digital Control | | | | | | | |
| Input High Voltage | V_{INH} | | Full | 2 | | | V |
| Input Low Voltage | V_{INL} | | Full | | | 0.4 | |
| Input Capacitance ^d | C_{in} | | Full | | 3 | | pF |
| Input Current | I_{INL} or I_{INH} | $V_{IN} = 0\text{ or }V_+$ | Full | - 1 | | 1 | μA |
| Dynamic Characteristics | | | | | | | |
| Turn-On Time ^d | t_{ON} | V_{NO} or $V_{NC} = 2.0\text{ V}, R_L = 300\text{ Ω}, C_L = 35\text{ pF}$ Figures 1 and 2 | Room Full | | 12 | 21 22 | ns |
| Turn-Off Time ^d | t_{OFF} | | Room Full | | 7 | 14 15 | |
| Break-Before-Make Time ^d | t_d | | Room | 1 | 6 | | |
| Charge Injection ^d | Q_{INJ} | $C_L = 1\text{ nF}, V_{GEN} = 0\text{ V}, R_{GEN} = 0\text{ Ω}$, Figure 3 | Room | | 5 | 10 | pC |
| Off-Isolation ^d | OIRR | $R_L = 50\text{ Ω}, C_L = 5\text{ pF}, f = 1\text{ MHz}$ | Room | | - 67 | | dB |
| Crosstalk ^d | X_{TALK} | | Room | | - 69 | | |
| NO, NC Off Capacitance ^d | $C_{NO(off)}$ $C_{NC(off)}$ | $V_{IN} = 0\text{ or }V_+, f = 1\text{ MHz}$ | Room | | 5 | | pF |
| Channel-On Capacitance ^d | C_{ON} | | Room | | 29 | | |
| Power Supply | | | | | | | |
| Power Supply Range | V_+ | | | 2.7 | | 3.3 | V |
| Power Supply Current | I_+ | $V_{IN} = 0\text{ or }V_+$ | | | 0.01 | 1.0 | μA |
| Power Consumption | P_C | | | | | | 3.3 |

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| SPECIFICATIONS $V_+ = 5.0\text{ V}$ | | | | | | | |
|-------------------------------------|----------------------------|--|-------------------|-------------------------|------------------|------------------|------|
| Parameter | Symbol | Test Conditions Unless Otherwise Specified $V_+ = 5\text{ V}, \pm 10\%$ $V_{IN} = 0.8\text{ or }2.4\text{ V}^e$ | Temp ^a | Limits - 40 to 85 °C | | | Unit |
| | | | | Min ^b | Typ ^c | Max ^b | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^d | V_{NO}, V_{NC}, V_{COM} | | Full | 0 | | V_+ | V |
| On-Resistance | r_{ON} | $V_+ = 4.5\text{ V}, V_{COM} = 3\text{ V}, I_{NO}, I_{NC} = 10\text{ mA}$ | Room Full | | 6.4 7.4 | 7.8 8.8 | Ω |
| r_{ON} Flatness ^d | r_{ON} Flatness | $V_+ = 4.5\text{ V}, V_{COM} = 0\text{ to }V_+, I_{NO}, I_{NC} = 10\text{ mA}$ | Room | | 3 | | |
| Switch Off Leakage Current | $I_{NO(off)}, I_{NC(off)}$ | $V_+ = 5.5\text{ V}$ $V_{NO}, V_{NC} = 1\text{ V}/4.5\text{ V}, V_{COM} = 4.5\text{ V}/1\text{ V}$ | Room Full | - 1.0 - 4.0 | | 1.0 4.0 | nA |
| | $I_{COM(off)}$ | | Room Full | - 1.0 - 4.0 | | 1.0 4.0 | |
| Channel-On Leakage Current | $I_{COM(on)}$ | $V_+ = 5.5\text{ V}, V_+ = 5.5\text{ V}$ $V_{NO}, V_{NC} = V_{COM} = 1\text{ V}/4.5\text{ V}$ | Room Full | - 1.0 - 4.0 | | 1.0 4.0 | |
| Digital Control | | | | | | | |
| Input High Voltage | V_{INH} | | Full | 2.4 | | | V |
| Input Low Voltage | V_{INL} | | Full | | | 0.8 | |
| Input Capacitance | C_{in} | | Full | | 3 | | pF |
| Input Current | I_{INL} or I_{INH} | $V_{IN} = 0\text{ or }V_+$ | Full | - 1 | | 1 | μA |
| Dynamic Characteristics | | | | | | | |
| Turn-On Time ^d | t_{ON} | V_{NO} or $V_{NC} = 3\text{ V}, R_L = 300\ \Omega, C_L = 35\text{ pF}$ Figures 1 and 2 | Room Full | | 8 | 15 16 | ns |
| Turn-Off Time ^d | t_{OFF} | | Room Full | | 6 | 13 14 | |
| Break-Before-Make Time ^d | t_d | | Room | 1 | 4 | | |
| Charge Injection ^d | Q_{INJ} | $C_L = 1\text{ nF}, V_{GEN} = 0\text{ V}, R_{GEN} = 0\ \Omega$, Figure 3 | Room | | 5 | 10 | pC |
| Off-Isolation ^d | OIRR | $R_L = 50\ \Omega, C_L = 5\text{ pF}, f = 1\text{ MHz}$ | Room | | - 69 | | dB |
| Crosstalk ^d | X_{TALK} | | Room | | - 69 | | |
| Source-Off Capacitance ^d | $C_{NO(off)}, C_{NC(off)}$ | $V_{IN} = 0\text{ or }V_+, f = 1\text{ MHz}$ | Room | | 5 | | pF |
| Channel-On Capacitance ^d | C_{ON} | | Room | | 29 | | |
| Power Supply | | | | | | | |
| Power Supply Range | V_+ | | | 4.5 | | 5.5 | V |
| Power Supply Current | I_+ | $V_{IN} = 0\text{ or }V_+$ | | | 0.01 | 1.0 | μA |
| Power Consumption | P_C | | | | | | 5.5 |

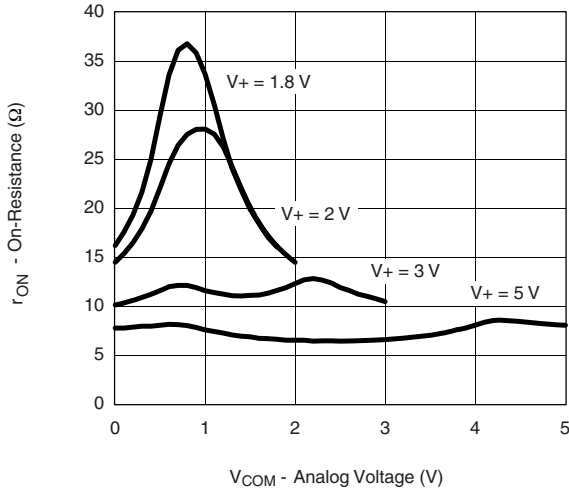
Notes:

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

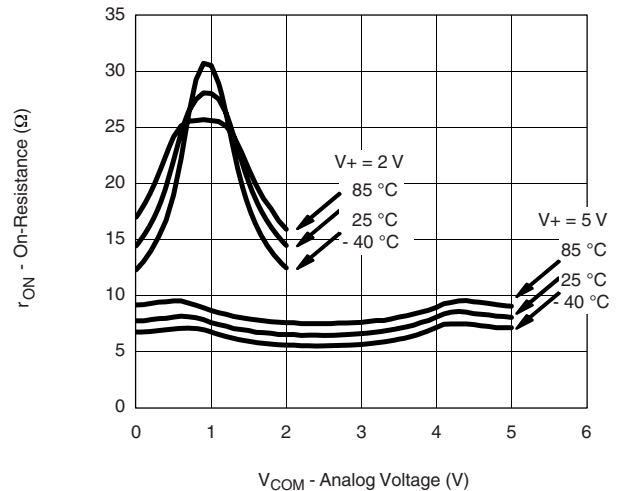
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



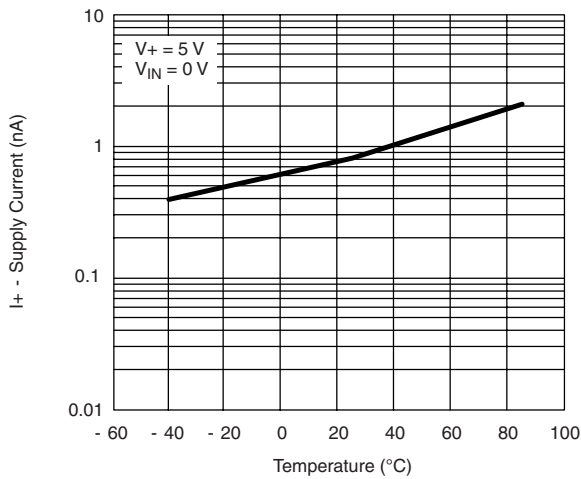
TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



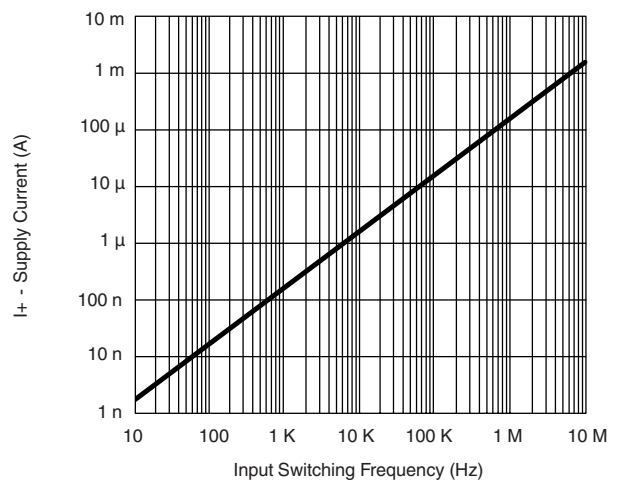
r_{ON} vs. V_{COM} and Supply Voltage



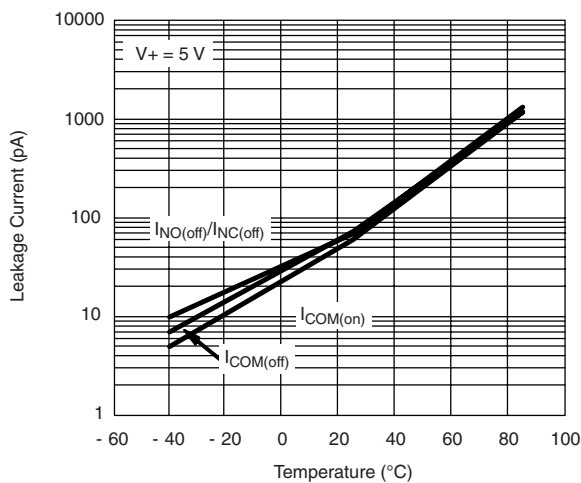
r_{ON} vs. Analog Voltage and Temperature



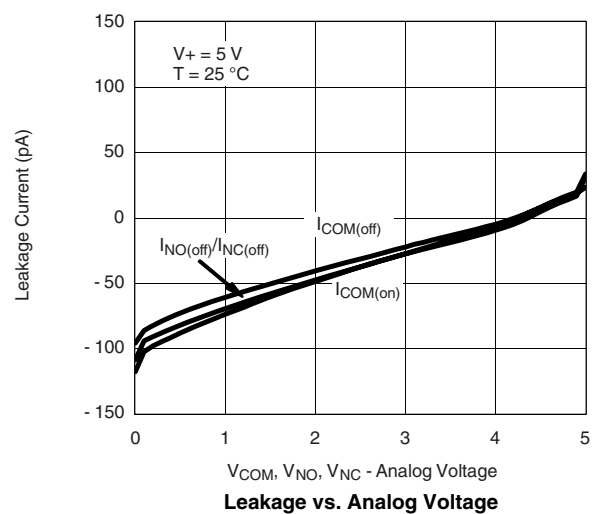
Supply Current vs. Temperature



Supply Current vs. Input Switching Frequency



Leakage Current vs. Temperature



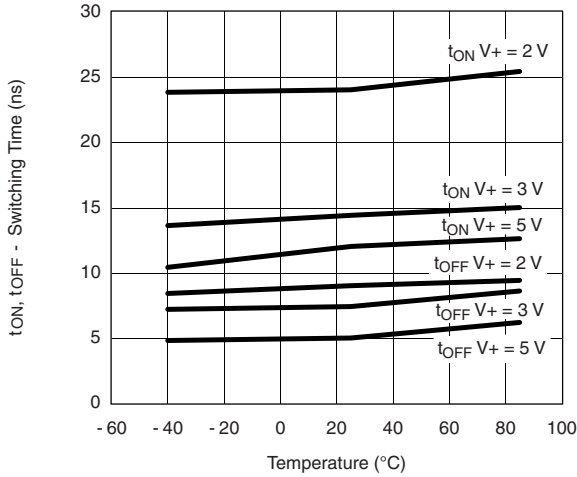
Leakage vs. Analog Voltage

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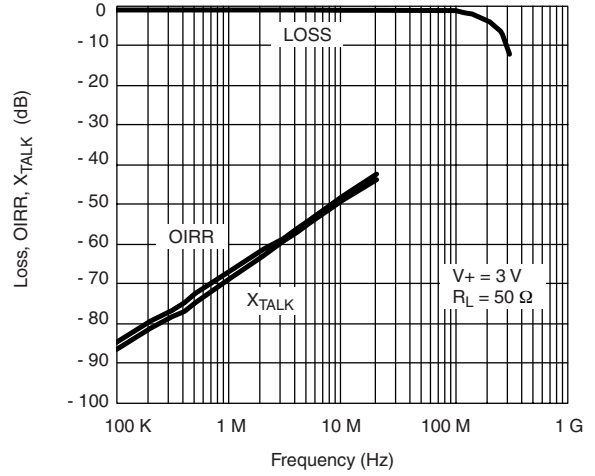
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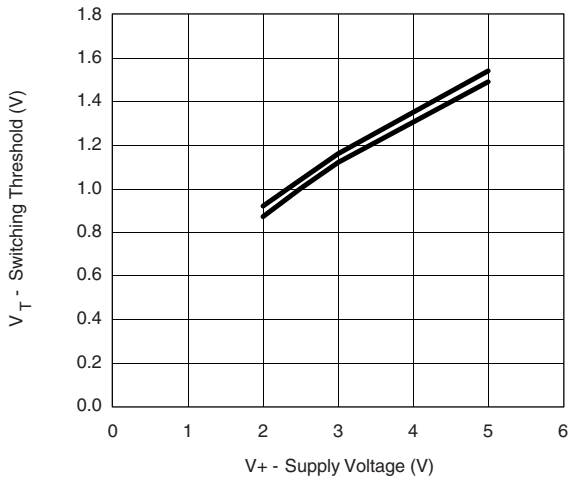
TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



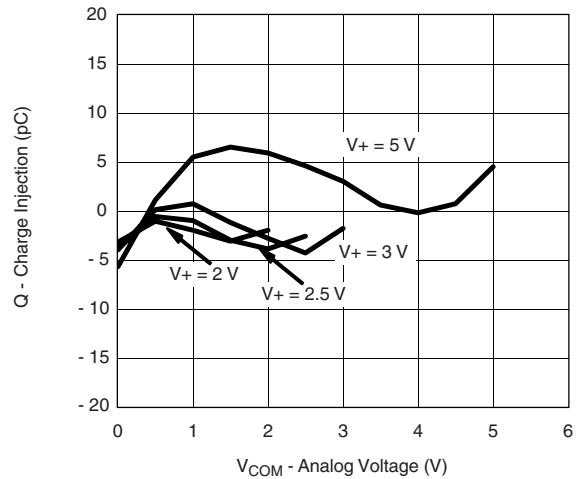
Switching Time vs. Temperature and Supply Voltage



Insertion Loss, Off-Isolation Crosstalk vs. Frequency



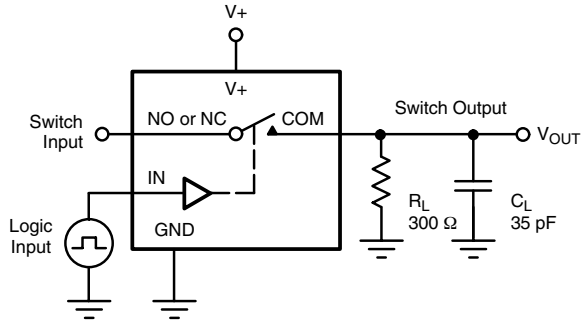
Switching Threshold vs. Supply Voltage



Charge Injection vs. Analog Voltage

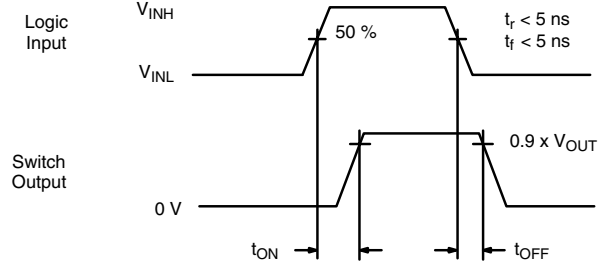


TEST CIRCUITS



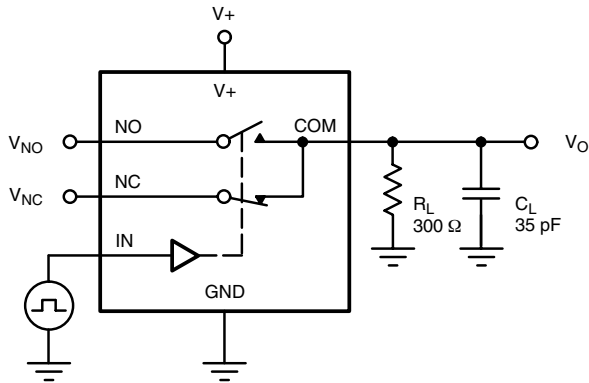
C_L (includes fixture and stray capacitance)

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



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

Figure 1. Switching Time



C_L (includes fixture and stray capacitance)

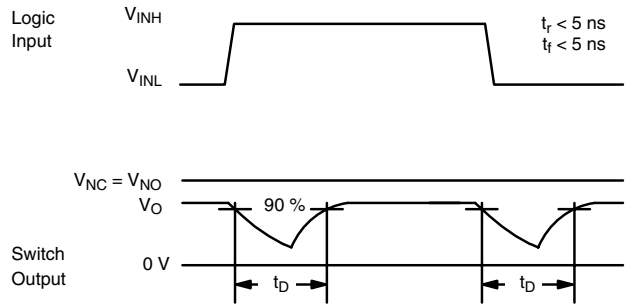
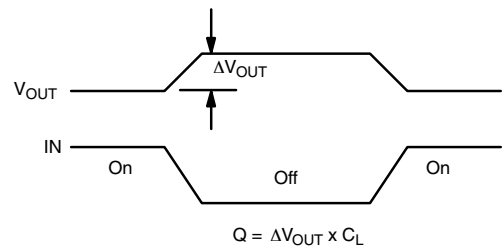
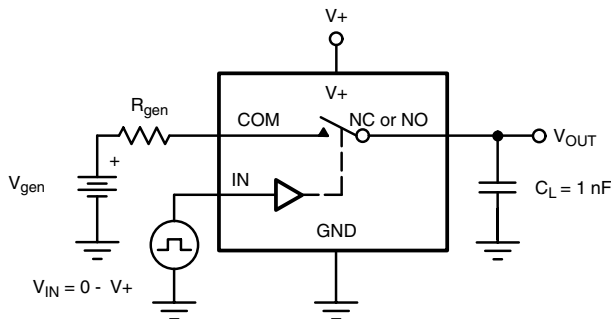


Figure 2. Break-Before-Make Interval



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

Figure 3. Charge Injection

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TEST CIRCUITS

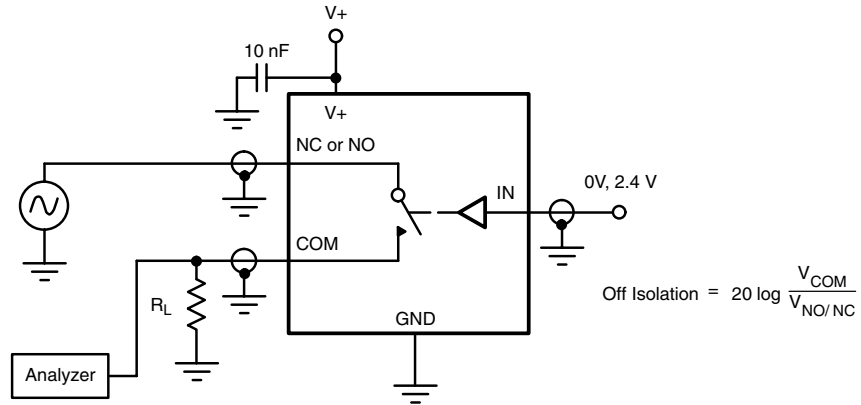


Figure 4. Off-Isolation

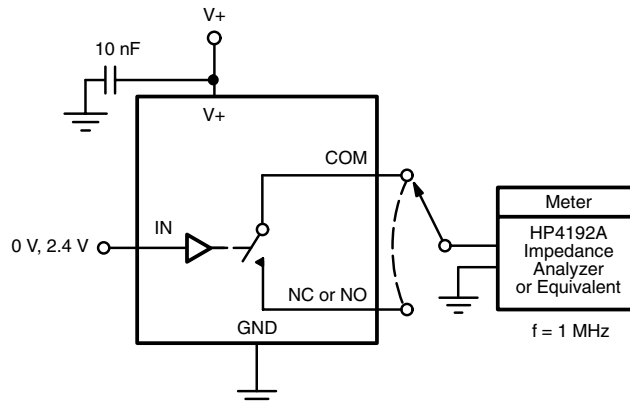


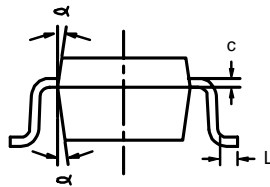
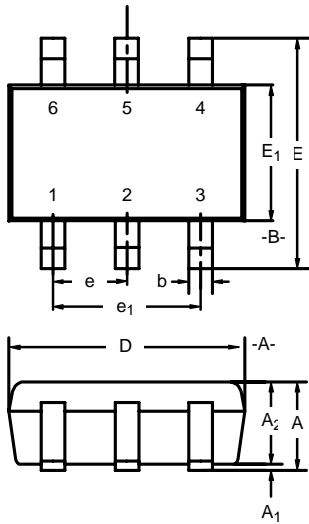
Figure 5. Channel Off/On Capacitance

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 <http://www.vishay.com/ppg?71448>.



Package Information
Vishay Siliconix

SC-70: 6-LEADS



| Dim | MILLIMETERS | | | INCHES | | |
|----------------|-------------|------|------|----------|-------|-------|
| | Min | Nom | Max | Min | Nom | Max |
| A | 0.90 | - | 1.10 | 0.035 | - | 0.043 |
| A ₁ | - | - | 0.10 | - | - | 0.004 |
| A ₂ | 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 ₁ | 1.15 | 1.25 | 1.35 | 0.045 | 0.049 | 0.053 |
| e | 0.65BSC | | | 0.026BSC | | |
| e ₁ | 1.20 | 1.30 | 1.40 | 0.047 | 0.051 | 0.055 |
| L | 0.10 | 0.20 | 0.30 | 0.004 | 0.008 | 0.012 |
| α | 7°Nom | | | 7°Nom | | |

ECN: S-03946—Rev. B, 09-Jul-01
DWG: 5550



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