

1 pC Charge Injection, 100 pA Maximum Leakage, +5 V / +3 V, SPDT Analog Switch

DESCRIPTION

The DG9431E is a monolithic CMOS switch designed for precision signal switching. The 17 Ω low voltage part exhibits low charge injection over the full signal range, low leakage, low parasitic capacitance, and fast switching.

The DG9431E can switch both analog and digital signals. Each switch conducts equally well in both directions when on, and blocks up to the power supply level when off. Break-before-make switching is guaranteed.

The DG9431E offers 1 nW typical power consumption and 8 kV ESD (HBM), 1 kV ESD (CDM) tolerance. It is ideal for use in low voltage instruments and healthcare devices, fitting the circuits of low voltage ADC and DAC, sample and hold, analog front end gain control, and signal path switching. The DG9431E is available in 6-lead TSOP and 8-lead SOIC packages.

APPLICATIONS

- Automatic test equipment
- Process control and automation
- Data acquisition systems
- Meters and instruments
- Medical and healthcare systems
- Communication systems
- Sample-and-hold systems
- Relay replacements
- Battery powered systems

FEATURES

- 1 pC charge injection
- Guaranteed 100 pA max. switch on leakage at 25 $^{\circ}\text{C}$
- 3.8 pF switch off and 7.8 pF switch on capacitances
- +2.7 V to +5 V single supply operation
- Low on-resistance - $R_{\text{DS(on)}}$: 17 Ω (typ.) at 5 V
- t_{ON} : 32 ns, t_{OFF} : 10 ns switching time
- Typical power consumption: 1 nW
- Over voltage tolerance on logic control IN pin
- TTL / CMOS compatible
- ESD (HBM): > 8000 V, ESD (CDM): >1000 V
- Latch-up current: > 300 mA (JESD78)
- Available in TSOP-6 and SOIC-8



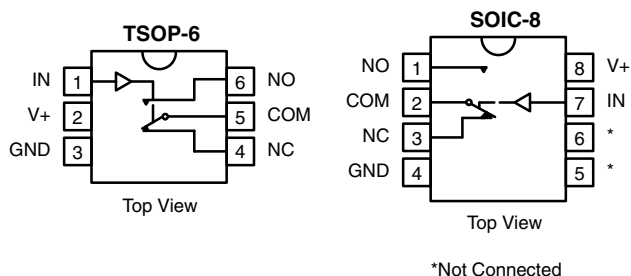
Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non-RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details.

BENEFITS

- Low charge injection and leakage
- Low parasitic capacitance
- Fast switching speed
- High ESD tolerance

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



| TRUTH TABLE | | |
|-------------|-----|-----|
| LOGIC | NC | NO |
| 0 | ON | OFF |
| 1 | OFF | ON |

Note

- Logic "0" ≤ 0.8 V
- Logic "1" ≥ 2.4 V

| ORDERING INFORMATION | | | | |
|--|---------------|-------------|------------------|-----------------------------------|
| TEMP. RANGE | CONFIGURATION | PART NUMBER | PACKAGE | MINIUM ORDER / PACKAGING QUANTITY |
| -40 $^{\circ}\text{C}$ to +85 $^{\circ}\text{C}$ | DG9431E | 6-pin TSOP | DG9431EDV-T1-GE3 | Tape and reel 3000 units |
| | | 8-pin SOIC | DG9431EDY-T1-GE3 | Tape and reel 2500 units |
| | | | DG9431EDY-GE3 | Tube 500 units |



| ABSOLUTE MAXIMUM RATINGS | | | |
|--|-------------------------------------|------|----|
| PARAMETER | LIMIT | UNIT | |
| Reference V+ to GND | -0.3 to +6 | V | |
| IN, COM, NC, NO ^a | -0.3 to (V+ + 0.3) | | |
| Continuous current (any terminal) | ± 20 | mA | |
| Peak current (pulsed at 1 ms, 10 % duty cycle) | ± 40 | | |
| ESD (HBM) (MIL-STD-883, method 3015) | > 8000 | V | |
| ESD (CDM) (ANSI / ESDA / JEDEC® JS-002) | > 1000 | | |
| Latch up current, per JESD78 | 300 | mA | |
| Storage temperature (D suffix) | -65 to +125 | °C | |
| Power dissipation (packages) ^b | 8-pin narrow body SOIC ^c | 400 | mW |
| | 6-pin TSOP ^d | 570 | |

Notes

- a. Signals on SX, DX, or INX exceeding V+ or 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 6.5 mW/°C above 75 °C.
- d. Derate 7 mW/°C above 70 °C.

| SPECIFICATIONS (V+ = 3 V) | | | | | | | |
|---|--------------------------------------|--|--------------------|------------------------------|-------------------|-------------------|------|
| PARAMETER | SYMBOL | TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 3 V, ± 10 %, V _{IN} = 0.8 V or 2.4 V ^e | TEMP. ^a | D SUFFIX -40 °C TO +85 °C | | | UNIT |
| | | | | MIN. ^c | TYP. ^b | MAX. ^c | |
| Analog Switch | | | | | | | |
| Analog signal range ^d | V _{ANALOG} | | Full | 0 | - | 3 | V |
| Drain-source on-resistance | R _{DS(on)} | V _{NO} or V _{NC} = 1.5 V, V+ = 2.7 V I _{COM} = 5 mA | Room | - | 35 | 50 | Ω |
| | | | Full | - | - | 65 | |
| R _{DS(on)} match ^d | ΔR _{DS(on)} | V _{NO} or V _{NC} = 1.5 V | Room | - | 0.4 | 2 | |
| R _{DS(on)} flatness ^f | R _{DS(on)} flatness | V _{NO} or V _{NC} = 1 V and 2 V | Room | - | 4 | 8 | |
| NO or NC off leakage current ^g | I _{NO/NC(off)} | V _{NO} or V _{NC} = 1 V / 2 V, V _{COM} = 2 V / 1 V | Room | -100 | 5 | 100 | pA |
| | | | Full | -5000 | - | 5000 | |
| COM off leakage current ^g | I _{COM(off)} | V _{COM} = 1 V / 2 V, V _{NO} or V _{NC} = 2 V / 1 V | Room | -100 | 5 | 100 | pA |
| | | | Full | -5000 | - | 5000 | |
| Channel-on leakage current ^g | I _{COM(on)} | V _{COM} = V _{NO} or V _{NC} = 1 V / 2 V | Room | -200 | 5 | 200 | pA |
| | | | Full | -10 000 | - | 10 000 | |
| Digital Control | | | | | | | |
| Input current | I _{INL} or I _{INH} | | Full | - | 0.001 | - | μA |
| Dynamic Characteristics | | | | | | | |
| Turn-on time | t _{ON} | V _{NO} or V _{NC} = 1.5 V | Room | - | 43 | 120 | ns |
| | | | Full | - | - | 200 | |
| Turn-Off Time | t _{OFF} | V _{NO} or V _{NC} = 1.5 V | Room | - | 16 | 50 | ns |
| | | | Full | - | - | 120 | |
| Break-before-make time | t _d | | Room | 3 | 26 | - | |
| Charge injection | Q _{INJ} | C _L = 1 nF, V _{gen} = 0 V, R _{gen} = 0 Ω | Room | - | -0.28 | - | pC |
| Off-isolation | O _{IRR} | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz | Room | - | -80 | - | dB |
| Crosstalk | X _{TALK} | | Room | - | -108 | - | |
| Source off capacitance | C _{S(off)} | f = 1 MHz | Room | - | 4 | - | pF |
| Channel-on capacitance | C _{D(on)} | | Room | - | 8 | - | |
| Power Supply | | | | | | | |
| Power supply range | V+ | | | 2.7 | - | 5.5 | V |
| Power supply current | I+ | V+ = 3.3 V, V _{IN} = 0 V or 3.3 V | | - | 0.0003 | 1 | μA |



| SPECIFICATIONS (V+ = 5 V) | | | | | | | | |
|---|--------------------------------------|--|---|------------------------------|-------------------|-------------------|------|----|
| PARAMETER | SYMBOL | TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 5 V, ± 10 %, VIN = 0.8 V or 2.4 V ^e | TEMP. ^a | D SUFFIX -40 °C to +85 °C | | | UNIT | |
| | | | | MIN. ^c | TYP. ^b | MAX. ^c | | |
| Analog Switch | | | | | | | | |
| Analog signal range ^d | V _{ANALOG} | | Full | 0 | - | 5 | V | |
| Drain-source on-resistance | R _{DS(on)} | V _{NO} or V _{NC} = 3.5 V, V+ = 4.5 V I _{COM} = 5 mA | Room | - | 17 | 25 | Ω | |
| | | | Full | - | - | 35 | | |
| R _{DS(on)} match ^d | ΔR _{DS(on)} | V _{NO} or V _{NC} = 1.5 V | Room | - | 0.4 | 2 | | |
| R _{DS(on)} flatness ^f | R _{DS(on)} flatness | V _{NO} or V _{NC} = 1 V, 2 V, and 3 V | Room | - | 3.5 | 6 | | |
| NO or NC off leakage current | I _{NO/NC(off)} | V _{NO} or V _{NC} = 1 V / 4 V, V _{COM} = 4 V / 1 V | Room | -100 | 10 | 100 | pA | |
| | | | Full | -5000 | - | 5000 | | |
| COM off leakage current | I _{COM(off)} | V _{COM} = 1 V / 4 V, V _{NO} or V _{NC} = 4 V / 1 V | Room | -100 | 10 | 100 | | |
| | | | Full | -5000 | - | 5000 | | |
| Channel-on leakage current | I _{COM(on)} | V _{COM} = V _{NO} or V _{NC} = 1 V / 4 V | Room | -200 | - | 200 | | |
| | | | Full | -10 000 | - | 10 000 | | |
| Digital Control | | | | | | | | |
| Input current | I _{INL} or I _{INH} | | Full | - | 0.001 | - | μA | |
| Dynamic Characteristics | | | | | | | | |
| Turn-on time | t _{ON} | V _{NO} or V _{NC} = 3 V | Room | - | 32 | 75 | ns | |
| | | | Full | - | - | 150 | | |
| Turn-off time | t _{OFF} | | Room | - | 10 | 50 | | |
| | | | Full | - | - | 100 | | |
| Break-before-make time | t _d | | | Room | 3 | 22 | - | |
| Charge injection | Q _{INJ} | | C _L = 1 nF, V _{gen} = 0 V, R _{gen} = 0 Ω | Room | - | -0.78 | - | pC |
| Off-isolation | O _{IRR} | | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz | Room | - | -80 | - | dB |
| Crosstalk | X _{TALK} | | | Room | - | -108 | - | |
| NC and NO capacitance | C _(off) | f = 1 MHz | Room | - | 3.8 | - | pF | |
| Channel-on capacitance | C _{D(on)} | | Room | - | 7.8 | - | | |
| Power Supply | | | | | | | | |
| Power supply range | V+ | | | 2.7 | - | 5.5 | V | |
| Power supply current | I+ | V+ = 5.5 V, V _{IN} = 0 V or 5.5 V | | - | 0.0004 | 1 | μA | |

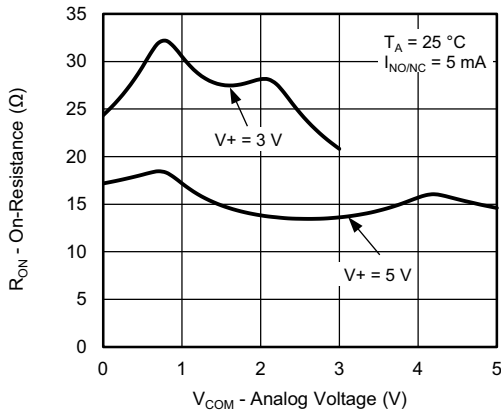
Notes

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

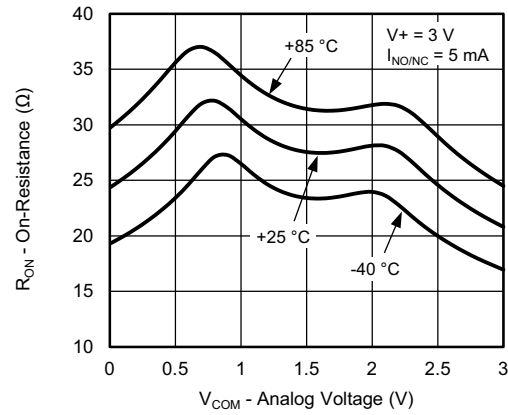
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



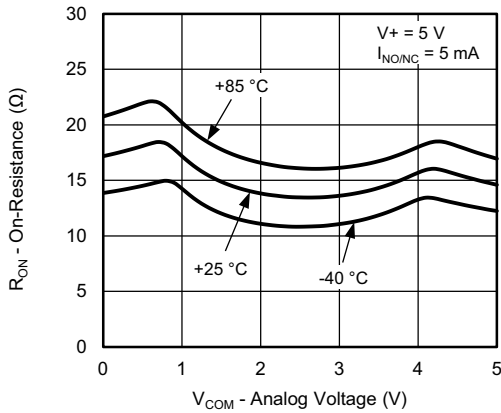
TYPICAL CHARACTERISTICS ($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted)



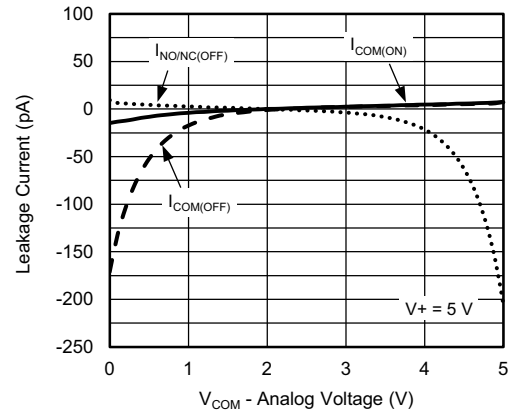
On-Resistance vs. Analog Voltage



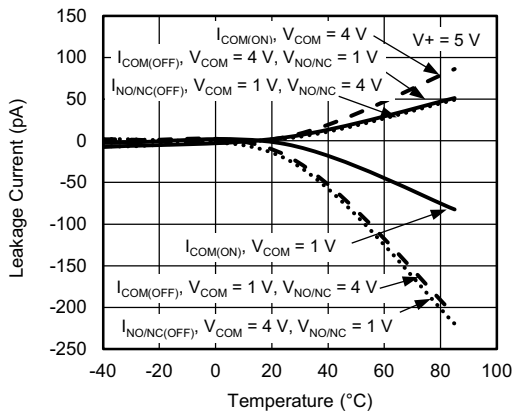
On-Resistance vs. Analog Voltage



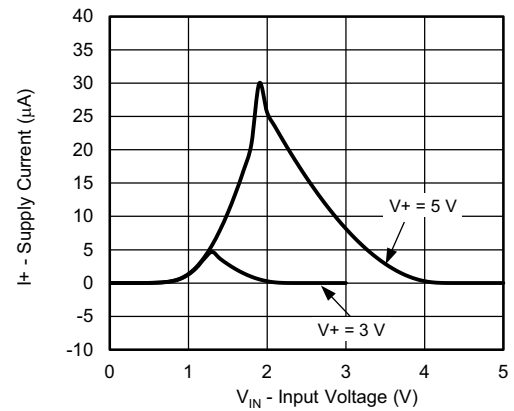
On-Resistance vs. Analog Voltage



Leakage Current vs. Analog Voltage

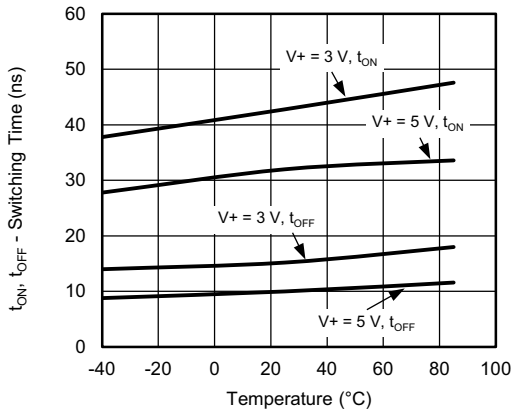


Leakage Current vs. Temperature

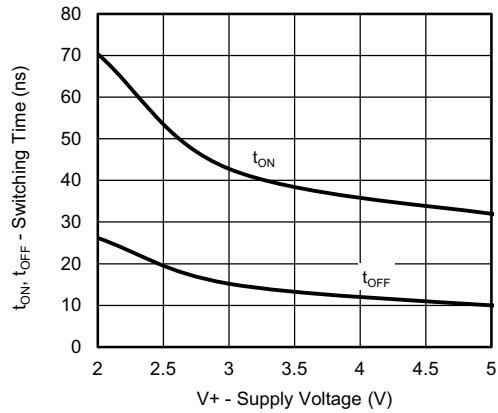


Supply Current vs. Input Voltage

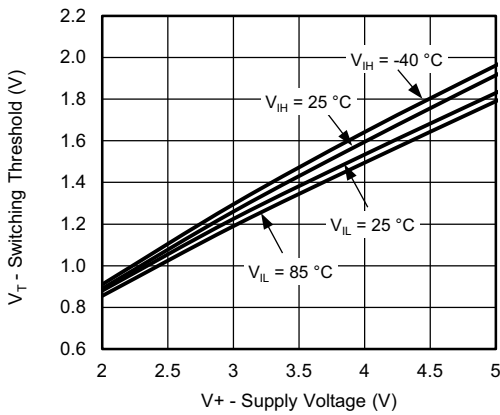
TYPICAL CHARACTERISTICS ($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted)



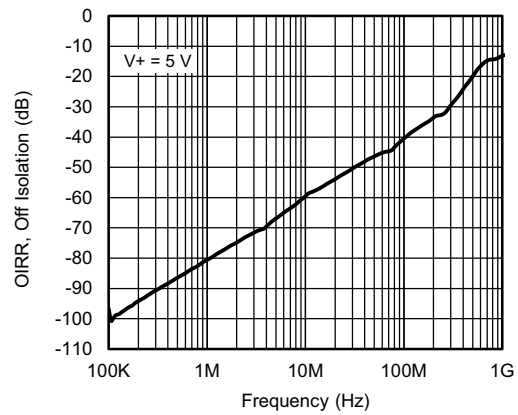
Switching Time vs. Temperature



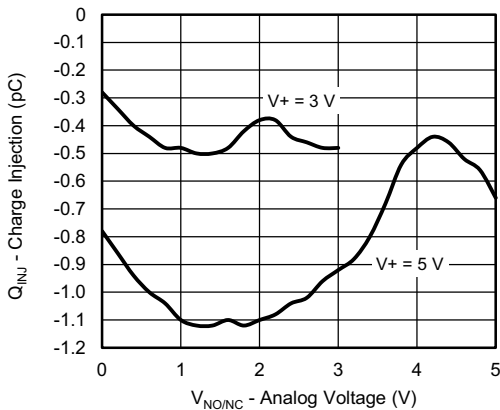
Switching Time vs. Supply Voltage



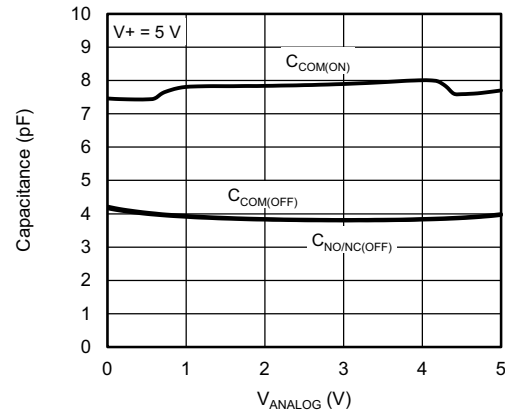
Switching Threshold vs. Supply Voltage



OIRR, Off Isolation vs. Frequency

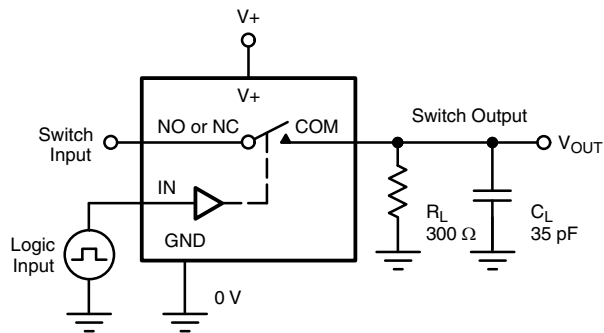


Charge Injection vs. Analog Voltage



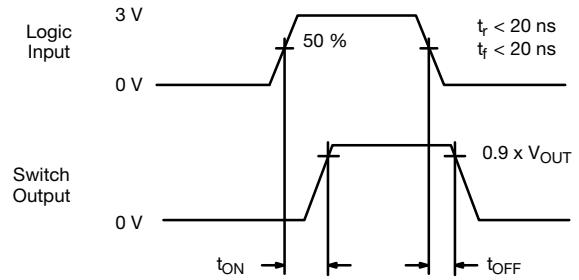
Capacitance

TEST CIRCUITS



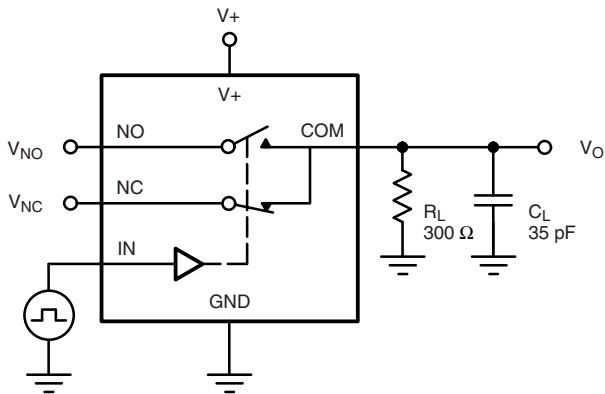
C_L (includes fixture and stray capacitance)

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



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)

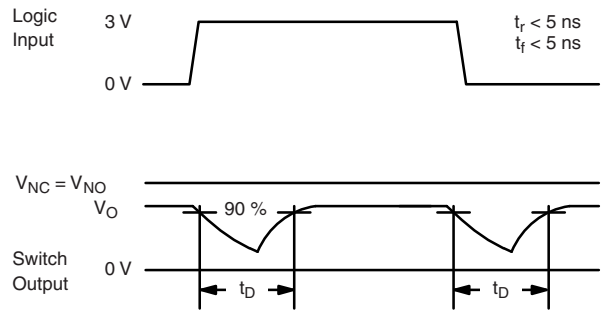
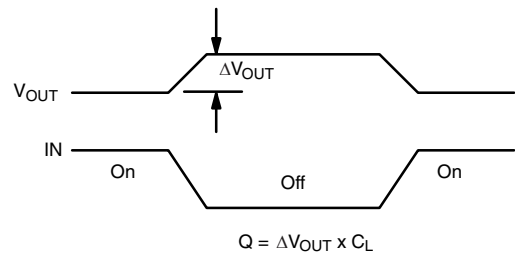
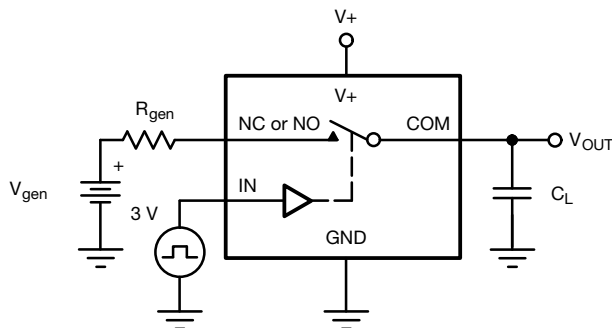


Figure 2. Break-Before-Make Interval



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

Figure 3. Charge Injection

TEST CIRCUITS

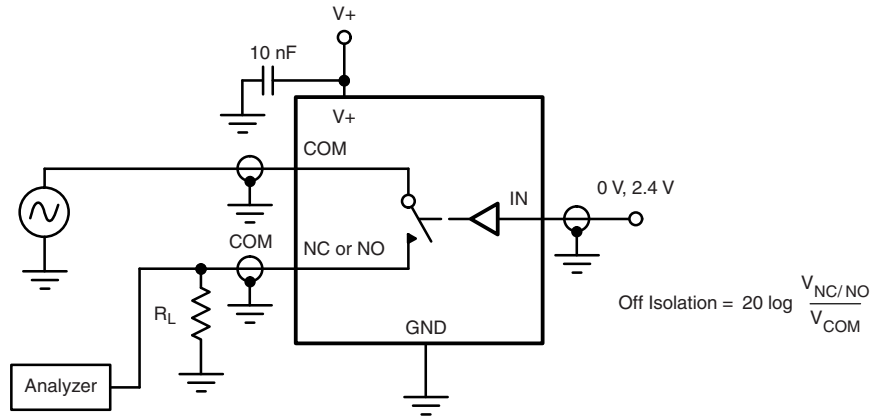


Figure 4. Off-Isolation

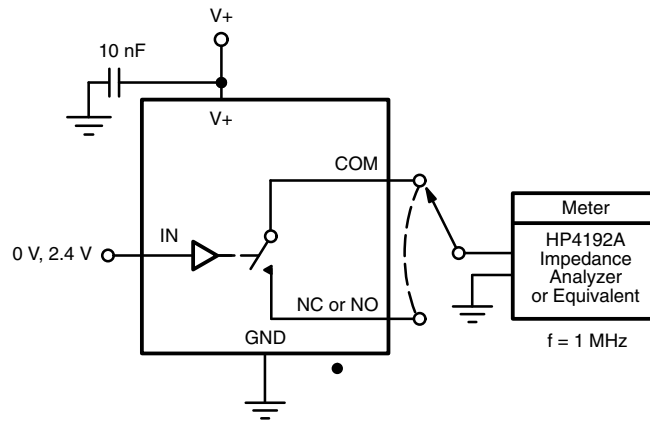


Figure 5. Channel Off/On Capacitance

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SOIC (NARROW): 8-LEAD

JEDEC Part Number: MS-012



| DIM | MILLIMETERS | | INCHES | |
|--------------------------------|-------------|------|-----------|-------|
| | Min | Max | Min | Max |
| A | 1.35 | 1.75 | 0.053 | 0.069 |
| A ₁ | 0.10 | 0.20 | 0.004 | 0.008 |
| B | 0.35 | 0.51 | 0.014 | 0.020 |
| C | 0.19 | 0.25 | 0.0075 | 0.010 |
| D | 4.80 | 5.00 | 0.189 | 0.196 |
| E | 3.80 | 4.00 | 0.150 | 0.157 |
| e | 1.27 BSC | | 0.050 BSC | |
| H | 5.80 | 6.20 | 0.228 | 0.244 |
| h | 0.25 | 0.50 | 0.010 | 0.020 |
| L | 0.50 | 0.93 | 0.020 | 0.037 |
| q | 0° | 8° | 0° | 8° |
| S | 0.44 | 0.64 | 0.018 | 0.026 |
| ECN: C-06527-Rev. I, 11-Sep-06 | | | | |
| DWG: 5498 | | | | |



TSOP: 5/6-LEAD

JEDEC Part Number: MO-193C



5-LEAD TSOP



6-LEAD TSOP



| Dim | MILLIMETERS | | | INCHES | | |
|--------------------------------|-------------|------|------|------------|-------|-------|
| | Min | Nom | Max | Min | Nom | Max |
| A | 0.91 | - | 1.10 | 0.036 | - | 0.043 |
| A ₁ | 0.01 | - | 0.10 | 0.0004 | - | 0.004 |
| A ₂ | 0.90 | - | 1.00 | 0.035 | 0.038 | 0.039 |
| b | 0.30 | 0.32 | 0.45 | 0.012 | 0.013 | 0.018 |
| c | 0.10 | 0.15 | 0.20 | 0.004 | 0.006 | 0.008 |
| D | 2.95 | 3.05 | 3.10 | 0.116 | 0.120 | 0.122 |
| E | 2.70 | 2.85 | 2.98 | 0.106 | 0.112 | 0.117 |
| E ₁ | 1.55 | 1.65 | 1.70 | 0.061 | 0.065 | 0.067 |
| e | 0.95 BSC | | | 0.0374 BSC | | |
| e ₁ | 1.80 | 1.90 | 2.00 | 0.071 | 0.075 | 0.079 |
| L | 0.32 | - | 0.50 | 0.012 | - | 0.020 |
| L ₁ | 0.60 Ref | | | 0.024 Ref | | |
| L ₂ | 0.25 BSC | | | 0.010 BSC | | |
| R | 0.10 | - | - | 0.004 | - | - |
| θ | 0° | 4° | 8° | 0° | 4° | 8° |
| θ ₁ | 7° Nom | | | 7° Nom | | |
| ECN: C-06593-Rev. I, 18-Dec-06 | | | | | | |
| DWG: 5540 | | | | | | |

RECOMMENDED MINIMUM PADS FOR SO-8



Recommended Minimum Pads
Dimensions in Inches/(mm)

[Return to Index](#)

RECOMMENDED MINIMUM PADS FOR TSOP-6



Recommended Minimum Pads
Dimensions in Inches/(mm)

[Return to Index](#)



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[TC4W53FU\(Te12L,F\)](#) [74HC2G66DC.125](#) [ADG619BRMZ-REEL](#) [ADG1611BRUZ-REEL7](#) [LTC201ACN#PBF](#) [74LV4066DB,118](#)