

# 1.8 V to 5.5 V, 4 $\Omega$ Dual SPST Switches

## DESCRIPTION

The DG721, DG722 and DG723 are precision dual SPST switches designed to operate from single 1.8 V to 5.5 V power supply with low power dissipation. The DG721, DG722 and DG723 can switch both analog and digital signals within the power supply rail, and conduct well in both directions.

Fabricated with advance submicron CMOS process, these switches provide high precision low and flat ON resistance, low leakage current, low parasitic capacitance, and low charge injection.

The DG721, DG722 and DG723 contain two independent Single Pole Single Throw (SPST) switches. Switch-1 and switch-2 are normally open for the DG721 and normally closed for the DG722. For the DG723, switch-1 is normally open and switch-2 is normally closed with a Break-Before-Make switching timing.

The DG721, DG722 and DG723 are the ideal switches for use in low voltage instruments and healthcare devices, fitting the circuits of low voltage ADC and DAC, analog front end gain control, and signal path control.

As a committed partner to the community and the environment, Vishay Siliconix manufactures this product with lead (Pb)-free device termination. The TDFN8 package has a nickel-palladium-gold device termination and is represented by the lead (Pb)-free “-E4” suffix to the ordering part number. The MSOP-8 package has tin device termination and is represented by “-E3”. Both device terminations meet all JEDEC standards for reflow and MSL rating.

As a further sign of Vishay Siliconix's commitment, the DG721, DG722 and D723 are fully RoHS compliant and Halogen-free.

## FEATURES

- **Halogen-free According to IEC 61249-2-21 Definition**
- 1.8 V to 5.5 V single power supply
- Low and flat switch on resistance, 2.5  $\Omega$ /typ.
- Low leakage and parasitic capacitance
- 366 MHz, - 3 dB bandwidth
- Latch-up current > 300 mA (JESD78)
- Space saving packages  
2 mm x 2 mm TDFN8  
MSOP8
- Over voltage tolerant TTL/CMOS compatible
- **Compliant to RoHS Directive 2002/95/EC**

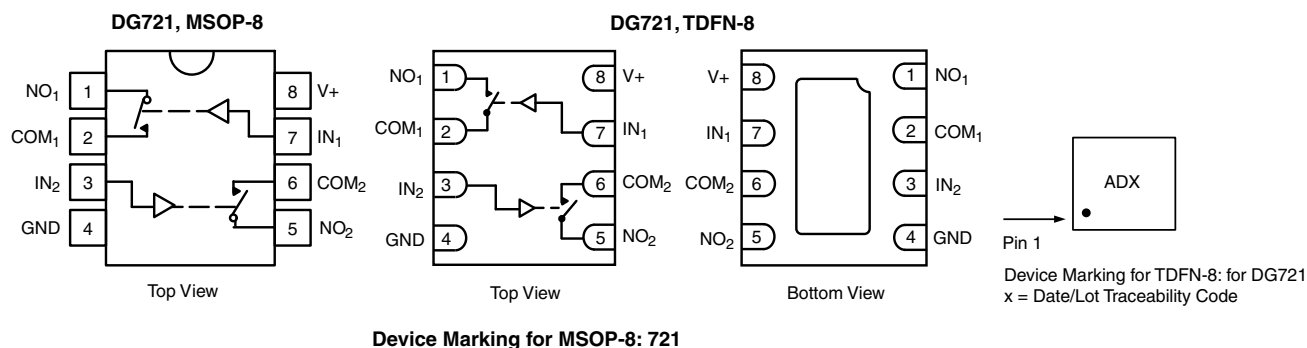


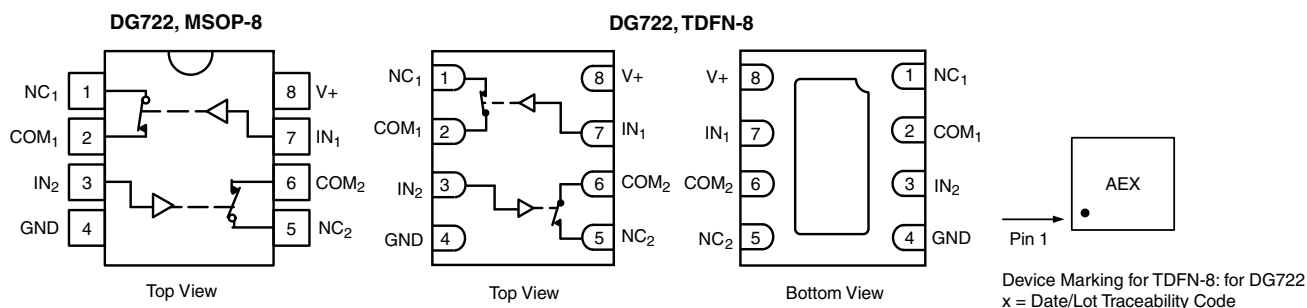
**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

## APPLICATIONS

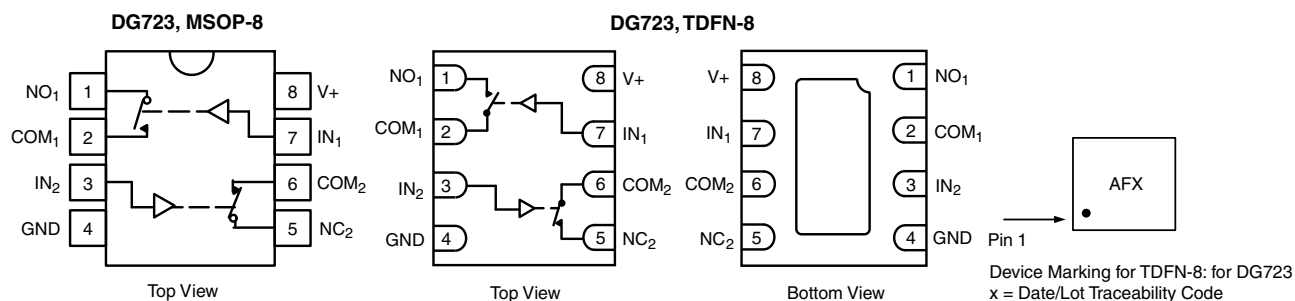
- Healthcare and medical devices
- Test instruments
- Portable meters
- Data acquisitions
- Control and automation
- PDAs and modems
- Communication systems
- Audio, video systems
- Mechanical reed relay replacement

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION





Device Marking for MSOP-8: 722



Device Marking for MSOP-8: 723

| TRUTH TABLE (DG721, DG722) |       |       |          |
|----------------------------|-------|-------|----------|
| Logic                      | DG721 | DG722 | Switches |
| 0                          | 0     | 1     | Off      |
| 1                          | 1     | 0     | On       |

| TRUTH TABLE (DG723) |          |          |
|---------------------|----------|----------|
| Logic               | Switch-1 | Switch-2 |
| 0                   | Off      | On       |
| 1                   | On       | Off      |

| ORDERING INFORMATION |         |                |
|----------------------|---------|----------------|
| Temperature Range    | Package | Part Number    |
| - 40 °C to 85 °C     | MSOP-8  | DG721DQ-T1-GE3 |
|                      |         | DG722DQ-T1-GE3 |
|                      |         | DG723DQ-T1-GE3 |
|                      | TDFN-8  | DG721DN-T1-GE4 |
|                      |         | DG722DN-T1-GE4 |
|                      |         | DG723DN-T1-GE4 |

| ABSOLUTE MAXIMUM RATINGS                       |                     |                     |      |
|------------------------------------------------|---------------------|---------------------|------|
| Parameter                                      |                     | Limit               | Unit |
| Referenced V+ to GND                           |                     | - 0.3 to 6          | V    |
| IN, COM, NC, NO <sup>a</sup>                   |                     | - 0.3 to (V+ + 0.3) |      |
| Continuous Current (Any Terminal)              |                     | ± 50                | mA   |
| Peak Current (Pulsed at 1 ms, 10 % duty cycle) |                     | ± 200               |      |
| Storage Temperature (D Suffix)                 |                     | - 65 to 150         | °C   |
| Power Dissipation (Packages) <sup>b</sup>      | MSOP-8 <sup>c</sup> | 320                 | mW   |
|                                                | TDFN-8 <sup>d</sup> | 842                 |      |

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 mW/°C above 70 °C.
- Derate 10.53 mW/°C above 70 °C.



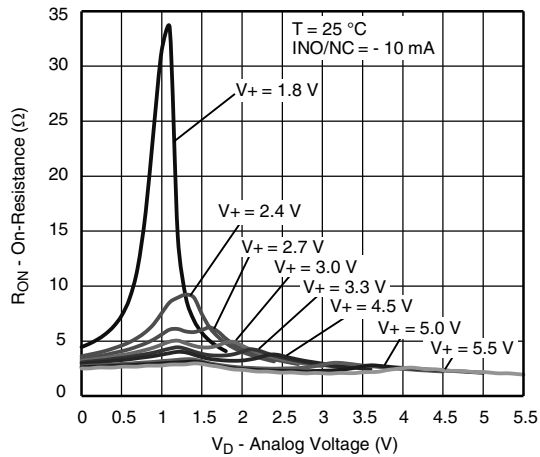
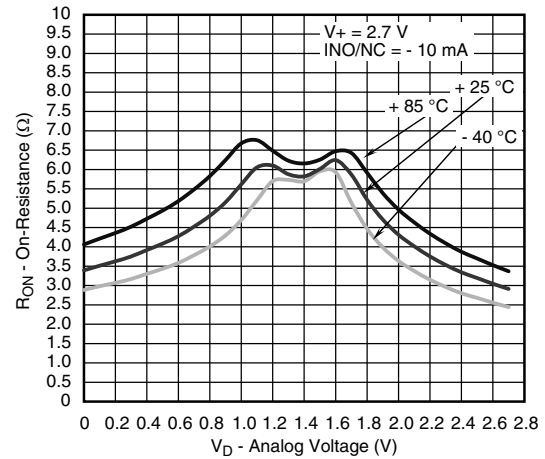
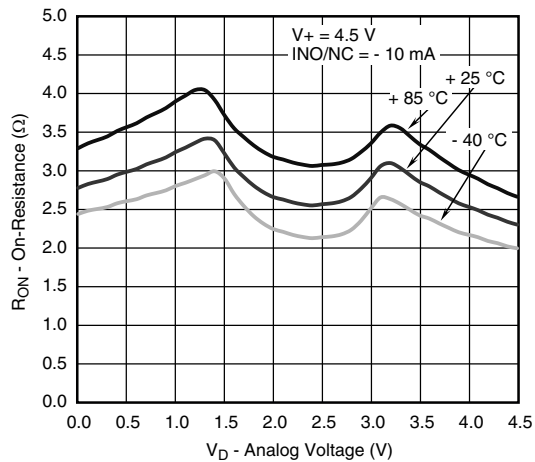
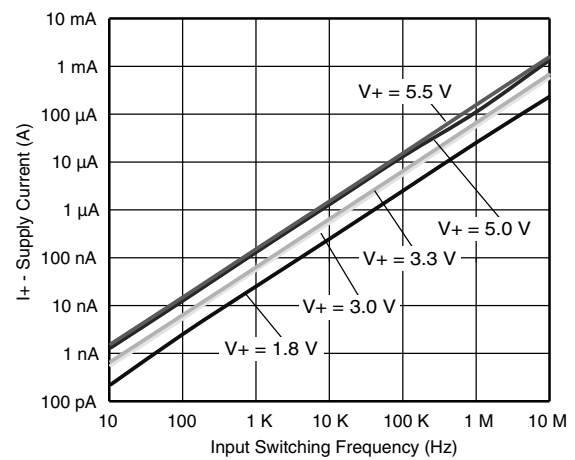
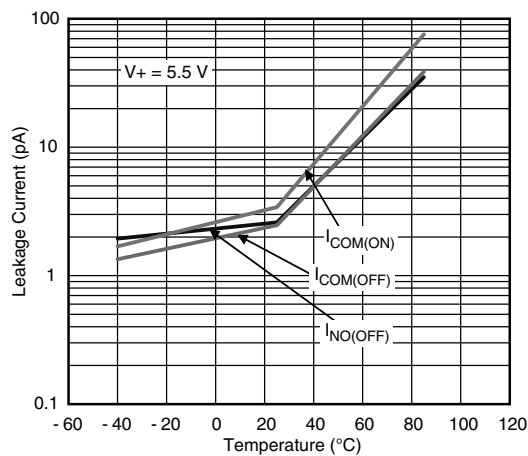
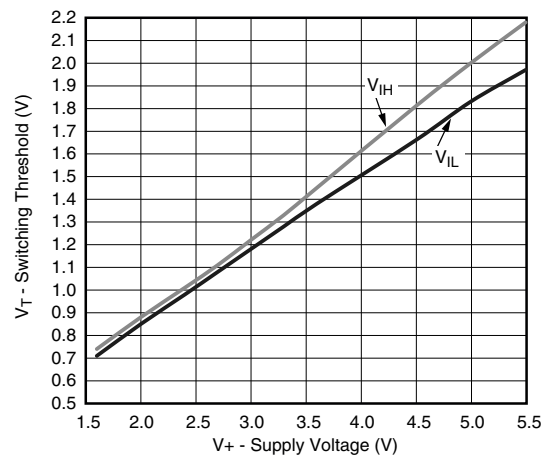
| SPECIFICATIONS (V+ = 3 V)             |                                                       |                                                                                                                |                    |                            |                   |                   |      |
|---------------------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|--------------------|----------------------------|-------------------|-------------------|------|
| Parameter                             | Symbol                                                | Test Conditions<br>Otherwise Unless Specified<br>V+ = 3 V, ± 10 %, V <sub>IN</sub> = 0.4 or 1.5 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+ = 2.7 V, V <sub>COM</sub> = 0 V to V+, I <sub>NO</sub> , I <sub>NC</sub> = - 10 mA                          | Room<br>Full       |                            | 6.5               | 10                | Ω    |
| R <sub>ON</sub> Flatness <sup>d</sup> | R <sub>ON</sub><br>Flatness                           | V+ = 2.7 V, V <sub>COM</sub> = 1.1 V to 1.6 V,<br>I <sub>NO</sub> , I <sub>NC</sub> = - 10 mA                  | Room               |                            | 0.4               |                   |      |
| R <sub>ON</sub> Match <sup>d</sup>    | R <sub>ON</sub><br>Match                              | V+ = 2.7 V, V <sub>D</sub> = 1.1 V to 1.6 V, I <sub>D</sub> = - 10 mA                                          | Room<br>Full       |                            | 0.3               | 0.9               |      |
| Switch Off Leakage Current            | 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       | - 0.25<br>- 0.35           |                   | 0.25<br>0.35      | nA   |
|                                       | I <sub>COM(off)</sub>                                 |                                                                                                                | Room<br>Full       | - 0.25<br>- 0.35           |                   | 0.25<br>0.35      |      |
| Channel-On Leakage Current            | 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       | - 0.25<br>- 0.35           |                   | 0.25<br>0.35      |      |
| Digital Control                       |                                                       |                                                                                                                |                    |                            |                   |                   |      |
| 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>                                       | f = 1 MHz                                                                                                      | Full               |                            | 2.4               |                   | pF   |
| Input Current                         | 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                          | t <sub>ON</sub>                                       | V <sub>NO</sub> or V <sub>NC</sub> = 2 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>figures 1 and 2    | Room<br>Full       |                            | 16                | 55                | ns   |
| Turn-Off Time                         | t <sub>OFF</sub>                                      |                                                                                                                | Room<br>Full       |                            | 7                 | 40                |      |
| 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               |                            | 1.8               |                   | pC   |
| Bandwidth <sup>d</sup>                | BW                                                    | V+ = 3 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, - 3dB                                                  | Room               |                            | 319               |                   | MHz  |
| Off-Isolation <sup>d</sup>            | OIRR                                                  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz                                                        | Room               |                            | - 67              |                   | dB   |
| Crosstalk <sup>d</sup>                | X <sub>TALK</sub>                                     |                                                                                                                | Room               |                            | - 92              |                   |      |
| Off-Isolation <sup>d</sup>            | OIRR                                                  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 10 MHz                                                       | Room               |                            | - 47              |                   |      |
| Crosstalk <sup>d</sup>                | X <sub>TALK</sub>                                     |                                                                                                                | Room               |                            | - 90              |                   |      |
| Source-Off Capacitance <sup>d</sup>   | C <sub>NC/NO(off)</sub>                               | V <sub>IN</sub> = 0 or V+, f = 1 MHz                                                                           | Room               |                            | 8                 |                   | pF   |
| Drain-Off Capacitance <sup>d</sup>    | C <sub>COM(off)</sub>                                 |                                                                                                                | Room               |                            | 9                 |                   |      |
| Channel-On Capacitance <sup>d</sup>   | C <sub>ON</sub>                                       |                                                                                                                | Room               |                            | 22                |                   |      |
| Power Supply                          |                                                       |                                                                                                                |                    |                            |                   |                   |      |
| Power Supply Current                  | I+                                                    | V <sub>IN</sub> = 0 or V+, V+ = 3.3 V                                                                          |                    |                            |                   | 1                 | μA   |

| 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 °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+ = 4.5 V, VCOM = 0 V to V+, INO, INC = 10 mA                                                     | Room<br>Full       |                            | 2.5               | 4.5<br>5          | Ω    |
| RON Flatness <sup>d</sup>           | RON<br>Flatness      | V+ = 4.5 V, VCOM = 1.3 V to 3 V, INO, INC = 10 mA                                                  | Room               |                            | 0.75              | 1.5               |      |
| RON Match <sup>d</sup>              | RON<br>Match         | V+ = 4.5 V, ID = 10 mA, VCOM = 1.3 V to 3 V                                                        | Room               |                            | 0.2               | 0.9               |      |
| 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>- 0.35           |                   | 0.25<br>0.35      | nA   |
|                                     | ICOM(off)            |                                                                                                    | Room<br>Full       | - 0.25<br>- 0.35           |                   | 0.25<br>0.35      |      |
| Channel-On Leakage Current          | ICOM(on)             | V+ = 5.5 V<br>VNO, VNC = VCOM = 1 V/4.5 V                                                          | Room<br>Full       | - 0.25<br>- 0.35           |                   | 0.25<br>0.35      |      |
| Digital Control                     |                      |                                                                                                    |                    |                            |                   |                   |      |
| Input High Voltage                  | VINH                 |                                                                                                    | Full               | 2.4                        |                   |                   | V    |
| Input Low Voltage                   | VINL                 |                                                                                                    | Full               |                            |                   | 0.8               |      |
| Input Capacitance                   | Cin                  | f = 1 MHz                                                                                          | Full               |                            | 2.2               |                   | pF   |
| Input Current                       | IINL or IINH         | VIN = 0 or V+                                                                                      | Full               | - 0.1                      | 0.005             | 0.1               | μA   |
| Dynamic Characteristics             |                      |                                                                                                    |                    |                            |                   |                   |      |
| Turn-On Time <sup>d</sup>           | tON                  | VNO or VNC = 3 V, RL = 300 Ω, CL = 35 pF<br>figures 1 and 2                                        | Room<br>Full       |                            | 17                | 30<br>40          | ns   |
| Turn-Off Time <sup>d</sup>          | tOFF                 |                                                                                                    | Room<br>Full       |                            | 9                 | 35                |      |
| Charge Injection <sup>d</sup>       | QINJ                 | CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω, figure 3                                                        | Room               |                            | 2.2               |                   | pC   |
| Bandwidth <sup>d</sup>              | BW                   | V+ = 5 V, RL = 50 Ω, CL = 5 pF, - 3 dB                                                             | Room               |                            | 366               |                   | MHz  |
| Off-Isolation <sup>d</sup>          | OIRR                 | RL = 50 Ω, CL = 5 pF, f = 1 MHz                                                                    | Room               |                            | - 67              |                   | dB   |
| Crosstalk <sup>d</sup>              | XTALK                |                                                                                                    | Room               |                            | - 90              |                   |      |
| Off-Isolation <sup>d</sup>          | OIRR                 | RL = 50 Ω, CL = 5 pF, f = 10 MHz                                                                   | Room               |                            | - 47              |                   |      |
| Crosstalk <sup>d</sup>              | XTALK                |                                                                                                    | Room               |                            | - 90              |                   |      |
| Source-Off Capacitance <sup>d</sup> | CNC/NO(off)          | VIN = 0 or V+, f = 1 MHz                                                                           | Room               |                            | 8                 |                   | pF   |
| Drain-Off Capacitance <sup>d</sup>  | CCOM(off)            |                                                                                                    | Room               |                            | 9                 |                   |      |
| Channel-On Capacitance <sup>d</sup> | CON                  |                                                                                                    | Room               |                            | 22                |                   |      |
| Power Supply                        |                      |                                                                                                    |                    |                            |                   |                   |      |
| Power Supply Range                  | V+                   |                                                                                                    |                    | 2.6                        |                   | 4.3               | V    |
| Power Supply Current                | I+                   | VIN = 0 or V+, V+ = 5.5 V                                                                          | Full               |                            |                   | 2                 | μA   |

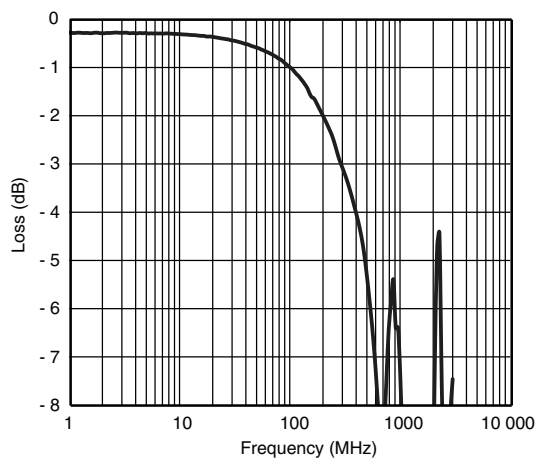
### Notes:

- 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<sub>IN</sub> = input voltage to perform proper function.
- Not production tested.

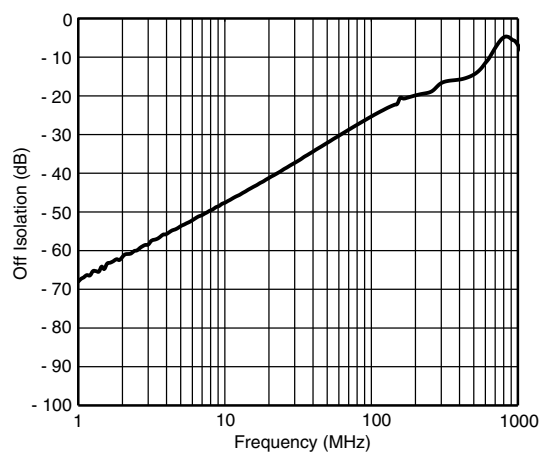
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

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

 **$R_{ON}$  vs.  $V_D$  and Single Supply Voltage**

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

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

**Supply Current vs. Input Switching Frequency**

**Leakage Current vs. Temperature**

**Switching Threshold vs. Supply Voltage**

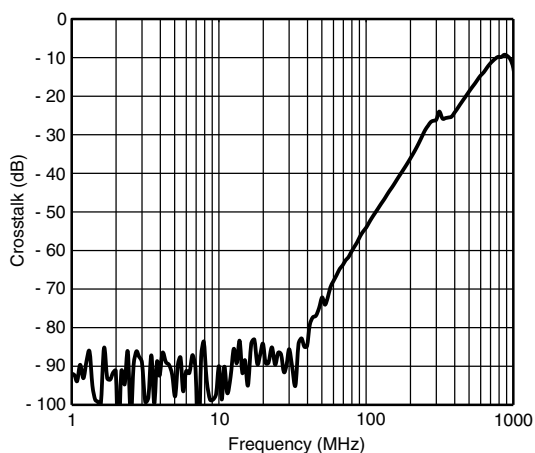
## TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



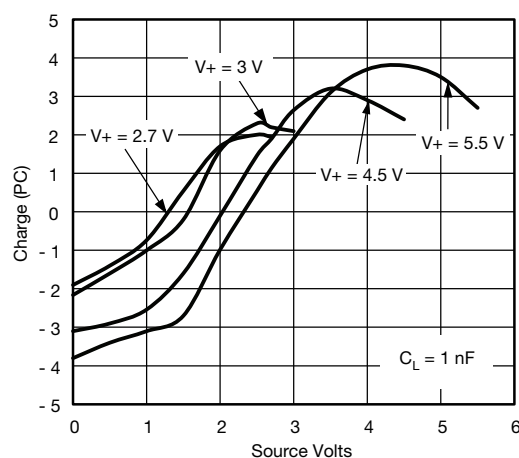
Insertion Loss vs. Frequency



Off Isolation vs. Frequency

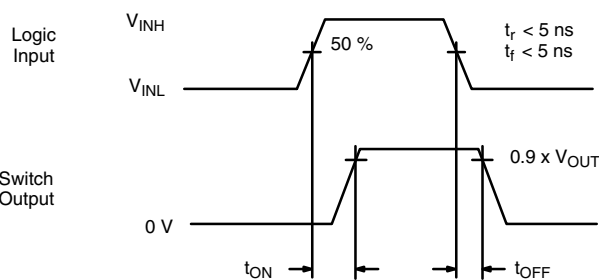
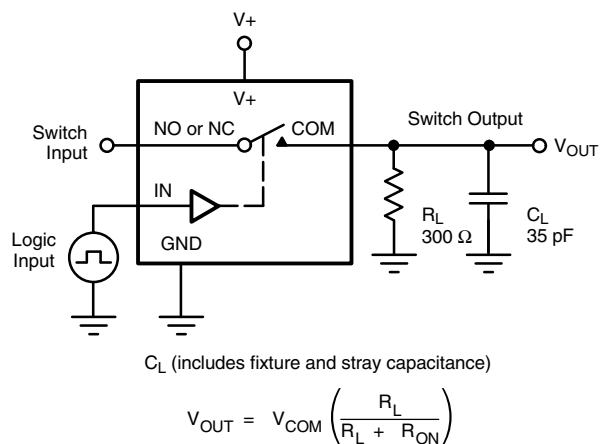


Crosstalk vs. Frequency



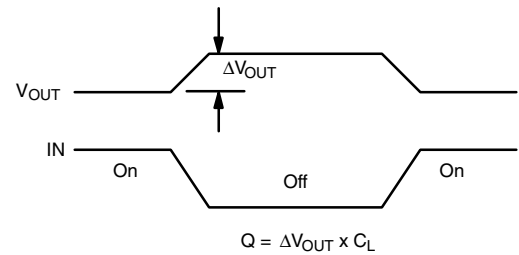
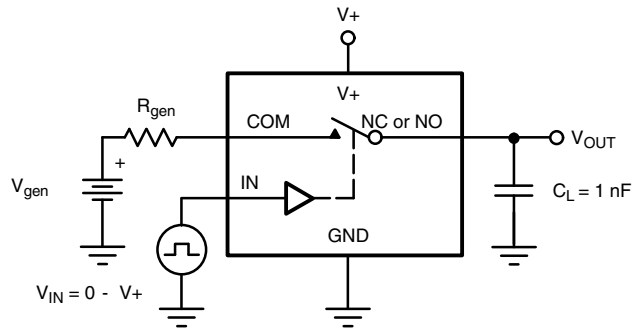
Charge Injection vs. Analog Voltage

## TEST CIRCUITS

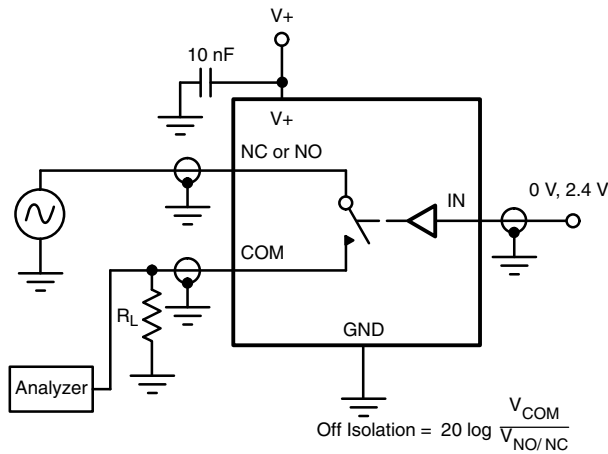
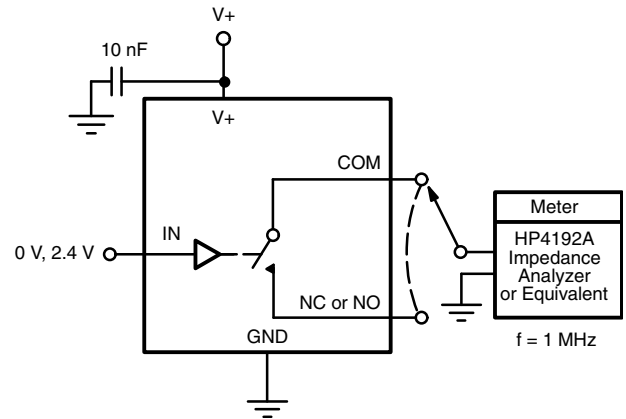
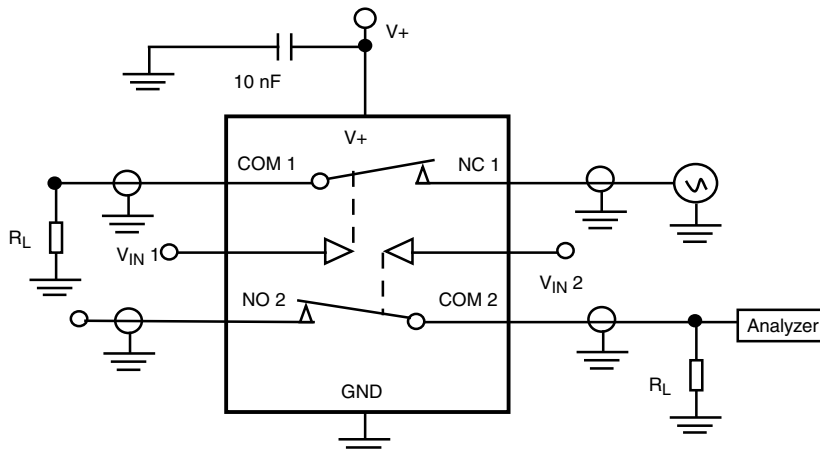


Logic "1" = Switch On  
Logic input waveforms inverted for switches that have the opposite logic sense.

Figure 1. Switching Time

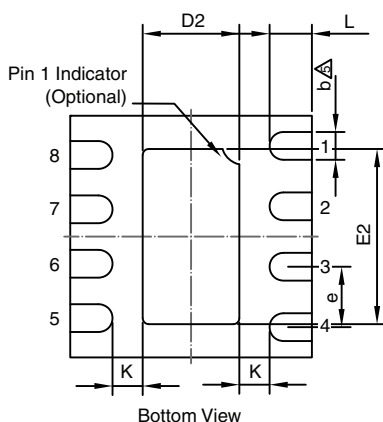
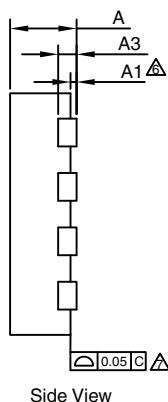
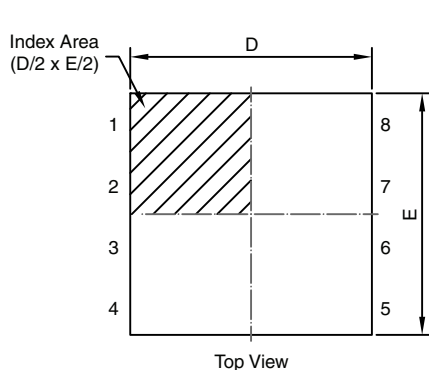
**TEST CIRCUITS**


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**

**Figure 5. Channel to Channel Crosstalk**

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?66586](http://www.vishay.com/ppg?66586).

## CASE OUTLINE FOR TDFN8 2 x 2



| DIM. | MILLIMETERS |      |      | INCHES    |       |       |
|------|-------------|------|------|-----------|-------|-------|
|      | MIN.        | NOM. | MAX. | MIN.      | NOM.  | MAX.  |
| A    | 0.50        | 0.55 | 0.60 | 0.020     | 0.022 | 0.024 |
| A1   | 0.00        | -    | 0.05 | 0.000     | -     | 0.002 |
| A3   | 0.152 REF   |      |      | 0.006 REF |       |       |
| b    | 0.18        | 0.23 | 0.28 | 0.007     | 0.009 | 0.011 |
| D    | 1.95        | 2.00 | 2.05 | 0.077     | 0.079 | 0.081 |
| D2   | 0.75        | 0.80 | 0.85 | 0.030     | 0.031 | 0.033 |
| e    | 0.50 BSC    |      |      | 0.020 BSC |       |       |
| E    | 1.95        | 2.00 | 2.05 | 0.077     | 0.079 | 0.081 |
| E2   | 1.40        | 1.45 | 1.50 | 0.055     | 0.057 | 0.059 |
| K    | -           | 0.20 | -    | -         | 0.008 | -     |
| L    | 0.30        | 0.35 | 0.40 | 0.012     | 0.014 | 0.016 |

ECN: C11-0033 Rev. A, 07-Feb-11  
DWG: 5997

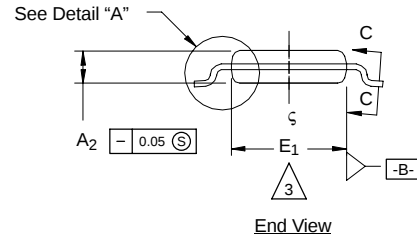
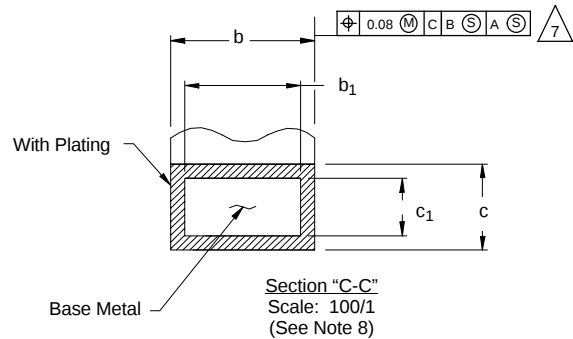
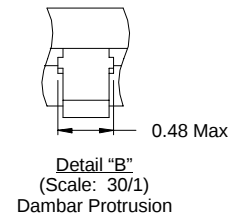
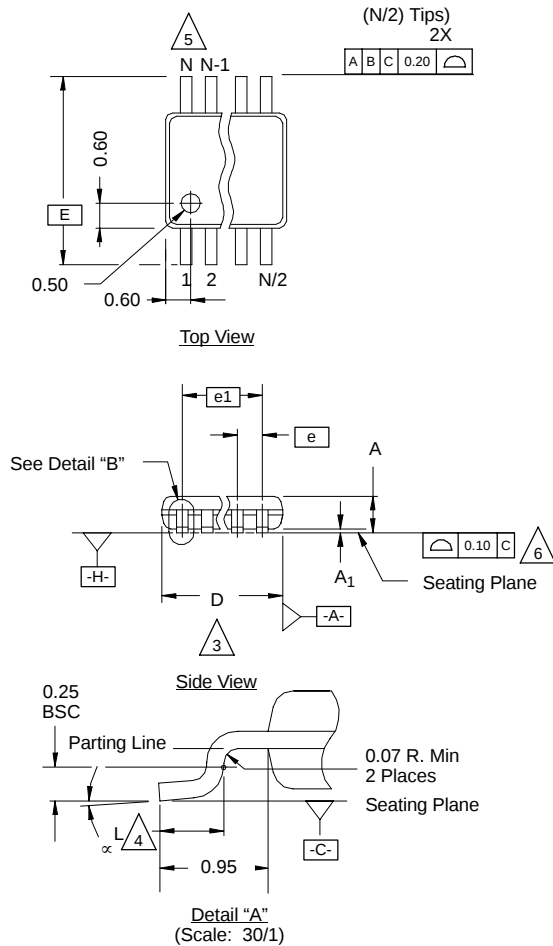
### Note

1. All dimensions are in millimeters which will govern.
2. Max. package warpage is 0.05 mm.
3. Max. allowable burrs is 0.076 mm in all directions.
4. Pin #1 ID on top will be laser/ink marked.
5. Dimension applies to meatlized terminal and is measured between 0.20 mm and 0.25 mm from terminal tip.
6. Applied only for terminals.
7. Applied for exposed pad and terminals.



**MSOP: 8-LEADS**

JEDEC Part Number: MO-187, (Variation AA and BA)



**NOTES:**

1. Die thickness allowable is  $0.203 \pm 0.0127$ .
2. Dimensioning and tolerances per ANSI.Y14.5M-1994.
3. Dimensions "D" and "E<sub>1</sub>" do not include mold flash or protrusions, and are measured at Datum plane  $-H-$ , mold flash or protrusions shall not exceed 0.15 mm per side.
4. Dimension is the length of terminal for soldering to a substrate.
5. Terminal positions are shown for reference only.
6. Formed leads shall be planar with respect to one another within 0.10 mm at seating plane.
7. The lead width dimension does not include Dambar protrusion. Allowable Dambar protrusion shall be 0.08 mm total in excess of the lead width dimension at maximum material condition. Dambar cannot be located on the lower radius or the lead foot. Minimum space between protrusions and an adjacent lead to be 0.14 mm. See detail "B" and Section "C-C".
8. Section "C-C" to be determined at 0.10 mm to 0.25 mm from the lead tip.
9. Controlling dimension: millimeters.
10. This part is compliant with JEDEC registration MO-187, variation AA and BA.
11. Datums  $-A-$  and  $-B-$  to be determined Datum plane  $-H-$ .
12. Exposed pad area in bottom side is the same as teh leadframe pad size.

**N = 8L**

| Dim                                         | MILLIMETERS |      |      | Note |
|---------------------------------------------|-------------|------|------|------|
|                                             | Min         | Nom  | Max  |      |
| A                                           | -           | -    | 1.10 |      |
| A <sub>1</sub>                              | 0.05        | 0.10 | 0.15 |      |
| A <sub>2</sub>                              | 0.75        | 0.85 | 0.95 |      |
| b                                           | 0.25        | -    | 0.38 | 8    |
| b <sub>1</sub>                              | 0.25        | 0.30 | 0.33 | 8    |
| c                                           | 0.13        | -    | 0.23 |      |
| c <sub>1</sub>                              | 0.13        | 0.15 | 0.18 |      |
| D                                           | 3.00 BSC    |      |      | 3    |
| E                                           | 4.90 BSC    |      |      |      |
| E <sub>1</sub>                              | 2.90        | 3.00 | 3.10 | 3    |
| e                                           | 0.65 BSC    |      |      |      |
| e <sub>1</sub>                              | 1.95 BSC    |      |      |      |
| L                                           | 0.40        | 0.55 | 0.70 | 4    |
| N                                           | 8           |      |      | 5    |
| α                                           | 0°          | 4°   | 6°   |      |
| ECN: T-02080—Rev. C, 15-Jul-02<br>DWG: 5867 |             |      |      |      |



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