

## Low Voltage, Dual DPDT and Quad SPDT Analog Switches

### DESCRIPTION

The DG2018 and DG2019 are low voltage, single supply analog switches. The DG2018 is a dual double-pole/double-throw (DPDT) with two control inputs that each controls a pair of single-pole/double-throw (SPDT). The DG2019 uses one control pin to operate four independent SPDT switches.

When operated on a + 3 V supply, the DG2018's control pins are compatible with 1.8 V digital logic. The DG2019 has an available feature of a  $V_L$  pin that allows a 1.0 V threshold for the control pin when  $V_L$  is powered with 1.5 V.

Built on Vishay Siliconix's low voltage submicron CMOS process, the DG2018 and DG2019 are ideal for high performance switching of analog signals; providing low on-resistance ( $6\ \Omega$  at + 2.7 V), fast speed ( $T_{on}$ ,  $T_{off}$  at 42 ns and 16 ns), and a bandwidth that exceeds 180 MHz.

The DG2018 and DG2019 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.

An epitaxial layer prevents latch-up. Brake-before-make is guaranteed for all SPDT's. All switches conduct 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
  - $R_{DS(on)}$ :  $6\ \Omega$  at 2.7 V
- Low voltage logic compatible
  - DG2019:  $V_{INH} = 1\text{ V}$
- High bandwidth: 180 MHz
- QFN-16 package

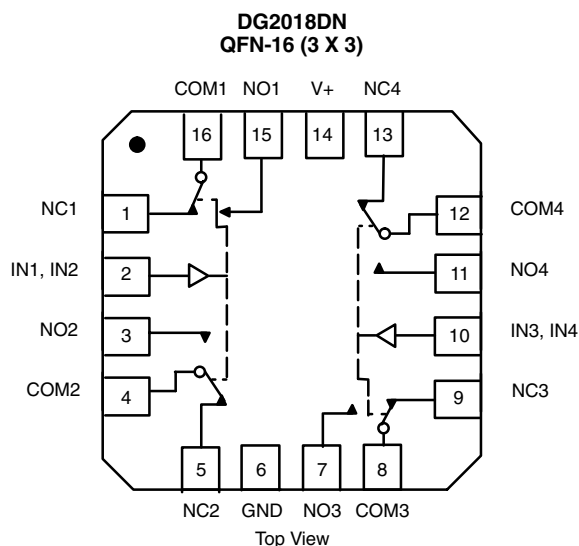
### BENEFITS

- Ideal for both analog and digital signal switching
- Reduced power consumption
- High accuracy
- Reduced PCB space
- Fast switching
- Low leakage

### APPLICATIONS

- Cellular phones
- Audio and video signal routing
- PCMCIA cards
- Battery operated systems
- Portable instrumentation

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



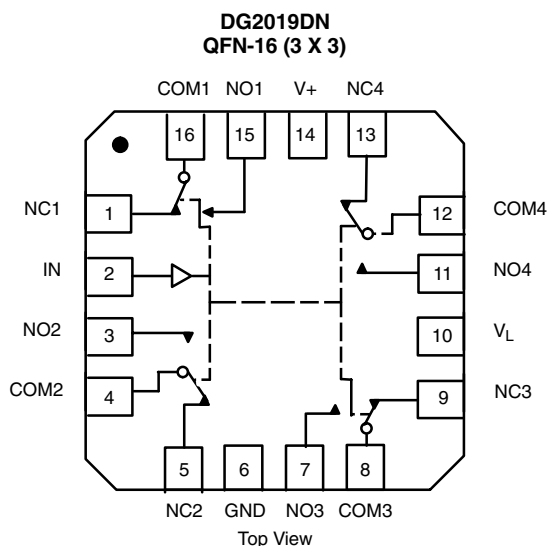
### TRUTH TABLE

| IN1, IN2 |             |             |
|----------|-------------|-------------|
| Logic    | NC1 and NC2 | NO1 and NO2 |
| 0        | ON          | OFF         |
| 1        | OFF         | ON          |
| IN3, IN4 |             |             |
| Logic    | NC3 and NC4 | NO3 and NO4 |
| 0        | ON          | OFF         |
| 1        | OFF         | ON          |

### ORDERING INFORMATION

| Temp. Range      | Package           | Part Number |
|------------------|-------------------|-------------|
| - 40 °C to 85 °C | QFN-16 (3 x 3 mm) | DG2018DN    |

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



### TRUTH TABLE

| Logic | NC1, 2, 3 and 4 | NO1, 2, 3 and 4 |
|-------|-----------------|-----------------|
| 0     | ON              | OFF             |
| 1     | OFF             | ON              |

### ORDERING INFORMATION

| Temp. Range      | Package           | Part Number |
|------------------|-------------------|-------------|
| - 40 °C to 85 °C | QFN-16 (3 x 3 mm) | DG2019DN    |

### ABSOLUTE MAXIMUM RATINGS

| Parameter                                      | Limit                          | Unit |
|------------------------------------------------|--------------------------------|------|
| Reference V+ to GND                            | - 0.3 to + 6                   | V    |
| IN, COM, NC, NO                                | - 0.3 to (V+ + 0.3)            |      |
| Continuous Current (Any terminal)              | ± 50                           | mA   |
| Peak Current (Pulsed at 1 ms, 10 % Duty Cycle) | ± 100                          |      |
| Storage Temperature (D Suffix)                 | - 65 to 150                    | °C   |
| Power Dissipation (Packages) <sup>b</sup>      | QFN-16 (3 x 3 mm) <sup>c</sup> | 850  |
|                                                |                                | 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 4.0 mW/°C above 70 °C.



| SPECIFICATIONS V+ = 3 V             |                      |                                                                                                                                                                                  |                    |                            |                   |                   |      |
|-------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|----------------------------|-------------------|-------------------|------|
| Parameter                           | Symbol               | Test Conditions<br>Otherwise Unless Specified<br>V+ = 3 V, ± 10 %,<br>(DG2018 Only) VIN = 0.5 or 1.4 V <sup>e</sup><br>(DG2019 Only) VL = 1.5 V, VIN = 0.4 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>    | VNO, VNC,<br>VCOM    |                                                                                                                                                                                  | Full               | 0                          |                   | V+                | V    |
| On-Resistance                       | RON                  | V+ = 2.7 V, VCOM = 0.2 V/1.5 V<br>INO, INC = 10 mA                                                                                                                               | Room<br>Full       |                            | 6                 | 12<br>15          | Ω    |
| RON Flatness                        | RON<br>Flatness      | V+ = 2.7 V<br>VCOM = 0 to V+, INO, INC = 10 mA                                                                                                                                   | Room               |                            | 0.5               | 2                 |      |
| RON Match Between<br>Channels       | ΔRON                 |                                                                                                                                                                                  | Room               |                            | 0.6               | 3                 |      |
| Switch Off Leakage Current          | INO(off)<br>INC(off) | V+ = 3.3 V, VNO, VNC = 0.3 V/3 V<br>VCOM = 3 V/0.3 V                                                                                                                             | Room<br>Full       | - 1<br>- 10                | 0.3               | 1<br>10           | nA   |
|                                     | ICOM(off)            |                                                                                                                                                                                  | Room<br>Full       | - 1<br>- 10                | 0.3               | 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                  | 0.3               | 1<br>10           |      |
| Digital Control                     |                      |                                                                                                                                                                                  |                    |                            |                   |                   |      |
| Input High Voltage                  | VINH                 |                                                                                                                                                                                  | DG2018             | Full                       | 1.4               |                   | V    |
|                                     |                      | VL = 1.5 V                                                                                                                                                                       | DG2019             | Full                       | 1.0               |                   |      |
| Input Low Voltage                   | VINL                 |                                                                                                                                                                                  | DG2018             | Full                       |                   | 0.5               |      |
|                                     |                      | VL = 1.5 V                                                                                                                                                                       | DG2019             | Full                       |                   | 0.4               |      |
| Input Capacitance                   | Cin                  | f = 1 MHz                                                                                                                                                                        | Full               |                            | 9                 |                   | pF   |
| Input Current                       | INL or INH           | VIN = 0 or V+                                                                                                                                                                    | Full               | - 1                        |                   | 1                 | μA   |
| Dynamic Characteristics             |                      |                                                                                                                                                                                  |                    |                            |                   |                   |      |
| Turn-On Time                        | tON                  | VNO or VNC = 2.0 V, RL = 300 Ω, CL = 35 pF                                                                                                                                       | Room<br>Full       |                            | 42                | 55<br>65          | ns   |
| Turn-Off Time                       | tOFF                 |                                                                                                                                                                                  | Room<br>Full       |                            | 16                | 25<br>35          |      |
| Break-Before-Make Time              | td                   | VNO or VNC = 2.0 V, RL = 50 Ω, CL = 35 pF                                                                                                                                        | Full               | 1                          |                   |                   |      |
| Charge Injection <sup>d</sup>       | QINJ                 | CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω                                                                                                                                                | Room               |                            | - 1.46            |                   | pC   |
| Off-Isolation <sup>d</sup>          | OIRR                 | RL = 50 Ω, CL = 5 pF, f = 1 MHz                                                                                                                                                  | Room               |                            | - 67              |                   | dB   |
| Crosstalk <sup>d</sup>              | XTALK                |                                                                                                                                                                                  | Room               |                            | - 72              |                   |      |
| Bandwidth <sup>d</sup>              | BW                   |                                                                                                                                                                                  | Room               |                            | 180               |                   | MHz  |
| NO, NC Off Capacitance <sup>d</sup> | CNO(off)             | VIN = 0 or V+, f = 1 MHz                                                                                                                                                         | Room               |                            | 9                 |                   | pF   |
|                                     | CNC(off)             |                                                                                                                                                                                  | Room               |                            | 9                 |                   |      |
| Channel-On Capacitance <sup>d</sup> | CNO(on)              |                                                                                                                                                                                  | Room               |                            | 30                |                   |      |
|                                     | CNC(on)              |                                                                                                                                                                                  | Room               |                            | 30                |                   |      |
| Power Supply                        |                      |                                                                                                                                                                                  |                    |                            |                   |                   |      |
| Power Supply Current                | I+                   | VIN = 0 or V+                                                                                                                                                                    | Full               |                            | 0.01              | 1.0               | 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 data sheet.

d. Guarantee by design, nor subjected to production test.

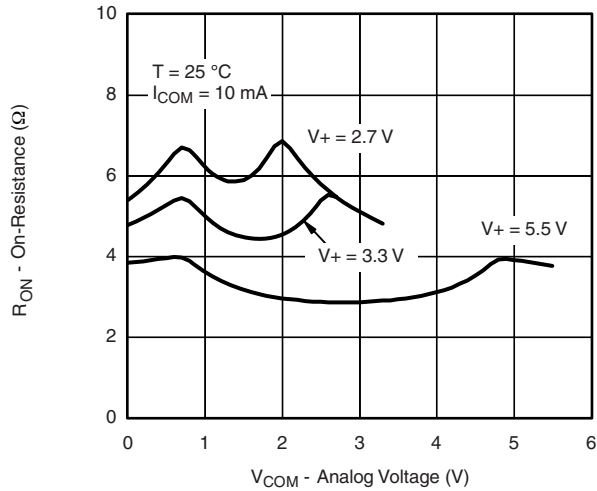
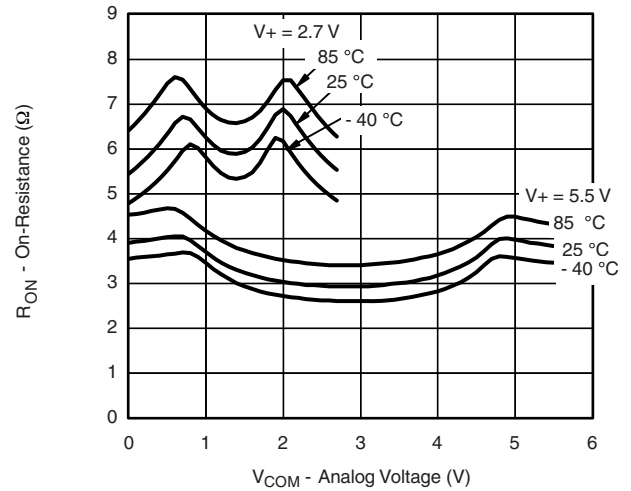
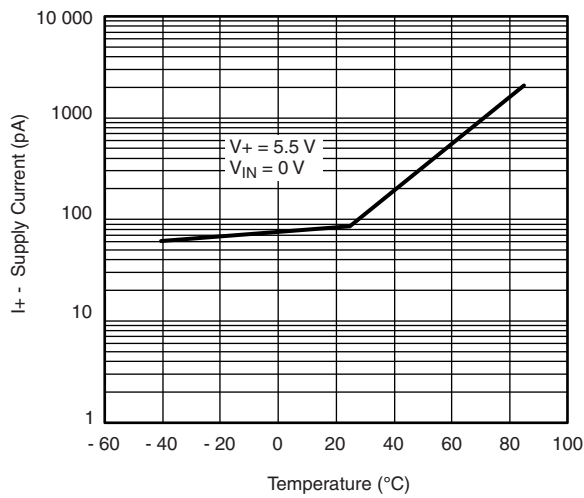
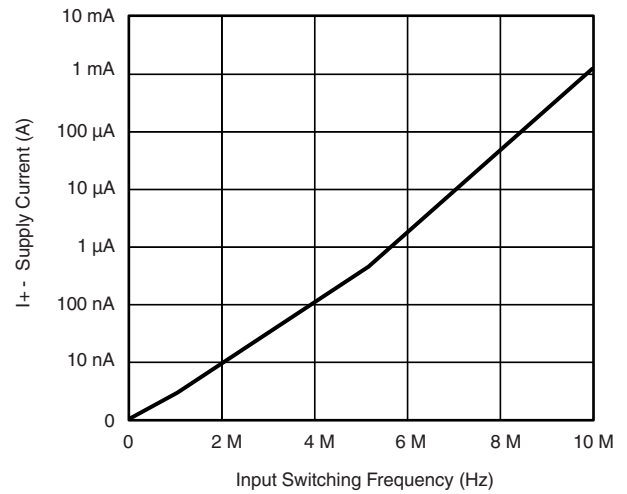
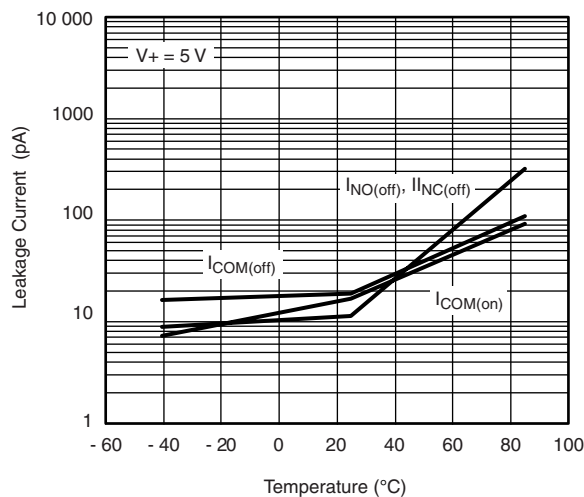
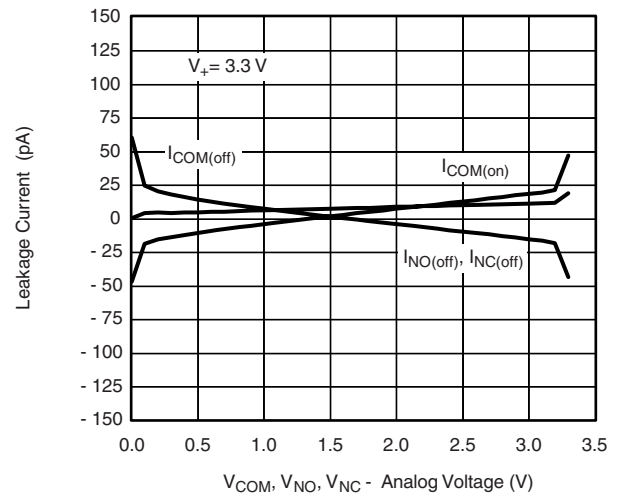
e.  $V_{IN}$  = input voltage to perform proper function.

| SPECIFICATIONS $V_+ = 5\text{ V}$       |                                                |                                                                                                                                                                                                                                    |        |                    |                            |                   |                   |               |
|-----------------------------------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------------------|----------------------------|-------------------|-------------------|---------------|
| Parameter                               | Symbol                                         | Test Conditions<br>Otherwise Unless Specified<br>$V_+ = 5\text{ V}, \pm 10\%$ ,<br>(DG2018 Only) $V_{\text{IN}} = 0.8$ or $1.8\text{ V}^e$<br>(DG2019 Only) $V_{\text{L}} = 1.5\text{ V}, V_{\text{IN}} = 0.4$ or $1.0\text{ V}^e$ |        | 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>        | $V_{\text{NO}}, V_{\text{NC}}, V_{\text{COM}}$ |                                                                                                                                                                                                                                    |        | Full               | 0                          |                   | $V_+$             | V             |
| On-Resistance                           | $R_{\text{ON}}$                                | $V_+ = 4.5\text{ V}, V_{\text{COM}} = 3\text{ V}, I_{\text{NO}}, I_{\text{NC}} = 10\text{ mA}$                                                                                                                                     |        | Room<br>Full       |                            | 4                 | 8<br>10           | $\Omega$      |
| $R_{\text{ON}}$ Flatness                | $R_{\text{ON}}$<br>Flatness                    | $V_+ = 4.5\text{ V}$<br>$V_{\text{COM}} = 0$ to $V_+, I_{\text{NO}}, I_{\text{NC}} = 10\text{ mA}$                                                                                                                                 |        | Room               |                            | 0.6               | 1.2               |               |
| $R_{\text{ON}}$ Match Between Channels  | $\Delta R_{\text{ON}}$                         |                                                                                                                                                                                                                                    |        | Room               |                            | 0.6               | 1.2               |               |
| Switch Off Leakage Current <sup>f</sup> | $I_{\text{NO(off)}}, I_{\text{NC(off)}}$       | $V_+ = 5.5\text{ V}$<br>$V_{\text{NO}}, V_{\text{NC}} = 1\text{ V}/4.5\text{ V}, V_{\text{COM}} = 4.5\text{ V}/1\text{ V}$                                                                                                         |        | Room<br>Full       | - 1<br>- 10                | 0.03              | 1<br>10           | nA            |
|                                         | $I_{\text{COM(off)}}$                          |                                                                                                                                                                                                                                    |        | Room<br>Full       | - 1<br>- 10                | 0.03              | 1<br>10           |               |
| Channel-On Leakage Current <sup>f</sup> | $I_{\text{COM(on)}}$                           | $V_+ = 5.5\text{ V}, V_{\text{NO}}, V_{\text{NC}} = V_{\text{COM}} = 1\text{ V}/4.5\text{ V}$                                                                                                                                      |        | Room<br>Full       | - 1<br>- 10                | 0.03              | 1<br>10           |               |
| Digital Control                         |                                                |                                                                                                                                                                                                                                    |        |                    |                            |                   |                   |               |
| Input High Voltage                      | $V_{\text{INH}}$                               |                                                                                                                                                                                                                                    | DG2018 | Full               | 1.8                        |                   |                   | V             |
|                                         |                                                | $V_{\text{L}} = 1.5\text{ V}$                                                                                                                                                                                                      | DG2019 | Full               | 1.0                        |                   |                   |               |
| Input Low Voltage                       | $V_{\text{INL}}$                               |                                                                                                                                                                                                                                    | DG2018 | Full               |                            |                   | 0.8               |               |
|                                         |                                                | $V_{\text{L}} = 1.5\text{ V}$                                                                                                                                                                                                      | DG2019 | Full               |                            |                   | 0.4               |               |
| Input Capacitance                       | $C_{\text{in}}$                                |                                                                                                                                                                                                                                    |        | Full               |                            | 9                 |                   | pF            |
| Input Current                           | $I_{\text{INL}}$ or $I_{\text{INH}}$           | $V_{\text{IN}} = 0$ or $V_+$                                                                                                                                                                                                       |        | Full               | 1                          |                   | 1                 | $\mu\text{A}$ |
| Dynamic Characteristics                 |                                                |                                                                                                                                                                                                                                    |        |                    |                            |                   |                   |               |
| Turn-On Time                            | $t_{\text{ON}}$                                | $V_{\text{NO}}$ or $V_{\text{NC}} = 3\text{ V}, R_{\text{L}} = 300\ \Omega, C_{\text{L}} = 35\text{ pF}$                                                                                                                           |        | Room<br>Full       |                            | 44                | 48<br>52          | ns            |
| Turn-Off Time                           | $t_{\text{OFF}}$                               |                                                                                                                                                                                                                                    |        | Room<br>Full       |                            | 19                | 33<br>35          |               |
| Break-Before-Make Time                  | $t_{\text{d}}$                                 | $V_{\text{NO}}$ or $V_{\text{NC}} = 3\text{ V}, R_{\text{L}} = 50\ \Omega, C_{\text{L}} = 35\text{ pF}$                                                                                                                            |        | Full               | 1                          |                   |                   |               |
| Charge Injection <sup>d</sup>           | $Q_{\text{INJ}}$                               | $C_{\text{L}} = 1\text{ nF}, V_{\text{GEN}} = 0\text{ V}, R_{\text{GEN}} = 0\ \Omega$                                                                                                                                              |        | Room               |                            | - 2.46            |                   | pC            |
| Off-Isolation <sup>d</sup>              | OIRR                                           | $R_{\text{L}} = 50\ \Omega, C_{\text{L}} = 5\text{ pF}, f = 1\text{ MHz}$                                                                                                                                                          |        | Room               |                            | - 67              |                   | dB            |
| Crosstalk <sup>d</sup>                  | $X_{\text{TALK}}$                              |                                                                                                                                                                                                                                    |        | Room               |                            | - 72              |                   |               |
| Bandwidth <sup>d</sup>                  | BW                                             |                                                                                                                                                                                                                                    |        | Room               |                            | 180               |                   |               |
| Source-Off Capacitance <sup>d</sup>     | $C_{\text{NO(off)}}$                           | $V_{\text{IN}} = 0$ or $V_+, f = 1\text{ MHz}$                                                                                                                                                                                     |        | Room               |                            | 7.5               |                   | pF            |
|                                         | $C_{\text{NC(off)}}$                           |                                                                                                                                                                                                                                    |        | Room               |                            | 7.5               |                   |               |
| Channel-On Capacitance <sup>d</sup>     | $C_{\text{NO(on)}}$                            |                                                                                                                                                                                                                                    |        | Room               |                            | 30                |                   |               |
|                                         | $C_{\text{NC(on)}}$                            |                                                                                                                                                                                                                                    |        | Room               |                            | 30                |                   |               |
| Power Supply                            |                                                |                                                                                                                                                                                                                                    |        |                    |                            |                   |                   |               |
| Power Supply Range                      | $V_+$                                          |                                                                                                                                                                                                                                    |        |                    | 1.8                        |                   | 5.5               | V             |
| Power Supply Current                    | $I_+$                                          | $V_{\text{IN}} = 0$ or $V_+$                                                                                                                                                                                                       |        | Full               |                            | 0.01              | 1.0               | $\mu\text{A}$ |

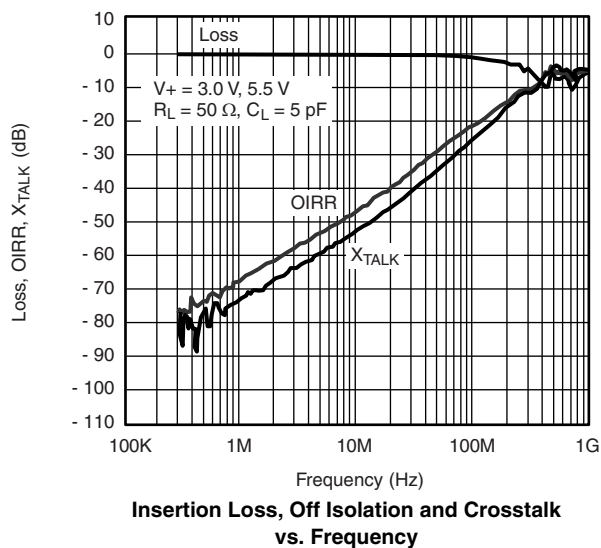
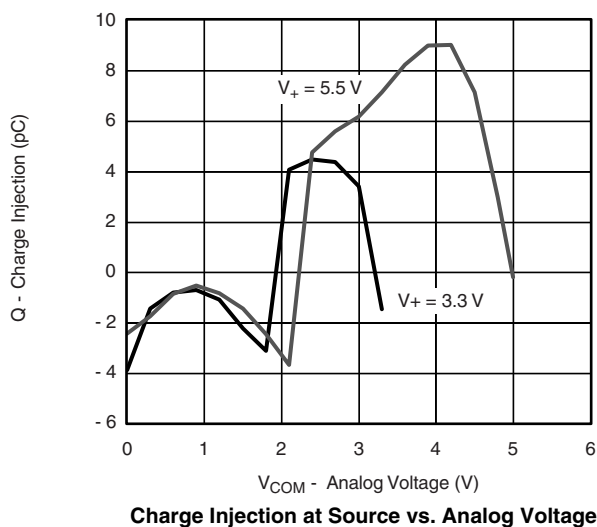
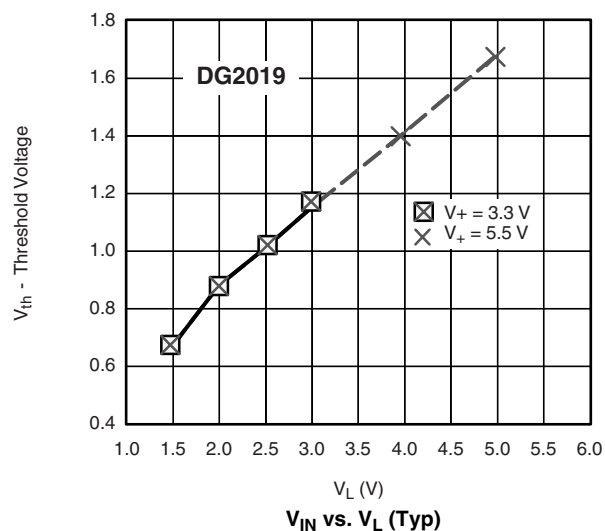
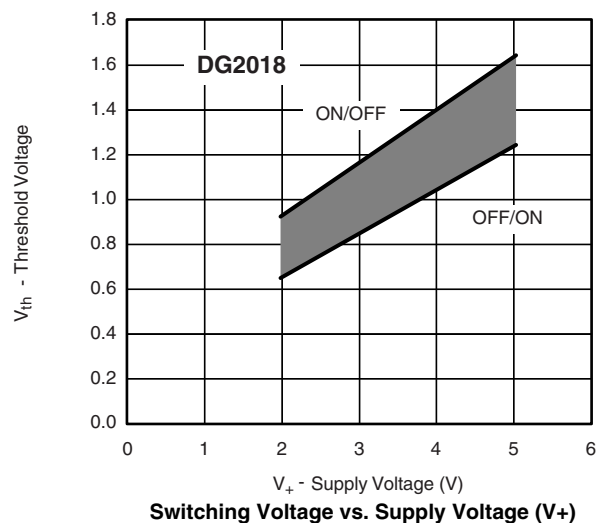
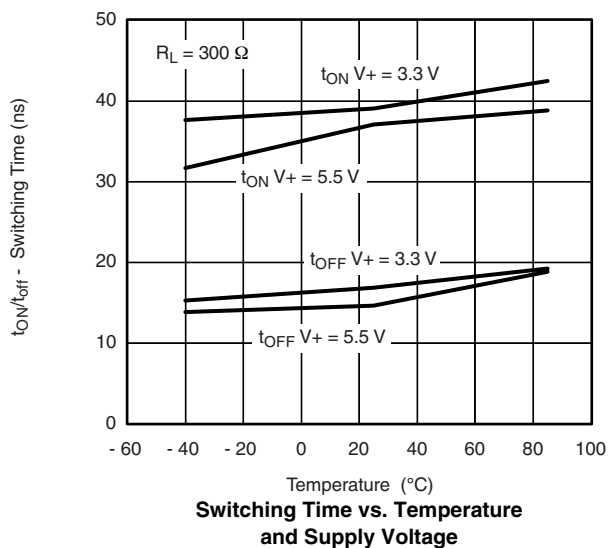
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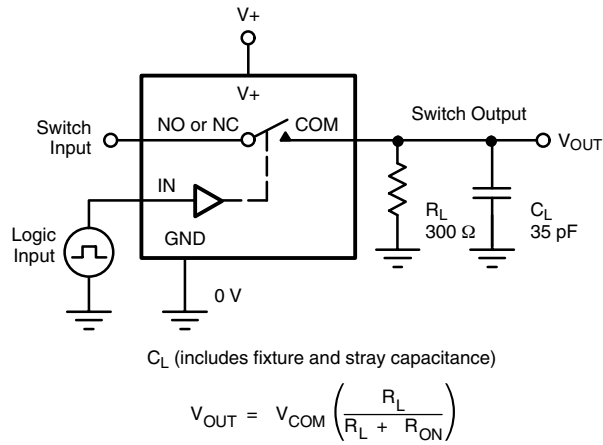
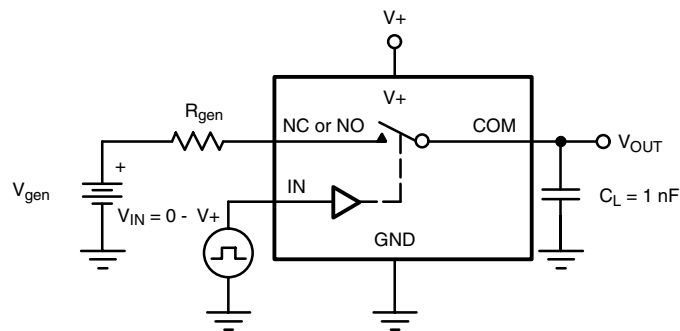
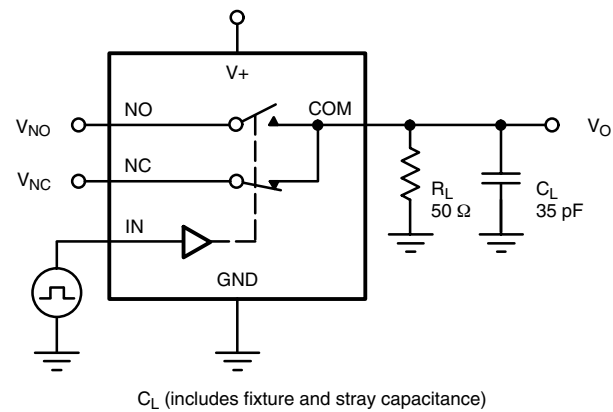
- a. Room = 25 °C, Full = as determined by the operating suffix.  
b. Typical values are for design aid only, not guaranteed nor subject to production testing.  
c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.  
d.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

## TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



**TEST CIRCUITS**

**Figure 1. Switching Time**

**Figure 2. Charge Injection**

**Figure 3. Break-Before-Make Interval**

## TEST CIRCUITS

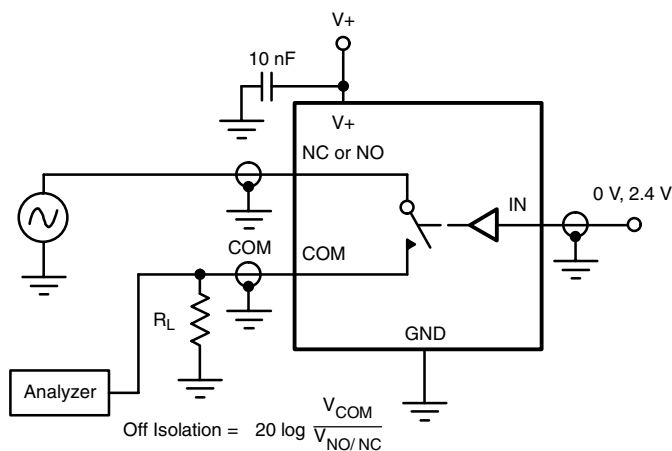


Figure 4. Off-Isolation

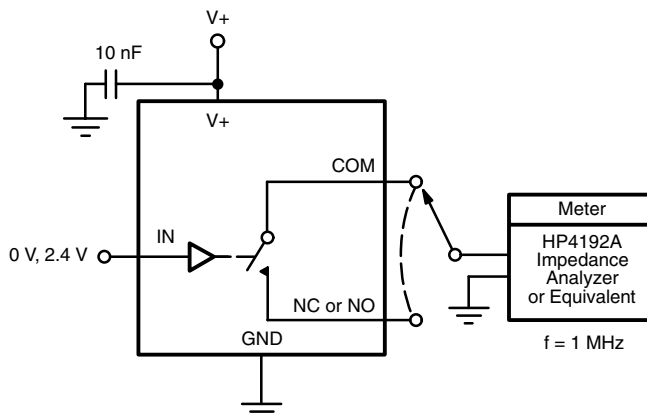
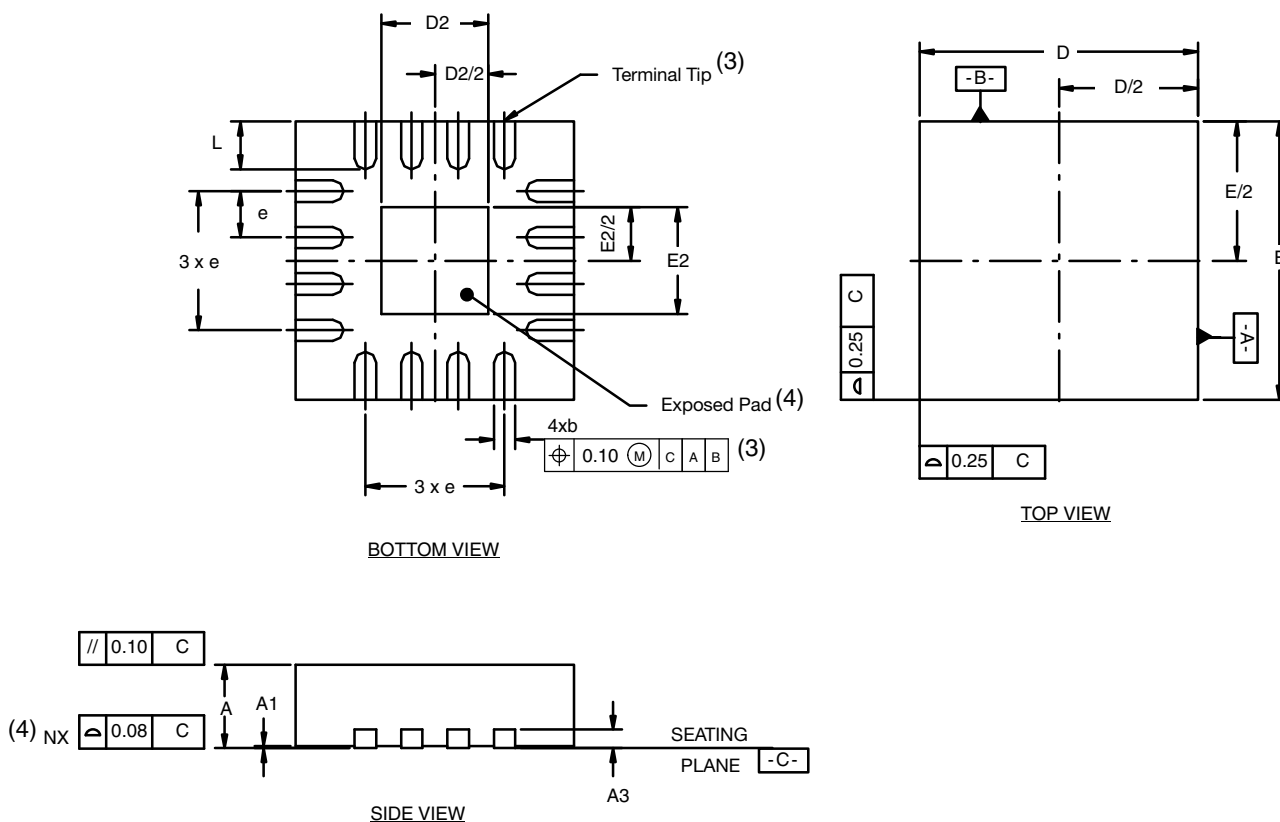


Figure 5. Channel Off/On Capacitance

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?72342>.



## QFN-16 Lead (3 x 3)



### Notes

- (1) All dimensions are in millimeters.
- (2) N is the total number of terminals.
- (3) Dimension b applies to metallized terminal and is measured between 0.25 and 0.30 mm from terminal tip.
- (4) Coplanarity applies to the exposed heat sink slug as well as the terminal.
- (5) The pin #1 identifier may be either a mold or marked feature, it must be located within the zone indicated.

| DIM.                                         | VARIATION 1 |      |      |           |       |       | VARIATION 2 |      |      |           |       |       |
|----------------------------------------------|-------------|------|------|-----------|-------|-------|-------------|------|------|-----------|-------|-------|
|                                              | MILLIMETERS |      |      | INCHES    |       |       | MILLIMETERS |      |      | INCHES    |       |       |
|                                              | MIN.        | NOM  | MAX. | MIN.      | NOM   | MAX.  | MIN.        | NOM  | MAX. | MIN.      | NOM   | MAX.  |
| A                                            | 0.80        | 0.90 | 1.00 | 0.031     | 0.035 | 0.039 | 0.80        | 0.90 | 1.00 | 0.031     | 0.035 | 0.039 |
| b                                            | 0.18        | 0.23 | 0.30 | 0.007     | 0.009 | 0.012 | 0.18        | 0.25 | 0.30 | 0.007     | 0.010 | 0.012 |
| D                                            | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 |
| D2                                           | 1.00        | 1.15 | 1.25 | 0.039     | 0.045 | 0.049 | 1.50        | 1.70 | 1.80 | 0.059     | 0.067 | 0.071 |
| E                                            | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 |
| E2                                           | 1.00        | 1.15 | 1.25 | 0.039     | 0.045 | 0.049 | 1.50        | 1.70 | 1.80 | 0.059     | 0.067 | 0.071 |
| e                                            | 0.50 BSC    |      |      | 0.020 BSC |       |       | 0.50 BSC    |      |      | 0.020 BSC |       |       |
| L                                            | 0.30        | 0.40 | 0.50 | 0.012     | 0.016 | 0.020 | 0.30        | 0.40 | 0.50 | 0.012     | 0.016 | 0.020 |
| ECN: T16-0233-Rev. D, 09-May-16<br>DWG: 5899 |             |      |      |           |       |       |             |      |      |           |       |       |



## Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

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