

# Low-Voltage, Low $R_{ON}$ , Dual DPDT Analog Switch

## DESCRIPTION

The DG2015 is a dual double-pole/double-throw monolithic CMOS analog switch designed for high performance switching of analog signals. Combining low power, high speed, low on-resistance and small physical size, the DG2015 is ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2015 is built on Vishay Siliconix's low voltage J12 process. An epitaxial layer prevents latchup. Break-before-make is guaranteed.

The switch conducts equally well in both directions when on, and blocks up to the power supply level when off.

## FEATURES

- Low Voltage Operation (2.7 V to 3.3 V)
- Low On-Resistance -  $R_{ON}$ : 0.85  $\Omega$
- 3 dB Loss at 100 MHz
- Fast Switching:  $t_{ON} = 40$  ns  
 $t_{OFF} = 35$  ns
- QFN-16 Package
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

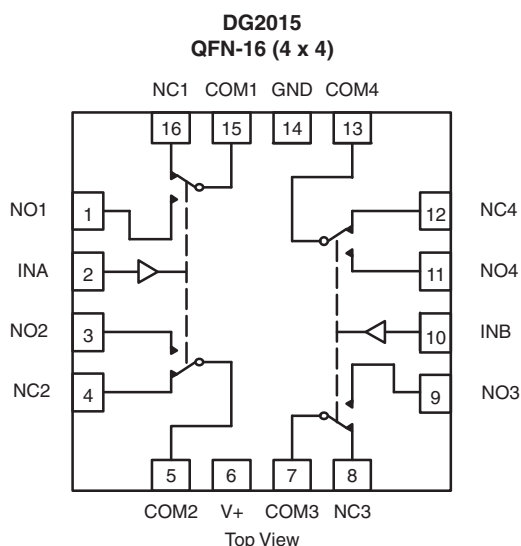
## BENEFITS

- Reduced Power Consumption
- High Accuracy
- Reduced Board Space
- Reduce Board Space
- TTL/1.8 V Logic Compatible

## APPLICATIONS

- Cellular Phones
- Speaker Headset Switching
- Audio and Video Signal Routing
- PCMCIA Cards
- Battery Operated Systems

## 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 | 16-pin QFN<br>(4 mm x 4 mm)<br>(Variation 1) | DG2015DN-T1-E4 |

**ABSOLUTE MAXIMUM RATINGS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| Parameter                                      | Limit                    | Unit               |
|--|--------------------------|--------------------|
| Reference $V_+$ to GND                         | - 0.3 to + 6             | V                  |
| IN, COM, NC, $\text{NO}^a$                     | - 0.3 to ( $V_+ + 0.3$ ) |                    |
| Current (Any terminal except NO, NC or COM)    | 30                       | mA                 |
| Continuous Current (NO, NC, or COM)            | $\pm 150$                |                    |
| Peak Current (Pulsed at 1 ms, 10 % duty cycle) | $\pm 200$                |                    |
| Storage Temperature (D Suffix)                 | - 65 to 150              | $^{\circ}\text{C}$ |
| Package Solder Reflow Conditions <sup>d</sup>  | 16-pin QFN (4 mm x 4 mm) |                    |
| Power Dissipation (Packages) <sup>b</sup>      | QFN-16 <sup>c</sup>      | mW                 |

Notes:

a. Signals on NC, NO, or COM or IN exceeding  $V_+$  will be clamped by internal diodes. Limit forward diode current to maximum current ratings.

b. All leads welded or soldered to PC Board.

c. Derate 23.5 mW/ $^{\circ}\text{C}$  above 70  $^{\circ}\text{C}$ .

d. Manual soldering with iron is not recommended for leadless components. The QFN is a leadless package. The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing. A solder fillet at the exposed copper lip cannot be guaranteed and is not required to ensure adequate bottom side solder interconnection.

**SPECIFICATIONS** ( $V_+ = 3\text{ V}$ )

| Parameter                           | Symbol               | Test Conditions<br>Otherwise Unless Specified<br>V+ = 3 V, ± 10 %, VIN = 0.4 V or 2 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, INO, INC = 100 mA  | Room<br>Full       |                            | 0.85              | 1.6<br>1.7        | Ω    |
| RON Flatness                        | RON<br>Flatness      | V+ = 2.7 V, VCOM = 0 V to V+, INO, INC = 100 mA  | Room               |                            | 0.16              |                   |      |
| RON Match                           | ΔRON                 |  | Room               |                            | 0.15              |                   |      |
| Switch Off<br>Leakage Current       | INO(off)<br>INC(off) | V+ = 3.3 V<br>VNO, VNC = 1 V/3 V, VCOM = 3 V/1 V   | Room<br>Full       | - 1<br>- 10                |                   | 1<br>10           | nA   |
|                                     | ICOM(off)            |  | Room<br>Full       | - 1<br>- 10                |                   | 1<br>10           |      |
| Channel-On<br>Leakage Current       | ICOM(on)             | V+ = 3.3 V, VNO, VNC = VCOM = 1 V/3 V  | Room<br>Full       | - 1<br>- 10                |                   | 1<br>10           |      |
| Digital Control                     |                      |  |                    |                            |                   |                   |      |
| Input High Voltage                  | VINH                 |  | Full               | 2                          |                   |                   | V    |
| Input Low Voltage                   | VINL                 |  | Full               |                            |                   | 0.4               |      |
| Input Capacitance                   | Cin                  |  | Full               |                            | 4                 |                   | pF   |
| Input Current                       | IINL or IINH         | VIN = 0 V or V+  | Full               | - 1                        |                   | 1                 | μA   |
| Dynamic Characteristics             |                      |  |                    |                            |                   |                   |      |
| Turn-On Time                        | tON                  | VNO or VNC = 2 V, RL = 300 Ω, CL = 35 pF   | Room<br>Full       |                            | 40                | 65<br>67          | ns   |
| Turn-Off Time                       | tOFF                 |  | Room<br>Full       |                            | 35                | 60<br>62          |      |
| Break-Before-Make Time              | td                   |  | Full               | 1                          | 3                 |                   |      |
| Charge Injection <sup>d</sup>       | QINJ                 | CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω  | Room               |                            | 7                 |                   | 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               |                            | - 70              |                   |      |
| NO, NC Off Capacitance <sup>d</sup> | CNO(off)             | VIN = 0 V or V+, f = 1 MHz   | Room               |                            | 63                |                   | pF   |
|                                     | CNC(off)             |  | Room               |                            | 67                |                   |      |
| Channel-On Capacitance <sup>d</sup> | CNO(on)              |  | Room               |                            | 200               |                   |      |
|                                     | CNC(on)              |  | Room               |                            | 196               |                   |      |

| SPECIFICATIONS (V+ = 3 V) |        |  |                    |                            |                   |                   |      |
|---------------------------|--------|--|--------------------|----------------------------|-------------------|-------------------|------|
| Parameter                 | Symbol | Test Conditions<br>Otherwise Unless Specified<br>V+ = 3 V, ± 10 %, VIN = 0.4 V or 2 Ve | Temp. <sup>a</sup> | Limits<br>- 40 °C to 85 °C |                   |                   | Unit |
|                           |        |  |                    | Min. <sup>b</sup>          | Typ. <sup>c</sup> | Max. <sup>b</sup> |      |
| Power Supply              |        |  |                    |                            |                   |                   |      |
| Power Supply Range        | V+     |  |                    | 2.7                        |                   | 3.3               | V    |
| Power Supply Current      | I+     | VIN = 0 V or V+  | Full               |                            |                   | 1                 | μA   |
| Power Consumption         | PC     |  | Full               |                            |                   | 3.3               | μW   |

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.

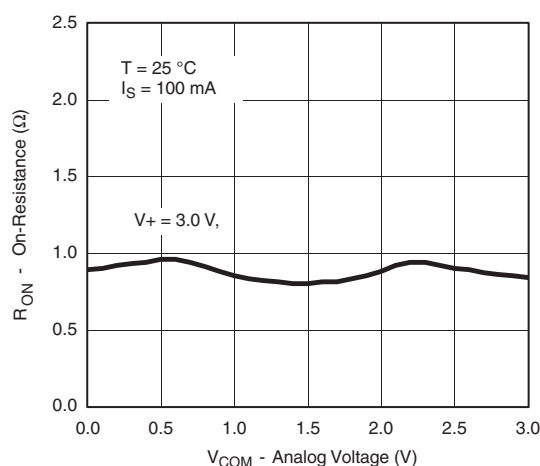
d. Guarantee by design, not subjected to production test.

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

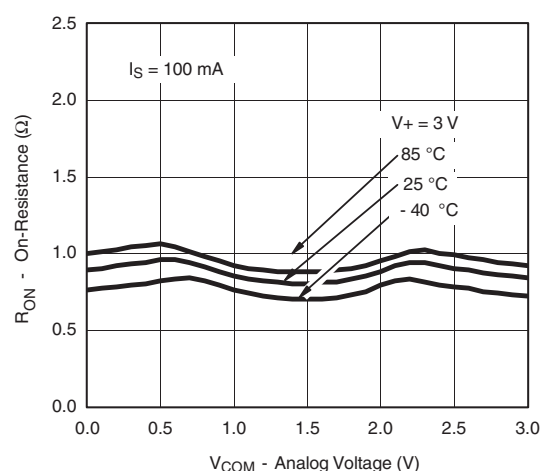
f. Guaranteed by 5 V leakage testing, not production tested.

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.

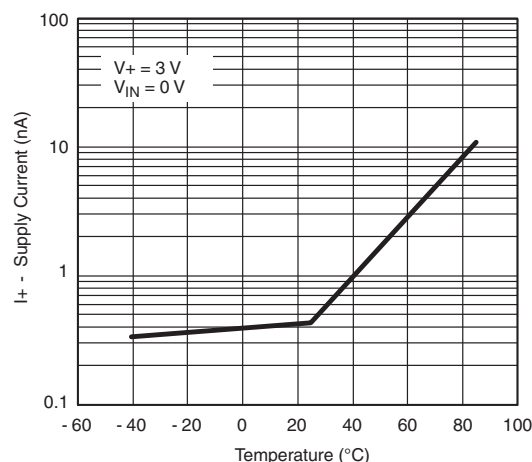
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



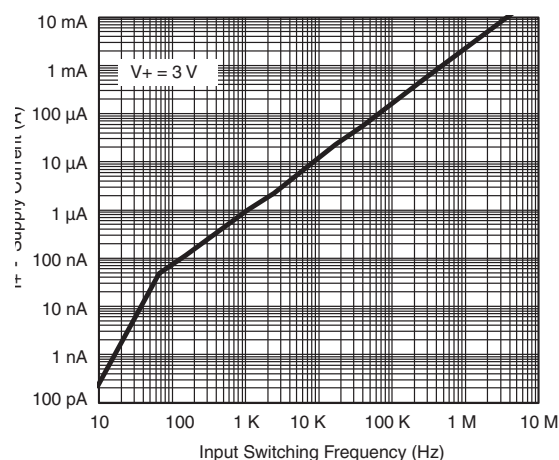
**$R_{ON}$  vs.  $V_{COM}$  and Supply Voltage**



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

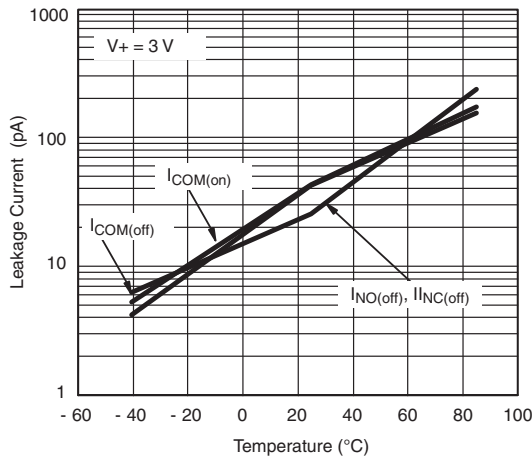


**Supply Current vs. Temperature**

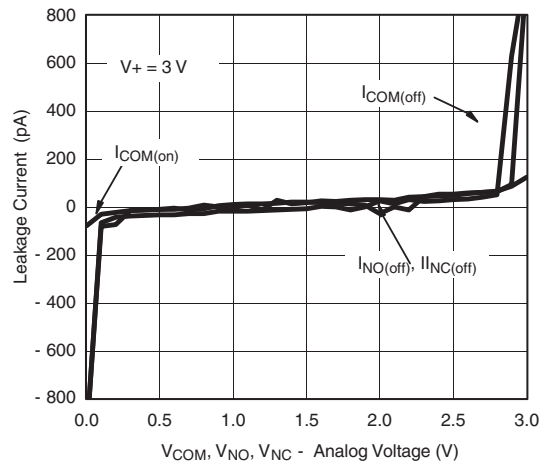


**Supply Current vs. Input Switching Frequency**

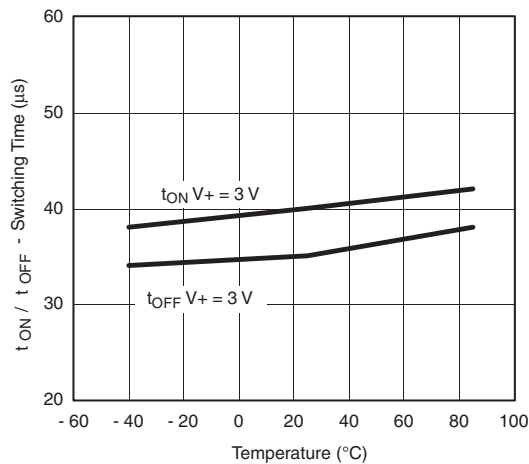
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



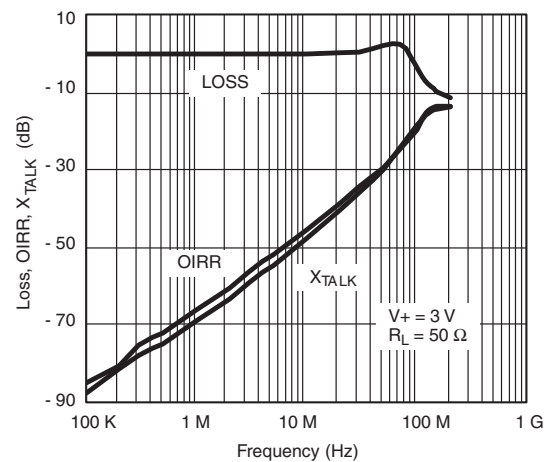
**Leakage Current vs. Temperature**



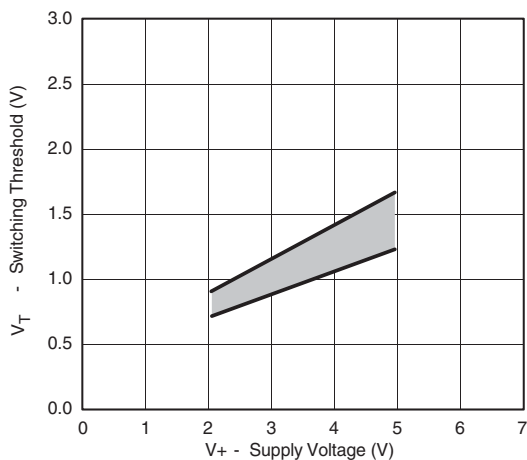
**Leakage vs. Analog Voltage**



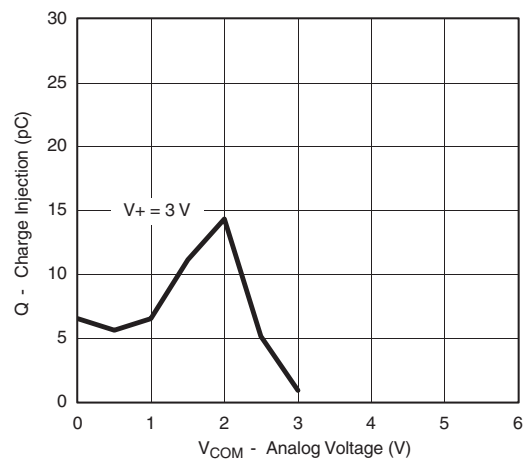
**Switching Time vs. Temperature**



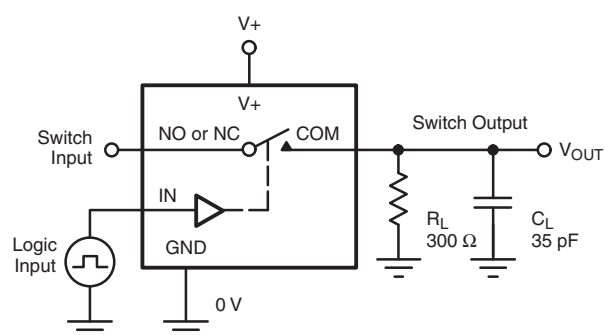
**Insertion Loss, Off-Isolation Crosstalk vs. Frequency**



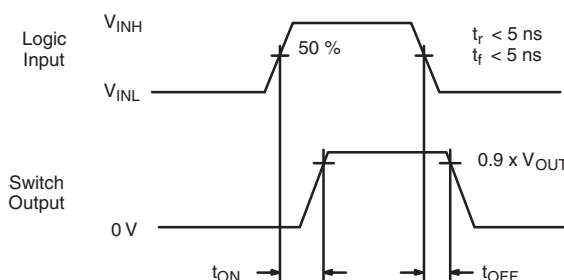
**Switching Threshold vs. Supply Voltage**



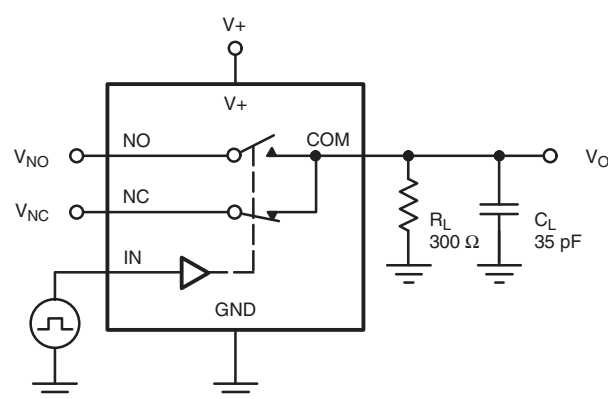
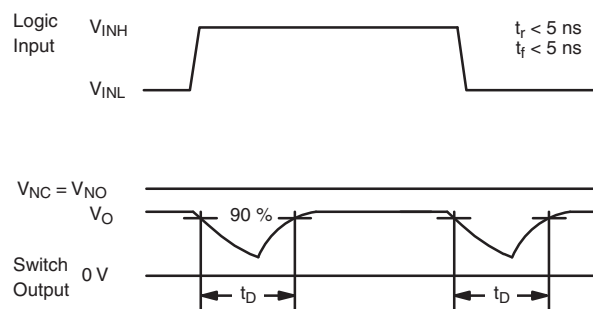
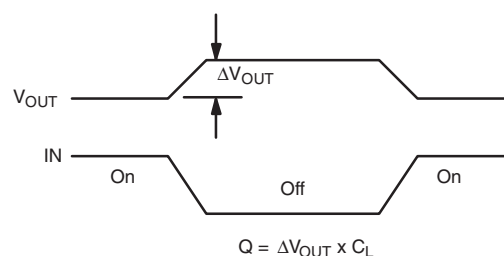
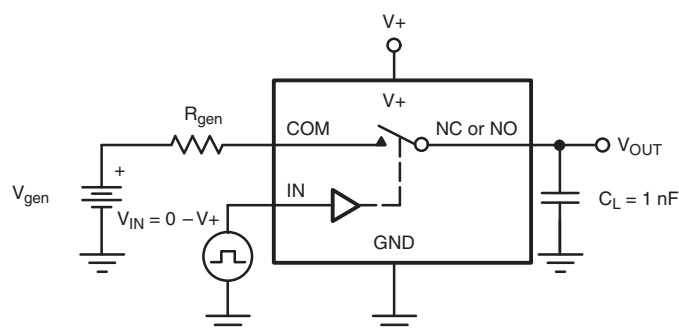
**Charge Injection vs. Analog Voltage**

**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**

### TEST CIRCUITS

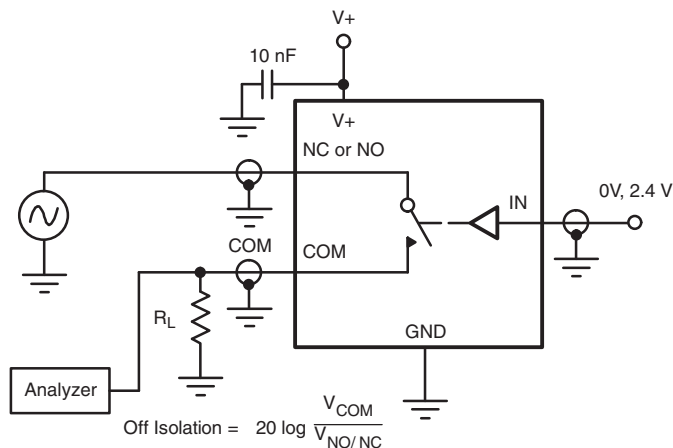


Figure 4. Off-Isolation

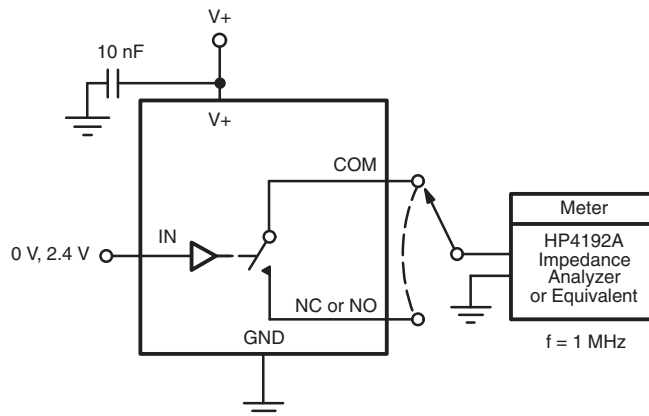
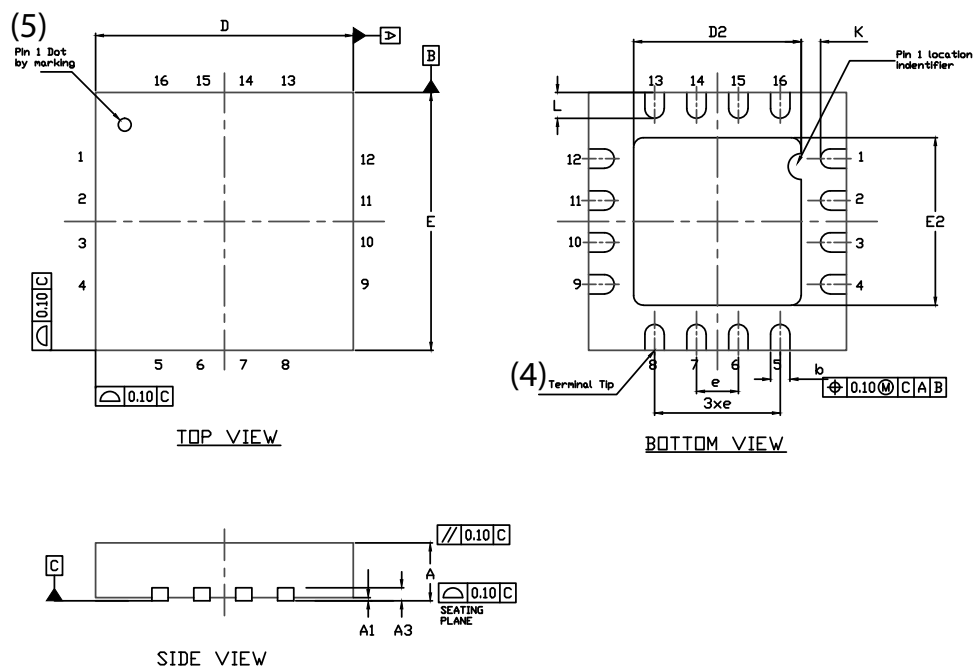


Figure 5. Channel Off/On Capacitance

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## QFN 4x4-16L Case Outline



| DIM               | VARIATION 1                |      |      |            |       |       | VARIATION 2                |      |      |            |       |       |
|-------------------|----------------------------|------|------|------------|-------|-------|----------------------------|------|------|------------|-------|-------|
|                   | MILLIMETERS <sup>(1)</sup> |      |      | INCHES     |       |       | MILLIMETERS <sup>(1)</sup> |      |      | INCHES     |       |       |
|                   | MIN.                       | NOM. | MAX. | MIN.       | NOM.  | MAX.  | MIN.                       | NOM. | MAX. | MIN.       | NOM.  | MAX.  |
| A                 | 0.75                       | 0.85 | 0.95 | 0.029      | 0.033 | 0.037 | 0.75                       | 0.85 | 0.95 | 0.029      | 0.033 | 0.037 |
| A1                | 0                          | -    | 0.05 | 0          | -     | 0.002 | 0                          | -    | 0.05 | 0          | -     | 0.002 |
| A3                | 0.20 ref.                  |      |      | 0.008 ref. |       |       | 0.20 ref.                  |      |      | 0.008 ref. |       |       |
| b                 | 0.25                       | 0.30 | 0.35 | 0.010      | 0.012 | 0.014 | 0.25                       | 0.30 | 0.35 | 0.010      | 0.012 | 0.014 |
| D                 | 4.00 BSC                   |      |      | 0.157 BSC  |       |       | 4.00 BSC                   |      |      | 0.157 BSC  |       |       |
| D2                | 2.0                        | 2.1  | 2.2  | 0.079      | 0.083 | 0.087 | 2.5                        | 2.6  | 2.7  | 0.098      | 0.102 | 0.106 |
| e                 | 0.65 BSC                   |      |      | 0.026 BSC  |       |       | 0.65 BSC                   |      |      | 0.026 BSC  |       |       |
| E                 | 4.00 BSC                   |      |      | 0.157 BSC  |       |       | 4.00 BSC                   |      |      | 0.157 BSC  |       |       |
| E2                | 2.0                        | 2.1  | 2.2  | 0.079      | 0.083 | 0.087 | 2.5                        | 2.6  | 2.7  | 0.098      | 0.102 | 0.106 |
| K                 | 0.20 min.                  |      |      | 0.008 min. |       |       | 0.20 min.                  |      |      | 0.008 min. |       |       |
| L                 | 0.5                        | 0.6  | 0.7  | 0.020      | 0.024 | 0.028 | 0.3                        | 0.4  | 0.5  | 0.012      | 0.016 | 0.020 |
| N <sup>(3)</sup>  | 16                         |      |      | 16         |       |       | 16                         |      |      | 16         |       |       |
| Nd <sup>(3)</sup> | 4                          |      |      | 4          |       |       | 4                          |      |      | 4          |       |       |
| Ne <sup>(3)</sup> | 4                          |      |      | 4          |       |       | 4                          |      |      | 4          |       |       |

### Notes

- (1) Use millimeters as the primary measurement.
- (2) Dimensioning and tolerances conform to ASME Y14.5M. - 1994.
- (3) N is the number of terminals. Nd and Ne is the number of terminals in each D and E site respectively.
- (4) Dimensions b applies to plated terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.
- (5) The pin 1 identifier must be existed on the top surface of the package by using identification mark or other feature of package body.
- (6) Package warpage max. 0.05 mm.

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DWG: 5890



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