

## 200 Ω, Low Leakage, Low Parasitic and Low Charge Injection, Quad SPST Analog Switches

### DESCRIPTION

The DG2501, DG2502, and DG2503 are monolithic quad single-pole single-throw (SPST) analog switches that operate from a single 1.8 V to 5.5 V power supply.

These switches are fully specified at 3 V and 5 V. The parts feature low parasitic capacitance, low charge injection, and low leakage performance over the full operating temperature range of -40 °C to +85 °C. Their ESD/HBM tolerance is over 8 kV.

The DG2501, DG2502, and DG2503 each feature four independently selectable SPST switches with closely matched channel resistance. The DG2501 is normally closed, while the DG2502 is normally open.

The DG2503 has two normally open and two normally closed switches. All parts are guaranteed break-before-make operation for use in multiplexer applications. The parts have a guaranteed control logic high of 1.4 V when V+ is 3 V and 1.8 V when V+ is 5 V.

Each switch conducts equally well in both directions when on, and each has an input signal range that extends to the supplies.

The DG2501, DG2502, and DG2503 are ideal for portable healthcare, instrument, and communication devices.

The DG2501, DG2502, and DG2503 are available in wafer level CSP package with top side lamination.

The package has a 4 x 4 bump array, 0.35 mm pitch, and 1.44 mm x 1.44 mm length and width.

### FEATURES

- 1.8 V to 5.5 V single supply operation
- Low leakage, 1 nA / max. at 85 °C
- Low switch off capacitance
- Rail-to-rail signal handling
- Latch up current > 800 mA (JESD78)
- ESD: 8000 V/HBM, 500 V/CDM
- Typical power consumption (< 0.01 μW)
- TTL/CMOS compatible
- Compact WCSP16 1.44 mm x 1.44 mm
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

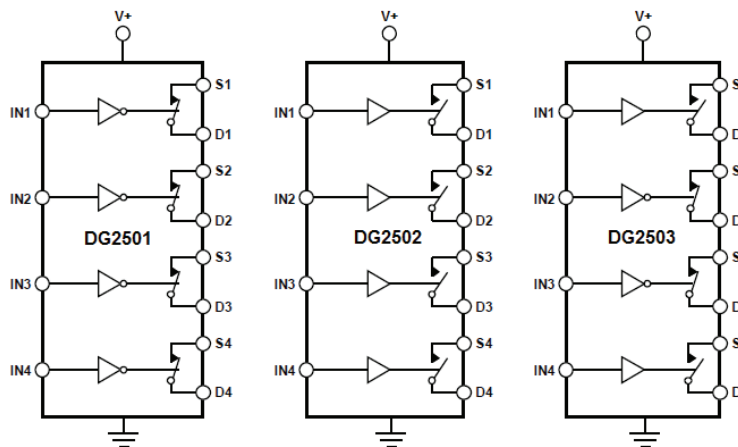


**RoHS**  
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(5-2008)

### APPLICATIONS

- Analog front end signal switching
- Sample-and-hold circuits
- Battery-powered systems
- Portable meters
- Automatic test equipment
- Medical and healthcare equipment
- Communication systems

### FUNCTIONAL BLOCK DIAGRAM



Switches are shown for a Logic 0 Input

| TRUTH TABLE |        |        |        |        |          |          |
|-------------|--------|--------|--------|--------|----------|----------|
| DG2501      |        | DG2502 |        | DG2503 |          |          |
| LOGIC       | SWITCH | LOGIC  | SWITCH | LOGIC  | SW1, SW4 | SW2, SW3 |
| 0           | ON     | 0      | OFF    | 0      | OFF      | ON       |
| 1           | OFF    | 1      | ON     | 1      | ON       | OFF      |

| ORDERING INFORMATION |               |                 |                   |                           |               |
|----------------------|---------------|-----------------|-------------------|---------------------------|---------------|
| PART NUMBER          | CONFIGURATION | SWITCH FUNCTION | TEMPERATURE RANGE | PACKAGE                   | REEL QUANTITY |
| DG2501DB-T2-GE1      | Quad SPST     | NC              | -40 °C to +85 °C  | WCSP16, 1.44 mm x 1.44 mm | 3000          |
| DG2501DB-T4-GE1      | Quad SPST     | NC              | -40 °C to +85 °C  | WCSP16, 1.44 mm x 1.44 mm | 10 000        |
| DG2502DB-T2-GE1      | Quad SPST     | NO              | -40 °C to +85 °C  | WCSP16, 1.44 mm x 1.44 mm | 3000          |
| DG2502DB-T4-GE1      | Quad SPST     | NO              | -40 °C to +85 °C  | WCSP16, 1.44 mm x 1.44 mm | 10 000        |
| DG2503DB-T2-GE1      | Quad SPST     | NC/NO           | -40 °C to +85 °C  | WCSP16, 1.44 mm x 1.44 mm | 3000          |
| DG2503DB-T4-GE1      | Quad SPST     | NC/NO           | -40 °C to +85 °C  | WCSP16, 1.44 mm x 1.44 mm | 10 000        |

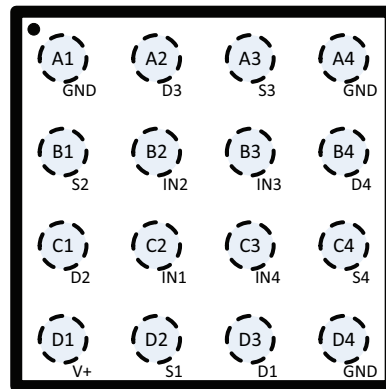
**PACKAGE OUTLINE**

 Top View  
(Bump Side Down)

Fig. 1 - Package Outline for WCSP16, 1.44 mm x 1.44 mm, 0.35 mm Pitch

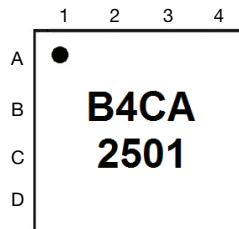
**DEVICE MARKING**

 Row 1 Dot = Pin A1 Locator  
 Row 2 B = Fab, 4 = Year, C = Week Code, A = Lot Code  
 Row 3 2501 = Part Code

Fig. 2 - Device Marking

| ABSOLUTE MAXIMUM RATINGS                               |                             |                   |      |
|--|-----------------------------|-------------------|------|
| ELECTRICAL PARAMETERS                                  | CONDITIONS                  | LIMITS            | UNIT |
| V+, INx  | Reference to GND            | -0.3 to 6         | V    |
| Sx, Dx   | Reference to GND            | -0.3 to (V+) +0.3 |      |
| Maximum Continuous Switch Current                      |                             | 5                 | mA   |
| Maximum Peak Current<br>(Pulsed 1 ms, 10 % Duty Cycle) |                             | 20                |      |
| Thermal Resistance                                     |                             | 80                | °C/W |
| Latch Up Current                                       | JESD78                      | > 800             | mA   |
| ESD - HBM  | ANSI / ESDA / JEDEC® JS-001 | > 8000            | V    |
| ESD - CDM  | JESD22-C101                 | > 500             |      |
| Temperature  |                             |                   |      |
| Operating Temperature                                  |                             | -40 to 85         | °C   |
| Storage Temperature                                    |                             | -65 to 150        |      |

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.



| ELECTRICAL CHARACTERISTICS 3 V Supply  |                                     |  |                    |                   |                   |                   |      |
|--|-------------------------------------|--|--------------------|-------------------|-------------------|-------------------|------|
| PARAMETER                              | SYMBOL                              | TEST CONDITION<br>UNLESS OTHERWISE SPECIFIED,<br>V+ = 3 V<br>VINH = 1.4 V, VINL = 0.8 V <sup>a</sup>     | TEMP. <sup>b</sup> | TYP. <sup>c</sup> | -40 °C to 85 °C   |                   | UNIT |
|  |                                     |  |                    |                   | MIN. <sup>d</sup> | MAX. <sup>d</sup> |      |
| <b>Analog Switch</b>                   |                                     |  |                    |                   |                   |                   |      |
| Analog Signal Range <sup>e</sup>       | V <sub>ANALOG</sub>                 |  | Full               | -                 | 0                 | 3                 | V    |
| Drain-Source On Resistance             | R <sub>DS(on)</sub>                 | V <sub>S</sub> = 1.5 V, I <sub>S</sub> = -1 mA   | Room               | 133               | -                 | 200               | Ω    |
|  |                                     |  | Full               | -                 | -                 | 250               |      |
| On-Resistance Matching                 | ΔR <sub>on</sub>                    |  | Room               | 0.83              | -                 | 10                | Ω    |
|  |                                     |  | Full               | -                 | -                 | 13                |      |
| Switch Off Leakage Current             | I <sub>S</sub> /I <sub>D(off)</sub> | V+ = 3.3 V,<br>V <sub>S</sub> = 0.3 V/3 V, V <sub>D</sub> = 3 V/0.3 V                                    | Room               | ± 0.016           | -0.4              | +0.4              | nA   |
|  |                                     |  | Full               | -                 | -1                | +1                |      |
| Channel On Leakage Current             | I <sub>D(on)</sub>                  | V+ = 3.3 V,<br>V <sub>D</sub> = 0.3 V/3 V  | Room               | ± 0.009           | -0.4              | +0.4              | nA   |
|  |                                     |  | Full               | -                 | -1                | +1                |      |
| <b>Digital Control</b>                 |                                     |  |                    |                   |                   |                   |      |
| Input, High Voltage                    | V <sub>INH</sub>                    |  | Full               | -                 | 1.4               | -                 | V    |
| Input, Low Voltage                     | V <sub>INL</sub>                    |  | Full               | -                 | -                 | 0.4               |      |
| Input Leakage                          | I <sub>IN</sub>                     | V <sub>IN</sub> = V <sub>GND</sub> or V+   | Room               | ± 0.001           | -                 | -                 | μA   |
|  |                                     |  | Full               | -                 | -0.1              | +0.1              |      |
| Digital Input Capacitance <sup>e</sup> | C <sub>IN</sub>                     | f = 1 MHz  | Room               | 2                 | -                 | -                 | pF   |
| <b>Dynamic Characteristics</b>         |                                     |  |                    |                   |                   |                   |      |
| Break-Before Make Time                 | t <sub>BBM</sub>                    | DG2503 only, V <sub>S1</sub> = V <sub>S2</sub> = 1.5 V,<br>R <sub>L</sub> = 300 Ω C <sub>L</sub> = 35 pF | Room               | 47                | 10                | -                 | ns   |
|  |                                     |  | Full               | -                 | 10                | -                 |      |
| Turn-On Time                           | t <sub>ON</sub>                     | V <sub>S</sub> = 1.5 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                   | Room               | 175               | -                 | 220               | ns   |
|  |                                     |  | Full               | -                 | -                 | 250               |      |
| Turn-Off Time                          | t <sub>OFF</sub>                    |  | Room               | 77                | -                 | 100               | ns   |
|  |                                     |  | Full               | -                 | -                 | 120               |      |
| Charge Injection <sup>e</sup>          | Q <sub>INJ</sub>                    | C <sub>L</sub> = 1 nF, R <sub>GEN</sub> = 0 Ω, V <sub>S</sub> = 1.5 V                                    | Room               | -0.7              | -                 | -                 | pC   |
| Off Isolation <sup>e</sup>             | OIRR                                | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1MHz   | Room               | -83               | -                 | -                 | dB   |
| Cross Talk <sup>e</sup>                | X Talk                              |  | Room               | -85               | -                 | -                 |      |
| 3 dB Bandwidth <sup>e</sup>            | BW                                  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF   | Room               | 510               | -                 | -                 | MHz  |
| Source Off Capacitance <sup>e</sup>    | C <sub>S(off)</sub>                 | f = 1 MHz, V <sub>S</sub> = 1.5 V  | Room               | 2.9               | -                 | -                 | pF   |
| Drain Off Capacitance <sup>e</sup>     | C <sub>D(off)</sub>                 |  | Room               | 2.8               | -                 | -                 |      |
| Drain On Capacitance <sup>e</sup>      | C <sub>D(on)</sub>                  |  | Room               | 7.8               | -                 | -                 |      |
| <b>Power Requirements</b>              |                                     |  |                    |                   |                   |                   |      |
| Power Supply Current                   | I+                                  | Digital Input 0 or V+  | Room               | 0.001             | -                 | -                 | μA   |
|  |                                     |  | Full               | -                 | -                 | 1                 |      |



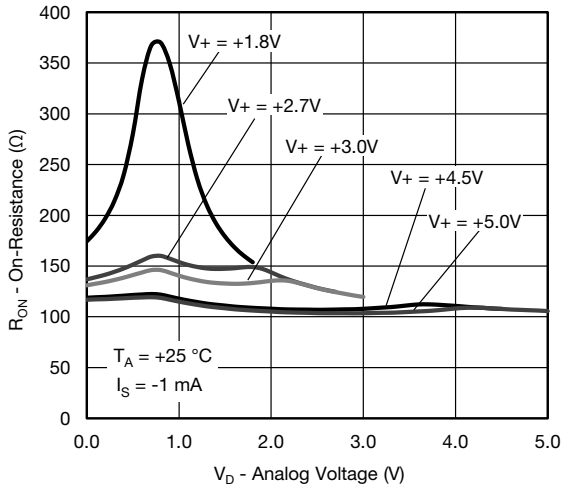
| ELECTRICAL CHARACTERISTICS 5 V Supply  |                                     |  |                    |                   |                   |                   |      |
|--|-------------------------------------|--|--------------------|-------------------|-------------------|-------------------|------|
| PARAMETER                              | SYMBOL                              | TEST CONDITION<br>UNLESS OTHERWISE SPECIFIED,<br>V <sub>+</sub> = 5 V<br>V <sub>INH</sub> = 1.8 V, V <sub>INL</sub> = 0.5 V <sup>a</sup> | TEMP. <sup>b</sup> | TYP. <sup>c</sup> | -40 °C to 85 °C   |                   | UNIT |
|  |                                     |  |                    |                   | MIN. <sup>d</sup> | MAX. <sup>d</sup> |      |
| <b>Analog Switch</b>                   |                                     |  |                    |                   |                   |                   |      |
| Analog Signal Range <sup>e</sup>       | V <sub>ANALOG</sub>                 |  | Full               | -                 | 0                 | 5                 | V    |
| Drain-Source On Resistance             | R <sub>DS(on)</sub>                 | V <sub>S</sub> = 2.5 V, I <sub>S</sub> = -1 mA   | Room               | 104               | -                 | 150               | Ω    |
| On-Resistance Matching                 | ΔR <sub>on</sub>                    |  | Full               | -                 | -                 | 200               |      |
|  |                                     |  | Room               | 0.39              | -                 | 8                 |      |
|  |                                     |  | Full               | -                 | -                 | 10                |      |
| Switch Off Leakage Current             | I <sub>S</sub> /I <sub>D(off)</sub> | V <sub>+</sub> = 5.5 V,<br>V <sub>S</sub> = 1 V/4.5 V, V <sub>D</sub> = 4.5 V/1 V  | Room               | ± 0.022           | -0.4              | +0.4              | nA   |
|  |                                     |  | Full               | -                 | -1                | +1                |      |
| Channel On Leakage Current             | I <sub>D(on)</sub>                  | V <sub>+</sub> = 5.5 V,<br>V <sub>D</sub> = 4.5 V/1 V  | Room               | ± 0.017           | -0.4              | +0.4              | nA   |
|  |                                     |  | Full               | -                 | -1                | +1                |      |
| <b>Digital Control</b>                 |                                     |  |                    |                   |                   |                   |      |
| Input, High Voltage                    | V <sub>INH</sub>                    |  | Full               | -                 | 1.8               | -                 | V    |
| Input, Low Voltage                     | V <sub>INL</sub>                    |  | Full               | -                 | -                 | 0.5               |      |
| Input Leakage                          | I <sub>IN</sub>                     | V <sub>IN</sub> = V <sub>GND</sub> or V <sub>+</sub>   | Room               | ± 0.001           | -                 | -                 | μA   |
|  |                                     |  | Full               | -                 | -1                | +1                |      |
| Digital Input Capacitance <sup>e</sup> | C <sub>IN</sub>                     | f = 1 MHz  | Room               | 2                 | -                 | -                 | pF   |
| <b>Dynamic Characteristics</b>         |                                     |  |                    |                   |                   |                   |      |
| Break-Before Make Time                 | t <sub>BBM</sub>                    | DG2503 only, V <sub>S1</sub> = V <sub>S2</sub> = 3 V,<br>R <sub>L</sub> = 300 Ω C <sub>L</sub> = 35 pF                                   | Room               | 25                | 10                | -                 | ns   |
|  |                                     |  | Full               | -                 | 10                | -                 |      |
| Turn-On Time                           | t <sub>ON</sub>                     | V <sub>S</sub> = 3 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF   | Room               | 64                | -                 | 100               | ns   |
|  |                                     |  | Full               | -                 | -                 | 150               |      |
| Turn-Off Time                          | t <sub>OFF</sub>                    |  | Room               | 38                | -                 | 60                | ns   |
|  |                                     |  | Full               | -                 | -                 | 100               |      |
| Charge Injection <sup>e</sup>          | Q <sub>INJ</sub>                    | C <sub>L</sub> = 1 nF, R <sub>GEN</sub> = 0 Ω, V <sub>S</sub> = 3 V  | Room               | -2                | -                 | -                 | pC   |
| Off Isolation <sup>e</sup>             | OIRR                                | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1MHz   | Room               | -84               | -                 | -                 | dB   |
| Cross Talk <sup>e</sup>                | X Talk                              |  | Room               | -83               | -                 | -                 |      |
| 3 dB Bandwidth <sup>e</sup>            | BW                                  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF   | Room               | 550               | -                 | -                 | MHz  |
| Source Off Capacitance <sup>e</sup>    | C <sub>S(off)</sub>                 | f = 1 MHz, V <sub>S</sub> = 3 V  | Room               | 2.7               | -                 | -                 | pF   |
| Drain Off Capacitance <sup>e</sup>     | C <sub>D(off)</sub>                 |  | Room               | 2.6               | -                 | -                 |      |
| Drain On Capacitance <sup>e</sup>      | C <sub>D(on)</sub>                  |  | Room               | 7.6               | -                 | -                 |      |
| <b>Power Requirements</b>              |                                     |  |                    |                   |                   |                   |      |
| Power Supply Current                   | I <sub>+</sub>                      | Digital Input = 1.8 V, at one channel<br>V <sub>+</sub> = 5 V  | Room               | 4.6               | -                 | -                 | μA   |
|  |                                     |  | Full               | -                 | -                 | 30                |      |
|  |                                     | Digital Input 0 or V <sub>+</sub>  | Room               | 0.001             | -                 | -                 |      |
|  |                                     |  | Full               | -                 | -                 | 2                 |      |

**Notes**

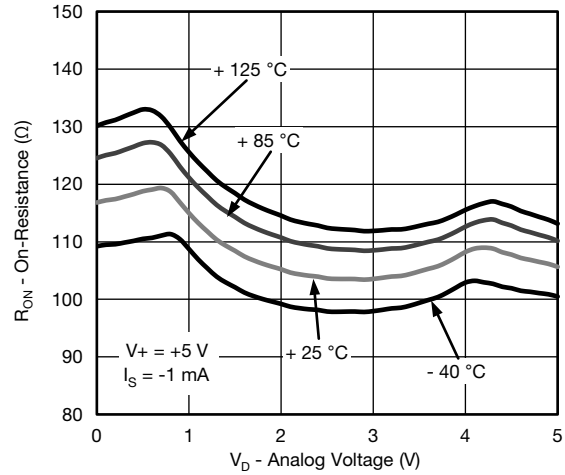
- a. V<sub>IN</sub> = input voltage to perform proper function.
- b. Room = 25 °C, Full = as determined by the operating temperature suffix.
- c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- d. The convention where the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- e. Guaranteed by design, not subject to production test.



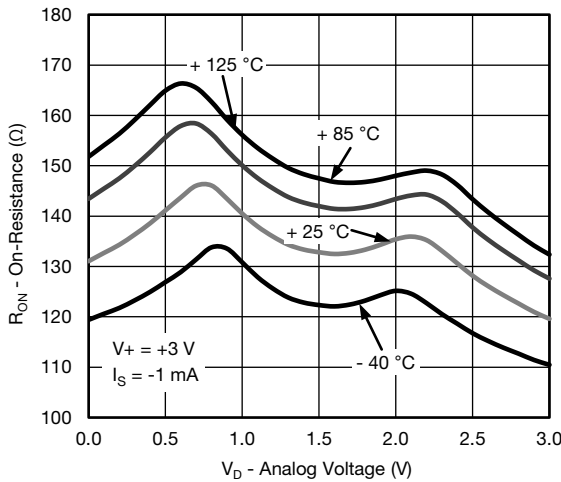
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



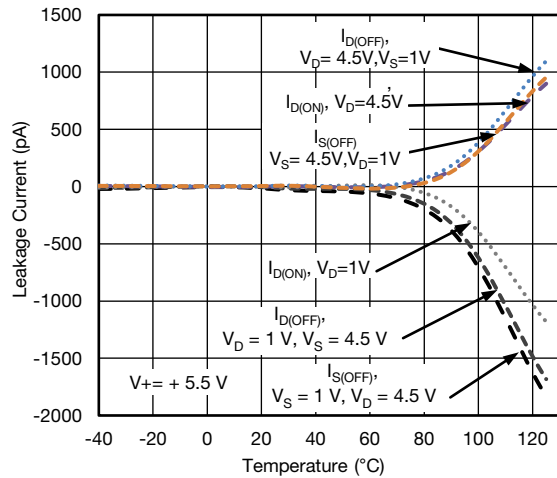
**On-Resistance vs. Analog Voltage**



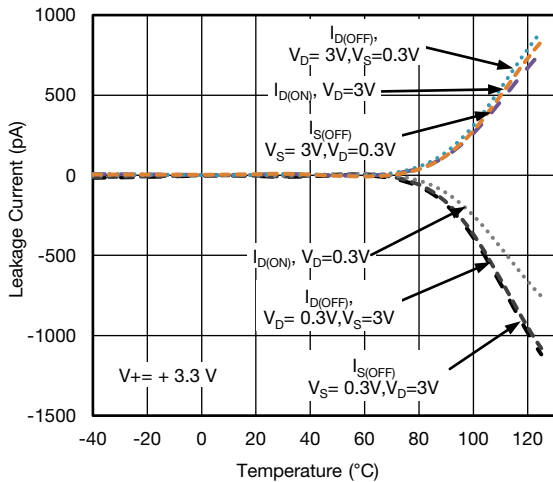
**On-Resistance vs. Analog Voltage**



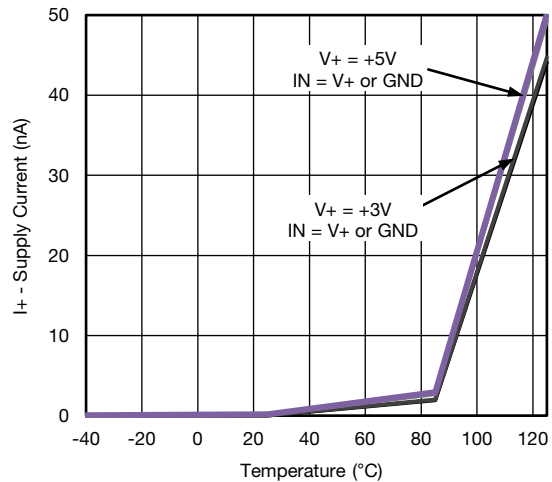
**On-Resistance vs. Analog Voltage**



**Leakage Current vs. Temperature**



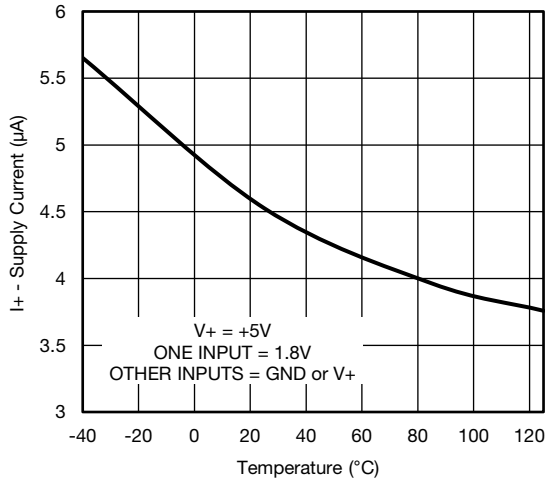
**Leakage Current vs. Temperature**



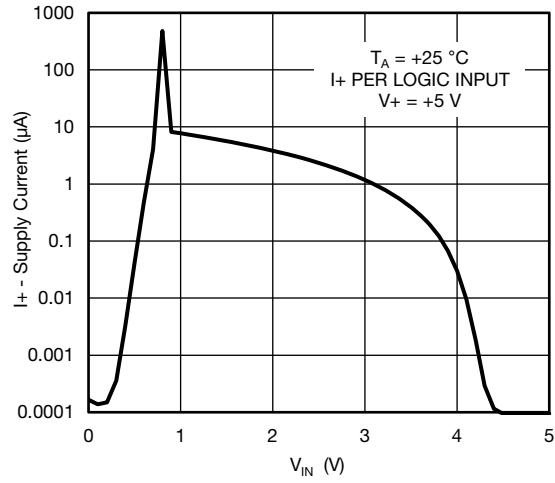
**Supply Current vs. Temperature**



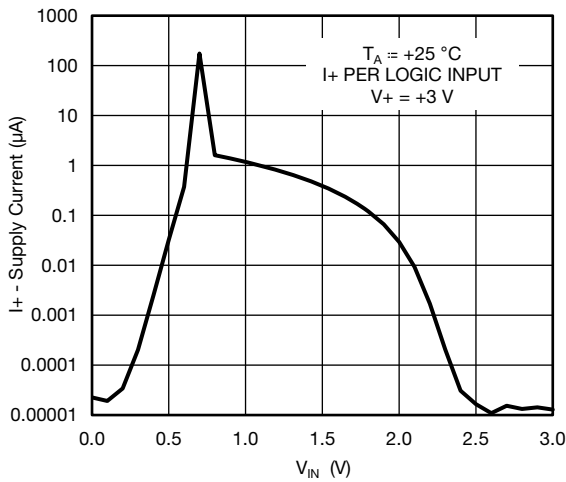
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



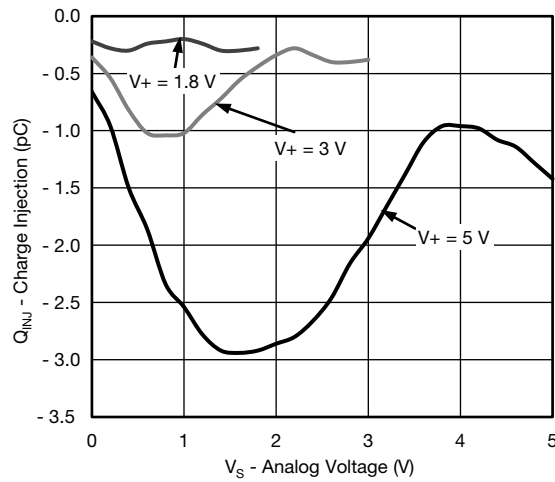
Supply Current vs. Temperature



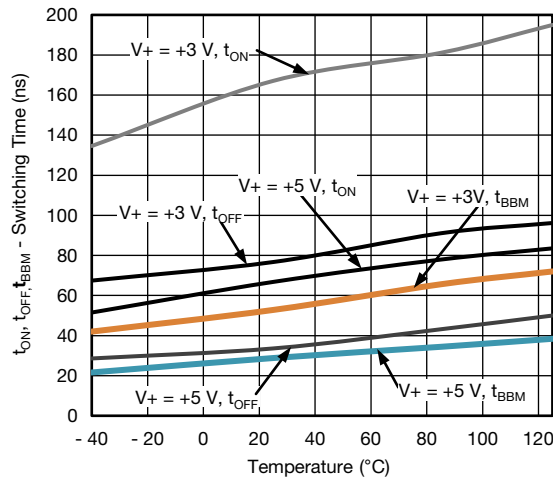
Supply Current vs.  $V_{IN}$



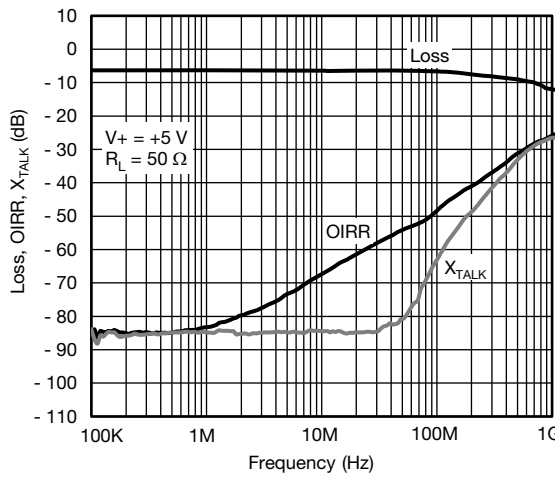
Supply Current vs.  $V_{IN}$



Charge Injection vs. Analog Voltage



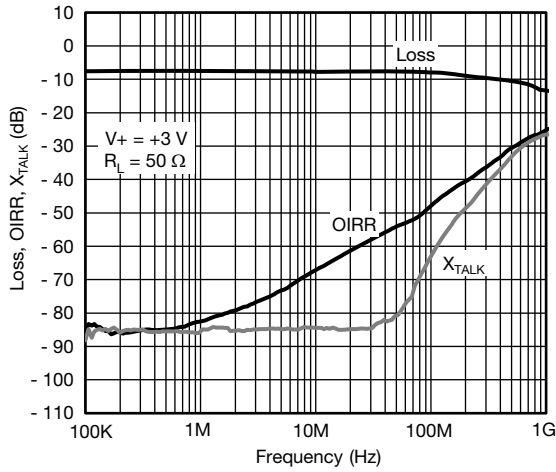
Switching Time vs. Temperature



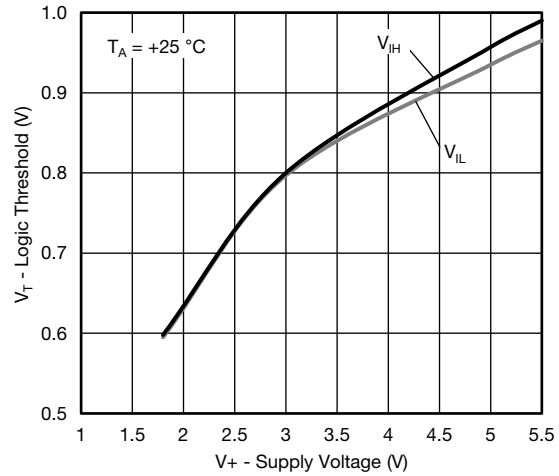
Loss, OIRR,  $X_{TALK}$  vs. Frequency



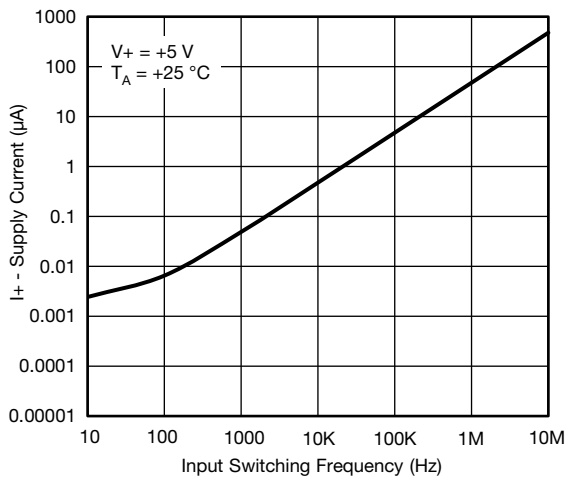
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



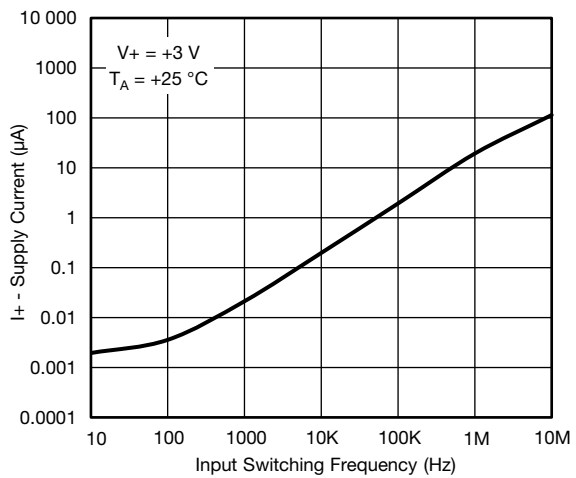
Loss, OIRR,  $X_{TALK}$  vs. Frequency



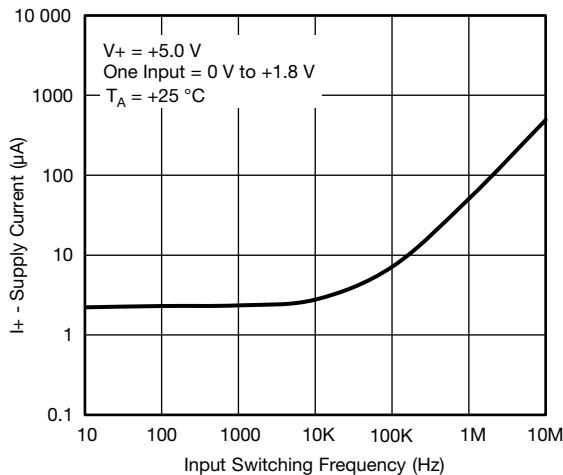
Logic Threshold vs. Supply Voltage



Supply Current vs. Input Switching Frequency

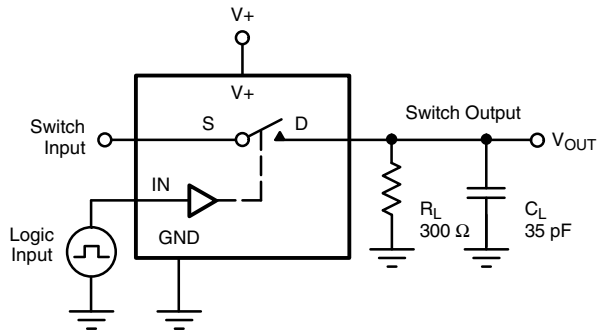


Supply Current vs. Input Switching Frequency



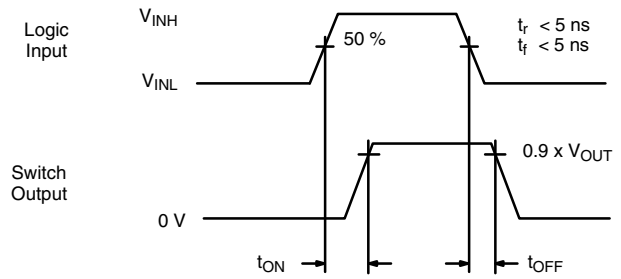
Supply Current vs. Input Switching Frequency

**TEST CIRCUIT**



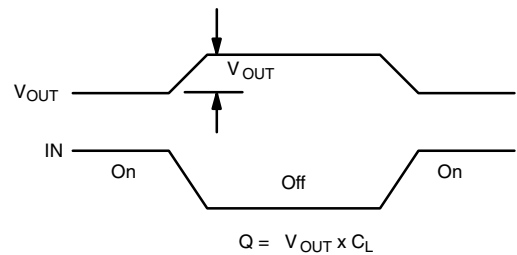
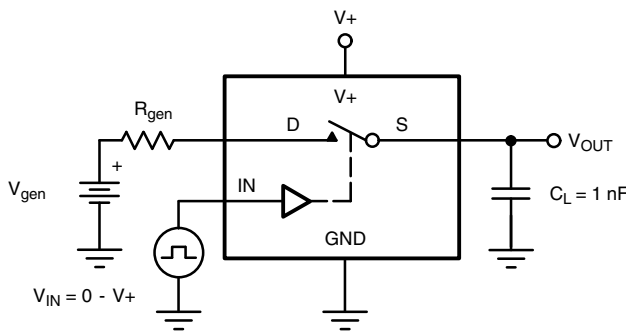
$C_L$  (includes fixture and stray capacitance)

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



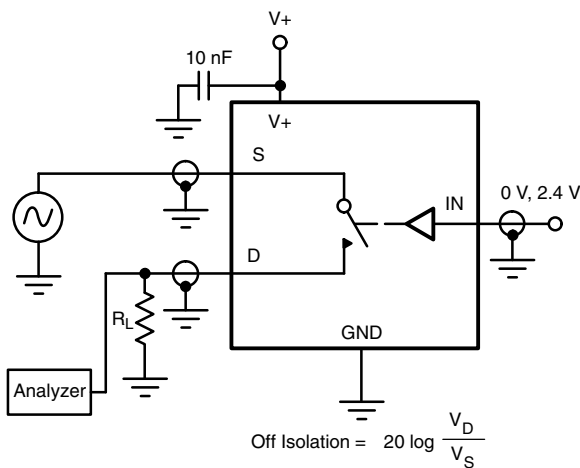
Logic "1" = Switch On  
 Logic input waveforms inverted for switches that have the opposite logic sense.

**Fig. 3 - Switching Time**

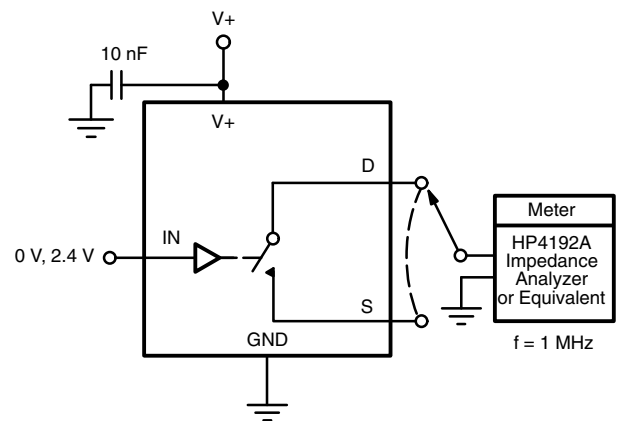


IN depends on switch configuration: input polarity determined by sense of switch.

**Fig. 4 - Charge Injection**



**Fig. 5 - Off-Isolation**



**Fig. 6 - 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 [www.vishay.com/ppg?62962](http://www.vishay.com/ppg?62962).





## Disclaimer

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Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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