

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

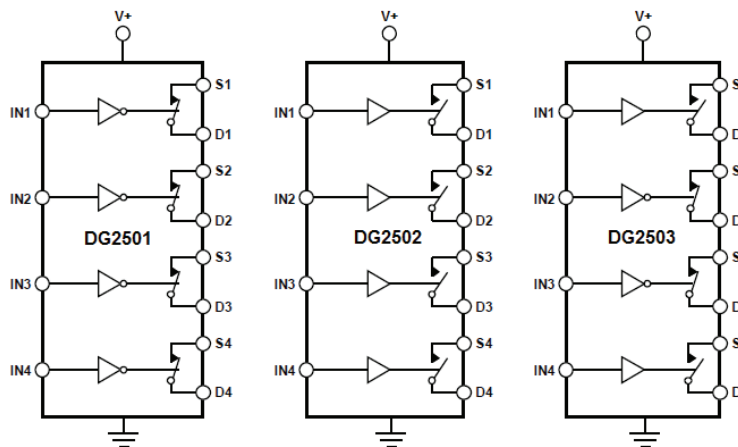


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APPLICATIONS

- 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 |

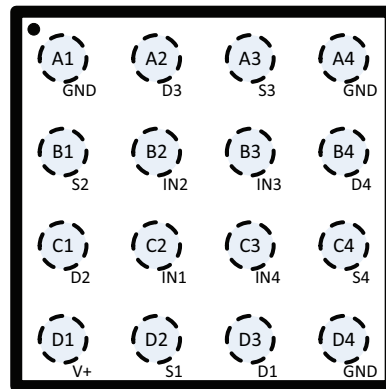
PACKAGE OUTLINE

 Top View
(Bump Side Down)

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

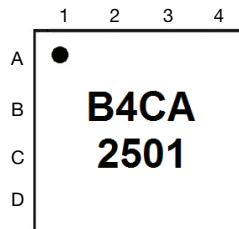
DEVICE MARKING

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



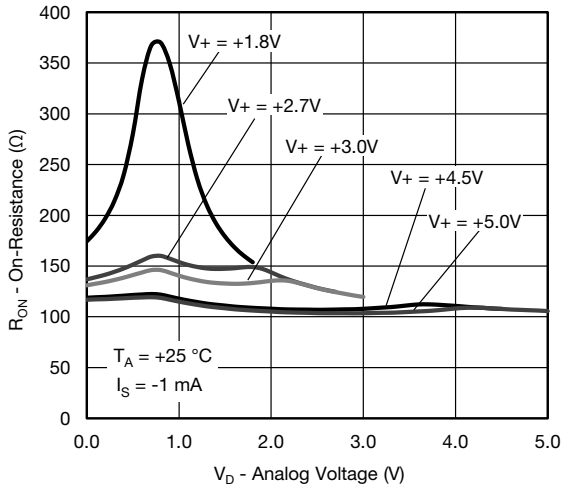
| ELECTRICAL CHARACTERISTICS 5 V Supply | | | | | | | |
|--|-------------------------------------|--|--------------------|-------------------|-------------------|-------------------|------|
| PARAMETER | SYMBOL | TEST CONDITION UNLESS OTHERWISE SPECIFIED, V ₊ = 5 V V _{INH} = 1.8 V, V _{INL} = 0.5 V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

Notes

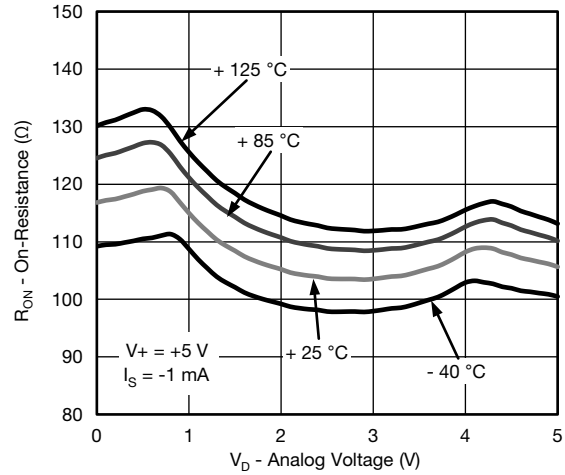
- a. V_{IN} = input voltage to perform proper function.
- b. Room = 25 °C, Full = as determined by the operating temperature suffix.
- c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- d. The convention where the most negative value is a minimum and the most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



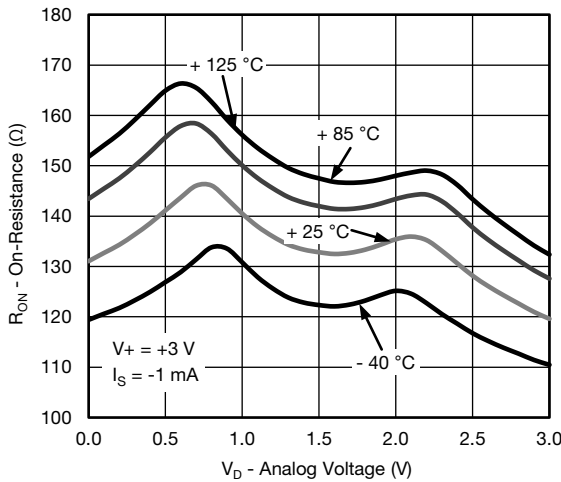
TYPICAL CHARACTERISTICS ($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted)



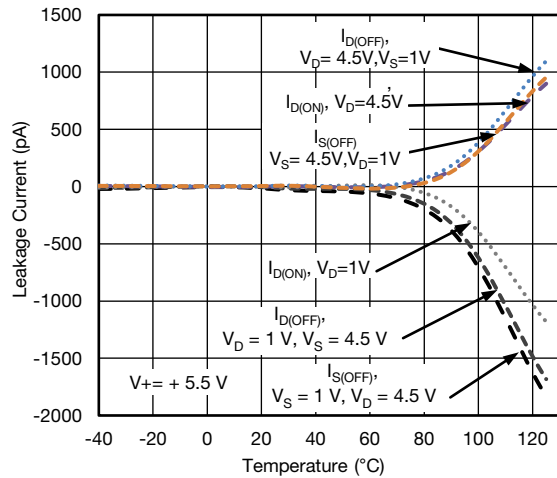
On-Resistance vs. Analog Voltage



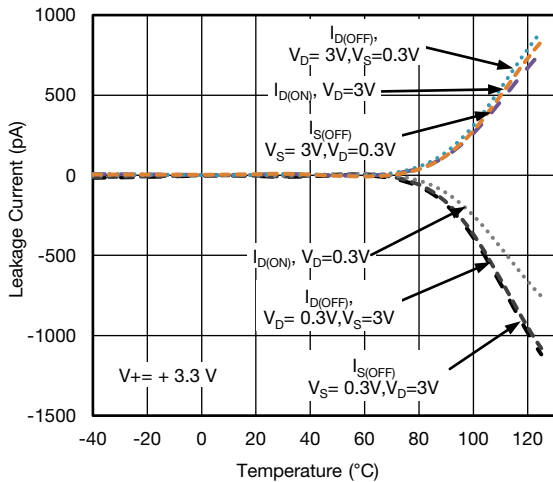
On-Resistance vs. Analog Voltage



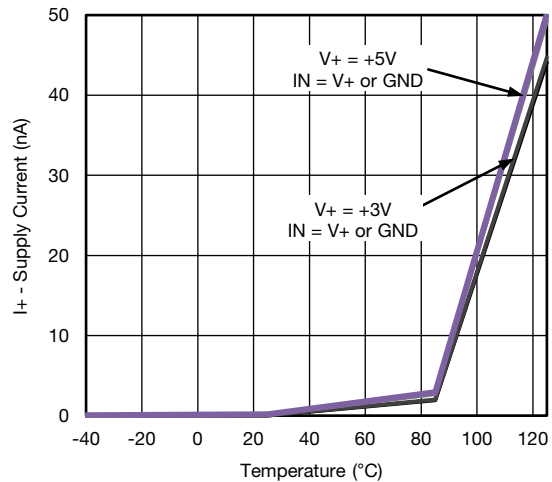
On-Resistance vs. Analog Voltage



Leakage Current vs. Temperature



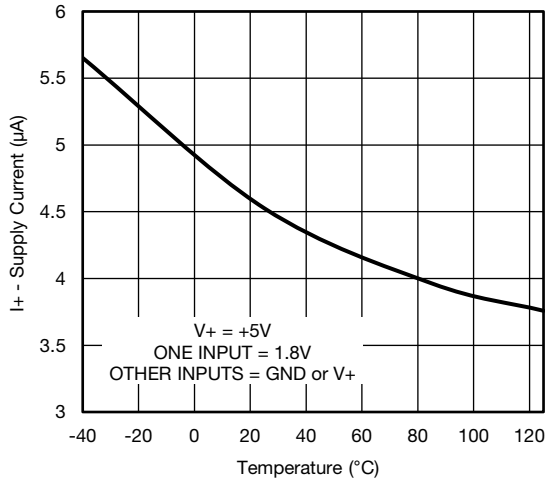
Leakage Current vs. Temperature



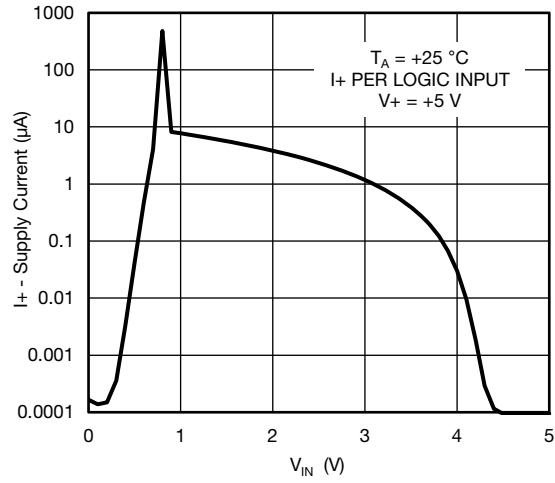
Supply Current vs. Temperature



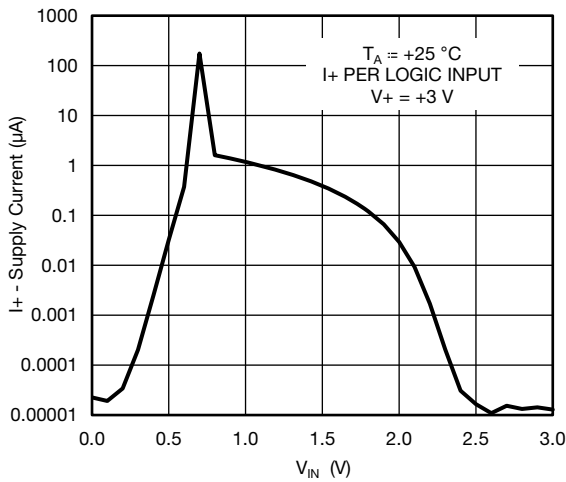
TYPICAL CHARACTERISTICS ($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted)



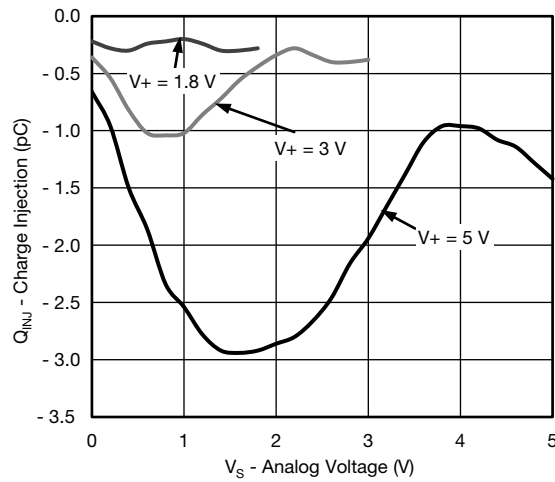
Supply Current vs. Temperature



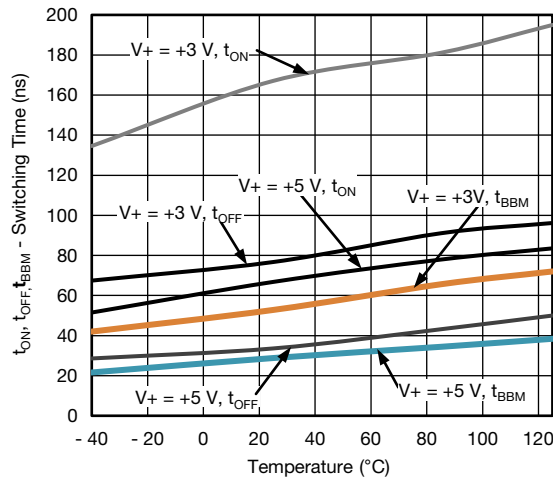
Supply Current vs. V_{IN}



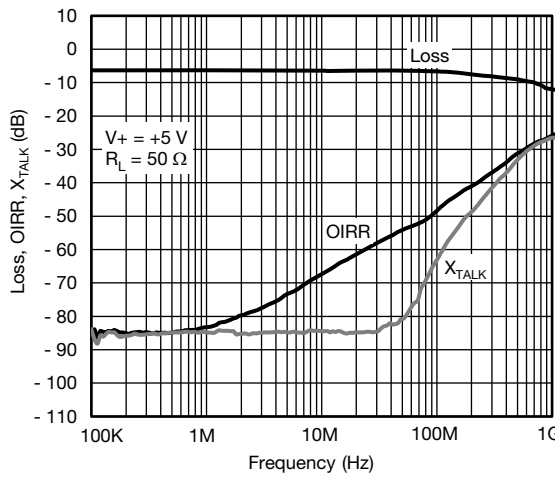
Supply Current vs. V_{IN}



Charge Injection vs. Analog Voltage



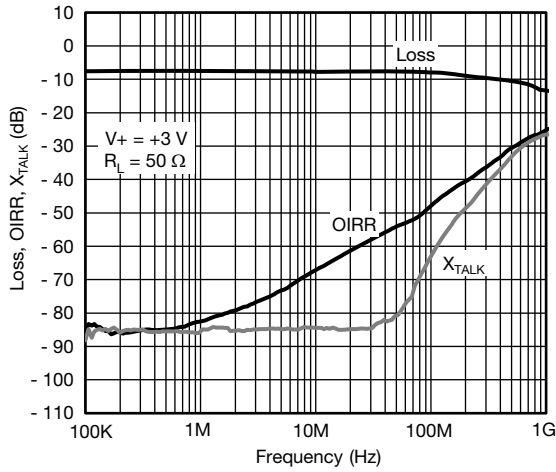
Switching Time vs. Temperature



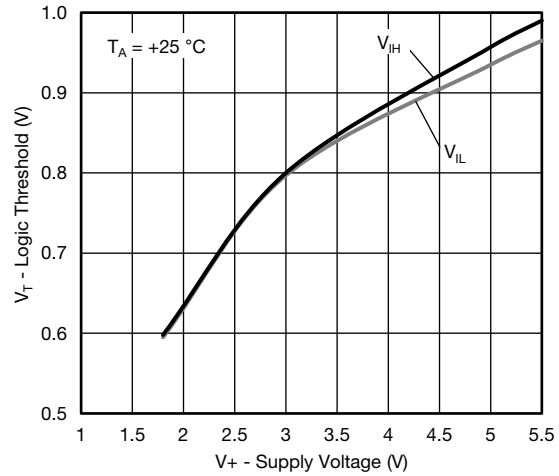
Loss, OIRR, X_{TALK} vs. Frequency



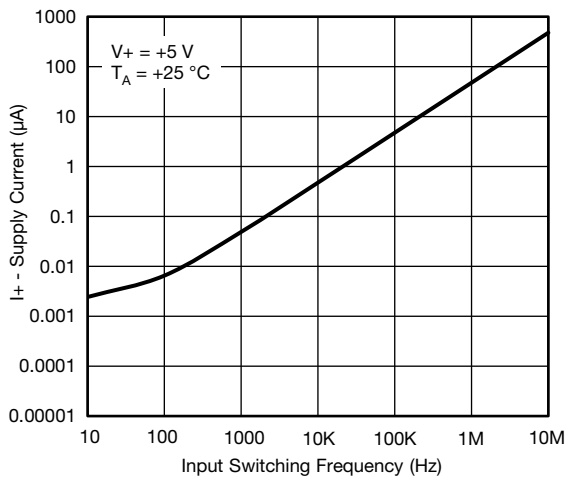
TYPICAL CHARACTERISTICS ($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted)



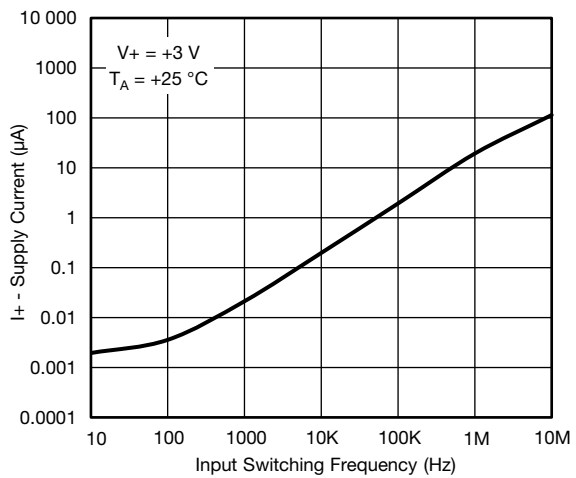
Loss, OIRR, X_{TALK} vs. Frequency



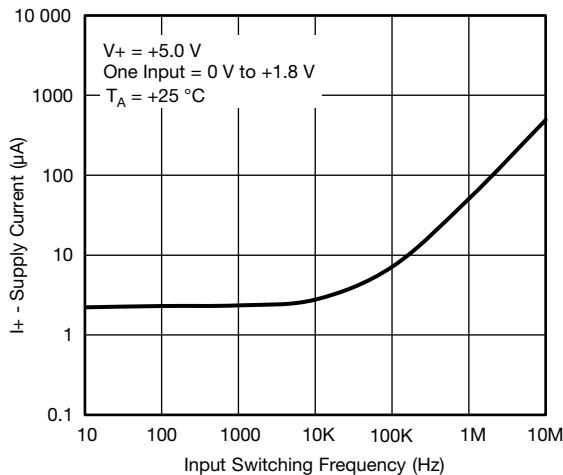
Logic Threshold vs. Supply Voltage



Supply Current vs. Input Switching Frequency

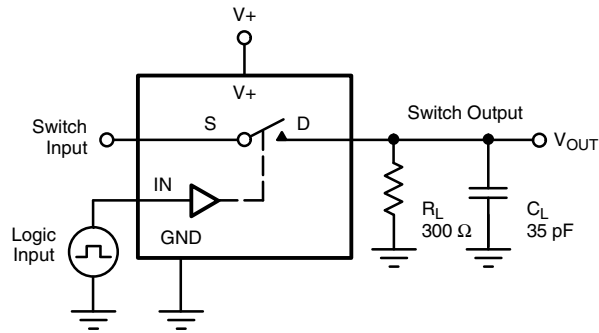


Supply Current vs. Input Switching Frequency



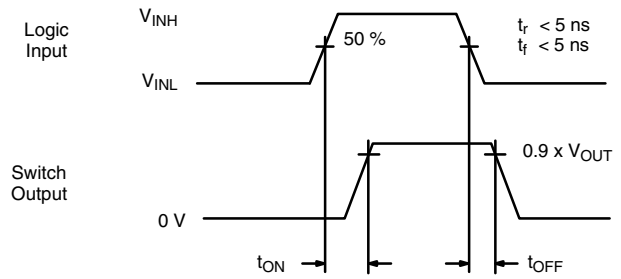
Supply Current vs. Input Switching Frequency

TEST CIRCUIT



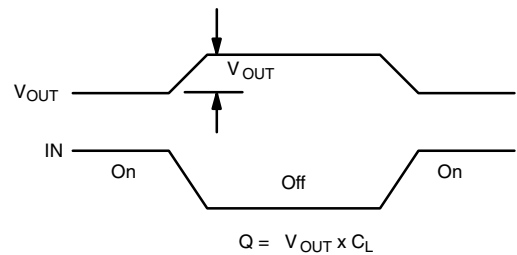
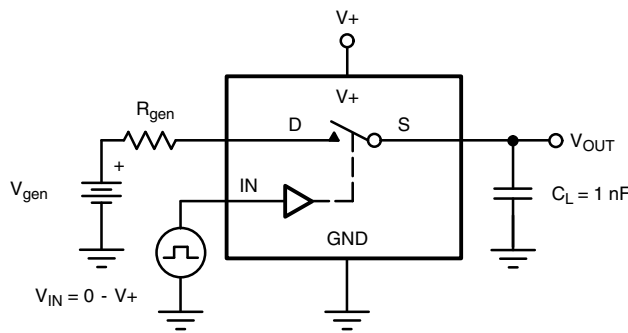
C_L (includes fixture and stray capacitance)

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



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

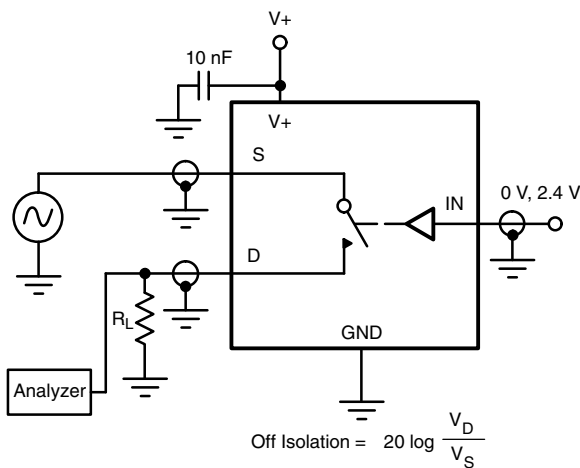


Fig. 5 - Off-Isolation

$$\text{Off Isolation} = 20 \log \frac{V_D}{V_S}$$

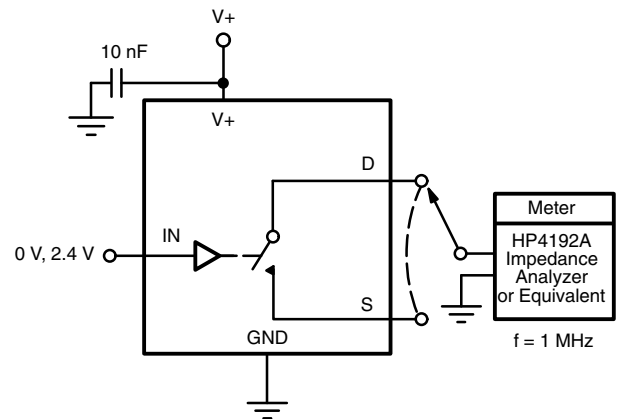


Fig. 6 - Channel Off/On Capacitance

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