# Improved Quad CMOS Analog Switches

## DESCRIPTION

The DG308B, DG309B analog switches are highly improved versions of the industry-standard DG308A, DG309. These devices are fabricated in Vishay Siliconix' proprietary silicon gate CMOS process, resulting in lower on-resistance, lower leakage, higher speed, and lower power consumption.

These quad single-pole single-throw switches are designed for a wide variety of applications in telecommunications, instrumentation, process control, computer peripherals, etc.

An improved charge injection compensation design minimizes switching transients. The DG308B and DG309B can handle up to ± 22 V input signals. An epitaxial layer prevents latchup.

All devices feature true bi-directional performance in the on condition, and will block signals to the supply levels in the off condition.

The DG308B is a normally open switch and the DG309B is a normally closed switch. (see Truth Table.)

## FEATURES

- ± 22 V supply voltage rating
- CMOS compatible logic
- Low on-resistance - $R_{DS(on)}$: 45 Ω
- Low leakage - $I_{D(on)}$: 20 pA
- Single supply operation possible
- Extended temperature range
- Fast switching - $t_{ON}$: < 200 ns
- Low glitching - Q: 1 pC

Pb
Pb-free
Available
RoHS*
COMPLIANT

## BENEFITS

- Wide analog signal range
- Simple logic interface
- Higher accuracy
- Minimum transients
- Reduced power consumption
- Superior to DG308A, DG309
- Space savings (TSSOP)

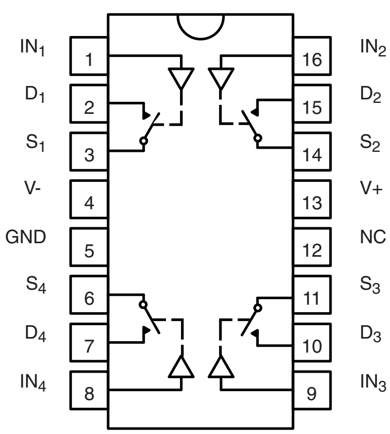
## APPLICATIONS

- Industrial instrumentation
- Test equipment
- Communications systems
- Disk drives
- Computer peripherals
- Portable instruments
- Sample-and-hold circuits

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

**DG308B**

Dual-In-Line, SOIC and TSSOP




Top View

| **TRUTH TABLE** | | |
|---|---|---|
| **Logic** | **DG308B** | **DG309B** |
| 0 | OFF | ON |
| 1 | ON | OFF |

Logic "0" ≤ 3.5 V
Logic "1" ≥ 11 V

* Pb containing terminations are not RoHS compliant, exemptions may apply

## ORDERING INFORMATION

| Temp. Range | Package | Part Number |
|---|---|---|
| - 40 °C to 85 °C | 16-Pin PlasticDIP | DG308BDJ<br>DG308BDJ-E3 |
| | | DG309BDJ<br>DG309BDJ-E3 |
| | 16-Pin Narrow SOIC | DG308BDY<br>DG308BDY-E3<br>DG308BDY-T1<br>DG308BDY-T1-E3 |
| | | DG309BDY<br>DG309BDY-E3<br>DG309BDY-T1<br>DG309BDY-T1-E3 |
| | 16-Pin TSSOP | DG308BDQ<br>DG308BDQ-E3<br>DG308BDQ-T1<br>DG308BDQ-T1-E3 |
| | | DG309BDQ<br>DG309BDQ-E3<br>DG309BDQ-T1<br>DG309BDQ-T1-E3 |

## ABSOLUTE MAXIMUM RATINGS

| Parameter | | Limit | Unit |
|---|---|---|---|
| Voltages Referenced, V+ to V- | | 44 | V |
| GND | | 25 | |
| Digital Inputs[a], $V_S$, $V_D$ | | (V-) - 2 to (V+) + 2<br>or<br>30 mA, whichever occurs first | |
| Current, Any Terminal | | 30 | mA |
| Peak Current, S or D (Pulsed at 1 ms, 10 % duty cycle max.) | | 100 | |
| Storage Temperature | (AK Suffix) | - 65 to 150 | °C |
| | (DJ, DY and DQ Suffix) | - 65 to 125 | |
| Power Dissipation (Package)[b] | 16-Pin Plastic DIP[c] | 470 | mW |
| | 16-Pin Narrow SOIC and TSSOP[d] | 640 | |
| | 16-Pin CerDIP[e] | 900 | |

Notes:
a. Signals on $S_X$, $D_X$, or $IN_X$ exceeding V+ or 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 6.5 mW/°C above 75 °C.
d. Derate 7.6 mW/°C above 75 °C.
e. Derate 12 mW/°C above 75 °C.

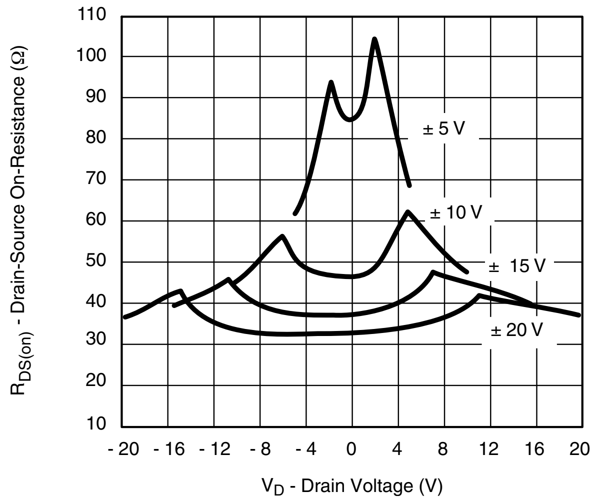
| SPECIFICATIONS[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Test Conditions Unless Specified** $V+ = 15$ V, $V- = -15$ V $V_{IN} = 11$ V, 3.5 V[f] | | | **A Suffix** - 55 °C to 125 °C | | **D Suffix** - 40 °C to 85 °C | | |
| **Parameter** | **Symbol** | | **Temp.[b]** | **Typ.[c]** | **Min.[d]** | **Max.[d]** | **Min.[d]** | **Max.[d]** | **Unit** |
| **Analog Switch** | | | | | | | | | |
| Analog Signal Range[e] | $V_{ANALOG}$ | | Full | | - 15 | 15 | - 15 | 15 | V |
| Drain-Source On-Resistance | $R_{DS(on)}$ | $V_D = \pm 10$ V, $I_S = 1$ mA | Room<br>Full | 45 | | 85<br>100 | | 85<br>100 | Ω |
| $R_{DS(on)}$ Match | $\Delta R_{DS(on)}$ | | Room | 2 | | | | | % |
| Source Off Leakage Current | $I_{S(off)}$ | $V_S = \pm 14$ V, $V_D = \pm 14$ V | Room<br>Full | ± 0.01 | - 0.5<br>- 20 | 0.5<br>20 | - 0.5<br>- 5 | 0.5<br>5 | nA |
| Drain Off Leakage Current | $I_{D(off)}$ | $V_D = \pm 14$ V, $V_S = \pm 14$ V | Room<br>Full | ± 0.01 | - 0.5<br>- 20 | 0.5<br>20 | - 0.5<br>- 5 | 0.5<br>5 | |
| Drain On Leakage Current | $I_{D(on)}$ | $V_S = V_D = \pm 14$ V | Room<br>Full | ± 0.02 | - 0.5<br>- 40 | 0.5<br>40 | - 0.5<br>- 10 | 0.5<br>10 | |
| **Digital Control** | | | | | | | | | |
| Input, Voltage High | $V_{INH}$ | | Full | | 11 | | 11 | | V |
| Input, Voltage Low | $V_{INL}$ | | Full | | | 3.5 | | 3.5 | |
| Input Current | $I_{INH}$ or $I_{INL}$ | $V_{INH}$ or $V_{INL}$ | Full | | - 1 | 1 | - 1 | 1 | µA |
| Input Capacitance | $C_{IN}$ | | Room | 5 | | | | | pF |
| **Dynamic Characteristics** | | | | | | | | | |
| Turn-On Time | $t_{ON}$ | $V_S = 3$ V, see figure 2 | Room | | | 200 | | 200 | ns |
| Turn-Off Time | $t_{OFF}$ | | Room | | | 150 | | 150 | |
| Charge Injection | Q | $C_L = 1000$ pF, $V_g = 0$ V, $R_g = 0\ \Omega$ | Room | 1 | | | | | pC |
| Source-Off Capacitance | $C_{S(off)}$ | $V_S = 0$ V, f = 1 MHz, | Room | 5 | | | | | pF |
| Drain-Off Capacitance | $C_{D(off)}$ | | Room | 5 | | | | | |
| Channel-On Capacitance | $C_{D(on)}$ | $V_D = V_S = 0$ V, f = 1 MHz | Room | 16 | | | | | |
| Off-Isolation | OIRR | $C_L = 15$ pF, $R_L = 50\ \Omega$, $V_S = 1\ V_{RMS}$, f = 100 kHz | Room | 90 | | | | | dB |
| Channel-to-Channel Crosstalk | $X_{TALK}$ | | Room | 95 | | | | | |
| **Power Supply** | | | | | | | | | |
| Positive Supply Current | I+ | $V_{IN} = 0$ V or 15 V | Room<br>Full | | | 1<br>5 | | 1<br>5 | µA |
| Negative Supply Current | I- | | Room<br>Full | | - 1<br>- 5 | | - 1<br>- 5 | | |
| Power Supply Range for Continuous Operation | $V_{OP}$ | | Full | | ± 4 | ± 22 | ± 4 | ± 22 | V |

| **SPECIFICATIONS**[a] (for Single Supply) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Test Conditions Unless Specified** V+ = 12 V, V- = 0 V $V_{IN}$ = 11 V, 3.5 V[f] | | | **A Suffix** - 55 °C to 125 °C | | **D Suffix** - 40 °C to 85 °C | | |
| **Parameter** | **Symbol** | | **Temp.**[b] | **Typ.**[c] | **Min.**[d] | **Max.**[d] | **Min.**[d] | **Max.**[d] | **Unit** |
| **Analog Switch** | | | | | | | | | |
| Analog Signal Range[e] | $V_{ANALOG}$ | | Full | | 0 | 12 | 0 | 12 | V |
| Drain-Source On-Resistance | $R_{DS(on)}$ | $V_D$ = 3 V, 8 V, $I_S$ = 1 mA | Room<br>Full | 90 | | 160<br>200 | | 160<br>200 | Ω |
| **Dynamic Characteristics** | | | | | | | | | |
| Turn-On Time | $t_{ON}$ | $V_S$ = 8 V, see figure 2 | Room | | | 300 | | 300 | ns |
| Turn-Off Time | $t_{OFF}$ | | Room | | | 200 | | 200 | |
| Charge Injection | Q | $C_L$ = 1 nF, $V_{gen}$ = 6 V, $R_{gen}$ = 0 Ω | Room | 4 | | | | | pC |
| **Power Supply** | | | | | | | | | |
| Positive Supply Current | I+ | $V_{IN}$ = 0 V or 12 V | Room<br>Full | | | 1<br>5 | | 1<br>5 | µA |
| Negative Supply Current | I- | | Room<br>Full | | - 1<br>- 5 | | - 1<br>- 5 | | |
| Power Supply Range for Continuous Operation | $V_{OP}$ | | Full | | 4 | 44 | 4 | 44 | V |

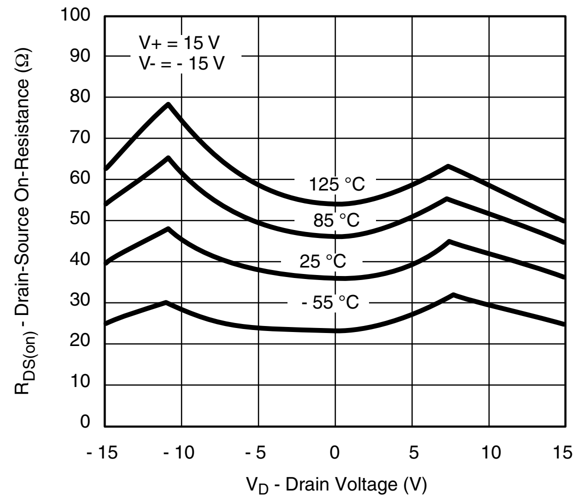
Notes:
a. Refer to PROCESS OPTION FLOWCHART .
b. Room = 25 °C, Full = as determined by the operating temperature suffix.
c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
d. The algebraic convention whereby the most negative value is a minimum and the most positive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

*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.*

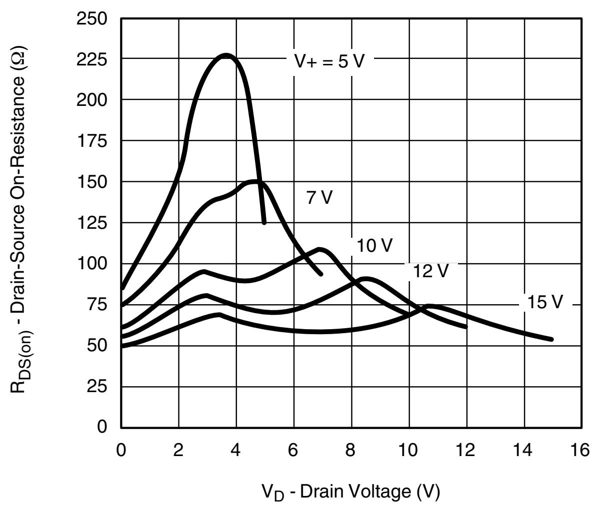
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



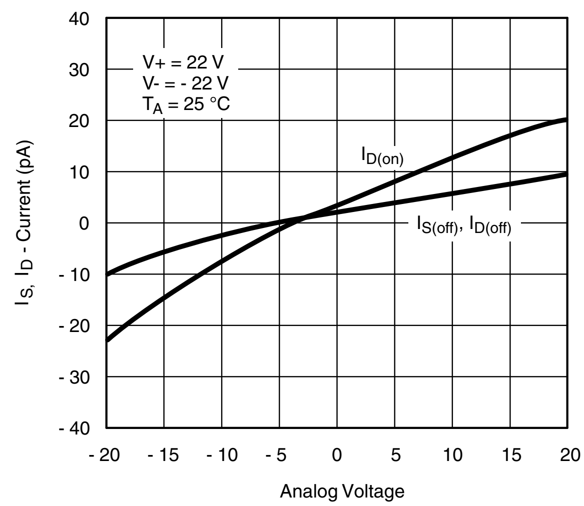

**$R_{DS(on)}$ vs. $V_D$ and Power Supply Voltages**



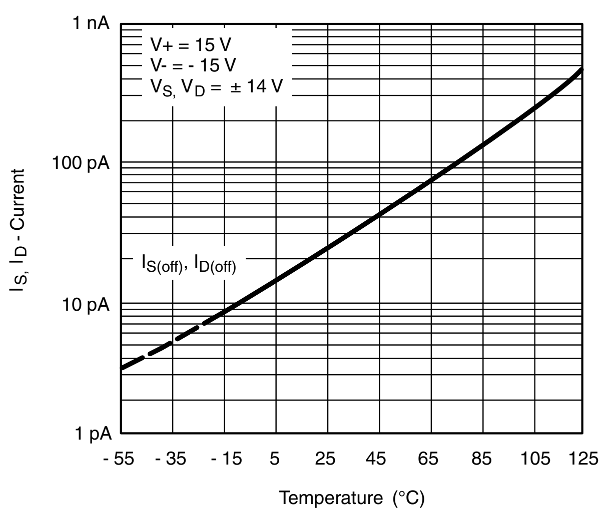

**$R_{DS(on)}$ vs. $V_D$ and Temperature**



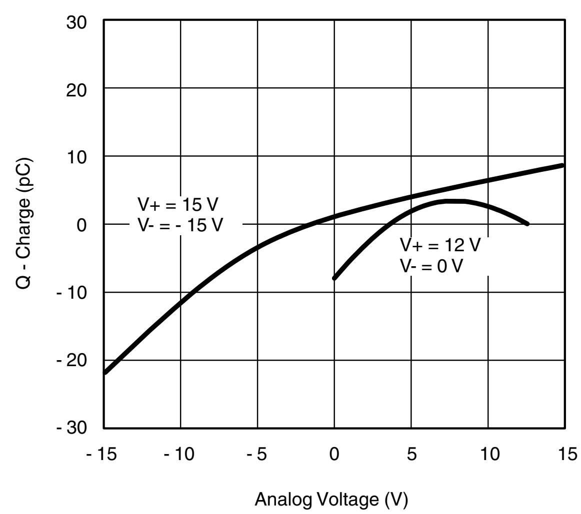

**$R_{DS(on)}$ vs. $V_D$ and Single Power Supply Voltages**




**Leakage Currents vs. Analog Voltage**

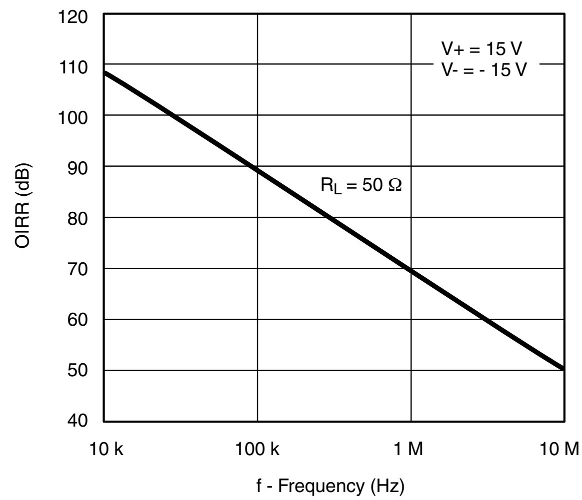



**Leakage Currents vs. Temperature**




**$Q_S$, $Q_D$ - Charge Injection vs. Analog Voltage**

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




**Off Isolation vs. Frequency**

**SCHEMATIC DIAGRAM** (Typical Channel)

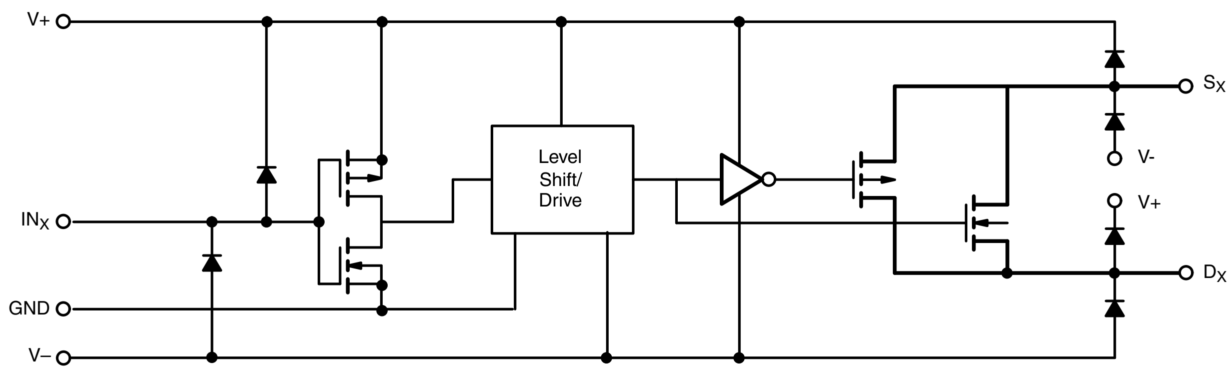



**Figure 1.**

## TEST CIRCUITS

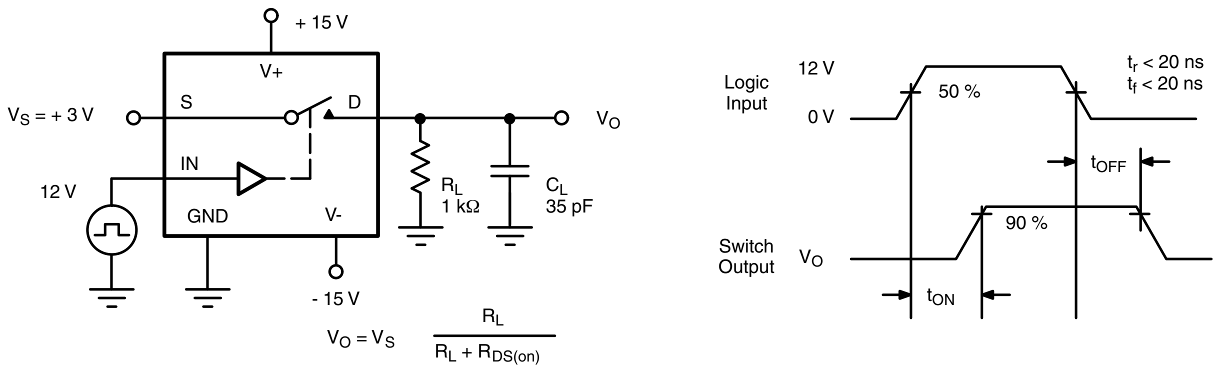



**Figure 2. Switching Time**

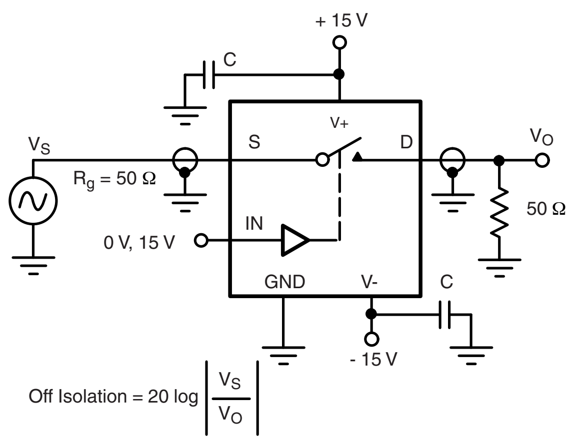



**Figure 3. Off Isolation**

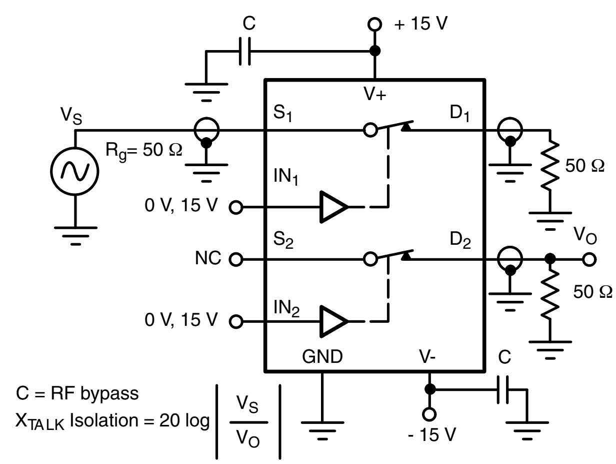



**Figure 4. Channel-to-Channel Crosstalk**

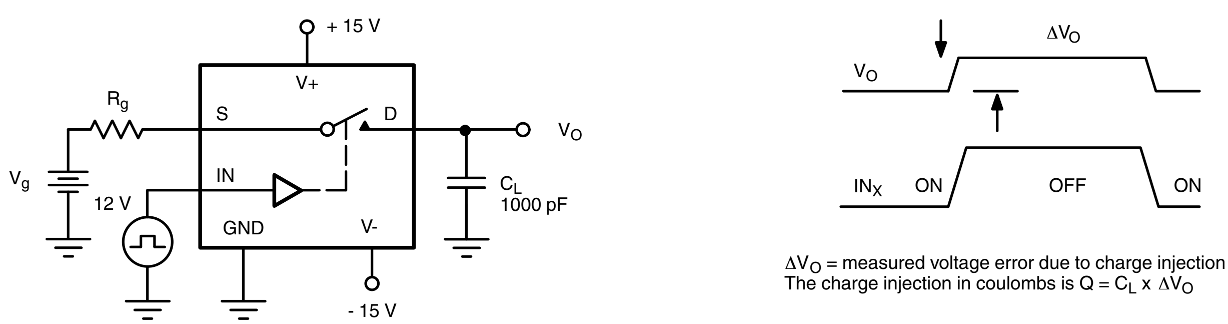



**Figure 5. Charge Injection**

## APPLICATIONS

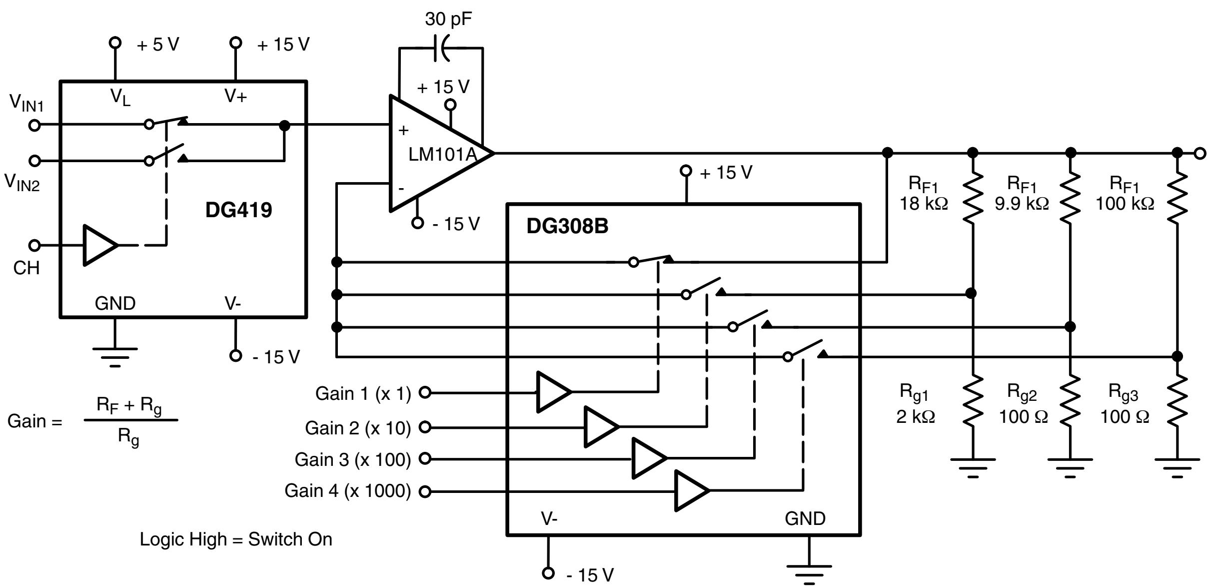



**Figure 6. A Precision Amplifier with Digitally Programmable Inputs and Gains**

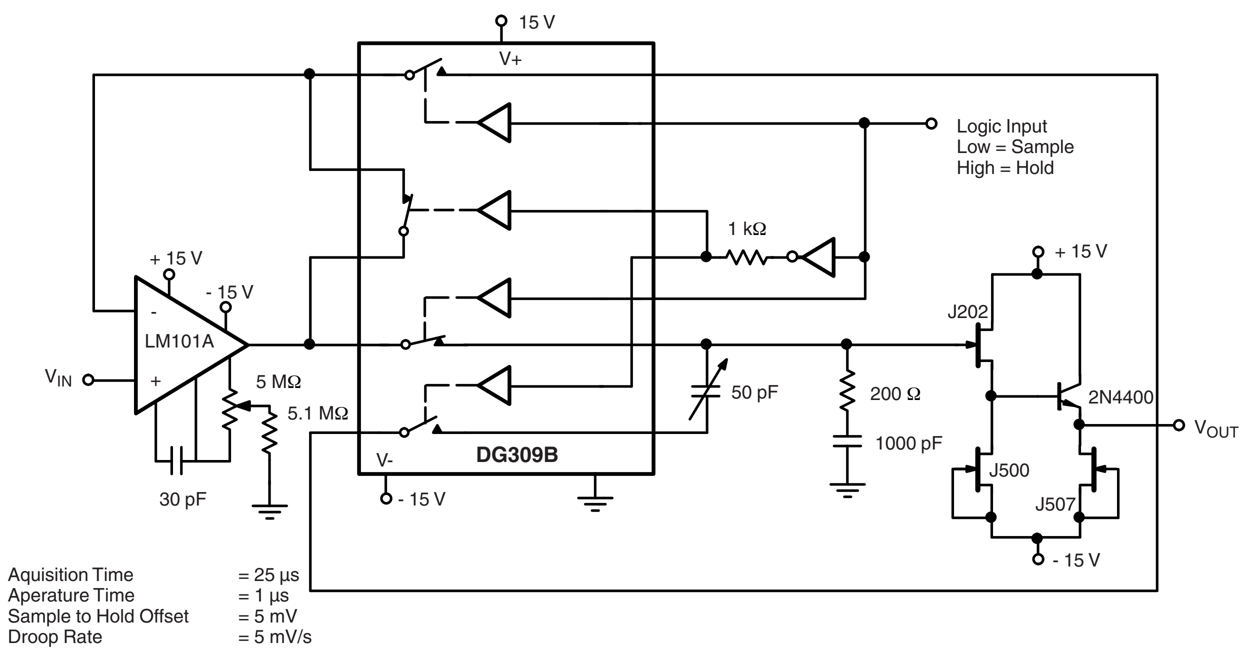
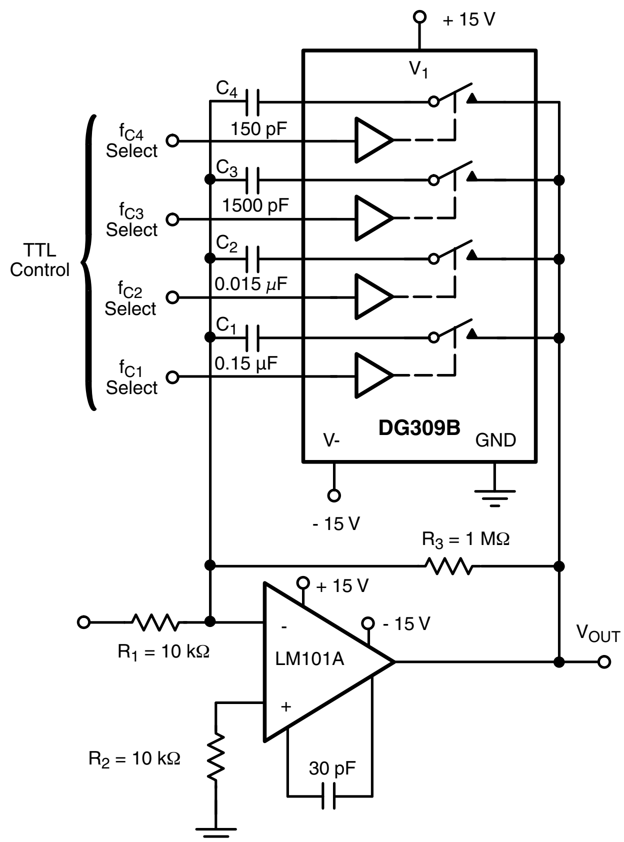
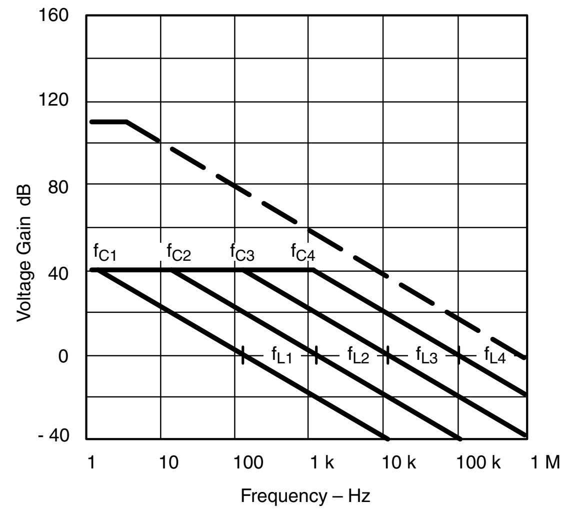



**Figure 7. Sample-and-Hold**

## APPLICATIONS




$A_L$ (Voltage Gain Below Break Frequency) = $\frac{R_3}{R_1}$ = 100 (40 dB)

$f_C$ (Break Frequency) = $\frac{1}{2\pi R_3 C_X}$

$f_L$ (Unity Gain Frequency) = $\frac{1}{2\pi R_1 C_X}$

Max Attenuation = $\frac{R_{DS(on)}}{10\ k\Omega} \approx -40$ dB

**Figure 8. Active Low Pass Filter with Digitally Selected Break Frequency**

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