# Improved Quad CMOS Analog Switches

## DESCRIPTION

The DG211B, DG212B analog switches are highly improved versions of the industry-standard DG211, DG212. 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 DG211B and DG212B can handle up to ± 22 V, and have an improved continuous current rating of 30 mA. 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 DG211B is a normally closed switch and the DG212B is a normally open switch (see Truth Table).

## BENEFITS

- Wide analog signal range
- Simple logic interface
- Higher accuracy
- Minimum transients
- Reduced power consumption
- Superior to DG211, DG212
- Space savings (TSSOP)

## FEATURES

Pb-free Available

RoHS* Available

- ± 22 V supply voltage rating
- TTL and CMOS compatible logic
- Low on-resistance - $R_{DS(on)}$: 50 Ω
- Low leakage - $I_{D(on)}$: 20 pA
- Single supply operation possible
- Extended temperature range
- Fast switching - $t_{on}$: 120 ns
- Low charge injection - Q: 1 pC
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

**Note**

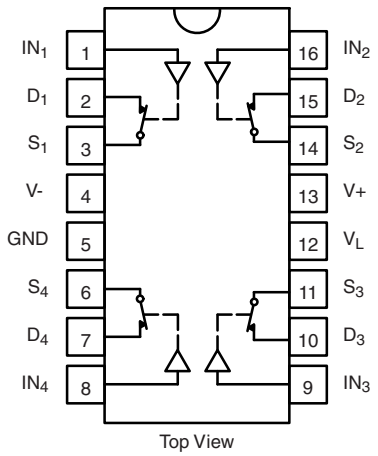
* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

## APPLICATIONS

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

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

**DG211B**
Dual-In-Line, SOIC and TSSOP




Top View

| TRUTH TABLE | | |
|---|---|---|
| LOGIC | DG211B | DG212B |
| 0 | On | Off |
| 1 | Off | On |

**Note**

- Logic "0" ≤ 0.8 V
  Logic "1" ≥ 2.4 V



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| ORDERING INFORMATION | | |
|---|---|---|
| **TEMP. RANGE** | **PACKAGE** | **PART NUMBER** |
| -40 °C to +85 °C | 16-pin narrow SOIC | DG211BDY-E3<br>DG211BDY-T1-E3 |
| | | DG212BDY-E3<br>DG212BDY-T1-E3 |
| | 16-pin TSSOP | DG211BDQ-E3<br>DG211BDQ-T1-E3 |
| | | DG212BDQ-E3<br>DG212BDQ-T1-E3 |

| **ABSOLUTE MAXIMUM RATINGS** ($T_A$ = 25 °C, unless otherwise noted) | | | |
|---|---|---|---|
| **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 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 | | -65 to +125 | °C |
| Power dissipation (package) [b] | 16-pin narrow SOIC and TSSOP [d] | 640 | mW |

**Notes**

a. Signals on SX, DX, or INX 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

## SCHEMATIC DIAGRAM (typical channel)

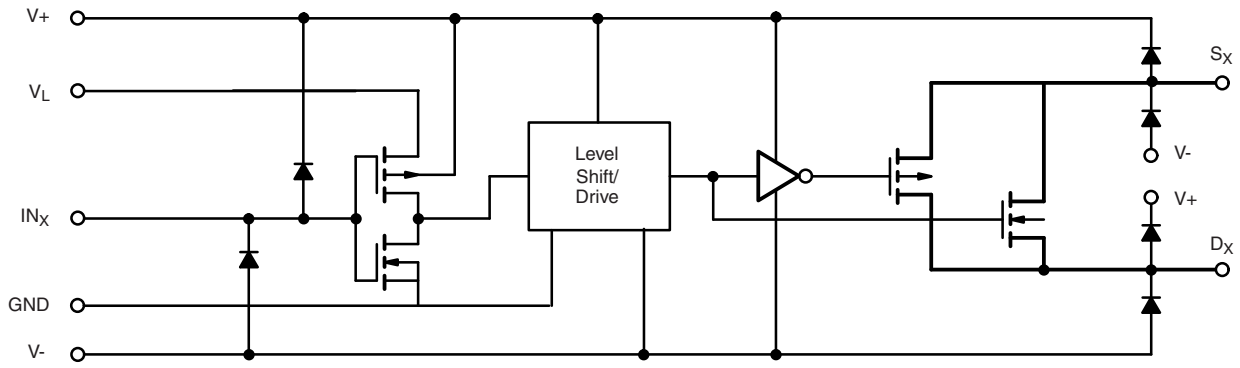



**Fig. 1**



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## SPECIFICATIONS

| PARAMETER | SYMBOL | TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 15 V, V- = -15 V $V_L$ = 5 V, $V_{IN}$ = 2.4 V, 0.8 V [e] | TEMP.[a] | D SUFFIX -40 °C to +85 °C MIN. [b] | TYP. [c] | MAX. [b] | UNIT |
|---|---|---|---|---|---|---|---|
| **Analog Switch** | | | | | | | |
| Analog signal range [d] | $V_{ANALOG}$ | | Full | -15 | - | 15 | V |
| Drain-source on-resistance | $R_{DS(on)}$ | $V_D$ = ± 10 V, $I_S$ = 1 mA | Room | - | 45 | 85 | Ω |
| | | | Full | - | - | 100 | |
| $R_{DS(on)}$ match | $\Delta R_{DS(on)}$ | | Room | - | 2 | - | |
| Source off leakage current | $I_{S(off)}$ | $V_S$ = ± 14 V, $V_D$ = ± 14 V | Room | -0.5 | ± 0.01 | 0.5 | nA |
| | | | Full | - | ± 0.01 | 5 | |
| Drain off leakage current | $I_{D(off)}$ | $V_D$ = ± 14 V, $V_S$ = ± 14 V | Room | -0.5 | ± 0.01 | 0.5 | |
| | | | Full | -5 | ± 0.01 | 5 | |
| Drain on leakage current | $I_{D(on)}$ | $V_S$ = $V_D$ = ± 14 V | Room | -0.5 | ± 0.02 | 0.5 | |
| | | | Full | -10 | ± 0.02 | 10 | |
| **Digital Control** | | | | | | | |
| Input voltage high | $V_{INH}$ | | Full | 2.4 | - | - | V |
| Input voltage low | $V_{INL}$ | | Full | - | - | 0.8 | |
| Input current | $I_{INH}$ or $I_{INL}$ | $V_{INH}$ or $V_{INL}$ | Full | -1 | - | 1 | µA |
| Input capacitance | $C_{IN}$ | | Room | - | 5 | - | pF |
| **Dynamic Characteristics** | | | | | | | |
| Turn-on time | $t_{on}$ | $V_S$ = 10 V, see Fig. 9 | Room | - | - | 300 | ns |
| Turn-off time | $t_{off}$ | | Room | - | - | 200 | |
| Charge injection | Q | $C_L$ = 1000 pF, $V_{gen}$ = 0 V, $R_{gen}$ = 0 Ω | 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 | $O_{IRR}$ | $C_L$ = 15 pF, $R_L$ = 50 Ω, $V_S$ = 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 5 V | Room | - | - | 10 | µA |
| | | | Full | - | - | 50 | |
| Negative supply current | I- | | Room | - 10 | - | - | |
| | | | Full | - 50 | - | - | |
| Logic supply current | $I_L$ | | Room | - | - | 10 | |
| | | | Full | - | - | 50 | |
| Power supply range for continuous operation | $V_{OP}$ | | Full | ± 4.5 | - | ± 22 | V |


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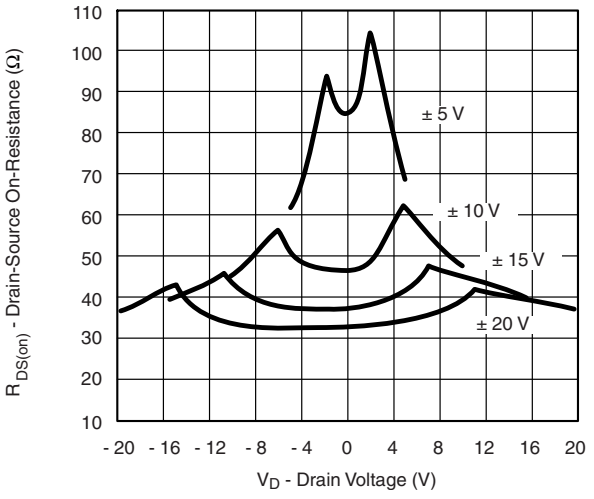
| **SPECIFICATIONS** (for Single Supply) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS UNLESS OTHERWISE SPECIFIED** V+ = 12 V, V- = 0 V $V_L$ = 5 V, $V_{IN}$ = 2.4 V, 0.8 V [e] | **TEMP.**[a] | **D SUFFIX** -40 °C to +85 °C | | | **UNIT** |
| | | | | **MIN.** [b] | **TYP.** [c] | **MAX.** [b] | |
| **Analog Switch** | | | | | | | |
| Analog signal range [d] | $V_{ANALOG}$ | | Full | 0 | - | 12 | V |
| Drain-source on-resistance | $R_{DS(on)}$ | $V_D$ = 3 V, 8 V, $I_S$ = 1 mA | Room | - | 90 | 160 | Ω |
| | | | Full | - | 90 | 200 | |
| **Dynamic Characteristics** | | | | | | | |
| Turn-on time | $t_{ON}$ | $V_S$ = 8 V, see Fig. 1 | Room | - | - | 300 | ns |
| Turn-off time | $t_{OFF}$ | | Room | - | - | 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 5 V | Room | - | - | 10 | µA |
| | | | Full | - | - | 50 | |
| Negative supply current | I- | | Room | - 10 | - | - | |
| | | | Full | - 50 | - | - | |
| Logic supply current | $I_L$ | $V_S$ = 8 V, see Fig. 1 | Room | - | - | 10 | |
| | | | Full | - | - | 50 | |
| Power supply range for continuous operation | $V_{OP}$ | | Full | + 4.5 | - | + 25 | V |

**Notes**

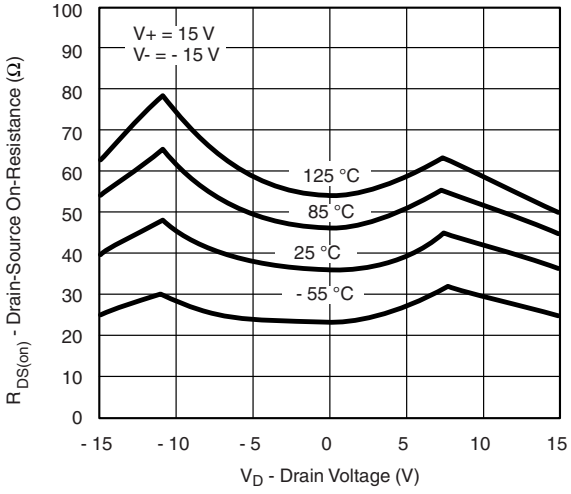
a. Room = 25 °C, Full = as determined by the operating temperature suffix
b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet
c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing
d. Guaranteed by design, not subject to production test
e. $V_{IN}$ = 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)



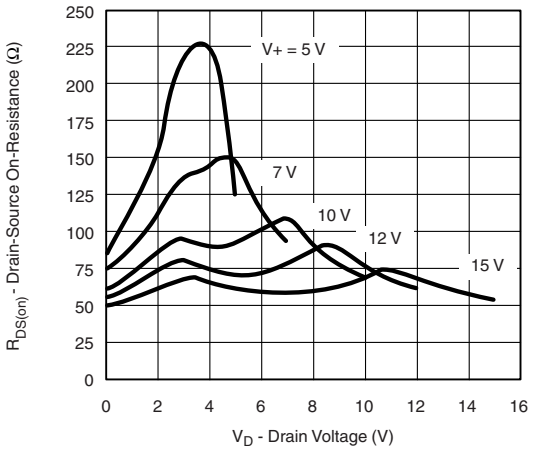

**$R_{DS(on)}$ vs. $V_D$ and Power Supply Voltages**



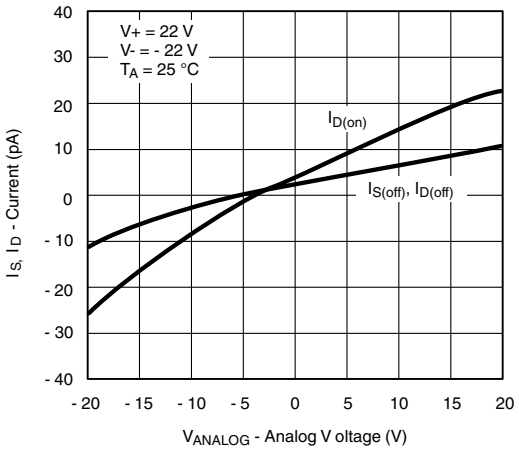

**$R_{DS(on)}$ vs. $V_D$ and Temperature**


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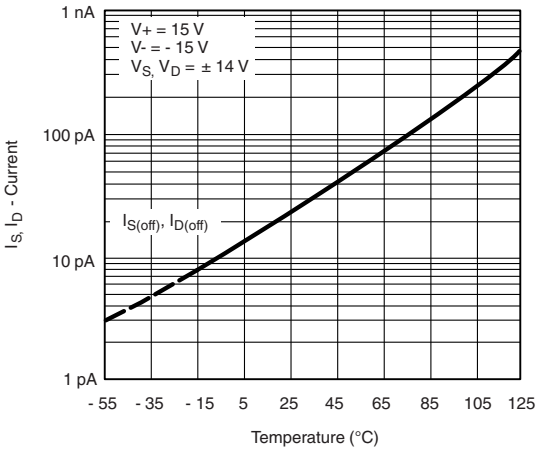
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



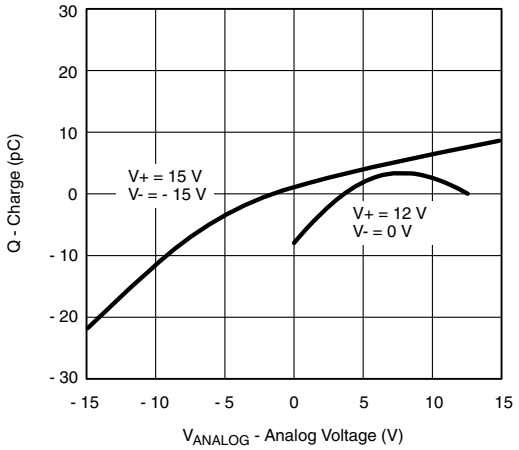

**$R_{DS(on)}$ vs. $V_D$ and Single Power Supply Voltages**



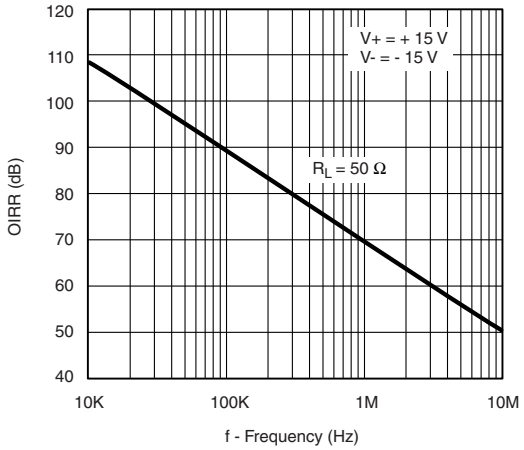

**Leakage Current vs. Temperature**




**Leakage Current vs. Temperature**



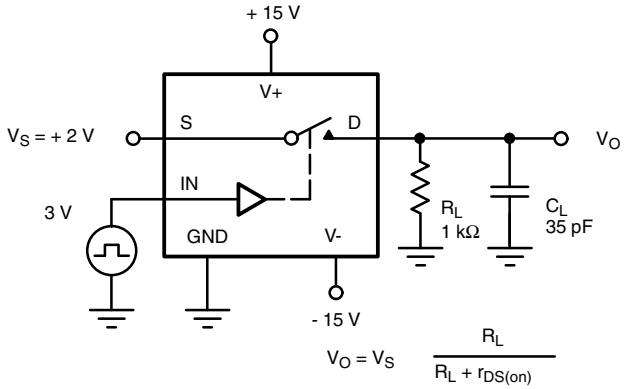

**$Q_S$, $Q_D$ - Charge Injection vs. Analog Voltage**




**Off Isolation vs. Frequency**


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## TEST CIRCUITS



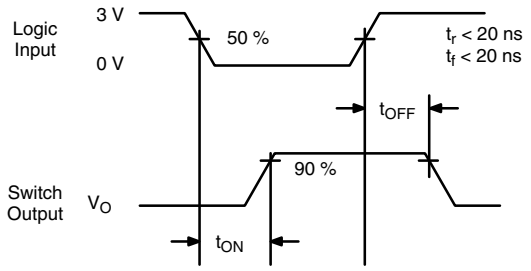




**Fig. 2 - Switching Time**

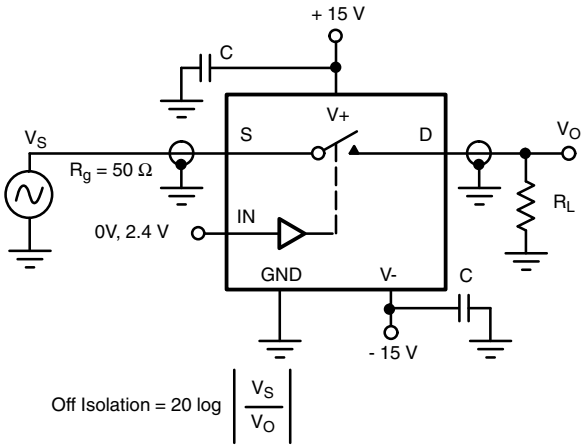



**Fig. 3 - Off Isolation**

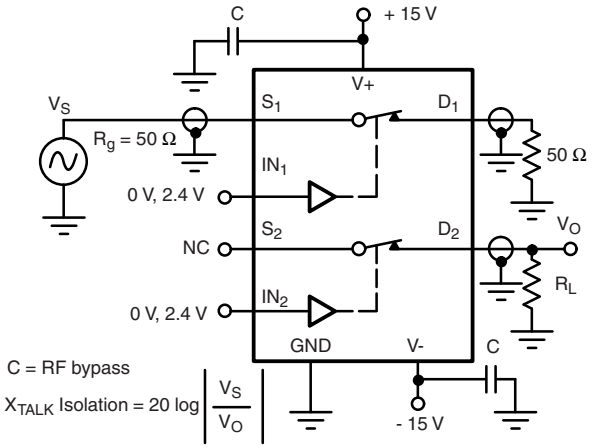
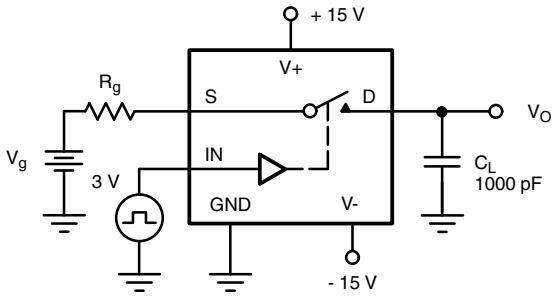
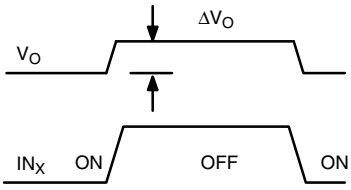



**Fig. 4 - Channel to Channel Crosstalk**




$\Delta V_O$ = measured voltage error due to charge injection
The charge injection in coulombs is $Q = C_L \times \Delta V_O$

**Fig. 5 - Charge Injection**


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## APPLICATIONS

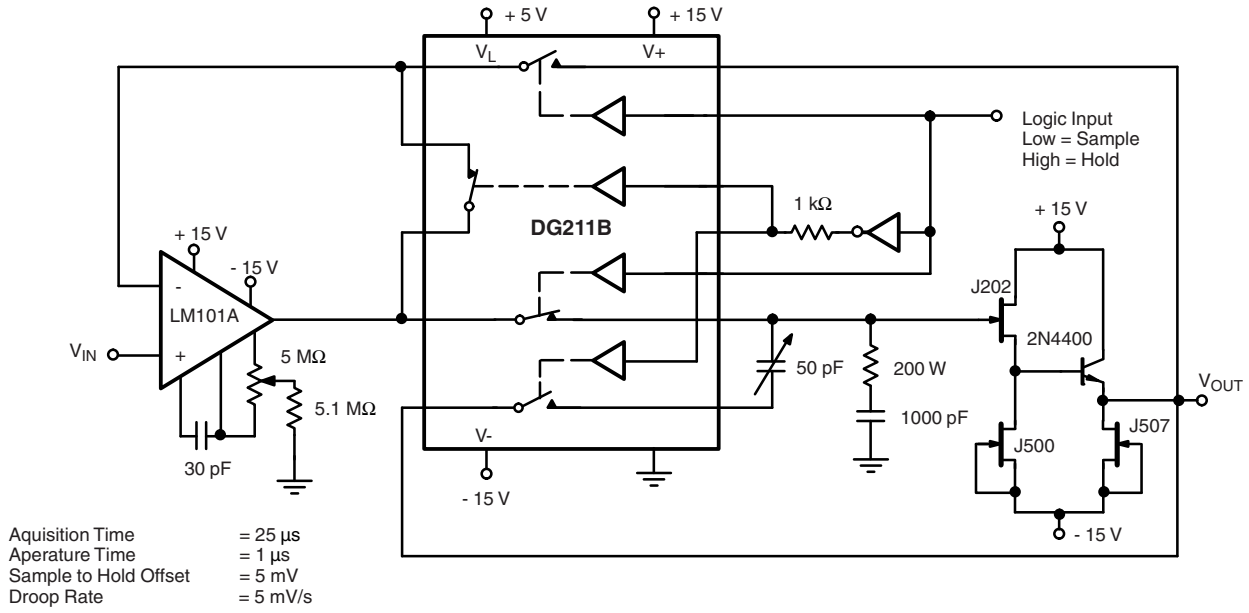
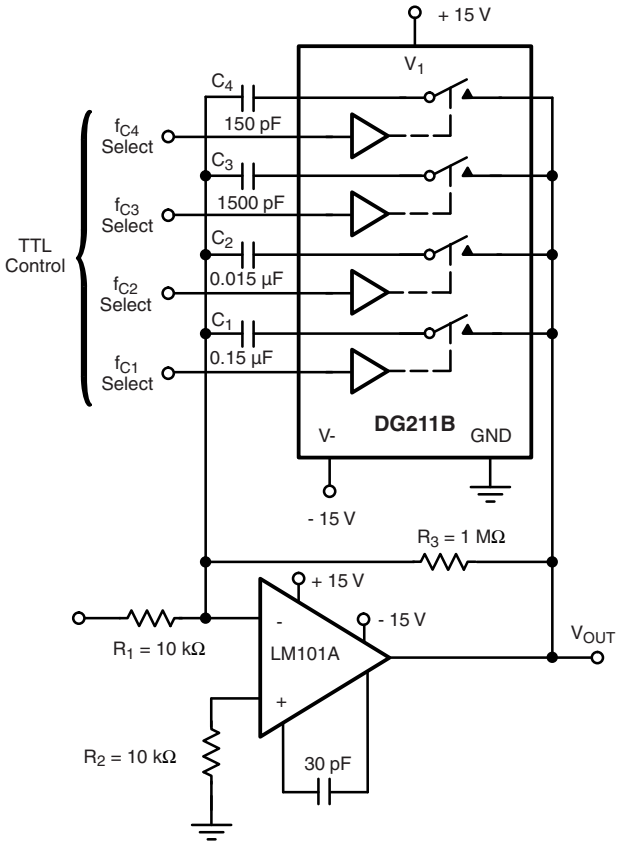
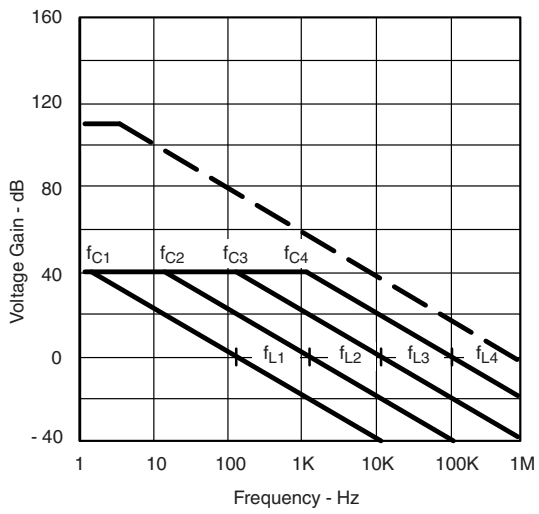



**Fig. 6 - Sample and Hold**




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

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

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

$$\text{Max. Attenuation} = \frac{R_{DS(on)}}{10\ k\Omega} \approx -47\ dB$$

**Fig. 7 - Active Low Pass Filter With Digitally Selected Break Frequency**


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## APPLICATIONS

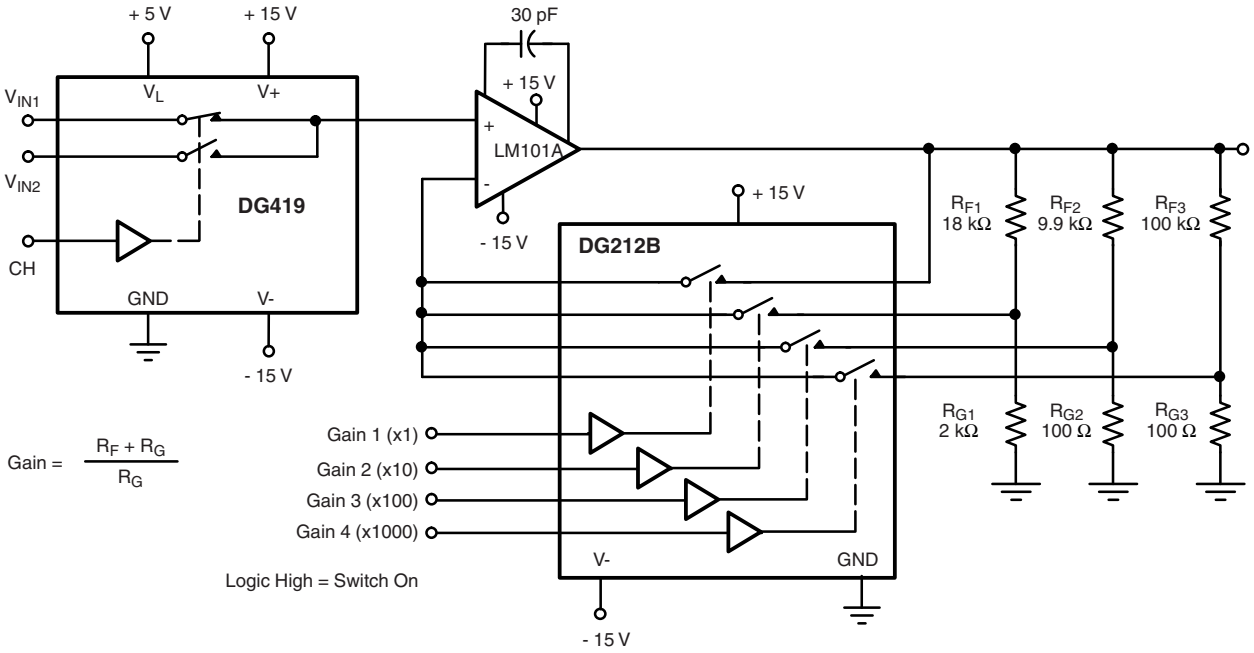



**Fig. 8 - A Precision Amplifier with Digitally Programmable Input and Gains**


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| PRODUCT SUMMARY | | | | |
|---|---|---|---|---|
| Part number | DG211B | DG211B | DG212B | DG212B |
| Status code | 2 | 2 | 2 | 2 |
| Configuration | SPST x 4, NC | SPST x 4, NC | SPST x 4, NO | SPST x 4, NO |
| Single supply min. (V) | 5 | 5 | 5 | 5 |
| Single supply max. (V) | 36 | 36 | 36 | 36 |
| Dual supply min. (V) | 5 | 5 | 5 | 5 |
| Dual supply max. (V) | 36 | 36 | 36 | 36 |
| On-resistance (Ω) | 22 | 22 | 22 | 22 |
| Charge injection (pC) | 45 | 45 | 45 | 45 |
| Source on capacitance (pF) | 1 | 1 | 1 | 1 |
| Source off capacitance (pF) | - | - | - | - |
| Leakage switch on typ. (nA) | 5 | 5 | 5 | 5 |
| Leakage switch off max. (nA) | 0.02 | 0.02 | 0.02 | 0.02 |
| -3 dB bandwidth (MHz) | 0.5 | 0.5 | 0.5 | 0.5 |
| Package | TSSOP-16 | SO-16 (narrow) AS | TSSOP-16 | SO-16 (narrow) AS |
| Functional circuit / applications | Multi purpose, instrumentation, medical and healthcare | Multi purpose, instrumentation, medical and healthcare | Multi purpose, instrumentation, medical and healthcare | Multi purpose, instrumentation, medical and healthcare |
| Interface | Parallel | Parallel | Parallel | Parallel |
| Single supply operation | Yes | Yes | Yes | Yes |
| Dual supply operation | Yes | Yes | Yes | Yes |
| Turn on time max. (ns) | 300 | 300 | 300 | 300 |
| Crosstalk and off isolation | -90 | -90 | -90 | -90 |

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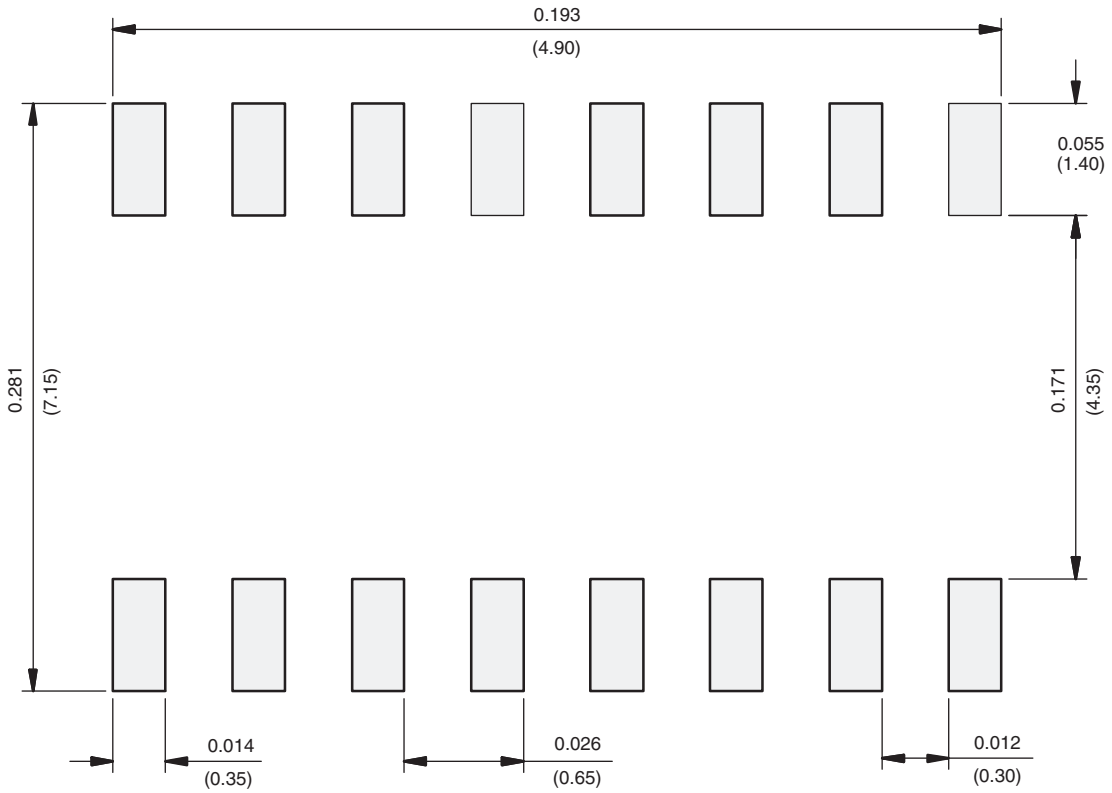


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## RECOMMENDED MINIMUM PAD FOR TSSOP-16



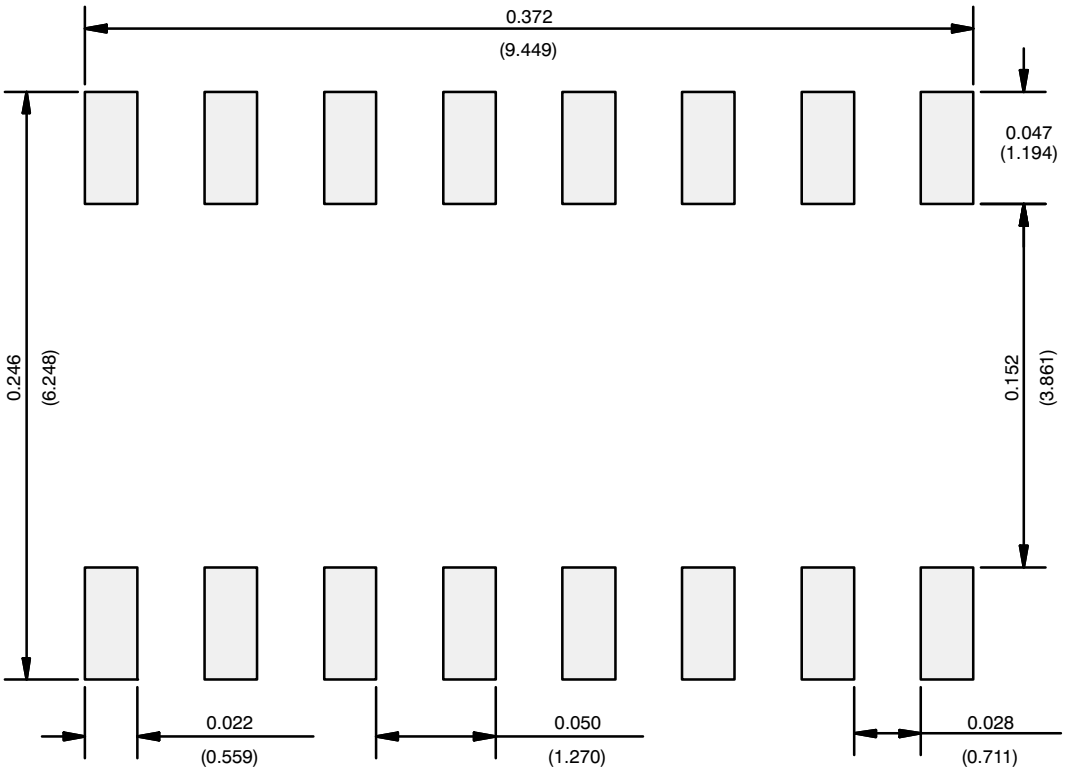

Recommended Minimum Pads
Dimensions in inches (mm)



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## RECOMMENDED MINIMUM PADS FOR SO-16




Recommended Minimum Pads
Dimensions in Inches/(mm)

Return to Index

APPLICATION NOTE



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