

## 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  $\pm 22$  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.)

### FEATURES

- $\pm 22$  V supply voltage rating
- TTL and CMOS compatible logic
- Low on-resistance -  $R_{DS(on)}$ : 50  $\Omega$
- 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

### BENEFITS

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

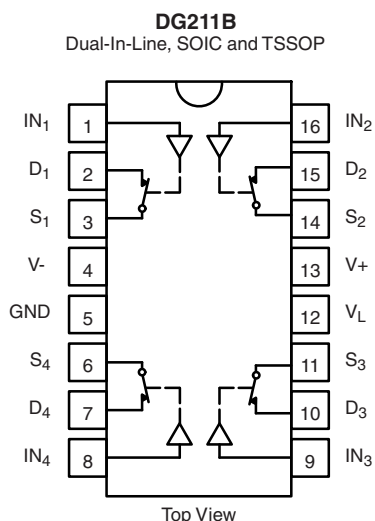
### APPLICATIONS

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



RoHS\*  
COMPLIANT

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



| TRUTH TABLE |        |        |
|-------------|--------|--------|
| Logic       | DG211B | DG212B |
| 0           | ON     | OFF    |
| 1           | OFF    | ON     |

Logic "0"  $\leq 0.8$  V  
Logic "1"  $\geq 2.4$  V

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

| ORDERING INFORMATION |                    |                         |                               |
|----------------------|--------------------|-------------------------|-------------------------------|
| Temp. Range          | Package            | Standard Part Number    | Lead (Pb)-free Part Number    |
| - 40 °C to 85 °C     | 16-Pin Plastic DIP | DG211BDJ                | DG211BDJ-E3                   |
|                      |                    | DG212BDJ                | DG212BDJ-E3                   |
|                      | 16-Pin Narrow SOIC | DG211BDY<br>DG211BDY-T1 | DG211BDY-E3<br>DG211BDY-T1-E3 |
|                      |                    | DG212BDY<br>DG212BDY-T1 | DG212BDY-E3<br>DG212BDY-T1-E3 |
|                      | 16-Pin TSSOP       | DG211BDQ<br>DG211BDQ-T1 | DG211BDQ-E3<br>DG211BDQ-T1-E3 |
|                      |                    | DG212BDQ<br>DG212BDQ-T1 | DG212BDQ-E3<br>DG212BDQ-T1-E3 |

| ABSOLUTE MAXIMUM RATINGS (T <sub>A</sub> = 25 °C, unless otherwise noted) |   |  |      |
|---|---|--|------|
| Parameter   |   | Limit  | Unit |
| Voltages Referenced, V <sub>+</sub> to V <sub>-</sub>                     |   | 44   | V    |
| GND   |   | 25   |      |
| Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub>             |   | (V <sub>-</sub> - 2 to (V <sub>+</sub> ) + 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) <sup>b</sup>                                  | 16-Pin Plastic DIP <sup>c</sup>           | 470  | mW   |
|   | 16-Pin Narrow SOIC and TSSOP <sup>d</sup> | 640  |      |

Notes:

- a. Signals on S<sub>x</sub>, D<sub>x</sub>, or IN<sub>x</sub> exceeding V<sub>+</sub> or V<sub>-</sub> 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)

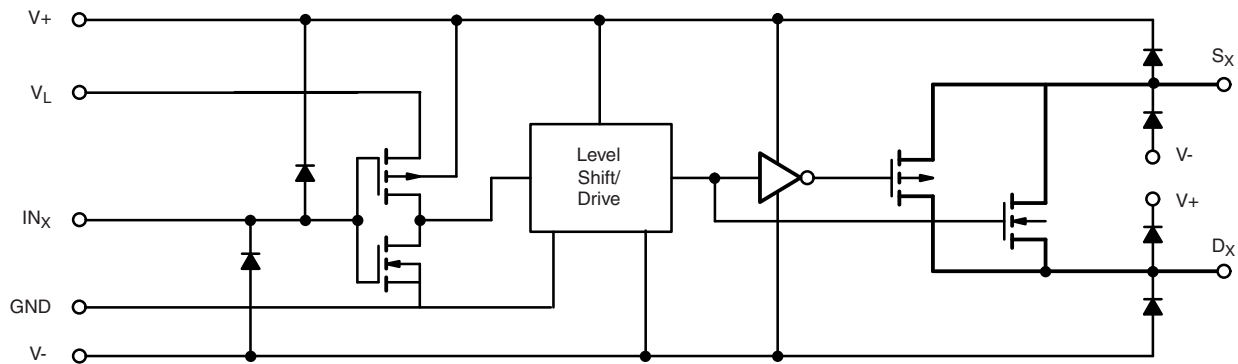


Figure 1.



| SPECIFICATIONS                              |                        |  |                    |                              |                   |                   |               |
|---|------------------------|--|--------------------|------------------------------|-------------------|-------------------|---------------|
| Parameter                                   | Symbol                 | Test Conditions<br>Unless Otherwise Specified<br>$V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$<br>$V_L = 5\text{ V}$ , $V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^e$ | Temp. <sup>a</sup> | D Suffix<br>- 40 °C to 85 °C |                   |                   | Unit          |
|   |                        |  |                    | Min. <sup>b</sup>            | Typ. <sup>c</sup> | Max. <sup>b</sup> |               |
| <b>Analog Switch</b>                        |                        |  |                    |                              |                   |                   |               |
| Analog Signal Range <sup>d</sup>            | $V_{ANALOG}$           |  | Full               | - 15                         |                   | 15                | V             |
| Drain-Source On-Resistance                  | $R_{DS(on)}$           | $V_D = \pm 10\text{ V}$ , $I_S = 1\text{ mA}$  | Room               |                              | 45                | 85                | $\Omega$      |
| $R_{DS(on)}$ Match                          | $\Delta R_{DS(on)}$    |  | Full               |                              | 2                 | 100               |               |
| Source Off Leakage Current                  | $I_{S(off)}$           | $V_S = \pm 14\text{ V}$ , $V_D = \pm 14\text{ V}$  | Room               | - 0.5                        | $\pm 0.01$        | 0.5               | nA            |
| Drain Off Leakage Current                   | $I_{D(off)}$           | $V_D = \pm 14\text{ V}$ , $V_S = \pm 14\text{ V}$  | Full               | - 5                          |                   | 5                 |               |
| Drain On Leakage Current                    | $I_{D(on)}$            | $V_S = V_D = \pm 14\text{ V}$  | Room               | - 0.5                        | $\pm 0.01$        | 0.5               |               |
|   |                        |  | Full               | - 10                         | $\pm 0.02$        | 10                |               |
| <b>Digital Control</b>                      |                        |  |                    |                              |                   |                   |               |
| 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                 | $\mu\text{A}$ |
| Input Capacitance                           | $C_{IN}$               |  | Room               |                              | 5                 |                   | pF            |
| <b>Dynamic Characteristics</b>              |                        |  |                    |                              |                   |                   |               |
| Turn-On Time                                | $t_{ON}$               | $V_S = 10\text{ V}$<br>see figure 2  | Room               |                              |                   | 300               | ns            |
| Turn-Off Time                               | $t_{OFF}$              |  | Room               |                              |                   | 200               |               |
| Charge Injection                            | Q                      | $C_L = 1000\text{ pF}$ , $V_{gen} = 0\text{ V}$ , $R_{gen} = 0\ \Omega$  | Room               |                              | 1                 |                   | pC            |
| Source-Off Capacitance                      | $C_{S(off)}$           | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  | Room               |                              | 5                 |                   | pF            |
| Drain-Off Capacitance                       | $C_{D(off)}$           |  | Room               |                              | 5                 |                   |               |
| Channel-On Capacitance                      | $C_{D(on)}$            | $V_D = V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  | Room               |                              | 16                |                   |               |
| Off Isolation                               | OIRR                   | $C_L = 15\text{ pF}$ , $R_L = 50\ \Omega$ ,<br>$V_S = 1\text{ V}_{RMS}$ , $f = 100\text{ kHz}$   | Room               |                              | 90                |                   | dB            |
| Channel-to-Channel Crosstalk                | $X_{TALK}$             |  | Room               |                              | 95                |                   |               |
| <b>Power Supply</b>                         |                        |  |                    |                              |                   |                   |               |
| Positive Supply Current                     | $I_+$                  | $V_{IN} = 0$ or $5\text{ V}$   | Room               |                              |                   | 10                | $\mu\text{A}$ |
| Negative Supply Current                     | $I_-$                  |  | Full               | - 10                         |                   | 50                |               |
| Logic Supply Current                        | $I_L$                  |  | Full               | - 50                         |                   |                   |               |
| Power Supply Range for Continuous Operation | $V_{OP}$               |  | Room               |                              |                   | 10                |               |
|   |                        |  | Full               | $\pm 4.5$                    |                   | $\pm 22$          | V             |

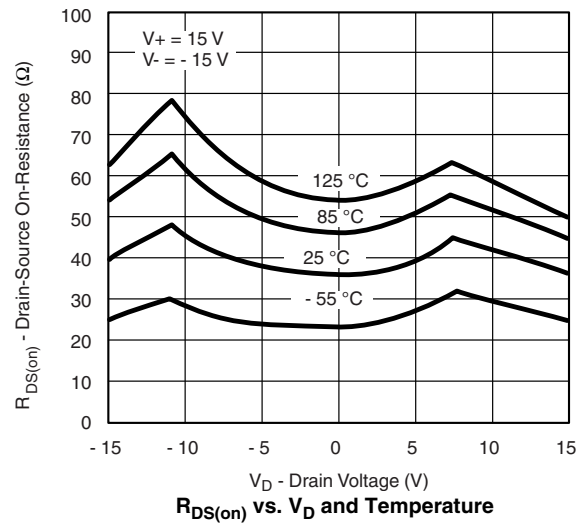
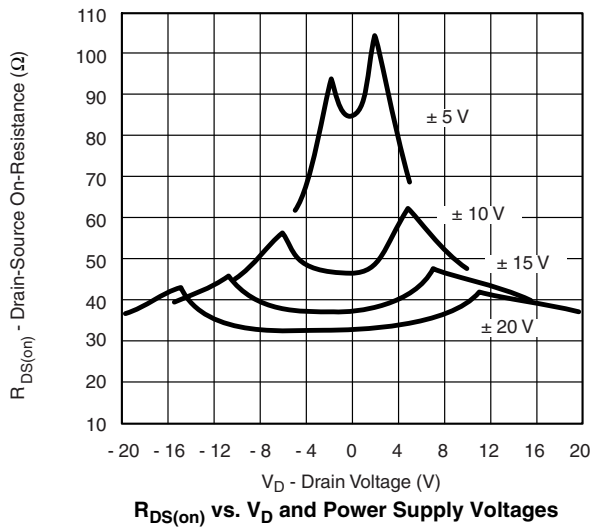
| SPECIFICATIONS (for Single Supply)          |              |  |                    |                             |                   |                   |               |
|---|--------------|--|--------------------|-----------------------------|-------------------|-------------------|---------------|
| Parameter                                   | Symbol       | Test Conditions<br>Unless Otherwise Specified<br>$V_+ = 12\text{ V}$ , $V_- = 0\text{ V}$<br>$V_L = 5\text{ V}$ , $V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^e$ | Temp. <sup>a</sup> | D Suffix<br>-40 °C to 85 °C |                   |                   | Unit          |
|   |              |  |                    | Min. <sup>b</sup>           | Typ. <sup>c</sup> | Max. <sup>b</sup> |               |
| <b>Analog Switch</b>                        |              |  |                    |                             |                   |                   |               |
| Analog Signal Range <sup>d</sup>            | $V_{ANALOG}$ |  | Full               | 0                           |                   | 12                | V             |
| Drain-Source On-Resistance                  | $R_{DS(on)}$ | $V_D = 3\text{ V}$ , $8\text{ V}$ , $I_S = 1\text{ mA}$  | Room<br>Full       |                             | 90                | 160<br>200        | $\Omega$      |
| <b>Dynamic Characteristics</b>              |              |  |                    |                             |                   |                   |               |
| Turn-On Time                                | $t_{ON}$     | $V_S = 8\text{ V}$<br>see figure 1   | Room               |                             |                   | 300               | ns            |
| Turn-Off Time                               | $t_{OFF}$    |  | Room               |                             |                   | 200               |               |
| Charge Injection                            | Q            | $C_L = 1\text{ nF}$ , $V_{gen} = 6\text{ V}$ , $R_{gen} = 0\ \Omega$   | Room               |                             | 4                 |                   | pC            |
| <b>Power Supply</b>                         |              |  |                    |                             |                   |                   |               |
| Positive Supply Current                     | $I_+$        | $V_{IN} = 0\text{ or }5\text{ V}$  | Room<br>Full       |                             |                   | 10<br>50          | $\mu\text{A}$ |
| Negative Supply Current                     | $I_-$        |  | Room<br>Full       | -10<br>-50                  |                   |                   |               |
| Logic Supply Current                        | $I_L$        |  | Room<br>Full       |                             |                   | 10<br>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 data sheet.
- 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.

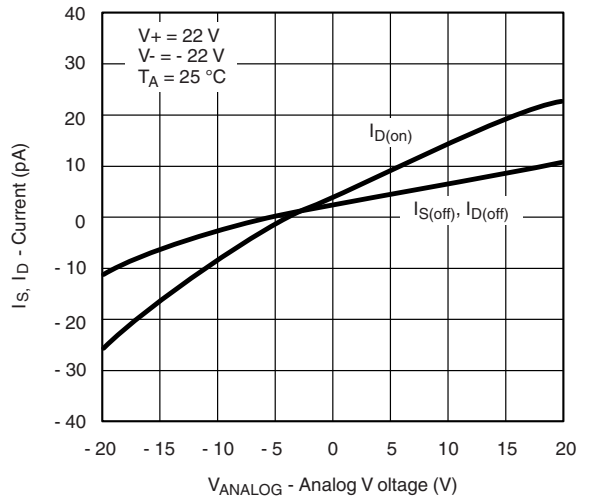
### TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



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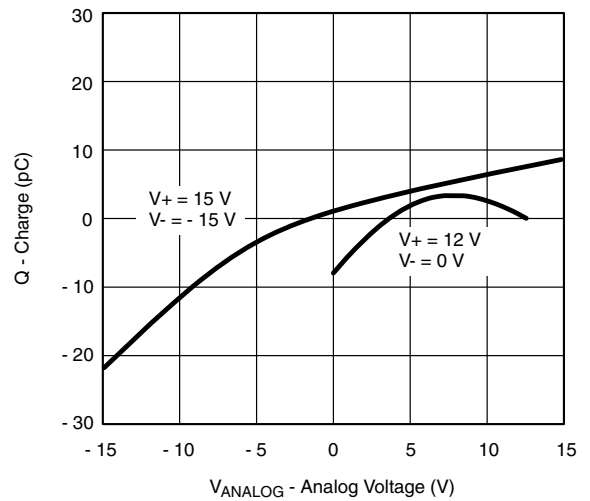
**$R_{DS(on)}$  vs.  $V_D$  and Single Power Supply Voltages**



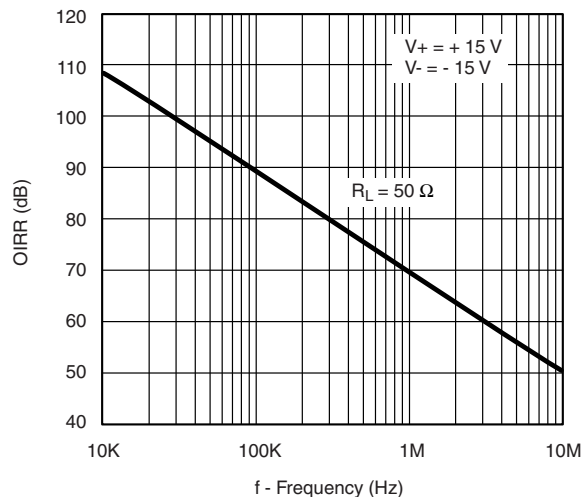
**Leakage Currents vs. Analog Voltage**



**Leakage Current vs. Temperature**



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



**Off Isolation vs. Frequency**

## TEST CIRCUITS



Figure 2. Switching Time

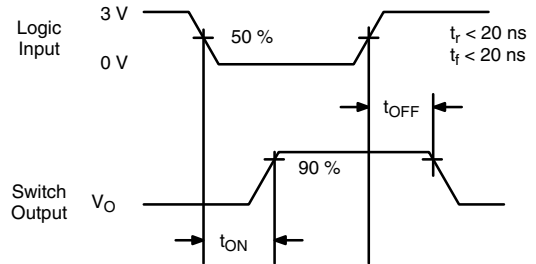


Figure 3. Off Isolation

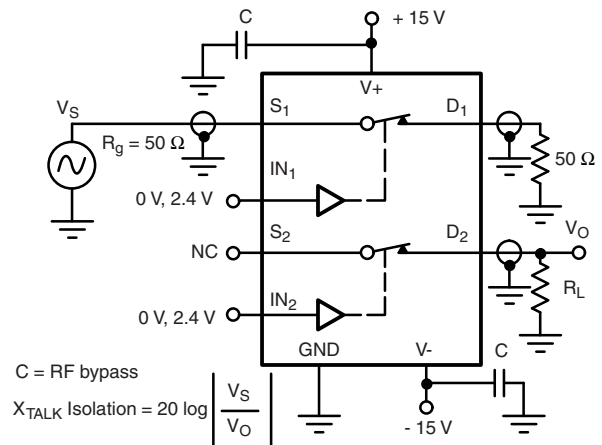


Figure 4. Channel-to-Channel Crosstalk

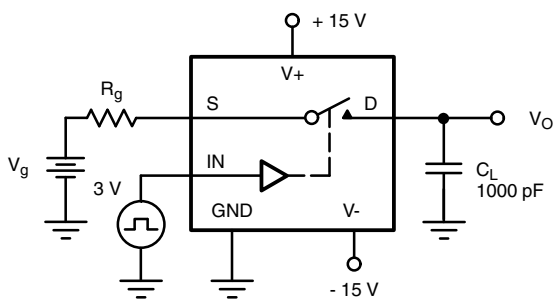
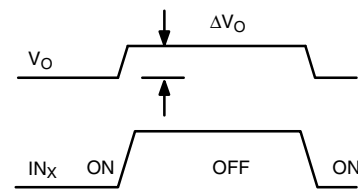


Figure 5. Charge Injection



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

## APPLICATIONS

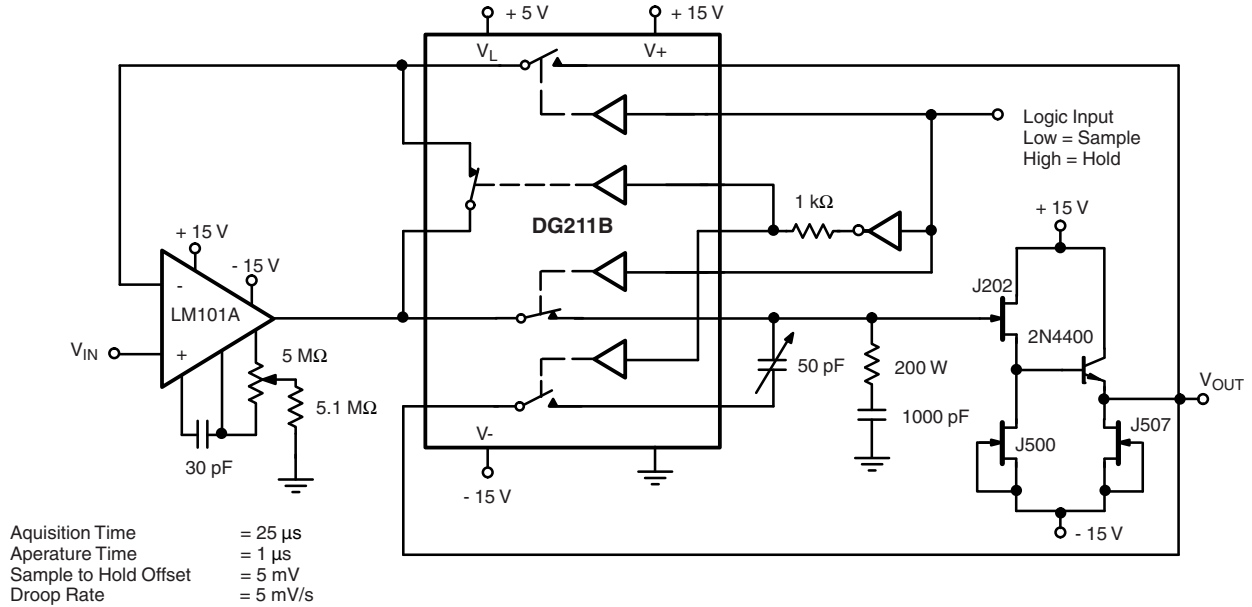


Figure 6. Sample-and-Hold

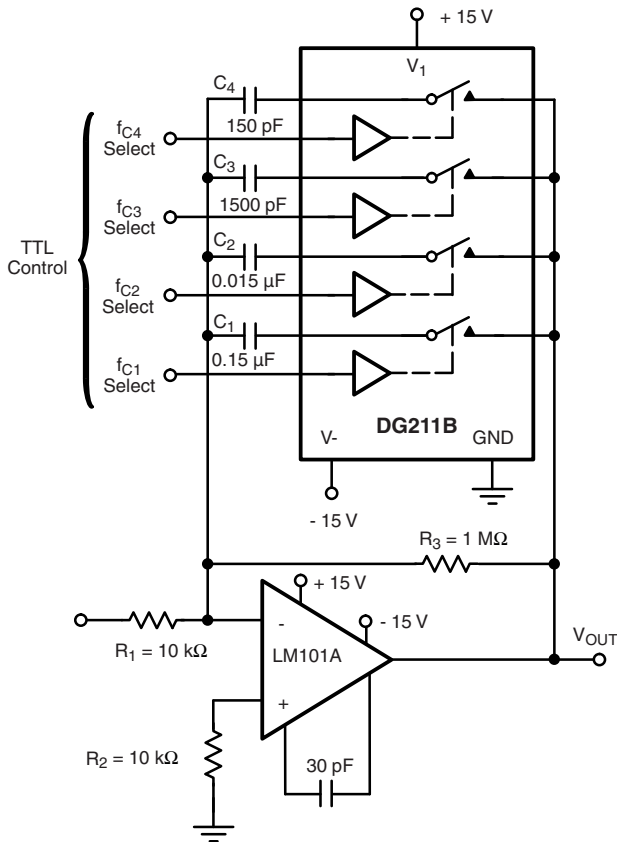
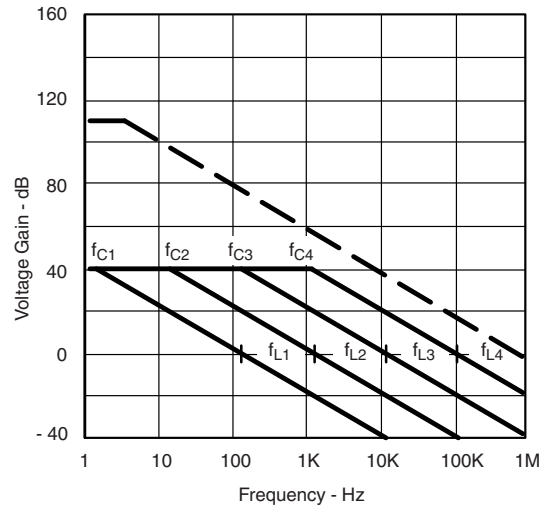


Figure 7. Active Low Pass Filter with Digitally Selected Break Frequency



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

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

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

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

## APPLICATIONS



Figure 8. A Precision Amplifier with Digitally Programmable Input and Gains

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?70040](http://www.vishay.com/ppg?70040).





**SOIC (NARROW): 16-LEAD**  
JEDEC Part Number: MS-012



| Dim            | MILLIMETERS |       | INCHES    |       |
|----------------|-------------|-------|-----------|-------|
|                | Min         | Max   | Min       | Max   |
| A              | 1.35        | 1.75  | 0.053     | 0.069 |
| A <sub>1</sub> | 0.10        | 0.20  | 0.004     | 0.008 |
| B              | 0.38        | 0.51  | 0.015     | 0.020 |
| C              | 0.18        | 0.23  | 0.007     | 0.009 |
| D              | 9.80        | 10.00 | 0.385     | 0.393 |
| E              | 3.80        | 4.00  | 0.149     | 0.157 |
| e              | 1.27 BSC    |       | 0.050 BSC |       |
| H              | 5.80        | 6.20  | 0.228     | 0.244 |
| L              | 0.50        | 0.93  | 0.020     | 0.037 |
| ∅              | 0°          | 8°    | 0°        | 8°    |

ECN: S-03946—Rev. F, 09-Jul-01  
DWG: 5300



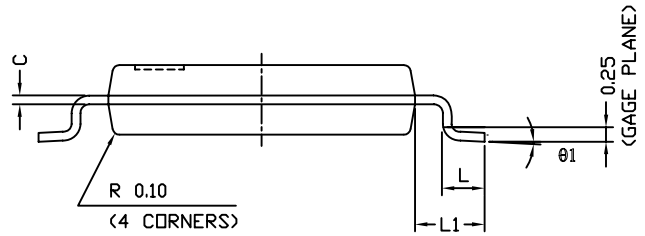
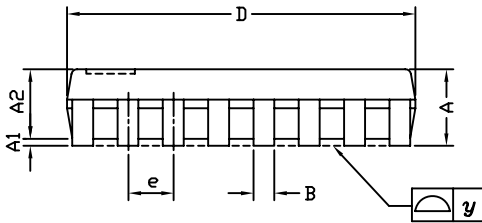
### PDIP: 16-LEAD



| Dim                  | MILLIMETERS |       | INCHES |       |
|----------------------|-------------|-------|--------|-------|
|                      | Min         | Max   | Min    | Max   |
| <b>A</b>             | 3.81        | 5.08  | 0.150  | 0.200 |
| <b>A<sub>1</sub></b> | 0.38        | 1.27  | 0.015  | 0.050 |
| <b>B</b>             | 0.38        | 0.51  | 0.015  | 0.020 |
| <b>B<sub>1</sub></b> | 0.89        | 1.65  | 0.035  | 0.065 |
| <b>C</b>             | 0.20        | 0.30  | 0.008  | 0.012 |
| <b>D</b>             | 18.93       | 21.33 | 0.745  | 0.840 |
| <b>E</b>             | 7.62        | 8.26  | 0.300  | 0.325 |
| <b>E<sub>1</sub></b> | 5.59        | 7.11  | 0.220  | 0.280 |
| <b>e<sub>1</sub></b> | 2.29        | 2.79  | 0.090  | 0.110 |
| <b>e<sub>A</sub></b> | 7.37        | 7.87  | 0.290  | 0.310 |
| <b>L</b>             | 2.79        | 3.81  | 0.110  | 0.150 |
| <b>Q<sub>1</sub></b> | 1.27        | 2.03  | 0.050  | 0.080 |
| <b>S</b>             | 0.38        | 1.52  | .015   | 0.060 |

ECN: S-03946—Rev. D, 09-Jul-01  
DWG: 5482

## TSSOP: 16-LEAD



| Symbols | DIMENSIONS IN MILLIMETERS |       |      |
|---------|---------------------------|-------|------|
|         | Min                       | Nom   | Max  |
| A       | -                         | 1.10  | 1.20 |
| A1      | 0.05                      | 0.10  | 0.15 |
| A2      | -                         | 1.00  | 1.05 |
| B       | 0.22                      | 0.28  | 0.38 |
| C       | -                         | 0.127 | -    |
| D       | 4.90                      | 5.00  | 5.10 |
| E       | 6.10                      | 6.40  | 6.70 |
| E1      | 4.30                      | 4.40  | 4.50 |
| e       | -                         | 0.65  | -    |
| L       | 0.50                      | 0.60  | 0.70 |
| L1      | 0.90                      | 1.00  | 1.10 |
| y       | -                         | -     | 0.10 |
| theta1  | 0°                        | 3°    | 6°   |

ECN: S-61920-Rev. D, 23-Oct-06  
DWG: 5624



## RECOMMENDED MINIMUM PAD FOR TSSOP-16



Recommended Minimum Pads  
Dimensions in inches (mm)

## RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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