

## Improved Quad SPST CMOS Analog Switches

### DESCRIPTION

The DG441B, DG442B are monolithic quad analog switches designed to provide high speed, low error switching of analog and audio signals. The DG441B, DG442B are upgrades to the original DG441, DG442.

Combining low on-resistance (45  $\Omega$ , typ.) with high speed ( $t_{ON}$  120 ns, typ.), the DG441B, DG442B are ideally suited for Data Acquisition, Communication Systems, Automatic Test Equipment, or Medical Instrumentation. Charge injection has been minimized on the drain for use in sample-and-hold circuits.

The DG441B, DG442B are built using Vishay Siliconix's high-voltage silicon-gate process. An epitaxial layer prevents latchup.

When on, each switch conducts equally well in both directions and blocks input voltages to the supply levels when off.

### FEATURES

- Halogen-free according to IEC 61249-2-21 Definition
- Low On-Resistance: 45  $\Omega$
- Low Power Consumption: 1 mW
- Fast Switching Action -  $t_{ON}$ : 120 ns
- Low Charge Injection - Q: - 1 pC
- TTL/CMOS-Compatible Logic
- Single Supply Capability
- Compliant to RoHS Directive 2002/95/EC



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

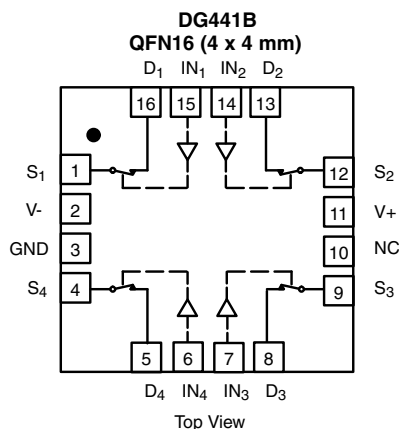
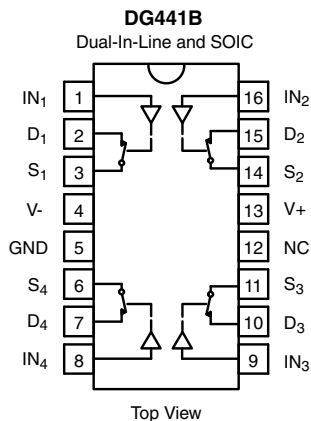
### BENEFITS

- Less Signal Errors and Distortion
- Reduced Power Supply Requirements
- Faster Throughput
- Reduced Pedestal Errors
- Simple Interfacing

### APPLICATIONS

- Audio Switching
- Data Acquisition
- Sample-and-Hold Circuits
- Communication Systems
- Automatic Test Equipment
- Medical Instruments

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



| TRUTH TABLE |        |        |
|-------------|--------|--------|
| Logic       | DG441B | DG442B |
| 0           | ON     | OFF    |
| 1           | OFF    | ON     |

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

| ORDERING INFORMATION |                     |                |
|----------------------|---------------------|----------------|
| Temp Range           | Package             | Part Number    |
| - 40 °C to 85 °C     | 16-pin Plastic DIP  | DG441BDJ       |
|                      |                     | DG441BDJ-E3    |
|                      |                     | DG442BDJ       |
|                      | 16-pin Narrow SOIC  | DG442BDJ-E3    |
|                      |                     | DG441BDY-E3    |
|                      |                     | DG441BDY-T1-E3 |
|                      |                     | DG442BDY-E3    |
|                      | 16 pin QFN 4 x 4 mm | DG442BDY-T1-E3 |
|                      |                     | DG441BDN-T1-E4 |
|                      |                     |                |

| <b>ABSOLUTE MAXIMUM RATINGS</b> ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                                      |  |                  |
|--|--------------------------------------|--|------------------|
| Parameter  | Symbol                               | Limit  | Unit             |
| V+ to V-   |                                      | 44   | V                |
| GND to V-  |                                      | 25   |                  |
| Digital Inputs <sup>a</sup> , $V_S$ , $V_D$  |                                      | (V-) - 2 to (V+) + 2 or<br>30 mA, whichever occurs first |                  |
| Continuous Current (Any Terminal)  |                                      | 30   | mA               |
| Current, S or D (Pulsed at 1 ms, 10 % duty cycle )   |                                      | 100  |                  |
| Storage Temperature  |                                      | - 65 to 125  | $^\circ\text{C}$ |
| Power Dissipation (Package) <sup>b</sup>   | 16-pin Plastic DIP <sup>c</sup>      | 470  | mW               |
|  | 16-pin Narrow Body SOIC <sup>d</sup> | 900  |                  |
|  | QFN-16 <sup>d</sup>                  | 850  |                  |

Notes:

- 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.
- All leads welded or soldered to PC Board.
- Derate 6 mW/ $^\circ\text{C}$  above 75  $^\circ\text{C}$ .
- Derate 12 mW/ $^\circ\text{C}$  above 75  $^\circ\text{C}$ .



| SPECIFICATIONS <sup>a</sup> (for dual supplies)   |                      |  |                    |                            |                   |                   |      |
|---|----------------------|--|--------------------|----------------------------|-------------------|-------------------|------|
| Parameter   | Symbol               | Test Conditions<br>Unless Otherwise Specified<br>V <sub>+</sub> = 15 V, V <sub>-</sub> = - 15 V<br>V <sub>L</sub> = 5 V, V <sub>IN</sub> = 2.4 V, 0.8 V <sup>e</sup> | Temp. <sup>b</sup> | Limits<br>- 40 °C to 85 °C |                   |                   | Unit |
|   |                      |  |                    | Min. <sup>d</sup>          | Typ. <sup>c</sup> | Max. <sup>d</sup> |      |
| <b>Analog Switch</b>                              |                      |  |                    |                            |                   |                   |      |
| Analog Signal Range <sup>e</sup>                  | V <sub>ANALOG</sub>  |  | Full               | - 15                       |                   | 15                | V    |
| Drain-Source On-Resistance                        | R <sub>DS(on)</sub>  | I <sub>S</sub> = 1 mA, V <sub>D</sub> = ± 10 V   | Room<br>Full       |                            | 45                | 80<br>95          | Ω    |
| On-Resistance Match Between Channels <sup>e</sup> | ΔR <sub>DS(on)</sub> | I <sub>S</sub> = 1 mA, V <sub>D</sub> = ± 10 V   | Room<br>Full       |                            | 2                 | 4<br>5            |      |
| Switch Off Leakage Current                        | I <sub>S(off)</sub>  | V <sub>D</sub> = ± 14 V, V <sub>S</sub> = ± 14 V   | Room<br>Full       | - 0.5<br>- 5               | ± 0.01            | 0.5<br>5          | nA   |
|   | I <sub>D(off)</sub>  |  | Room<br>Full       | - 0.5<br>- 5               | ± 0.01            | 0.5<br>5          |      |
| Channel On Leakage Current                        | I <sub>D(on)</sub>   | V <sub>S</sub> = V <sub>D</sub> = ± 14 V   | Room<br>Full       | - 0.5<br>- 10              | ± 0.02            | 0.5<br>10         |      |
| <b>Digital Control</b>                            |                      |  |                    |                            |                   |                   |      |
| Input Voltage Low                                 | V <sub>INL</sub>     |  | Full               |                            |                   | 0.8               | V    |
| Input Voltage High                                | V <sub>INH</sub>     |  | Full               | 2.4                        |                   |                   |      |
| Input Current V <sub>IN</sub> Low                 | I <sub>INL</sub>     | V <sub>IN</sub> under test = 0.8 V<br>All Other = 2.4 V  | Full               | - 1                        | - 0.01            | 1                 | μA   |
| Input Current V <sub>IN</sub> High                | I <sub>INH</sub>     | V <sub>IN</sub> under test = 2.4 V<br>All Other = 0.8 V  | Full               | - 1                        | 0.01              | 1                 |      |
| <b>Dynamic Characteristics</b>                    |                      |  |                    |                            |                   |                   |      |
| Turn-On Time                                      | t <sub>ON</sub>      | R <sub>L</sub> = 1 kΩ, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 10 V, See Figure 2   | Room               |                            |                   | 120               | ns   |
| Turn-Off Time                                     | t <sub>OFF</sub>     |  | Room               |                            |                   | 65                |      |
| Charge Injection <sup>e</sup>                     | Q                    | C <sub>L</sub> = 1 nF, V <sub>S</sub> = 0 V<br>V <sub>gen</sub> = 0 V, R <sub>gen</sub> = 0 Ω  | Room               |                            | - 1               |                   | pC   |
| Off Isolation <sup>e</sup>                        | OIRR                 | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 15 pF<br>V <sub>S</sub> = 1 V <sub>RMS</sub> , f = 100 kHz   | Room               |                            |                   | - 90              | dB   |
| Crosstalk (Channel-to-Channel)                    | X <sub>TALK</sub>    |  | Room               |                            |                   | - 95              |      |
| Source Off Capacitance <sup>e</sup>               | C <sub>S(off)</sub>  | f = 1 MHz  | Room               |                            |                   | 4                 | pF   |
| Drain Off Capacitance <sup>e</sup>                | C <sub>D(off)</sub>  |  | Room               |                            |                   | 4                 |      |
| Channel On Capacitance <sup>e</sup>               | C <sub>D(on)</sub>   | V <sub>S</sub> = V <sub>D</sub> = 0 V, f = 1 MHz   | Room               |                            |                   | 16                |      |
| <b>Power Supplies</b>                             |                      |  |                    |                            |                   |                   |      |
| Positive Supply Current                           | I <sub>+</sub>       | V <sub>+</sub> = 16.5 V, V <sub>-</sub> = - 16.5 V<br>V <sub>IN</sub> = 0 or 5 V   | Room<br>Full       |                            |                   | 1<br>5            | μA   |
| Negative Supply Current                           | I <sub>-</sub>       |  | Room<br>Full       | - 1<br>- 5                 |                   |                   |      |

| SPECIFICATIONS (for single supply) |              |   |                    |                            |                   |                   |               |
|------------------------------------|--------------|---|--------------------|----------------------------|-------------------|-------------------|---------------|
| Parameter                          | Symbol       | Test Conditions<br>Unless Otherwise Specified<br>$V_+ = 12\text{ V}$ , $V_- = 0\text{ V}$<br>$V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^e$ | Temp. <sup>b</sup> | Limits<br>- 40 °C to 85 °C |                   |                   | Unit          |
|                                    |              |   |                    | Min. <sup>d</sup>          | Typ. <sup>c</sup> | Max. <sup>d</sup> |               |
| <b>Analog Switch</b>               |              |   |                    |                            |                   |                   |               |
| Analog Signal Range <sup>e</sup>   | $V_{ANALOG}$ |   | Full               | 0                          |                   | 12                | V             |
| Drain-Source On-Resistance         | $R_{DS(on)}$ | $I_S = 1\text{ mA}$ , $V_D = 3\text{ V}$ , $8\text{ V}$   | Room<br>Full       |                            | 90                | 160<br>200        | $\Omega$      |
| <b>Dynamic Characteristics</b>     |              |   |                    |                            |                   |                   |               |
| Turn-On Time                       | $t_{ON}$     | $R_L = 1\text{ k}\Omega$ , $C_L = 35\text{ pF}$ , $V_S = 8\text{ V}$  | Room               |                            | 120               | 300               | ns            |
| Turn-Off Time                      | $t_{OFF}$    | See Figure 2  | Room               |                            | 60                | 200               |               |
| Charge Injection                   | Q            | $C_L = 1\text{ nF}$ , $V_{gen} = 6\text{ V}$ , $R_{gen} = 0\ \Omega$  | Room               |                            | 4                 |                   | pC            |
| <b>Power Supplies</b>              |              |   |                    |                            |                   |                   |               |
| Positive Supply Current            | $I_+$        | $V_{IN} = 0\text{ V}$ or $5\text{ V}$   | Room<br>Full       |                            |                   | 1<br>5            | $\mu\text{A}$ |
| Negative Supply Current            | $I_-$        |   | Room<br>Full       | - 1<br>- 5                 |                   |                   |               |

**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.

### SCHEMATIC DIAGRAM (typical channel)

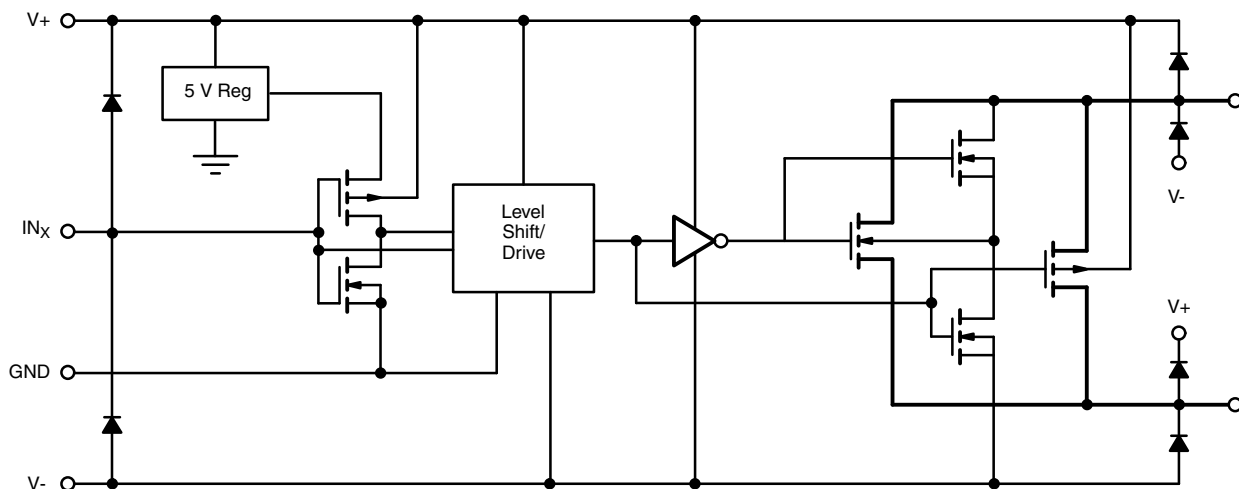
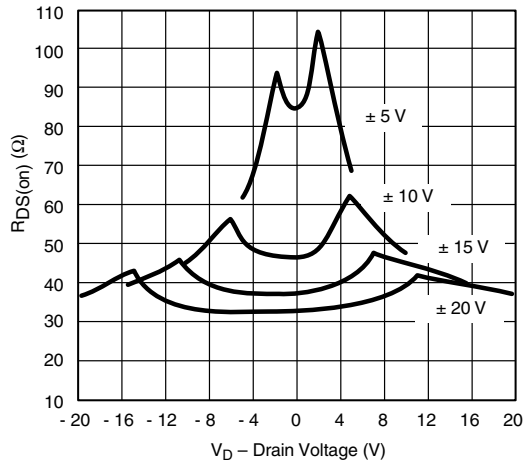
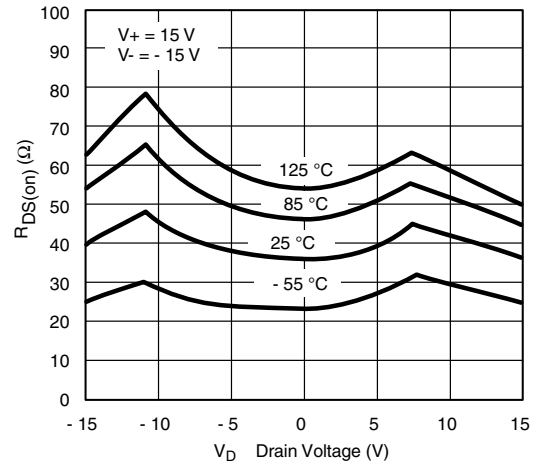
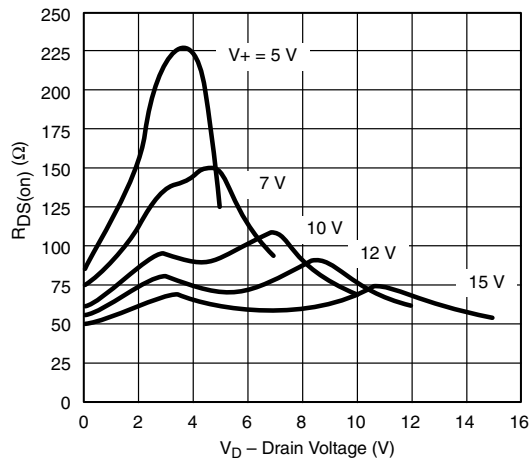
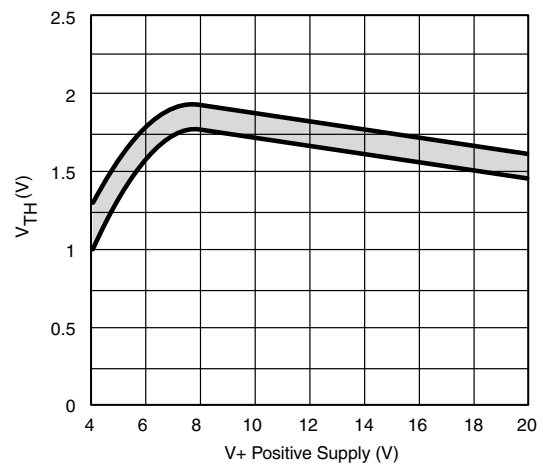
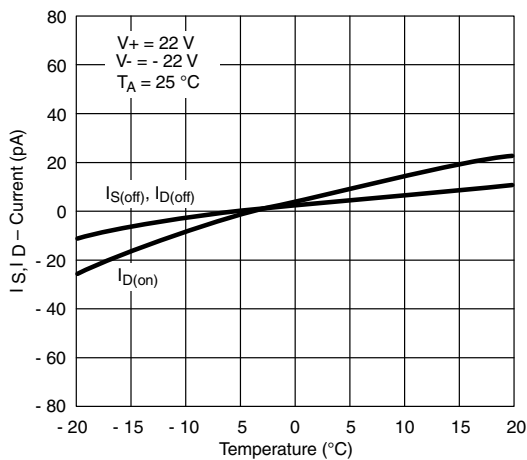
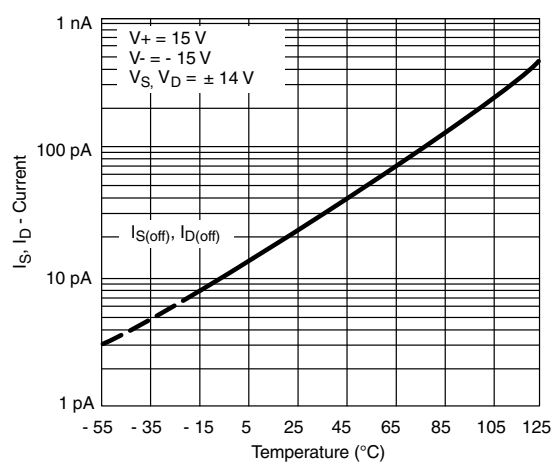
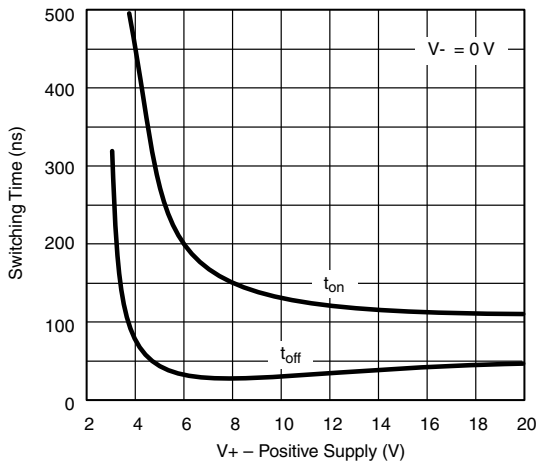


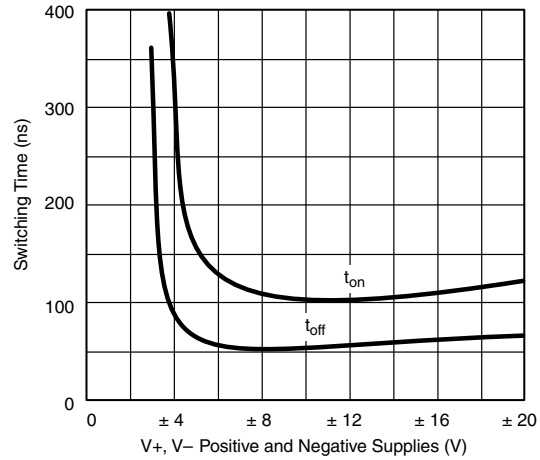
Figure 1.

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

**Input Switching Threshold vs. Supply Voltage**

**Leakage Currents vs. Analog Voltage**

**Leakage Currents vs. Temperature**

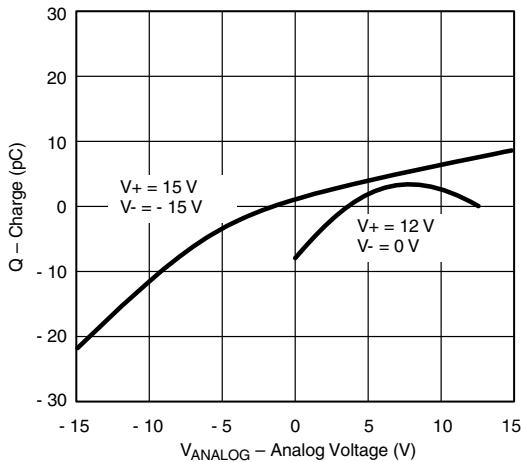
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



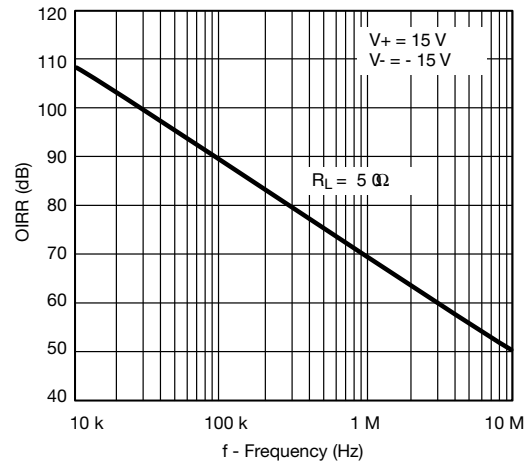
**Switching Time vs. Single Supply Voltage**



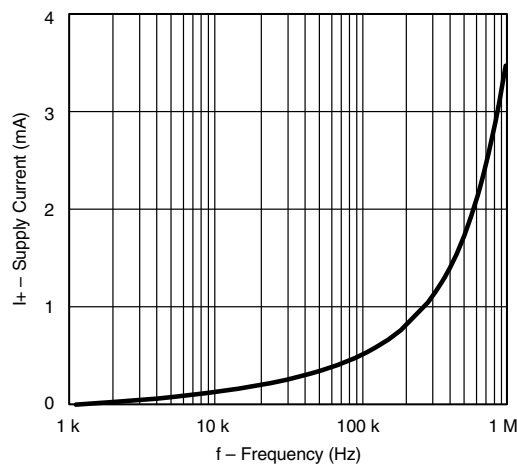
**Switching Times vs. Power Supply Voltage**



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

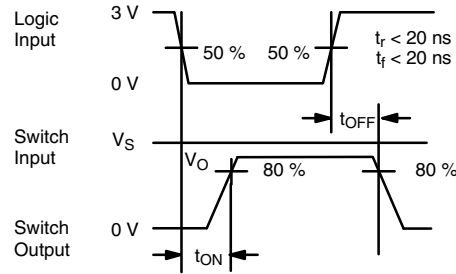
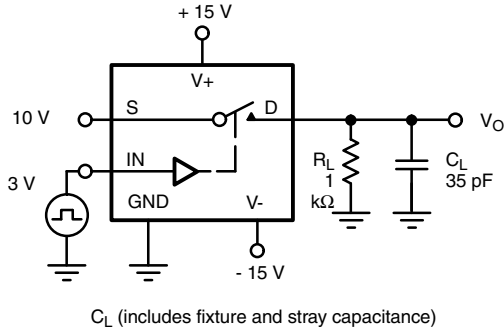


**Off Isolation vs. Frequency**



**Supply Current vs. Switching Frequency**

## TEST CIRCUITS



Note: Logic input waveform is inverted for DG442.

Figure 2. Switching Time

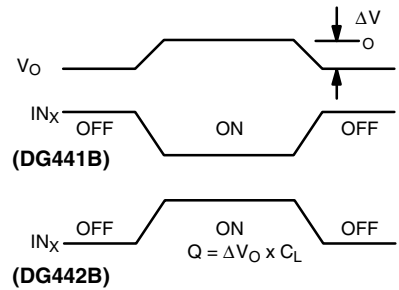
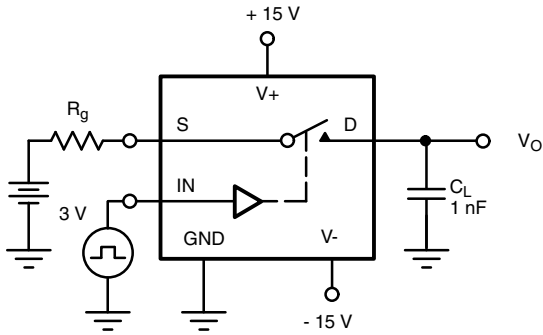


Figure 3. Charge Injection

$C = 1 \text{ mF}$  tantalum in parallel with  $0.01 \text{ mF}$  ceramic

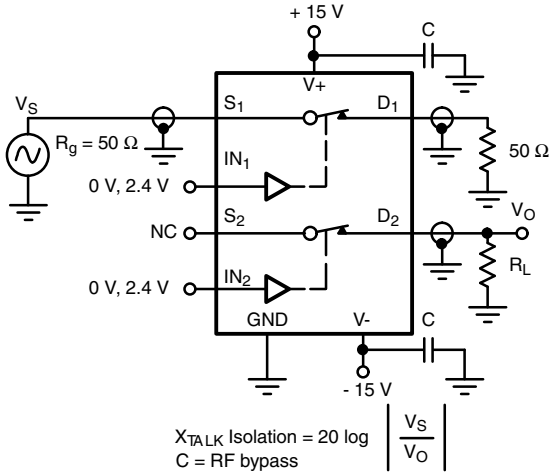


Figure 4. Crosstalk

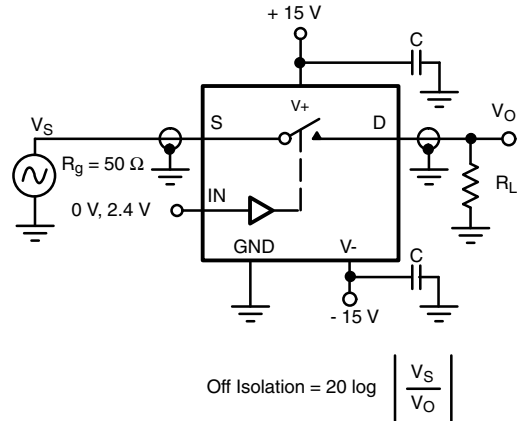


Figure 5. Off Isolation

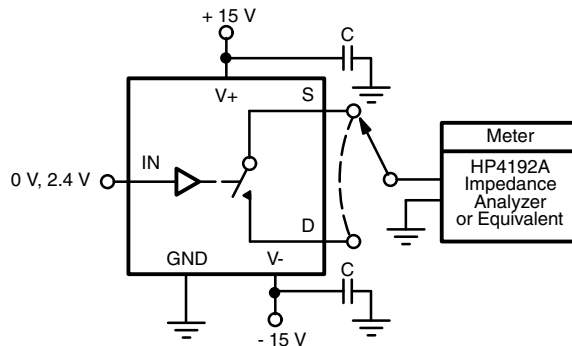


Figure 6. Source/Drain Capacitances

## APPLICATIONS

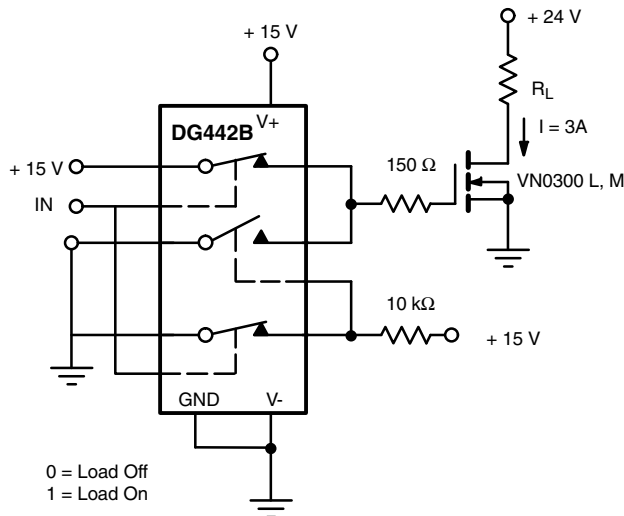


Figure 7. Power MOSFET Driver

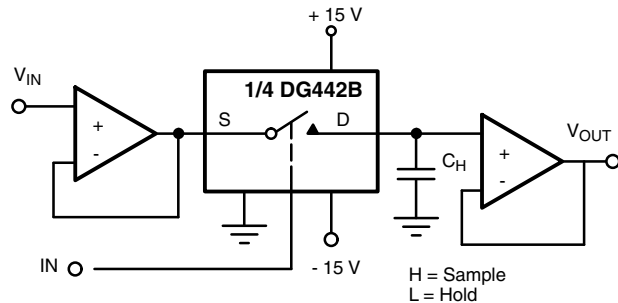


Figure 8. Open Loop Sample-and-Hold

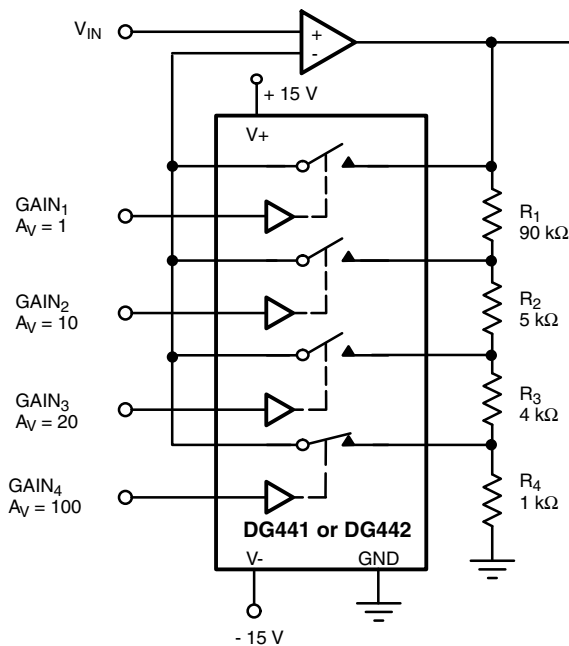


Figure 9. Precision-Weighted Resistor Programmable-Gain Amplifier

Gain error is determined only by the resistor tolerance. Op amp offset and CMRR will limit accuracy of circuit.

With SW<sub>4</sub> Closed

$$\frac{V_{OUT}}{V_{IN}} = \frac{R_1 + R_2 + R_3 + R_4}{R_4} = 100$$

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?72625](http://www.vishay.com/ppg?72625).





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



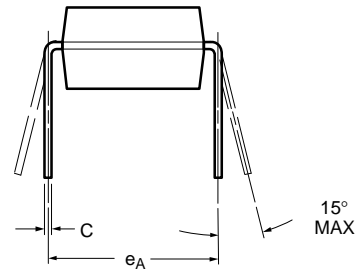
| Dim            | MILLIMETERS |       | INCHES    |       |
|----------------|-------------|-------|-----------|-------|
|                | Min         | Max   | Min       | Max   |
| A              | 1.35        | 1.75  | 0.053     | 0.069 |
| A <sub>1</sub> | 0.10        | 0.20  | 0.004     | 0.008 |
| 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**



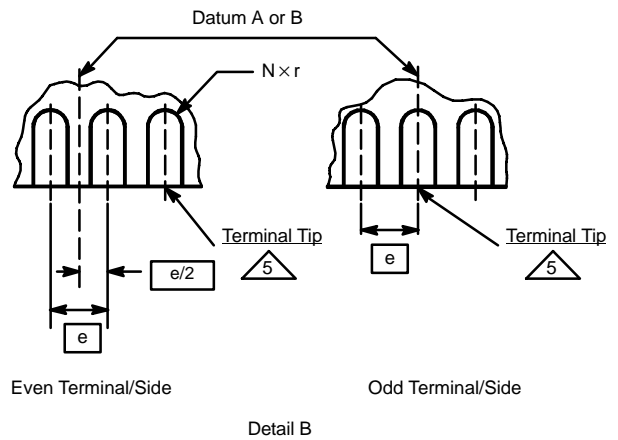
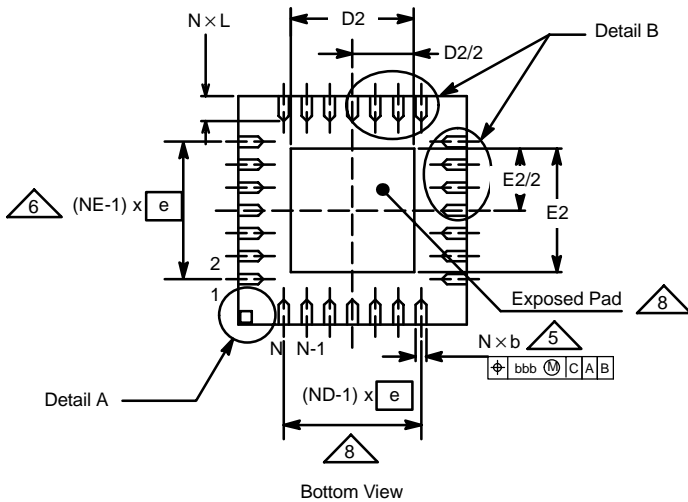
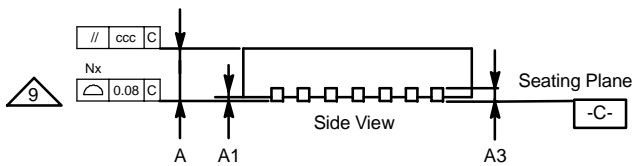
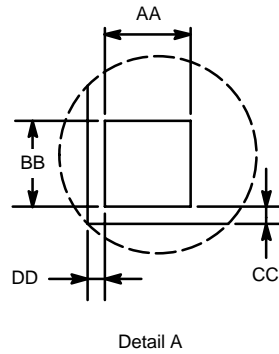
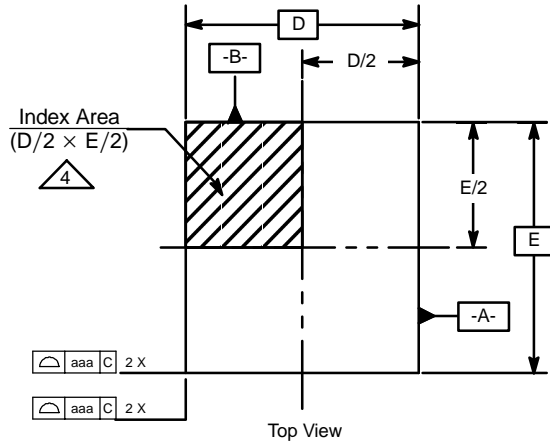
| Dim                  | MILLIMETERS |       | INCHES |       |
|----------------------|-------------|-------|--------|-------|
|                      | Min         | Max   | Min    | Max   |
| <b>A</b>             | 3.81        | 5.08  | 0.150  | 0.200 |
| <b>A<sub>1</sub></b> | 0.38        | 1.27  | 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



**QFN-16 (4 × 4 mm)**

JEDEC Part Number: MO-220



## Vishay Siliconix

### QFN-16 (4 × 4 mm)

JEDEC Part Number: MO-220

| Dim | MILLIMETERS* |          |      | INCHES     |        |        | Notes |
|-----|--------------|----------|------|------------|--------|--------|-------|
|     | Min          | Nom      | Max  | Min        | Nom    | Max    |       |
| A   | 0.80         | 0.90     | 1.00 | 0.0315     | 0.0354 | 0.0394 |       |
| A1  | 0            | 0.02     | 0.05 | 0          | 0.0008 | 0.0020 |       |
| A3  | -            | 0.20 Ref | -    | -          | 0.0079 | -      |       |
| AA  | -            | 0.345    | -    | -          | 0.0136 | -      |       |
| aaa | -            | 0.25     | -    | -          | 0.0098 | -      |       |
| BB  | -            | 0.345    | -    | -          | 0.0136 | -      |       |
| b   | 0.23         | 0.30     | 0.38 | 0.0091     | 0.0118 | 0.0150 | 5     |
| bbb | -            | 0.10     | -    | -          | 0.0039 | -      |       |
| CC  | -            | 0.18     | -    | -          | 0.0071 | -      |       |
| ccc | -            | 0.10     | -    | -          | 0.0039 | -      |       |
| D   | 4.00 BSC     |          |      | 0.1575 BSC |        |        |       |
| D2  | 2.00         | 2.15     | 2.25 | 0.0787     | 0.0846 | 0.0886 |       |
| DD  | -            | 0.18     | -    | -          | 0.0071 | -      |       |
| E   | 4.00 BSC     |          |      | 0.1575 BSC |        |        |       |
| E2  | 2.00         | 2.15     | 2.25 | 0.0787     | 0.0846 | 0.0886 |       |
| e   | 0.65 BSC     |          |      | 0.0256 BSC |        |        |       |
| L   | 0.45         | 0.55     | 0.65 | 0.0177     | 0.0217 | 0.0256 |       |
| N   | 16           |          |      | 16         |        |        | 3, 7  |
| ND  | -            | 4        | -    | -          | 4      | -      | 6     |
| NE  | -            | 4        | -    | -          | 4      | -      | 6     |
| r   | b(min)/2     | -        | -    | b(min)/2   | -      | -      |       |

\* Use millimeters as the primary measurement.

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#### NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5M-1994.
2. All dimensions are in millimeters. All angles are in degrees.
3. N is the total number of terminals.
4. The terminal #1 identifier and terminal numbering convention shall conform to JESD 95-1 SPP-012. Details of terminal #1 identifier are optional, but must be located within the zone indicated. The terminal #1 identifier may be either a molded or marked feature. The X and Y dimension will vary according to lead counts.
5. Dimension b applies to metallized terminal and is measured between 0.25 mm and 0.30 mm from the terminal tip.
6. ND and NE refer to the number of terminals on the D and E side respectively.
7. Depopulation is possible in a symmetrical fashion.
8. Variation HHD is shown for illustration only.
9. Coplanarity applies to the exposed heat sink slug as well as the terminals.

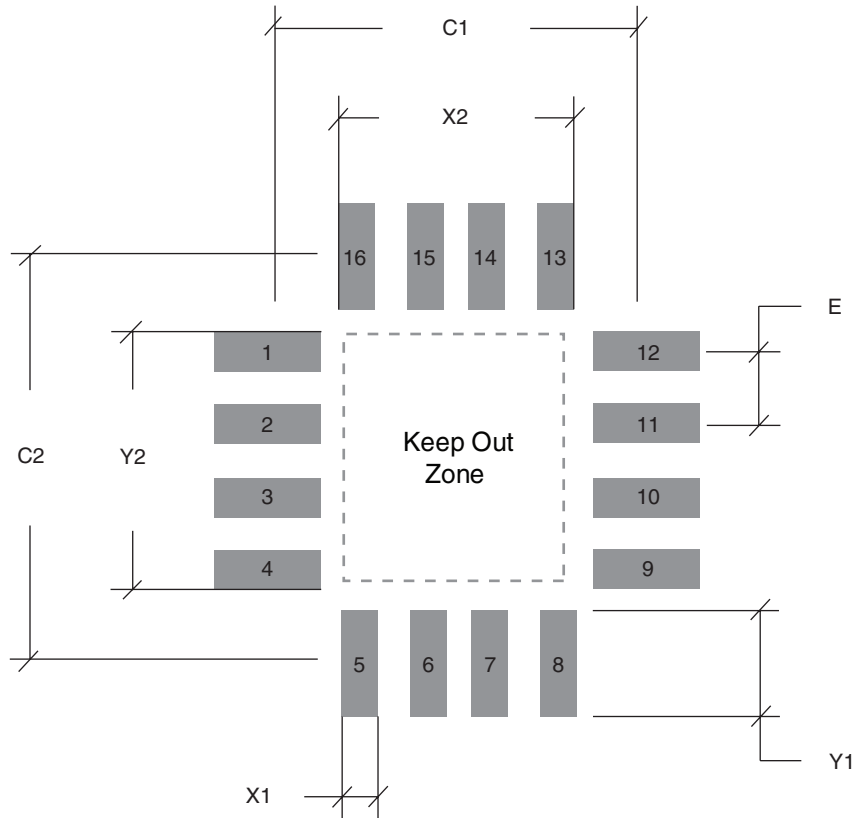
## RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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**RECOMMENDED MINIMUM PADS FOR QFN-16 (4 x 4 MM BODY)**



|    | Inches | Millimeters |
|----|--------|-------------|
| C1 | 0.142  | 3.60        |
| C2 | 0.142  | 3.60        |
| E  | 0.026  | 0.65        |
| X1 | 0.014  | 0.35        |
| X2 | 0.089  | 2.25        |
| Y1 | 0.037  | 0.95        |
| Y2 | 0.089  | 2.25        |

Note:  
QFN-16 (4 x 4) has an exposed center pad that must not come into contact with any metalized structure on the PCB. This area is considered a Keep Out Zone.



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