

## Quad SPST CMOS Analog Switches

### APPLICATIONS

- Audio switching
- Battery powered systems
- Data acquisition
- Sample-and-hold circuits
- Telecommunication systems
- Automatic test equipment
- Single supply circuits
- Hard disk drives

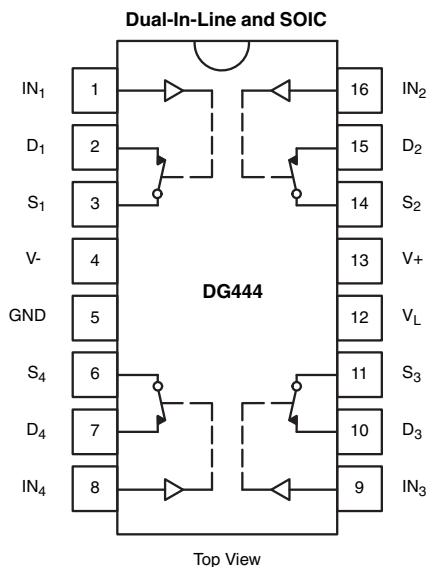
### DESCRIPTION

The DG444, DG445 monolithic quad analog switches are designed to provide high speed, low error switching of analog signals. The DG444 has a normally closed function. The DG445 has a normally open function. Combining low power (22 nW, typ.) with high speed ( $t_{ON}$ : 120 ns, typ.), the DG444, DG445 are ideally suited for upgrading DG211, DG212 sockets. Charge injection has been minimized on the drain for use in sample-and-hold circuits.

To achieve high-voltage ratings and superior switching performance, the DG444, DG445 are built on Vishay Siliconix's high-voltage silicon-gate process. An epitaxial layer prevents latchup.

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

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



### FEATURES

- Low on-resistance: 50  $\Omega$
- Low leakage: 80 pA
- Low power consumption: 22 nW
- Fast switching action -  $t_{ON}$ : 120 ns
- Low charge injection
- DG211, DG212 upgrades
- TTL/CMOS logic compatible

### BENEFITS

- Low signal errors and distortion
- Reduced power supply requirements
- Faster throughput
- Improved reliability
- Reduced pedestal errors
- Simple interfacing
- Wide supply ranges
  - Single supply: +5 V to 36 V
  - Dual supplies:  $\pm 5$  V to  $\pm 20$  V

### TRUTH TABLE

| LOGIC | DG444 | DG445 |
|-------|-------|-------|
| 0     | On    | Off   |
| 1     | Off   | On    |

#### Note

- 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 | DG444DJ     |
|                 |                    | DG445DJ     |
|                 | 16-pin narrow SOIC | DG444DY     |
|                 |                    | DG445DY     |



| ABSOLUTE MAXIMUM RATINGS (T <sub>A</sub> = 25 °C, unless otherwise noted) |  |     |      |
|---|--|-----|------|
| PARAMETER   | LIMIT  |     | UNIT |
| V <sub>+</sub> to V <sub>-</sub>  | 44   |     | V    |
| GND to V <sub>-</sub>   | 25   |     |      |
| V <sub>L</sub>  | (GND - 0.3) to (V <sub>+</sub> ) +0.3  |     |      |
| 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 |     |      |
| Continuous Current (Any Terminal)   | 30   |     | mA   |
| Current, S or D (Pulsed at 1 ms, 10 % Duty Cycle)                         | 100  |     |      |
| Storage Temperature   | -65 to 125   |     | °C   |
| Power Dissipation (Package) <sup>b</sup>                                  | 16-Pin Plastic DIP <sup>c</sup>  | 450 | mW   |
|   | 16-Pin Narrow Body SOIC <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 mW/°C above 75 °C.
- d. Derate 8 mW/°C above 75 °C.

| SPECIFICATIONS 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>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 <sub>ANALOG</sub> |   | Full                      | -15                         | -                 | 15                | V    |     |
| Drain-Source On-Resistanc <sup>e</sup>      | R <sub>DS(on)</sub> | I <sub>S</sub> = -10 mA, V <sub>D</sub> = ± 8.5 V<br>V <sub>+</sub> = 13.5 V, V <sub>-</sub> = -13.5 V  | Room                      | -                           | 50                | 85                | Ω    |     |
|   |                     |   | Full                      | -                           | -                 | 100               |      |     |
| Switch Off Leakage Current                  | I <sub>S(off)</sub> | V <sub>+</sub> = 16.5 V, V <sub>-</sub> = -16.5 V<br>V <sub>D</sub> = ± 15.5 V, V <sub>S</sub> = ± 15.5 V   | Room                      | -0.5                        | ± 0.01            | 0.5               | nA   |     |
|   |                     |   | Full                      | -5                          | ± 0.01            | 5                 |      |     |
|   | Room                |   | -0.5                      | ± 0.01                      | 0.5               |                   |      |     |
|   | Full                |   | -5                        | ± 0.01                      | 5                 |                   |      |     |
| Channel On Leakage Current                  | I <sub>D(on)</sub>  | V <sub>+</sub> = 16.5 V, V <sub>-</sub> = -16.5 V<br>V <sub>S</sub> = V <sub>D</sub> = ± 15.5 V   | Room                      | -0.5                        | ± 0.08            | 0.5               |      |     |
|   |                     |   | Full                      | -10                         | ± 0.08            | 10                |      |     |
| <b>Digital Control</b>                      |                     |   |                           |                             |                   |                   |      |     |
| Input Current V <sub>IN</sub> Low           | I <sub>IL</sub>     | V <sub>IN</sub> under test = 0.8 V<br>All Other = 2.4 V   | Full                      | -500                        | -0.01             | 500               | nA   |     |
| Input Current V <sub>IN</sub> High          | I <sub>IH</sub>     | V <sub>IN</sub> under test = 2.4 V<br>All Other = 0.8 V   | Full                      | -500                        | 0.01              | 500               |      |     |
| <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               | 250               | ns   |     |
| Turn-Off Time                               | t <sub>OFF</sub>    |   | DG444                     | Room                        | -                 | 110               |      | 140 |
|   |                     |   | DG445                     | Room                        | -                 | 160               |      | 210 |
| 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> = 5 pF, f = 1 MHz   | Room                      | -                           | 60                | -                 | dB   |     |
| Crosstalk (Channel-to-Channel) <sup>d</sup> | X <sub>TALK</sub>   |   | Room                      | -                           | 100               | -                 |      |     |
| Source Off Capacitance                      | C <sub>S(off)</sub> | f = 1 MHz   | Room                      | -                           | 4                 | -                 | pF   |     |
| Drain Off Capacitance                       | C <sub>D(off)</sub> |   | Room                      | -                           | 4                 | -                 |      |     |
| Channel On Capacitance                      | C <sub>D(on)</sub>  |   | V <sub>ANALOG</sub> = 0 V | Room                        | -                 | 16                |      | -   |



| SPECIFICATIONS for Dual Supplies |                  |  |                    |                             |                   |                   |      |
|----------------------------------|------------------|--|--------------------|-----------------------------|-------------------|-------------------|------|
| 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>Power Supplies</b>            |                  |  |                    |                             |                   |                   |      |
| Positive Supply Current          | I <sub>+</sub>   | $V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$<br>$V_{IN} = 0\text{ V}$ or $5\text{ V}$  | Room               | -                           | 0.001             | 1                 | μA   |
|                                  |                  |  | Full               | -                           | -                 | 5                 |      |
| Negative Supply Current          | I <sub>-</sub>   |  | Room               | -1                          | -0.0001           | -                 |      |
|                                  |                  |  | Full               | -5                          | -                 | -                 |      |
| Logic Supply Current             | I <sub>L</sub>   |  | Room               | -                           | 0.001             | 1                 |      |
|                                  |                  |  | Full               | -                           | 0.001             | 5                 |      |
| Ground Current                   | I <sub>GND</sub> |  | Room               | -1                          | -0.001            | -                 |      |
|                                  |                  |  | Full               | -5                          | -0.001            | -                 |      |

| SPECIFICATIONS for Unipolar Supplies    |                     |  |                    |                           |                   |                   |      |
|---|---------------------|--|--------------------|---------------------------|-------------------|-------------------|------|
| 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> | LIMITS<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 <sub>ANALOG</sub> |  | Full               | 0                         | -                 | 12                | V    |
| Drain-Source On-Resistance <sup>d</sup> | R <sub>DS(on)</sub> | $I_S = -10\text{ mA}$ , $V_D = 3\text{ V}$ , $8\text{ V}$<br>$V_+ = 10.8\text{ V}$ , $V_L = 5.25\text{ V}$   | Room               | -                         | 100               | 160               | Ω    |
|   |                     |  | Full               | -                         | -                 | 200               |      |
| <b>Dynamic Characteristics</b>          |                     |  |                    |                           |                   |                   |      |
| Turn-On Time                            | t <sub>ON</sub>     | $R_L = 1\text{ k}\Omega$ , $C_L = 35\text{ pF}$ , $V_S = 8\text{ V}$<br>See Figure 2   | Room               | -                         | 300               | 450               | ns   |
| Turn-Off Time                           | t <sub>OFF</sub>    |  | Room               | -                         | 60                | 200               |      |
| Charge Injection                        | Q                   | $C_L = 1\text{ nF}$ , $V_{gen} = 6\text{ V}$ , $R_{gen} = 0\ \Omega$   | Room               | -                         | 2                 | -                 | pC   |
| <b>Power Supplies</b>                   |                     |  |                    |                           |                   |                   |      |
| Positive Supply Current                 | I <sub>+</sub>      | $V_+ = 13.2\text{ V}$ , $V_{IN} = 0\text{ V}$ or $5\text{ V}$  | Room               | -                         | 0.001             | 1                 | μA   |
|   |                     |  | Full               | -                         | -                 | 5                 |      |
| Negative Supply Current                 | I <sub>-</sub>      |  | Room               | -1                        | -0.0001           | -                 |      |
|   |                     |  | Full               | -5                        | -                 | -                 |      |
| Logic Supply Current                    | I <sub>L</sub>      |  | Room               | -                         | 0.001             | 1                 |      |
|   |                     |  | Full               | -                         | -                 | 5                 |      |
| Ground Current                          | I <sub>GND</sub>    |  | Room               | -1                        | -0.001            | -                 |      |
|   |                     |  | Full               | -5                        | -                 | -                 |      |

**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<sub>IN</sub> = input voltage to perform proper function.

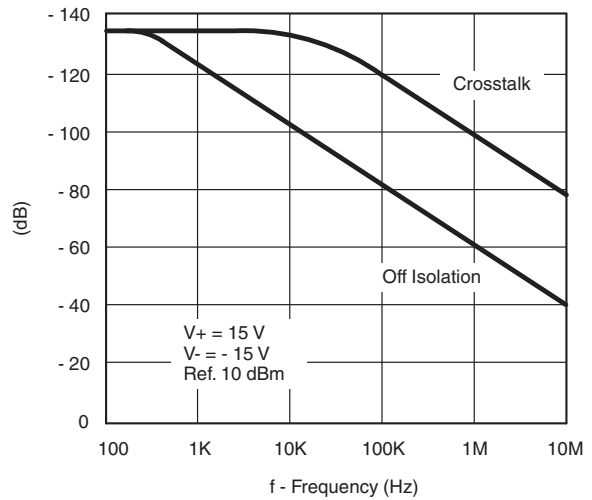
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.



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



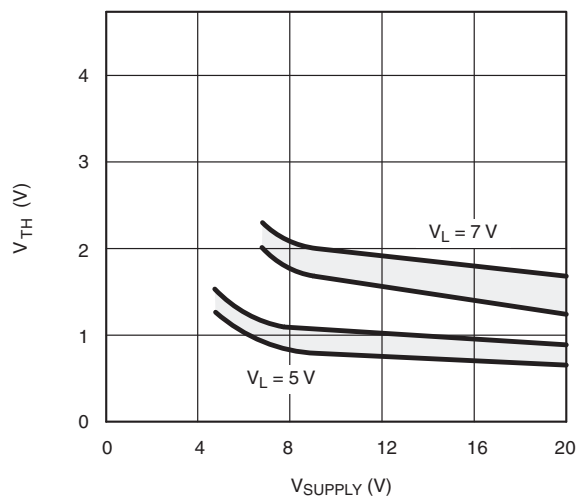
**$R_{DS(on)}$  vs.  $V_D$  and Temperature**



**Crosstalk and Off Isolation vs. Frequency**



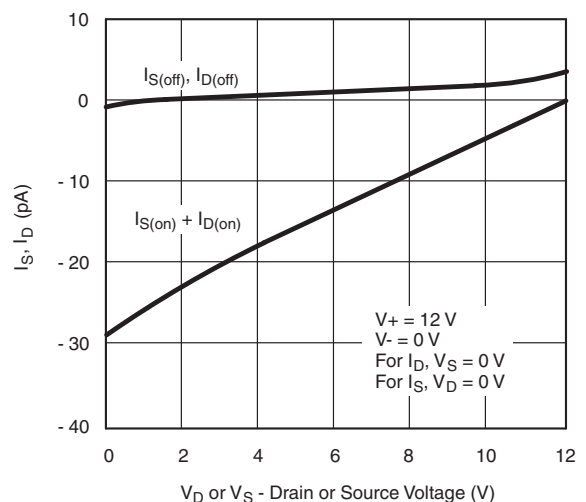
**Charge Injection vs. Source Voltage**



**Switching Threshold vs. Supply Voltage**



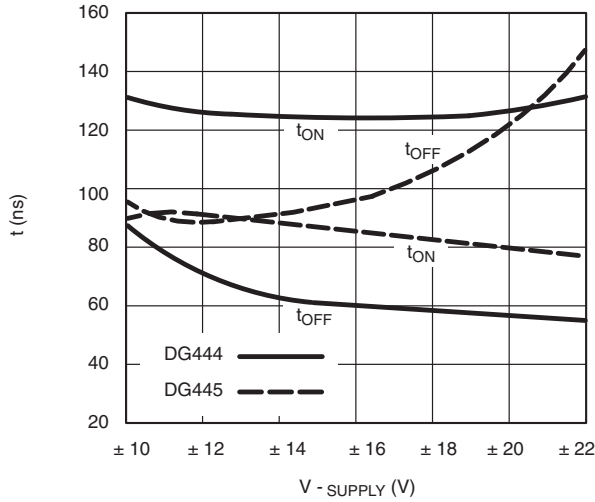
**Source/Drain Leakage Currents**



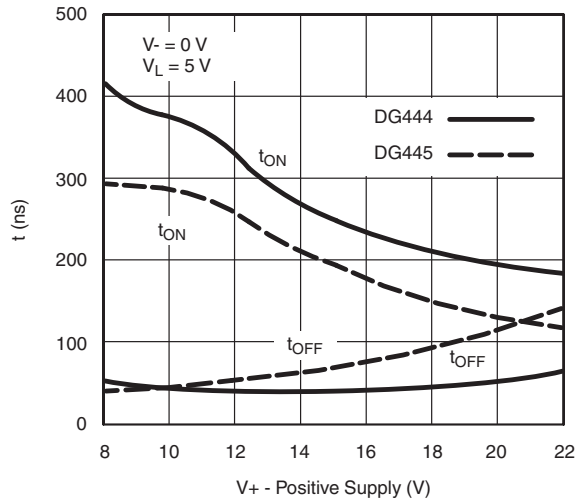
**Source/Drain Leakage Currents (Single 12-V Supply)**



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



Switching Time vs. Power Supply Voltage



Switching Times vs. Power Supply Voltage



Supply Current vs. Temperature



Source/Drain Capacitance vs. Analog Voltage



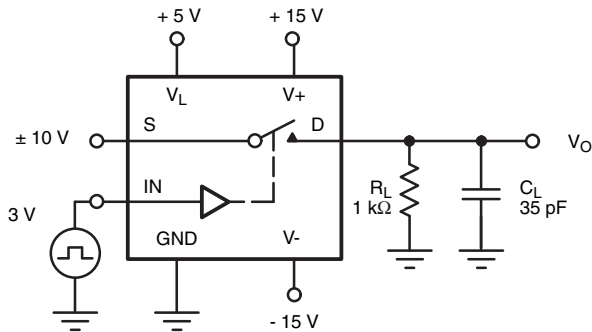
Switching Time vs. Input Voltage

**SCHEMATIC DIAGRAM TYPICAL CHANNEL**



Fig. 1

**TEST CIRCUITS**



$C_L$  (includes fixture and stray capacitance)



Note: Logic input waveform is inverted for DG445.

Fig. 2 - Switching Time

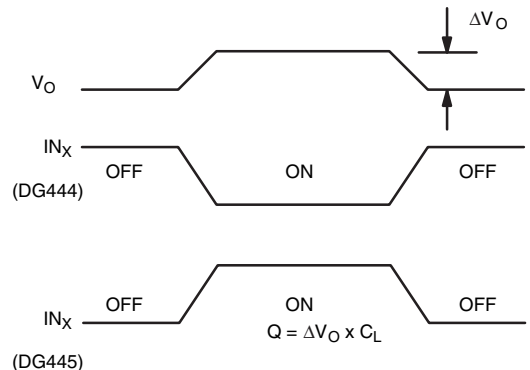
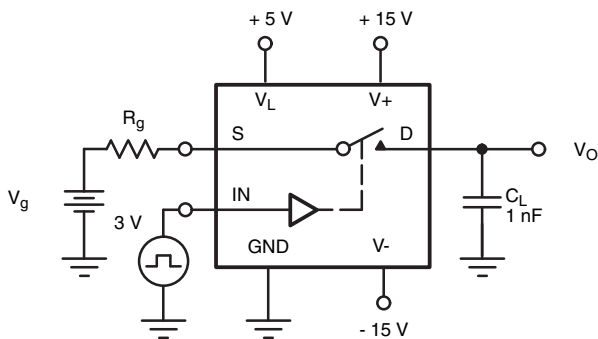


Fig. 3 - Charge Injection

TEST CIRCUITS

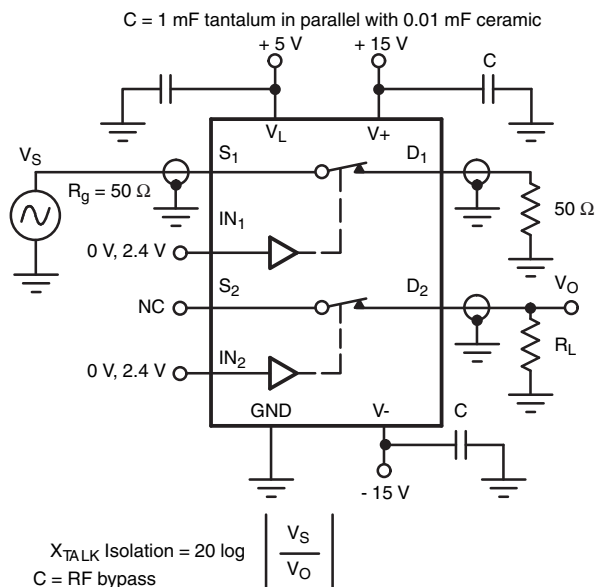


Fig. 4 - Crosstalk

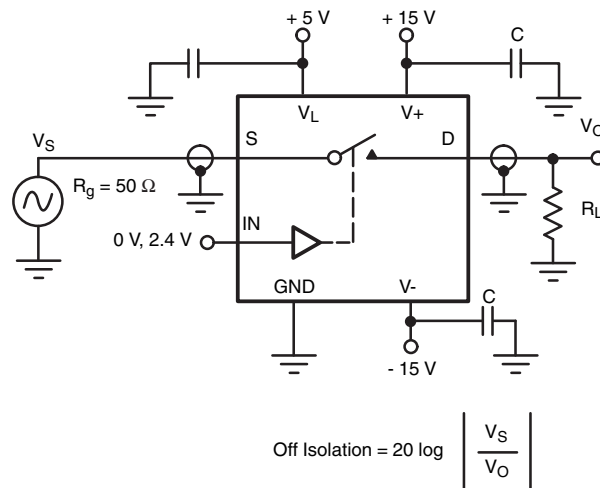


Fig. 5 - Off Isolation

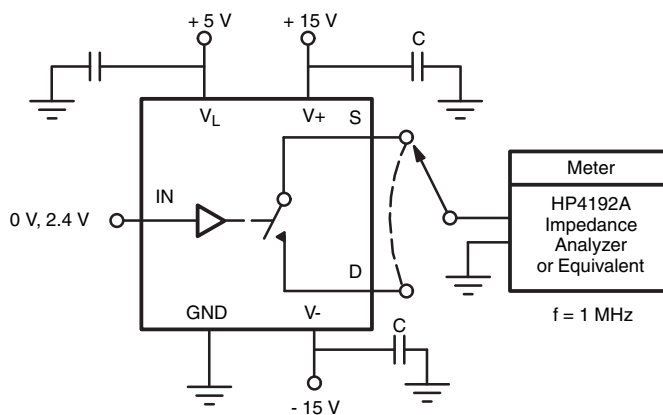


Fig. 6 - Source/Drain Capacitances

APPLICATIONS

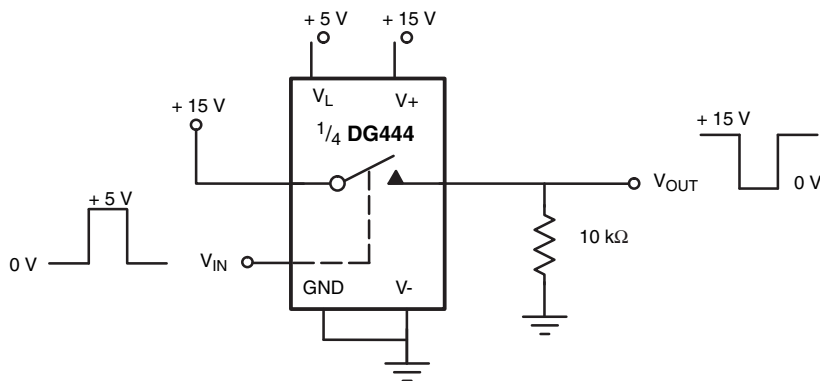


Fig. 7 - Level Shifter

APPLICATIONS



Fig. 8 - Precision-Weighted Resistor Programmable-Gain Amplifier



Fig. 9 - Precision Sample-and-Hold

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**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

## RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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