

Improved Quad SPST CMOS Analog Switches

DESCRIPTION

The DG444B, DG445B are monolithic quad analog switches designed to provide high speed, low error switching of analog and audio signals. The DG444B, DG445B are upgrades to the original DG444, DG445.

Combining low on-resistance (45 Ω , typ.) with high speed (t_{ON} 120 ns, typ.), the DG444B, DG445B 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 DG444B, DG445B 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

- Low On-Resistance: 45 Ω
- Low Power Consumption: 1 mW
- Fast Switching Action - t_{ON} : 120 ns
- Low Charge Injection
- TTL/CMOS-Compatible Logic
- Material categorization:
For definitions of compliance please see www.vishay.com/doc?99912



RoHS
COMPLIANT
HALOGEN
FREE

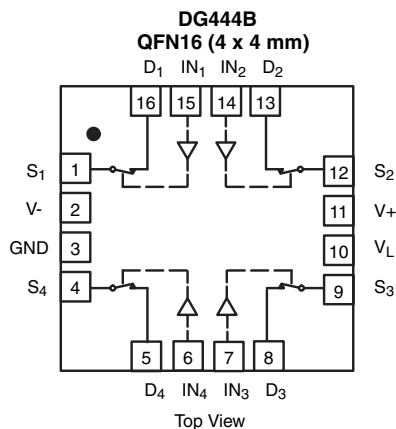
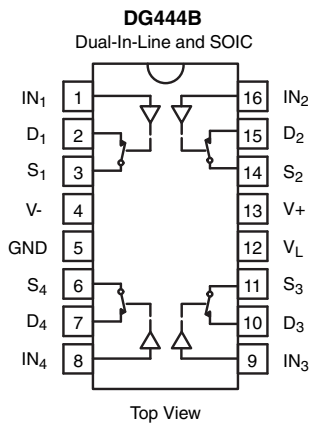
BENEFITS

- Low Signal Errors and Distortion
- Reduced Power Supply Consumption
- 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 | DG444B | DG445B |
| 0 | ON | OFF |
| 1 | OFF | ON |

Logic "0" ≤ 0.8 V
Logic "1" ≥ 2.4 V

| ORDERING INFORMATION | | |
|----------------------|-----------------------------------|----------------|
| Temp Range | Package | Part Number |
| - 40 °C to 85 °C | 16-pin Plastic DIP | DG444BDJ |
| | | DG444BDJ-E3 |
| | | DG445BDJ |
| | | DG445BDJ-E3 |
| | 16-pin Narrow SOIC | DG444BDY-E3 |
| | | DG444BDY-T1-E3 |
| | | DG445BDY-E3 |
| | | DG445BDY-T1-E3 |
| | 16 pin QFN 4 x 4 mm (Variation 1) | DG444BDN-T1-E4 |
| | | DG445BDN-T1-E4 |

| ABSOLUTE MAXIMUM RATINGS ($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted) | | | |
|--|--------------------------------------|--|------------------|
| Parameter | Symbol | Limit | Unit |
| V+ to V- | | 44 | V |
| GND to V- | | 25 | |
| V_L | | (GND - 0.3 V) to (V+) + 0.3 V | |
| Digital Inputs ^a , V_S , V_D | | (V-) - 2 to (V+) + 2 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 | $^\circ\text{C}$ |
| Power Dissipation (Package) ^b | 16-pin Plastic DIP ^c | 470 | mW |
| | 16-pin Narrow Body SOIC ^d | 640 | |
| | QFN-16 | 850 | |

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 mW/ $^\circ\text{C}$ above 75 $^\circ\text{C}$.
- d. Derate 8 mW/ $^\circ\text{C}$ above 75 $^\circ\text{C}$.



| SPECIFICATIONS (for dual supplies) | | | | | | | |
|---|--------------|--|--------------------|----------------------------|-------------------|-------------------|---------------|
| Parameter | Symbol | Test Conditions Unless Otherwise Specified $V_+ = 15\text{ V}$, $V_- = -15\text{ V}$ $V_L = 5\text{ V}$, $V_{IN} = 2.4\text{ V}$, 0.8 V^e | Temp. ^a | Limits - 40 °C to 85 °C | | | Unit |
| | | | | Min. ^b | Typ. ^c | Max. ^b | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^d | V_{ANALOG} | | Full | - 15 | | 15 | V |
| Drain-Source On-Resistance | $R_{DS(on)}$ | $I_S = 1\text{ mA}$, $V_D = \pm 10\text{ V}$ | Room Full | | 45 | 80 95 | Ω |
| Switch Off Leakage Current | $I_{S(off)}$ | $V_D = \pm 14\text{ V}$, $V_S = \pm 14\text{ V}$ | Room Full | - 0.5 - 5 | ± 0.01 | 0.5 5 | nA |
| | $I_{D(off)}$ | | Room Full | - 0.5 - 5 | ± 0.01 | 0.5 5 | |
| Channel On Leakage Current | $I_{D(on)}$ | $V_S = V_D = \pm 14\text{ V}$ | Room Full | - 0.5 - 10 | ± 0.02 | 0.5 10 | |
| Digital Control | | | | | | | |
| Input Voltage Low | V_{INL} | | Full | | | 0.8 | V |
| Input Voltage High | V_{INH} | | Full | 2.4 | | | |
| Input Current V_{IN} Low | I_{INL} | V_{IN} under test = 0.8 V All Other = 2.4 V | Full | - 1 | - 0.01 | 1 | μA |
| Input Current V_{IN} High | I_{INH} | V_{IN} under test = 2.4 V All Other = 0.8 V | Full | - 1 | 0.01 | 1 | |
| Dynamic Characteristics | | | | | | | |
| Turn-On Time | t_{ON} | $R_L = 1\text{ k}\Omega$, $C_L = 35\text{ pF}$ $V_S = \pm 10\text{ V}$, See Figure 2 | Room | | | 300 | ns |
| Turn-Off Time | t_{OFF} | | Room | | | 200 | |
| Charge Injection ^e | Q | $C_L = 1\text{ nF}$, $V_S = 0\text{ V}$ $V_{gen} = 0\text{ V}$, $R_{gen} = 0\ \Omega$ | Room | | 1 | | pC |
| Off Isolation ^e | OIRR | $R_L = 50\ \Omega$, $C_L = 15\text{ pF}$ $V_S = 1\text{ V}_{RMS}$, $f = 100\text{ kHz}$ | Room | | - 90 | | dB |
| Crosstalk (Channel-to-Channel) ^d | X_{TALK} | | Room | | - 95 | | |
| Source Off Capacitance | $C_{S(off)}$ | $V_S = 0\text{ V}$, $f = 100\text{ kHz}$ | Room | | 5 | | pF |
| Drain Off Capacitance | $C_{D(off)}$ | | Room | | 5 | | |
| Channel On Capacitance | $C_{D(on)}$ | | Room | | 16 | | |
| Power Supplies | | | | | | | |
| Positive Supply Current | I_+ | $V_{IN} = 0\text{ V}$ or 5 V | Room Full | | | 1 5 | μA |
| Negative Supply Current | I_- | | Room Full | - 1 - 5 | | | |
| Logic Supply Current | I_{IN} | | Room Full | | | 1 5 | |

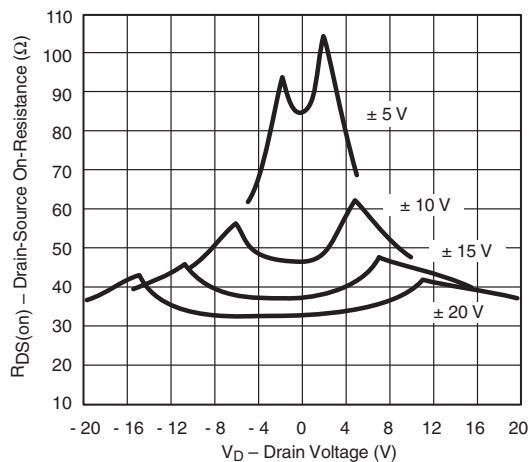
| SPECIFICATIONS (for unipolar supplies) | | | | | | | |
|---|--------------|---|--------------------|-----------------------------|-------------------|-------------------|---------------|
| Parameter | Symbol | Test Conditions Unless Otherwise Specified $V_+ = 12\text{ V}, V_- = 0\text{ V}$ $V_L = 5\text{ V}, V_{IN} = 2.4\text{ V}, 0.8\text{ V}^e$ | 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 ^d | $R_{DS(on)}$ | $I_S = 1\text{ mA}, V_D = 3\text{ V}, 8\text{ V}$ | Room Full | | 90 | 160 200 | Ω |
| Dynamic Characteristics | | | | | | | |
| Turn-On Time | t_{ON} | $R_L = 1\text{ k}\Omega, C_L = 35\text{ pF}, V_S = 8\text{ V}$ See Figure 2 | Room | | 120 | 300 | ns |
| Turn-Off Time | t_{OFF} | | Room | | 60 | 200 | |
| Charge Injection | Q | $C_L = 1\text{ nF}, V_{gen} = 6\text{ V}, R_{gen} = 0\ \Omega$ | Room | | 4 | | pC |
| Power Supplies | | | | | | | |
| Positive Supply Current | I_+ | $V_{IN} = 0\text{ or }5\text{ V}$ | Room Full | | | 1 5 | μA |
| Negative Supply Current | I_- | | Room Full | -1 -5 | | | |
| Logic Supply Current | I_{IN} | $V_L = 5.25\text{ V}, V_{IN} = 0\text{ or }5\text{ V}$ | Room Full | | | 1 5 | |

Notes:

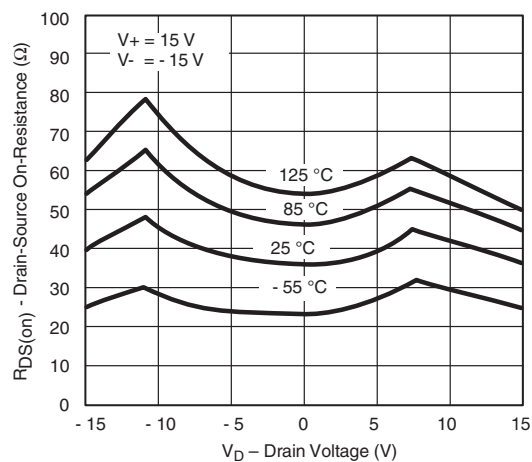
- a. Room = 25 °C, Full = as determined by the operating temperature suffix.
- b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- 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 ($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted)



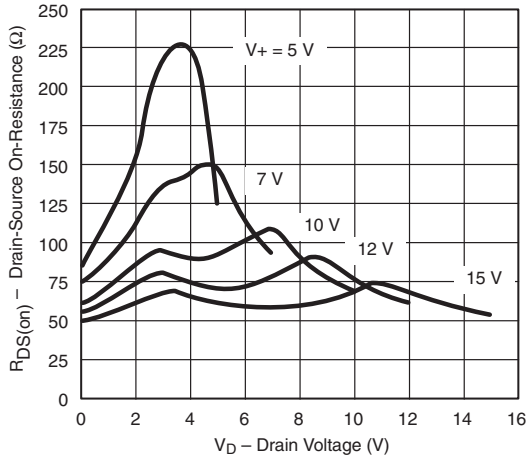
$R_{DS(on)}$ vs. V_D and Power Supply Voltages



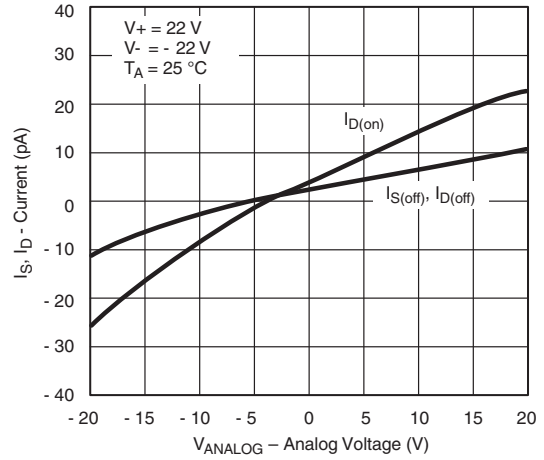
$R_{DS(on)}$ vs. V_D and Temperature



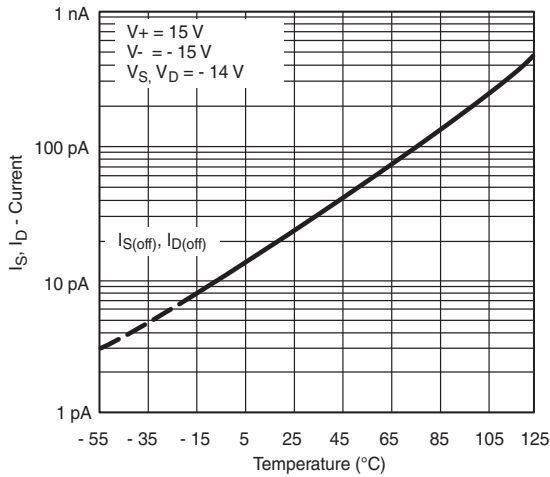
TYPICAL CHARACTERISTICS ($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted)



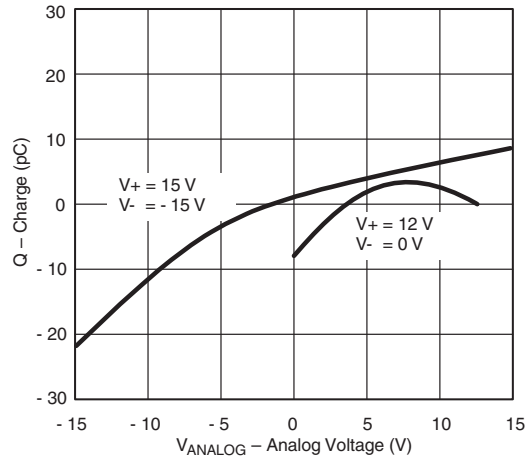
$R_{DS(on)}$ vs. V_D and Single Power Supply Voltages



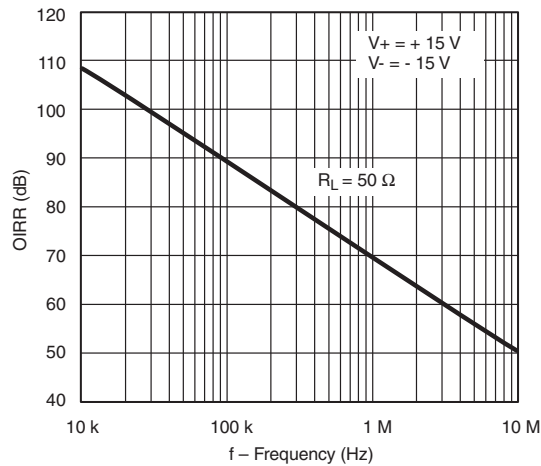
Leakage Currents vs. Analog Voltage



Leakage Current vs. Temperature



Q_S, Q_D - Charge Injection vs. Analog Voltage



Off Isolation vs. Frequency

SCHEMATIC DIAGRAM (typical channel)

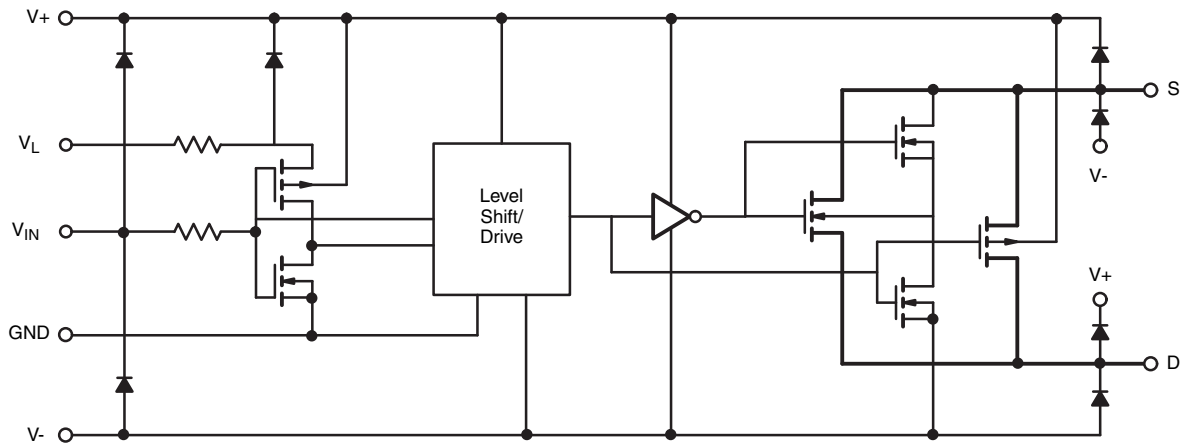
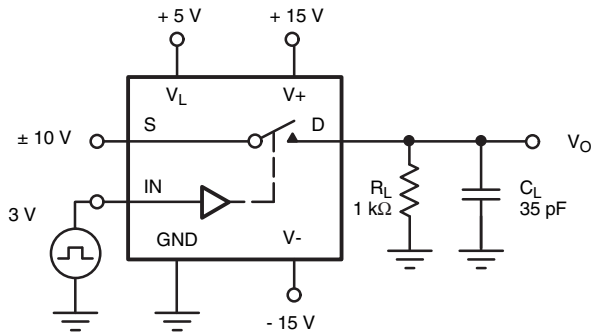
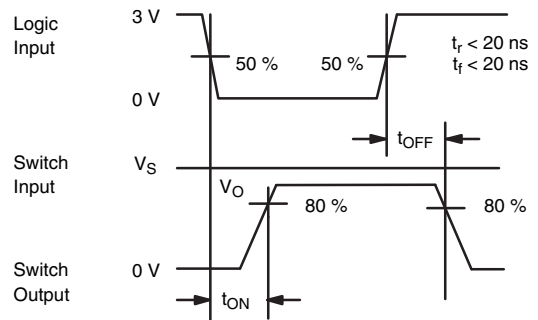


Figure 1.

TEST CIRCUITS



C_L (includes fixture and stray capacitance)



Note: Logic input waveform is inverted for DG445.

Figure 2. Switching Time

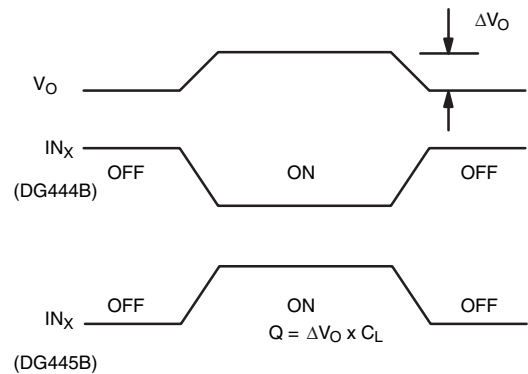
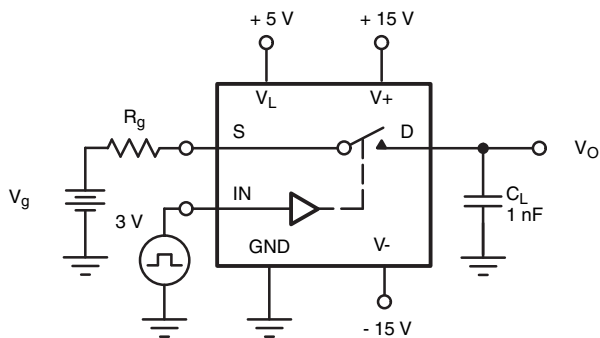


Figure 3. Charge Injection

TEST CIRCUITS

C = 1 mF tantalum in parallel with 0.01 mF ceramic

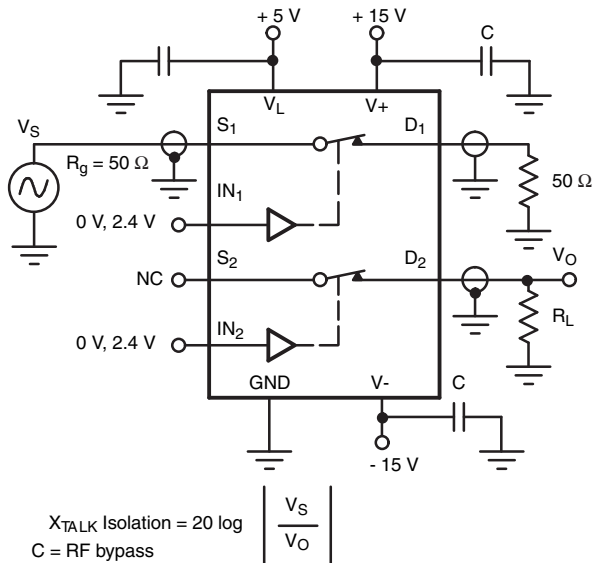


Figure 4. Crosstalk

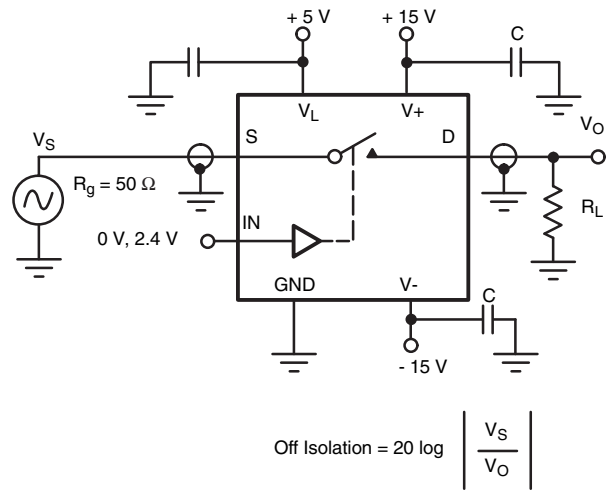


Figure 5. Off Isolation

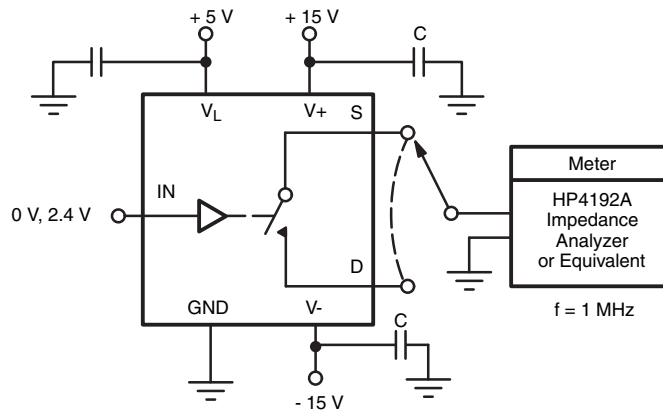


Figure 6. Source/Drain Capacitances

APPLICATIONS

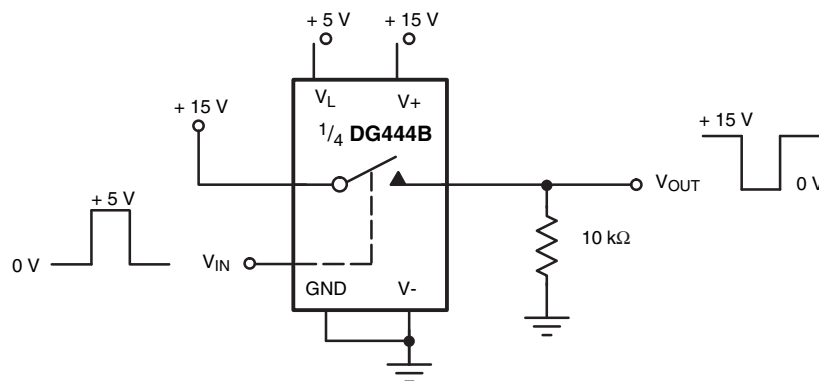


Figure 7. Level Shifter

APPLICATIONS

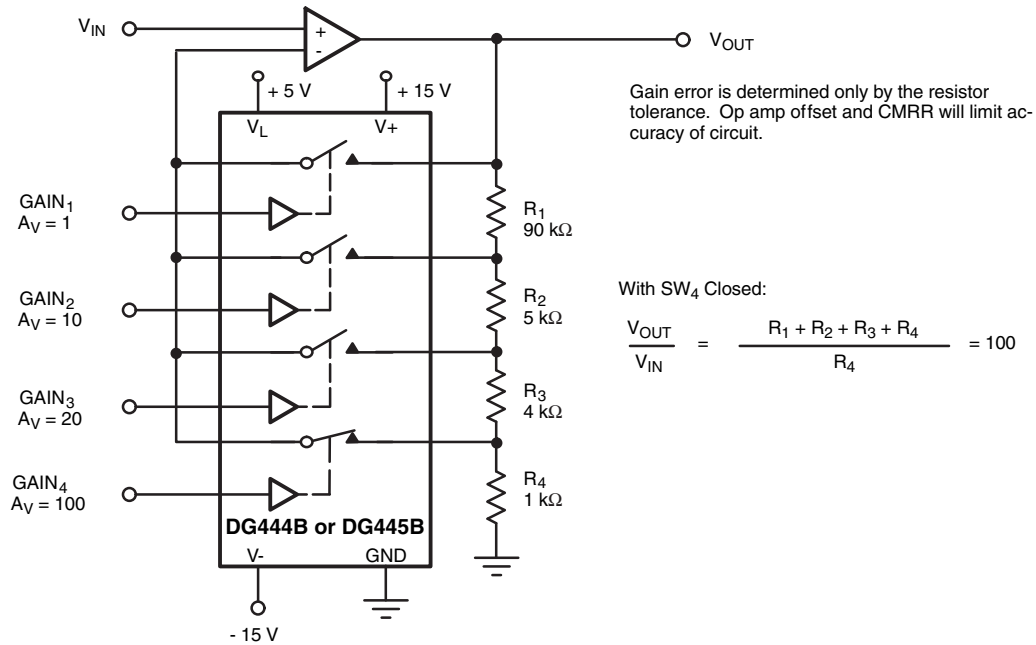


Figure 8. Precision-Weighted Resistor Programmable-Gain Amplifier

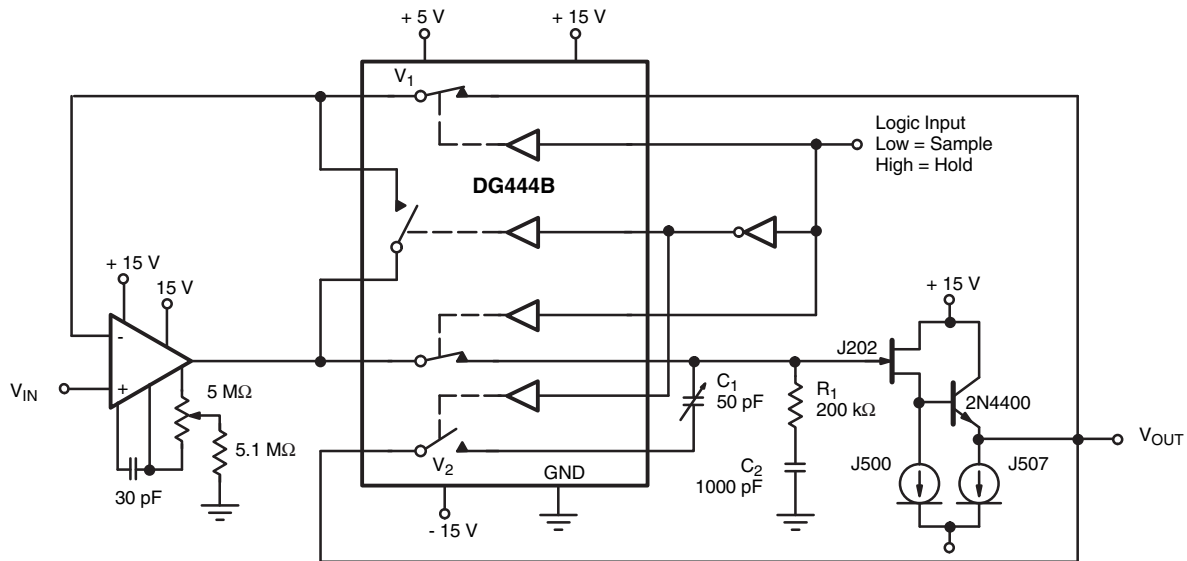
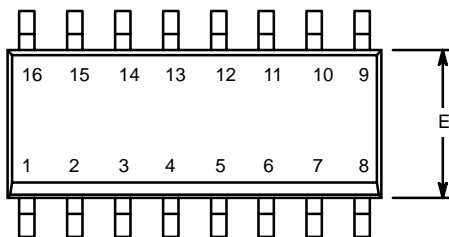


Figure 9. Precision Sample-and-Hold

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?72626.

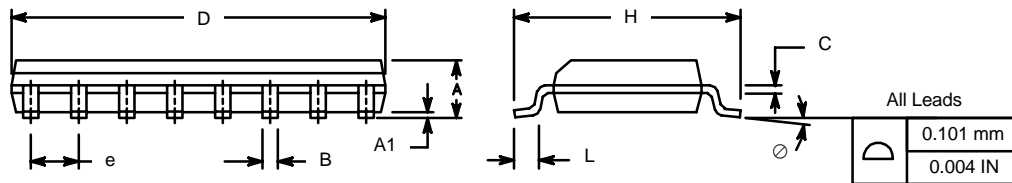


SOIC (NARROW): 16-LEAD
JEDEC Part Number: MS-012

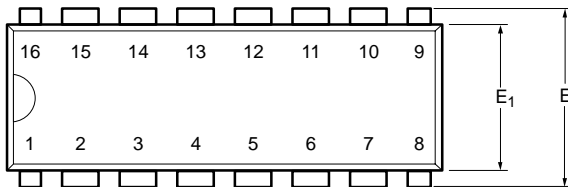


| Dim | MILLIMETERS | | INCHES | |
|----------------|-------------|-------|-----------|-------|
| | Min | Max | Min | Max |
| A | 1.35 | 1.75 | 0.053 | 0.069 |
| A ₁ | 0.10 | 0.20 | 0.004 | 0.008 |
| B | 0.38 | 0.51 | 0.015 | 0.020 |
| C | 0.18 | 0.23 | 0.007 | 0.009 |
| D | 9.80 | 10.00 | 0.385 | 0.393 |
| 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



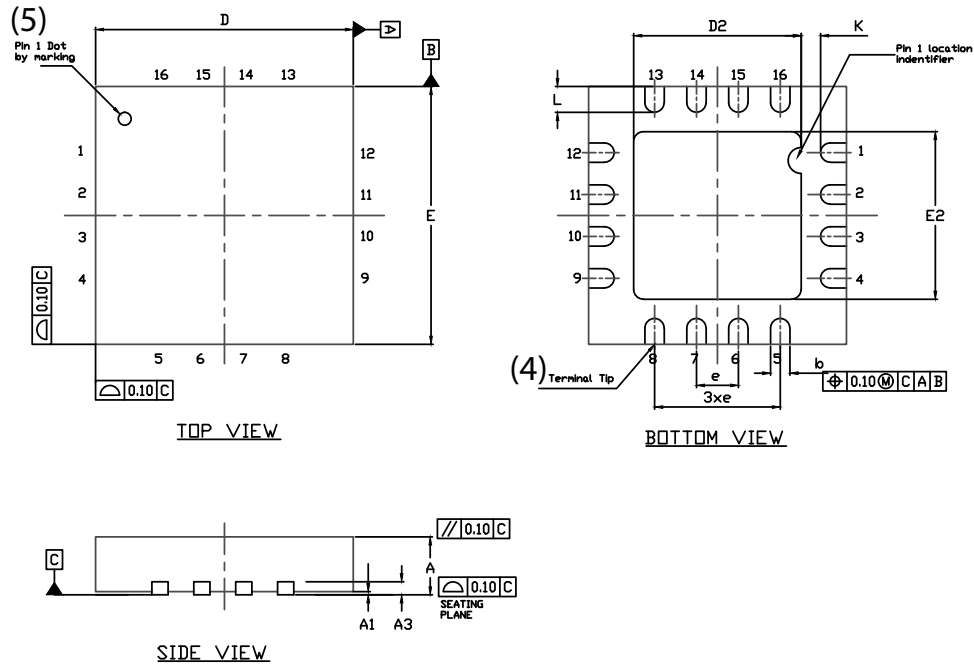
PDIP: 16-LEAD



| Dim | MILLIMETERS | | INCHES | |
|----------------------|-------------|-------|--------|-------|
| | Min | Max | Min | Max |
| A | 3.81 | 5.08 | 0.150 | 0.200 |
| A₁ | 0.38 | 1.27 | 0.015 | 0.050 |
| B | 0.38 | 0.51 | 0.015 | 0.020 |
| B₁ | 0.89 | 1.65 | 0.035 | 0.065 |
| C | 0.20 | 0.30 | 0.008 | 0.012 |
| D | 18.93 | 21.33 | 0.745 | 0.840 |
| E | 7.62 | 8.26 | 0.300 | 0.325 |
| E₁ | 5.59 | 7.11 | 0.220 | 0.280 |
| e₁ | 2.29 | 2.79 | 0.090 | 0.110 |
| e_A | 7.37 | 7.87 | 0.290 | 0.310 |
| L | 2.79 | 3.81 | 0.110 | 0.150 |
| Q₁ | 1.27 | 2.03 | 0.050 | 0.080 |
| S | 0.38 | 1.52 | .015 | 0.060 |

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

QFN 4x4-16L Case Outline



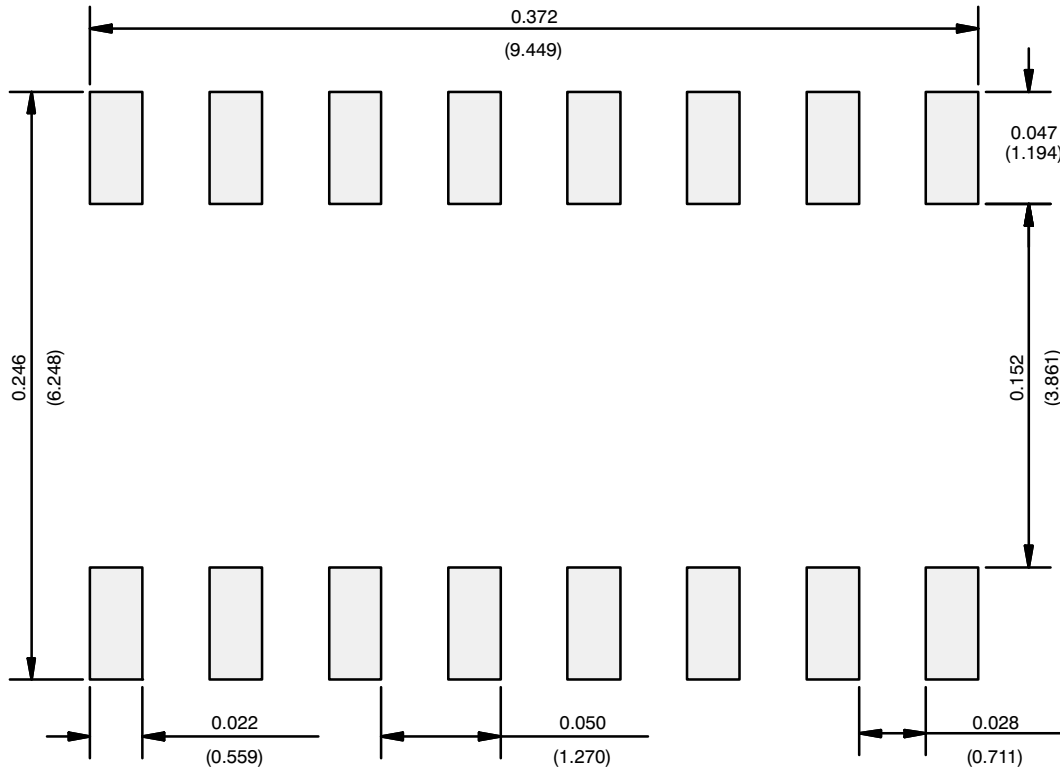
| DIM | VARIATION 1 | | | | | | VARIATION 2 | | | | | |
|-------------------|----------------------------|------|------|------------|-------|-------|----------------------------|------|------|------------|-------|-------|
| | MILLIMETERS ⁽¹⁾ | | | INCHES | | | MILLIMETERS ⁽¹⁾ | | | INCHES | | |
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.75 | 0.85 | 0.95 | 0.029 | 0.033 | 0.037 | 0.75 | 0.85 | 0.95 | 0.029 | 0.033 | 0.037 |
| A1 | 0 | - | 0.05 | 0 | - | 0.002 | 0 | - | 0.05 | 0 | - | 0.002 |
| A3 | 0.20 ref. | | | 0.008 ref. | | | 0.20 ref. | | | 0.008 ref. | | |
| b | 0.25 | 0.30 | 0.35 | 0.010 | 0.012 | 0.014 | 0.25 | 0.30 | 0.35 | 0.010 | 0.012 | 0.014 |
| D | 4.00 BSC | | | 0.157 BSC | | | 4.00 BSC | | | 0.157 BSC | | |
| D2 | 2.0 | 2.1 | 2.2 | 0.079 | 0.083 | 0.087 | 2.5 | 2.6 | 2.7 | 0.098 | 0.102 | 0.106 |
| e | 0.65 BSC | | | 0.026 BSC | | | 0.65 BSC | | | 0.026 BSC | | |
| E | 4.00 BSC | | | 0.157 BSC | | | 4.00 BSC | | | 0.157 BSC | | |
| E2 | 2.0 | 2.1 | 2.2 | 0.079 | 0.083 | 0.087 | 2.5 | 2.6 | 2.7 | 0.098 | 0.102 | 0.106 |
| K | 0.20 min. | | | 0.008 min. | | | 0.20 min. | | | 0.008 min. | | |
| L | 0.5 | 0.6 | 0.7 | 0.020 | 0.024 | 0.028 | 0.3 | 0.4 | 0.5 | 0.012 | 0.016 | 0.020 |
| N ⁽³⁾ | 16 | | | 16 | | | 16 | | | 16 | | |
| Nd ⁽³⁾ | 4 | | | 4 | | | 4 | | | 4 | | |
| Ne ⁽³⁾ | 4 | | | 4 | | | 4 | | | 4 | | |

Notes

- (1) Use millimeters as the primary measurement.
- (2) Dimensioning and tolerances conform to ASME Y14.5M. - 1994.
- (3) N is the number of terminals. Nd and Ne is the number of terminals in each D and E site respectively.
- (4) Dimensions b applies to plated terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.
- (5) The pin 1 identifier must be existed on the top surface of the package by using identification mark or other feature of package body.
- (6) Package warpage max. 0.05 mm.

ECN: S13-0893-Rev. B, 22-Apr-13
 DWG: 5890

RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads
Dimensions in Inches/(mm)

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