

# **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 (toN: 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.

#### **FEATURES**

• Low on-resistance: 50  $\Omega$ 

Low leakage: 80 pA

Low power consumption: 22 nW
Fast switching action - t<sub>ON</sub>: 120 ns

· Low charge injection

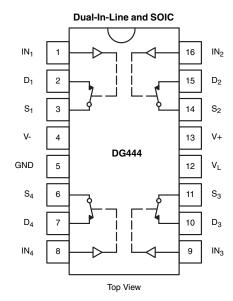
DG211, DG212 upgrades

• 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: ± 5 V to ± 20 V

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



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

#### Note

 Logic "0" ≤ 0.8 V Logic "1" ≥ 2.4 V

| ORDERING INFORMATION            |                     |                    |         |  |  |  |
|---------------------------------|---------------------|--------------------|---------|--|--|--|
| TEMP. RANGE PACKAGE PART NUMBER |                     |                    |         |  |  |  |
|                                 | 16-pin plastic DIP  | DG444DJ            |         |  |  |  |
| -40 °C to 85 °C                 | 10-pili piastic Die | DG445DJ            |         |  |  |  |
| -40 C t0 65 C                   | 16 pip parrow SOIC  | DG444DY            |         |  |  |  |
|                                 | ro-pin narrow SOIC  | 16-pin narrow SOIC | DG445DY |  |  |  |



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| <b>ABSOLUTE MAXIMUM RATINGS</b> (T <sub>A</sub> = 25 °C, unless otherwise noted) |                                      |  |       |  |  |
|--|--------------------------------------|--|-------|--|--|
| PARAMETER  |                                      | LIMIT  | UNIT  |  |  |
| V+ to V-   |                                      | 44   |       |  |  |
| GND to V-  |                                      | 25   |       |  |  |
| V <sub>L</sub>   |                                      | (GND - 0.3) to (V+) +0.3                               | V     |  |  |
| Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub>                    |                                      | (V-) -2 to (V+) +2<br>or 30 mA, whichever occurs first |       |  |  |
| Continuous Current (Any Terminal)  | ninal) 30                            |  | A     |  |  |
| Current, S or D (Pulsed at 1 ms, 10  | % Duty Cycle)                        | 100  | – mA  |  |  |
| Storage Temperature  |                                      | -65 to 125   | °C    |  |  |
| Power Dissipation (Package) b  | 16-Pin Plastic DIP <sup>c</sup>      | 450  | mW    |  |  |
| rower Dissipation (Package)  | 16-Pin Narrow Body SOIC <sup>d</sup> | 640  | 11100 |  |  |

## 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/°C above 75 °C.
- d. Derate 8 mW/°C above 75 °C.

| SPECIFICATIONS for Dual Supplies   |                     |  |   |                    |                                    |        |        |      |
|------------------------------------|---------------------|--|---|--------------------|------------------------------------|--------|--------|------|
| PARAMETER                          | SYMBOL              | TEST CONDITIONS<br>UNLESS OTHERWISE SPECI  | RWISE SPECIFIED   |                    | <b>D SUFFIX</b><br>-40 °C TO 85 °C |        |        | UNIT |
| TANAMETEN                          | O'IMBOL             | V+ = 15 V, V- = -15 V<br>$V_L = 5 V, V_{IN} = 2.4 V, 0.8 V$                                      | е   | TEMP. <sup>a</sup> | MIN. b                             | TYP. ° | MAX. b |      |
| Analog Switch                      |                     |  |   |                    |                                    |        |        |      |
| Analog Signal Range <sup>d</sup>   | V <sub>ANALOG</sub> |  |   | Full               | -15                                | -      | 15     | V    |
| Drain-Source On-Resistanc e        | R-ac                | $I_S = -10 \text{ mA}, V_D = \pm 8.5 \text{ V}$  |   | Room               | -                                  | 50     | 85     | Ω    |
| Dialii-30dice Oil-nesistalic       | R <sub>DS(on)</sub> | V+ = 13.5 V, V- = -13.5 V  |   | Full               | ı                                  | -      | 100    | 52   |
|                                    | lov m               |  |   | Room               | -0.5                               | ± 0.01 | 0.5    |      |
| Switch Off Leakage Current         | I <sub>S(off)</sub> | V+ = 16.5, V- = -16.5 V  |   | Full               | -5                                 | ± 0.01 | 5      |      |
| Switch Off Leakage Current         | 1                   | $V_D = \pm 15.5 V, V_S = \pm 15.5$   | V   | Room               | -0.5                               | ± 0.01 | 0.5    | nA   |
|                                    | I <sub>D(off)</sub> |  |   | Full               | -5                                 | ± 0.01 | 5      | nA   |
| Channel On Leakage Current         |                     | V+ = 16.5 V, V- = -16.5 V  | $V_{+} = 16.5 \text{ V}, V_{-} = -16.5 \text{ V}$<br>$V_{S} = V_{D} = \pm 15.5 \text{ V}$ |                    | -0.5                               | ± 0.08 | 0.5    |      |
| Charmer On Leakage Current         | I <sub>D(on)</sub>  | $V_S = V_D = \pm 15.5 \text{ V}$   |   |                    | -10                                | ± 0.08 | 10     |      |
| Digital Control                    |                     |  |   |                    |                                    |        |        |      |
| Input Current V <sub>IN</sub> Low  | I <sub>IL</sub>     | $V_{IN}$ under test = 0.8 V<br>All Other = 2.4 V   |   | Full               | -500                               | -0.01  | 500    | n 1  |
| Input Current V <sub>IN</sub> High | I <sub>IH</sub>     | $V_{IN}$ under test = 2.4 V<br>All Other = 0.8 V   |   | Full               | -500                               | 0.01   | 500    | - nA |
| Dynamic Characteristics            |                     |  |   |                    |                                    |        |        |      |
| Turn-On Time                       | t <sub>ON</sub>     |  |   | Room               | -                                  | 120    | 250    |      |
| Turn-Off Time                      |                     | $R_L = 1 \text{ k}\Omega, C_L = 35 \text{ pF}$<br>$V_S = \pm 10 \text{ V}, \text{ See Figure 2}$ | DG444   | Room               | -                                  | 110    | 140    | ns   |
| rum-On Time                        | t <sub>OFF</sub>    | V5 = ± 10 V, 000 Figure 2  | DG445   | Room               | -                                  | 160    | 210    |      |
| Charge Injection <sup>e</sup>      | Q                   | $C_L$ = 1 nF, $V_S$ = 0 V $V_{gen}$ = 0 V, $R_{gen}$ = 0 $\Omega$                                |   | Room               | -                                  | -1     | -      | рС   |
| Off Isolation e                    | OIRR                | $R_L = 50 \Omega$ , $C_L = 5 pF$ , $f = 1 MHz$   |   | Room               | -                                  | 60     | -      | ٩D   |
| Crosstalk (Channel-to-Channel) d   | X <sub>TALK</sub>   |  |   | Room               | -                                  | 100    | -      | dB   |
| Source Off Capacitance             | C <sub>S(off)</sub> | f = 1 MHz  |   | Room               | -                                  | 4      | -      |      |
| Drain Off Capacitance              | C <sub>D(off)</sub> |  |   | Room               | -                                  | 4      | -      | pF   |
| Channel On Capacitance             | C <sub>D(on)</sub>  | V <sub>ANALOG</sub> = 0 V  |   | Room               | -                                  | 16     | -      |      |



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| SPECIFICATIONS for Dual Supplies |  |   |                                    |        |         |        |    |
|----------------------------------|--|---|------------------------------------|--------|---------|--------|----|
| PARAMETER                        | TEST CONDITIONS UNLESS OTHERWISE SPECIFIED | TEMP. a   | <b>D SUFFIX</b><br>-40 °C TO 85 °C |        |         | UNIT   |    |
|                                  | 01202                                      | V+ = 15 V, V- = -15 V<br>$V_L = 5 V, V_{IN} = 2.4 V, 0.8 V^e$ |                                    | MIN. b | TYP. c  | MAX. b |    |
| Power Supplies                   |  |   |                                    |        |         |        |    |
| Positive Supply Current          | I+   |   | Room                               | -      | 0.001   | 1      |    |
| 1 ositive Supply Current         | 17   |   | Full                               | -      | -       | 5      |    |
| Negative Supply Current          | I-   |   | Room                               | -1     | -0.0001 | ı      |    |
| Negative Supply Current          | Į-   | V+ = 16.5 V, V- = -16.5 V                                     | Full                               | -5     | ı       | ı      | μA |
| Logic Supply Current             | I.   | $V_{IN} = 0 \text{ V or } 5 \text{ V}$                        | Room                               | -      | 0.001   | 1      | μΛ |
| Logic Supply Guirent             | IL   |   | Full                               | -      | 0.001   | 5      |    |
| Ground Current                   | la   |   | Room                               | -1     | -0.001  | ı      |    |
| Ground Gurrent                   | I <sub>GND</sub>                           |   | Full                               | -5     | -0.001  | 1      |    |

| SPECIFICATIONS for Unipolar Supplies |                     |  |         |                                     |         |        |      |  |
|--------------------------------------|---------------------|--|---------|-------------------------------------|---------|--------|------|--|
| PARAMETER                            | SYMBOL              | TEST CONDITIONS UNLESS OTHERWISE SPECIFIED   | TEMP. a | <b>LIMITS</b><br>-40 °C °C TO 85 °C |         |        | UNIT |  |
| .,                                   |                     | V+ = 12 V, V- = 0 V<br>$V_L = 5 V, V_{IN} = 2.4 V, 0.8 V^e$                                |         | MIN. b                              | TYP. °  | MAX. b | ONIT |  |
| Analog Switch                        |                     |  |         |                                     |         |        |      |  |
| Analog Signal Range <sup>d</sup>     | V <sub>ANALOG</sub> |  | Full    | 0                                   | -       | 12     | V    |  |
| Drain-Source On-Resistance d         |                     | I <sub>S</sub> = -10 mA, V <sub>D</sub> = 3 V, 8 V<br>V+ = 10.8 V, V <sub>L</sub> = 5.25 V | Room    | -                                   | 100     | 160    | Ω    |  |
| Drain-Source On-Resistance           | R <sub>DS(on)</sub> |  | Full    | -                                   | -       | 200    | 52   |  |
| Dynamic Characteristics              |                     |  |         |                                     |         |        |      |  |
| Turn-On Time                         | t <sub>ON</sub>     | $R_L = 1 \text{ k}\Omega, C_L = 35 \text{ pF}, V_S = 8 \text{ V}$                          | Room    | -                                   | 300     | 450    | no   |  |
| Turn-Off Time                        | t <sub>OFF</sub>    | See Figure 2   | Room    | -                                   | 60      | 200    | ns   |  |
| Charge Injection                     | Q                   | $C_L$ = 1 nF, $V_{gen}$ = 6 V, $R_{gen}$ = 0 $\Omega$                                      | Room    | -                                   | 2       | -      | рС   |  |
| Power Supplies                       |                     |  |         |                                     |         |        |      |  |
| Positive Supply Current              | I+                  | V+ = 13.2 V, V <sub>IN</sub> = 0 V or 5 V  | Room    | -                                   | 0.001   | 1      |      |  |
| Positive Supply Current              | 1+                  | $v + = 13.2 \text{ v}, v_{1N} = 0 \text{ v or } 3 \text{ v}$                               | Full    | -                                   | -       | 5      |      |  |
| Nametica Complex Company             | _                   | V <sub>IN</sub> = 0 V or 5 V   | Room    | -1                                  | -0.0001 | -      |      |  |
| Negative Supply Current              | I-                  | VIN = 0 V OI 3 V   | Full    | -5                                  | -       | -      |      |  |
| Logic Supply Current                 | 1.                  | V FOEV V OVER EV   | Room    | -                                   | 0.001   | 1      | μA   |  |
| Logic Supply Current                 | IL                  | $V_L = 5.25 \text{ V}, V_{IN} = 0 \text{ V or } 5 \text{ V}$                               | Full    | -                                   | -       | 5      |      |  |
| Ground Current                       |                     | V <sub>IN</sub> = 0 V or 5 V   |         | Room                                | -1      | -0.001 | -    |  |
| Ground Current                       | I <sub>GND</sub>    |  | Full    | -5                                  | -       | -      |      |  |

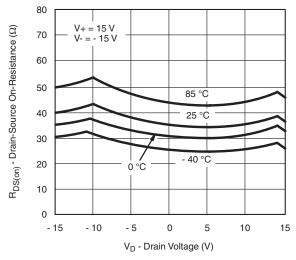
## Notes

- 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.  $V_{IN}$  = input voltage to perform proper function.

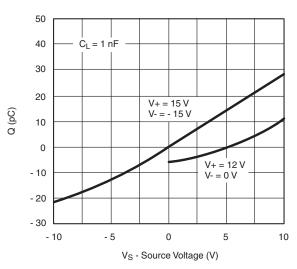
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



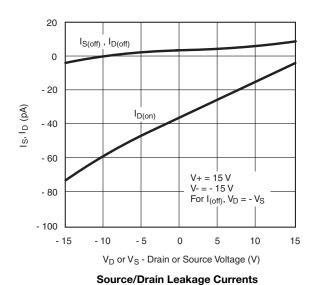
## **TYPICAL CHARACTERISTICS** (T<sub>A</sub> = 25 °C, unless otherwise noted)

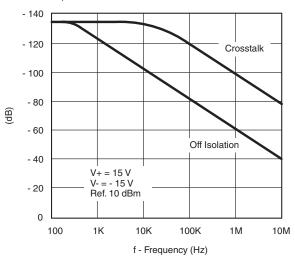


R<sub>DS(on)</sub> vs. V<sub>D</sub> and Temperature

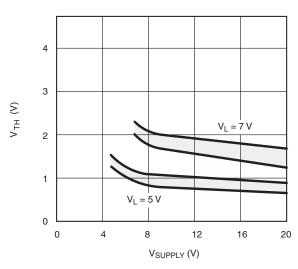


Charge Injection vs. Source Voltage

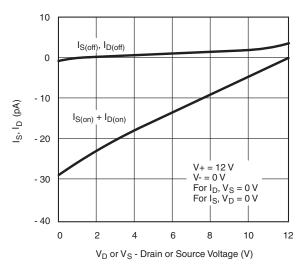




Crosstalk and Off Isolation vs. Frequency



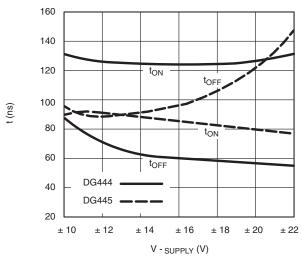
Switching Threshold vs. Supply Voltage



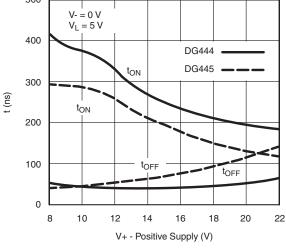
Source/Drain Leakage Currents (Single 12-V Supply)



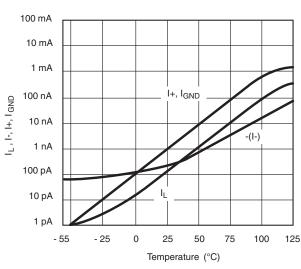
## **TYPICAL CHARACTERISTICS** (T<sub>A</sub> = 25 °C, unless otherwise noted)



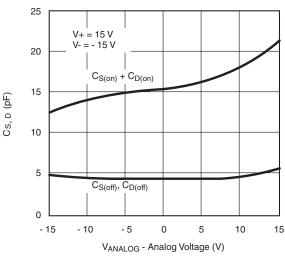
Switching Time vs. Power Supply Voltage



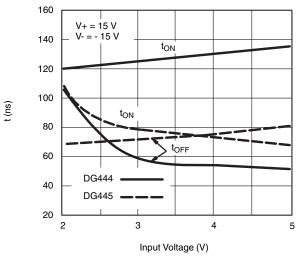
**Switching Times vs. Power Supply Voltage** 



Supply Current vs. Temperature



Source/Drain Capacitance vs. Analog Voltage



Switching Time vs. Input Voltage



## **SCHEMATIC DIAGRAM TYPICAL CHANNEL**

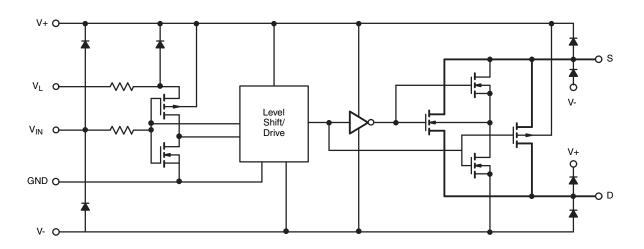


Fig. 1

## **TEST CIRCUITS**

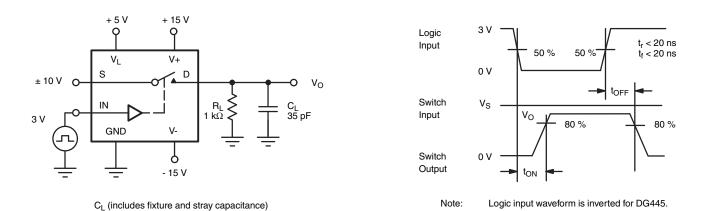


Fig. 2 - Switching Time

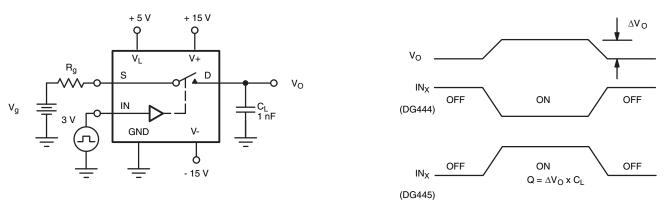


Fig. 3 - Charge Injection



## **TEST CIRCUITS**

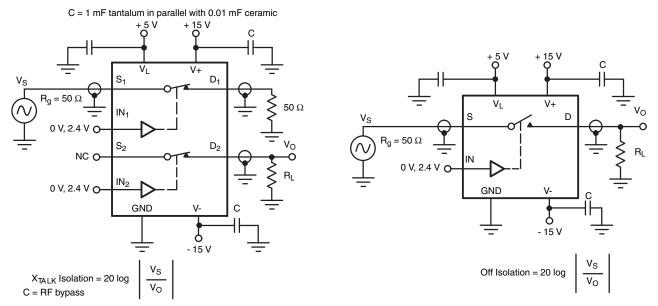


Fig. 4 - Crosstalk

Fig. 5 - Off Isolation

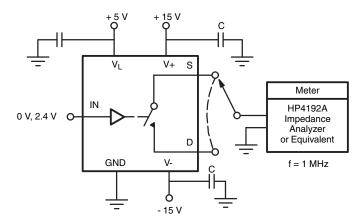


Fig. 6 - Source/Drain Capacitances

## **APPLICATIONS**

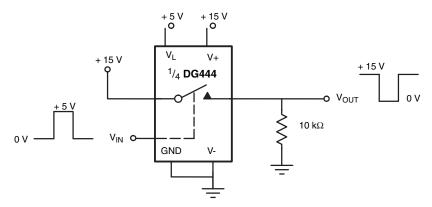


Fig. 7 - Level Shifter

## **APPLICATIONS**

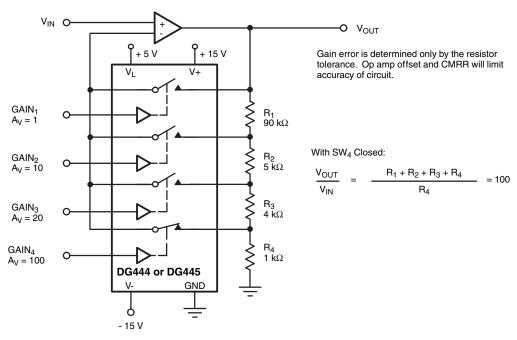


Fig. 8 - Precision-Weighted Resistor Programmable-Gain Amplifier

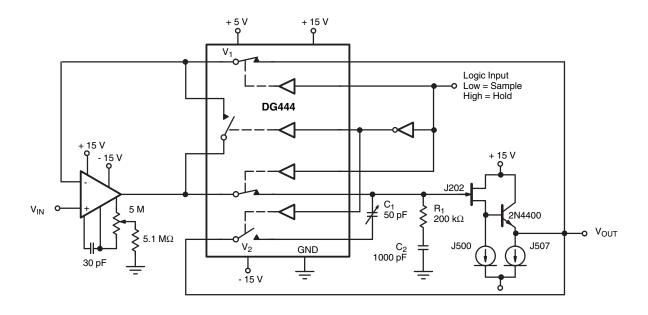
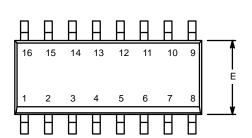


Fig. 9 - Precision Sample-and-Hold

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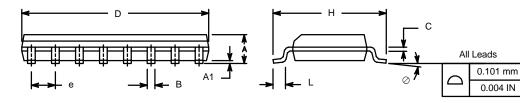


SOIC (NARROW): 16-LEAD JEDEC Part Number: MS-012



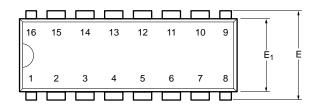
|                | MILLIM                         | IETERS | INC   | HES   |  |  |  |
|----------------|--------------------------------|--------|-------|-------|--|--|--|
| Dim            | Min                            | Max    | Min   | Max   |  |  |  |
| Α              | 1.35                           | 1.75   | 0.053 | 0.069 |  |  |  |
| A <sub>1</sub> | 0.10                           | 0.20   | 0.004 | 0.008 |  |  |  |
| В              | 0.38                           | 0.51   | 0.015 | 0.020 |  |  |  |
| С              | 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 |  |  |  |
| е              | 1.27                           | BSC    | 0.050 | BSC   |  |  |  |
| Н              | 5.80                           | 6.20   | 0.228 | 0.244 |  |  |  |
| L              | 0.50                           | 0.93   | 0.020 | 0.037 |  |  |  |
| 0              | 0°                             | 8°     | 0°    | 8°    |  |  |  |
| ECN: S-0       | ECN: S-03946—Rev. F, 09-Jul-01 |        |       |       |  |  |  |

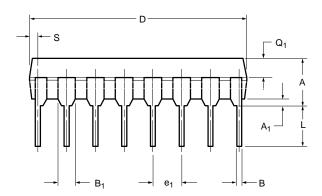
DWG: 5300

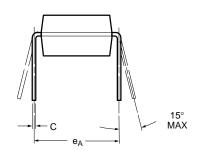




PDIP: 16-LEAD







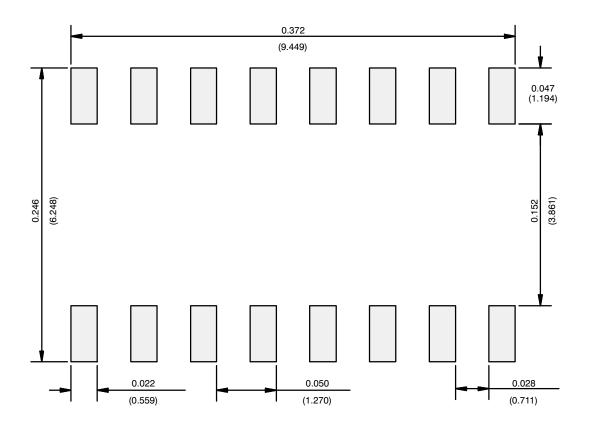
|                | MILLIN                         | IETERS | INC   | HES   |  |  |  |  |
|----------------|--------------------------------|--------|-------|-------|--|--|--|--|
| Dim            | Min                            | Max    | Min   | Max   |  |  |  |  |
| Α              | 3.81                           | 5.08   | 0.150 | 0.200 |  |  |  |  |
| A <sub>1</sub> | 0.38                           | 1.27   | 0.015 | 0.050 |  |  |  |  |
| В              | 0.38                           | 0.51   | 0.015 | 0.020 |  |  |  |  |
| B <sub>1</sub> | 0.89                           | 1.65   | 0.035 | 0.065 |  |  |  |  |
| С              | 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 |  |  |  |  |
| E <sub>1</sub> | 5.59                           | 7.11   | 0.220 | 0.280 |  |  |  |  |
| e <sub>1</sub> | 2.29                           | 2.79   | 0.090 | 0.110 |  |  |  |  |
| e <sub>A</sub> | 7.37                           | 7.87   | 0.290 | 0.310 |  |  |  |  |
| L              | 2.79                           | 3.81   | 0.110 | 0.150 |  |  |  |  |
| Q <sub>1</sub> | 1.27                           | 2.03   | 0.050 | 0.080 |  |  |  |  |
| S              | 0.38                           | 1.52   | .015  | 0.060 |  |  |  |  |
| ECN: S-0       | ECN: S-03946—Rev. D, 09-Jul-01 |        |       |       |  |  |  |  |

DWG: 5482

Document Number: 71261 www.vishay.com 06-Jul-01



## **RECOMMENDED MINIMUM PADS FOR SO-16**



Recommended Minimum Pads Dimensions in Inches/(mm)

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