



## Precision Monolithic Quad SPST CMOS Analog Switches

### DESCRIPTION

The DG411HS series of monolithic quad analog switches was designed to provide high speed, low error switching of precision analog signals. Combining low power (0.35  $\mu$ W) with high speed ( $t_{on}$ : 68 ns), the DG411HS family is ideally suited for portable and battery powered industrial and military applications.

To achieve high-voltage ratings and superior switching performance, the DG411HS series was 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 up to the supply levels when off.

The DG411HS and DG412HS respond to opposite control logic as shown in the Truth Table. The DG413HS has two normally open and two normally closed switches.

### BENEFITS

- Widest dynamic range
- Low signal errors and distortion
- Break-before-make switching action
- Simple interfacing

### FEATURES

- 44 V supply max. rating
- $\pm 15$  V analog signal range
- On-resistance -  $R_{DS(on)}$ : 25  $\Omega$
- Fast switching -  $t_{on}$ : 68 ns
- Ultra low power -  $P_D$ : 0.35  $\mu$ W
- TTL, CMOS compatible
- Single supply capability
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

#### Note

\* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

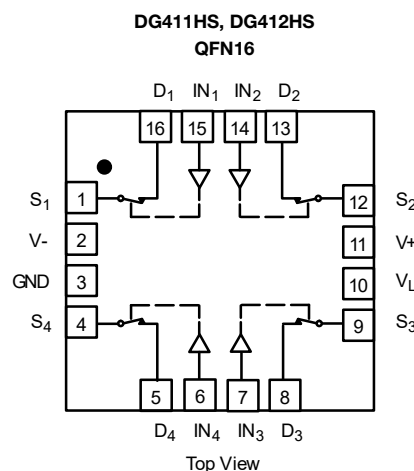
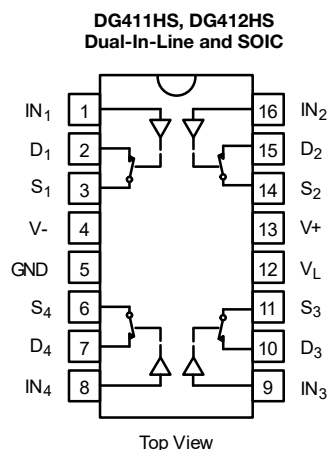


**RoHS\***  
Available

### APPLICATIONS

- Precision automatic test equipment
- Precision data acquisition
- Communication systems
- Battery powered systems
- Computer peripherals

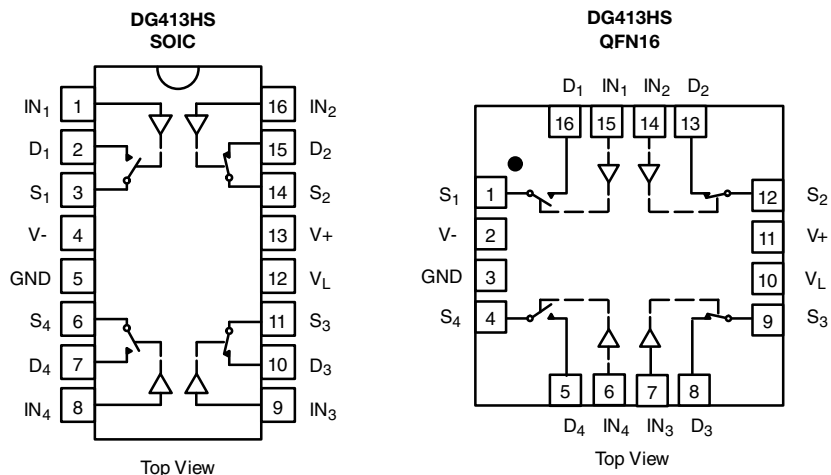
### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



| TRUTH TABLE |         |         |
|-------------|---------|---------|
| LOGIC       | DG411HS | DG412HS |
| 0           | On      | Off     |
| 1           | Off     | On      |



## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



| TRUTH TABLE |          |          |
|-------------|----------|----------|
| LOGIC       | SW1, SW4 | SW2, SW3 |
| 0           | Off      | On       |
| 1           | On       | Off      |

| ORDERING INFORMATION |                                   |                                 |
|----------------------|-----------------------------------|---------------------------------|
| TEMP. RANGE          | PACKAGE                           | PART NUMBER                     |
| DG411HS, DG412HS     |                                   |                                 |
| -40 °C to +85 °C     | 16-pin plastic DIP                | DG411HSDJ-E3                    |
|                      |                                   | DG412HSDJ-E3                    |
|                      | 16-pin narrow SOIC                | DG411HSDY-E3<br>DG411HSDY-T1-E3 |
|                      |                                   | DG412HSDY-E3<br>DG412HSDY-T1-E3 |
|                      | 16-pin QFN 4 x 4 mm (variation 1) | DG411HSDN-T1-E4                 |
|                      |                                   | DG412HSDN-T1-E4                 |
| DG413HS              |                                   |                                 |
| -40 °C to +85 °C     | 16-pin narrow SOIC                | DG413HSDY-E3<br>DG413HSDY-T1-E3 |
|                      | 16-pin QFN 4 x 4 mm (variation 1) | DG413HSDN-T1-E4                 |



| ABSOLUTE MAXIMUM RATINGS (T <sub>A</sub> = 25 °C, unless otherwise noted) |                                    |                                                          |      |
|---------------------------------------------------------------------------|------------------------------------|----------------------------------------------------------|------|
| PARAMETER                                                                 |                                    | LIMIT                                                    | UNIT |
| V+ to V-                                                                  |                                    | 44                                                       | V    |
| GND to V-                                                                 |                                    | 25                                                       |      |
| V <sub>L</sub>                                                            |                                    | (GND - 0.3) to (V+) + 0.3                                |      |
| 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)                                         |                                    | 30                                                       | mA   |
| Peak current, S or D (pulsed at 1 ms, 10 % duty cycle max.)               |                                    | 100                                                      |      |
| Storage temperature                                                       | (AK, AZ suffix)                    | -65 to +150                                              | °C   |
|                                                                           | (DJ, DY, DN suffix)                | -65 to +125                                              |      |
| Power dissipation (package) <sup>b</sup>                                  | 16-pin plastic DIP <sup>c</sup>    | 470                                                      | mW   |
|                                                                           | 16-pin narrow SOIC <sup>d</sup>    | 600                                                      |      |
|                                                                           | 16-pin (4 x 4 mm) QFN <sup>f</sup> | 1880                                                     |      |

**Notes**

- a. Signals on SX, DX, or INX 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 25  $^{\circ}\text{C}$   
d. Derate 7.6 mW/ $^{\circ}\text{C}$  above 75  $^{\circ}\text{C}$   
e. Derate 12 mW/ $^{\circ}\text{C}$  above 75  $^{\circ}\text{C}$   
f. Derate 23.5 mW/ $^{\circ}\text{C}$  above 70  $^{\circ}\text{C}$

| SPECIFICATIONS <sup>a</sup>               |                     |                                                                                                                                                            |                    |                   |                               |                   |                               |                   |      |
|-------------------------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------|-------------------------------|-------------------|-------------------------------|-------------------|------|
| PARAMETER                                 | SYMBOL              | TEST CONDITIONS<br>UNLESS 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>f</sup> | TEMP. <sup>b</sup> | TYP. <sup>c</sup> | A SUFFIX<br>-55 °C TO +125 °C |                   | D SUFFIX<br>- 40 °C TO +85 °C |                   | UNIT |
|                                           |                     |                                                                                                                                                            |                    |                   | MIN. <sup>d</sup>             | MAX. <sup>d</sup> | MIN. <sup>d</sup>             | MAX. <sup>d</sup> |      |
| Analog Switch                             |                     |                                                                                                                                                            |                    |                   |                               |                   |                               |                   |      |
| Analog signal range <sup>e</sup>          | V <sub>ANALOG</sub> |                                                                                                                                                            | Full               | -                 | -15                           | 15                | -15                           | 15                | V    |
| Drain-source on-resistance                | R <sub>DS(on)</sub> | V <sub>+</sub> = 13.5 V, V <sub>-</sub> = - 13.5 V ,<br>I <sub>S</sub> = -10 mA, V <sub>D</sub> = ± 8.5 V                                                  | Room               | 25                | -                             | 35                | -                             | 35                | Ω    |
|                                           |                     |                                                                                                                                                            | Full               | -                 | -                             | 45                | -                             | 45                |      |
| 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 mA, V <sub>S</sub> = ± 15.5 V                                               | Room               | ± 0.1             | -0.25                         | 0.25              | -0.25                         | 0.25              | nA   |
|                                           |                     |                                                                                                                                                            | Full               | -                 | -20                           | 20                | -5                            | 5                 |      |
|                                           | I <sub>D(off)</sub> |                                                                                                                                                            | Room               | ± 0.1             | -0.25                         | 0.25              | -0.25                         | 0.25              |      |
|                                           |                     |                                                                                                                                                            | Full               | -                 | -20                           | 20                | -5                            | 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>D</sub> = V <sub>S</sub> = ± 15.5 V                                                          | Room               | ± 0.1             | -0.4                          | 0.4               | -0.4                          | 0.4               |      |
|                                           |                     |                                                                                                                                                            | Full               | -                 | -40                           | 40                | -10                           | 40                |      |
| Digital Control                           |                     |                                                                                                                                                            |                    |                   |                               |                   |                               |                   |      |
| Input current, V <sub>IN</sub> low        | I <sub>IL</sub>     | V <sub>IN</sub> under test = 0.8 V                                                                                                                         | Full               | 0.005             | -0.5                          | 0.5               | -0.5                          | 0.5               | μA   |
| Input current, V <sub>IN</sub> high       | I <sub>IH</sub>     | V <sub>IN</sub> under test = 2.4 V                                                                                                                         | Full               | 0.005             | -0.5                          | 0.5               | -0.5                          | 0.5               |      |
| Input capacitance <sup>e</sup>            | C <sub>IN</sub>     | f = 1 MHz                                                                                                                                                  | Room               | 5                 | -                             | -                 | -                             | -                 | pF   |
| Dynamic Characteristics                   |                     |                                                                                                                                                            |                    |                   |                               |                   |                               |                   |      |
| Turn-on time                              | t <sub>on</sub>     | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = ± 10 V, see Fig. 2                                                                      | Room               | 68                | -                             | 105               | -                             | 105               | ns   |
|                                           |                     |                                                                                                                                                            | Full               | -                 | -                             | 127               | -                             | 116               |      |
| Turn-off time                             | t <sub>off</sub>    |                                                                                                                                                            | Room               | 42                | -                             | 80                | -                             | 80                |      |
|                                           |                     |                                                                                                                                                            | Full               | -                 | -                             | 94                | -                             | 90                |      |
| Break-before-make time delay              | t <sub>D</sub>      | DG413HS only, V <sub>S</sub> = 10 V,<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                                                     | Room               | 20                | -                             | -                 | -                             | -                 |      |
| Charge injection <sup>e</sup>             | Q                   | V <sub>g</sub> = 0 V, R <sub>g</sub> = 0 Ω, C <sub>L</sub> = 10 nF                                                                                         | Room               | 22                | -                             | -                 | -                             | -                 | pC   |
| Off Isolation <sup>e</sup>                | OIRR                | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz                                                                                                    | Room               | - 91              | -                             | -                 | -                             | -                 | dB   |
| Channel-to-channel crosstalk <sup>e</sup> | X <sub>TALK</sub>   |                                                                                                                                                            | Room               | - 88              | -                             | -                 | -                             | -                 |      |
| Source off capacitance <sup>e</sup>       | C <sub>S(off)</sub> | f = 1 MHz                                                                                                                                                  | Room               | 12                | -                             | -                 | -                             | -                 | pF   |
| Drain off capacitance <sup>e</sup>        | C <sub>D(off)</sub> |                                                                                                                                                            | Room               | 12                | -                             | -                 | -                             | -                 |      |
| Channel on capacitance <sup>e</sup>       | C <sub>D(on)</sub>  |                                                                                                                                                            | Room               | 30                | -                             | -                 | -                             | -                 |      |
| Power Supplies                            |                     |                                                                                                                                                            |                    |                   |                               |                   |                               |                   |      |

**SPECIFICATIONS<sup>a</sup>**

| PARAMETER               | SYMBOL           | TEST CONDITIONS<br>UNLESS 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>f</sup> | TEMP. <sup>b</sup> | TYP. <sup>c</sup> | A SUFFIX<br>-55 °C TO +125 °C |                   | D SUFFIX<br>-40 °C TO +85 °C |                   | UNIT |
|-------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------|-------------------------------|-------------------|------------------------------|-------------------|------|
|                         |                  |                                                                                                                                                            |                    |                   | MIN. <sup>d</sup>             | MAX. <sup>d</sup> | MIN. <sup>d</sup>            | MAX. <sup>d</sup> |      |
| Positive supply current | I <sub>+</sub>   | V <sub>+</sub> = 16.5 V, V <sub>-</sub> = -16.5 V,<br>V <sub>IN</sub> = 0 V or 5 V                                                                         | Room               | 0.0001            | -                             | 1                 | -                            | 1                 | μA   |
|                         |                  |                                                                                                                                                            | Full               | -                 | -                             | 5                 | -                            | 5                 |      |
| Negative supply current | I <sub>-</sub>   |                                                                                                                                                            | Room               | -0.0001           | -1                            | -                 | -1                           | -                 |      |
|                         |                  |                                                                                                                                                            | Full               | -                 | -5                            | -                 | -5                           | -                 |      |
| Logic supply current    | I <sub>L</sub>   |                                                                                                                                                            | Room               | 0.0001            | -                             | 1                 | -                            | 1                 |      |
|                         |                  |                                                                                                                                                            | Full               | -                 | -                             | 5                 | -                            | 5                 |      |
| Ground current          | I <sub>GND</sub> |                                                                                                                                                            | Room               | -0.0001           | -1                            | -                 | -1                           | -                 |      |
|                         |                  |                                                                                                                                                            | Full               | -                 | -5                            | -                 | -5                           | -                 |      |

**SPECIFICATIONS<sup>a</sup>** (for unipolar supplies)

| PARAMETER                        | SYMBOL              | TEST CONDITIONS<br>UNLESS SPECIFIED<br>V <sub>+</sub> = 12 V, V <sub>-</sub> = 0 V<br>V <sub>L</sub> = 5 V, V <sub>IN</sub> = 2.4 V, 0.8 V <sup>f</sup> | TEMP. <sup>b</sup> | TYP. <sup>c</sup> | A SUFFIX<br>-55 °C TO +125 °C |                   | D SUFFIX<br>- 40 °C TO +85 °C |                   | UNIT |
|----------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------|-------------------------------|-------------------|-------------------------------|-------------------|------|
|                                  |                     |                                                                                                                                                         |                    |                   | MIN. <sup>d</sup>             | MAX. <sup>d</sup> | MIN. <sup>d</sup>             | MAX. <sup>d</sup> |      |
| Analog Switch                    |                     |                                                                                                                                                         |                    |                   |                               |                   |                               |                   |      |
| Analog signal range <sup>e</sup> | V <sub>ANALOG</sub> |                                                                                                                                                         | Full               | -                 | -                             | 12                | -                             | 12                | V    |
| Drain-source on-resistance       | R <sub>DS(on)</sub> | V <sub>+</sub> = 10.8 V, I <sub>S</sub> = -10 mA,<br>V <sub>D</sub> = 3 V, 8 V                                                                          | Room               | 49                | -                             | 80                | -                             | 80                | Ω    |
|                                  |                     |                                                                                                                                                         | Full               | -                 | -                             | 100               | -                             | 100               |      |
| Dynamic Characteristics          |                     |                                                                                                                                                         |                    |                   |                               |                   |                               |                   |      |
| Turn-on time                     | t <sub>on</sub>     | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF,<br>VS = 8 V, see Fig. 2                                                                                 | Room               | 95                | -                             | 140               | -                             | 140               | ns   |
|                                  |                     |                                                                                                                                                         | Hot                | -                 | -                             | 180               | -                             | 160               |      |
| Turn-off time                    | t <sub>off</sub>    |                                                                                                                                                         | Room               | 36                | -                             | 70                | -                             | 70                |      |
|                                  |                     |                                                                                                                                                         | Hot                | -                 | -                             | 79                | -                             | 74                |      |
| Break-before-make time delay     | t <sub>D</sub>      | DG413HS only, VS = 8 V,<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                                                               | Room               | 60                | -                             | -                 | -                             | -                 |      |
| Charge injection                 | Q                   | V <sub>g</sub> = 6 V, R <sub>g</sub> = 0 Ω, C <sub>L</sub> = 1 nF                                                                                       | Room               | 60                | -                             | -                 | -                             | -                 | pC   |
| Power Supplies                   |                     |                                                                                                                                                         |                    |                   |                               |                   |                               |                   |      |
| Positive supply current          | I <sub>+</sub>      | V <sub>+</sub> = 13.2 V, V <sub>IN</sub> = 0 V or 5 V                                                                                                   | Room               | 0.0001            | -                             | 1                 | -                             | 1                 | μA   |
|                                  |                     |                                                                                                                                                         | Hot                | -                 | -                             | 5                 | -                             | 5                 |      |
| Negative supply current          | I <sub>-</sub>      |                                                                                                                                                         | Room               | -0.0001           | -1                            | -                 | -1                            | -                 |      |
|                                  |                     |                                                                                                                                                         | Hot                | -                 | -5                            | -                 | -5                            | -                 |      |
| Logic supply current             | I <sub>L</sub>      |                                                                                                                                                         | Room               | 0.0001            | -                             | 1                 | -                             | 1                 |      |
|                                  |                     |                                                                                                                                                         | Hot                | -                 | -                             | 5                 | -                             | 5                 |      |
| Ground current                   | I <sub>GND</sub>    |                                                                                                                                                         | Room               | -0.0001           | -1                            | -                 | -1                            | -                 |      |
|                                  |                     |                                                                                                                                                         | Hot                | -                 | -5                            | -                 | -5                            | -                 |      |

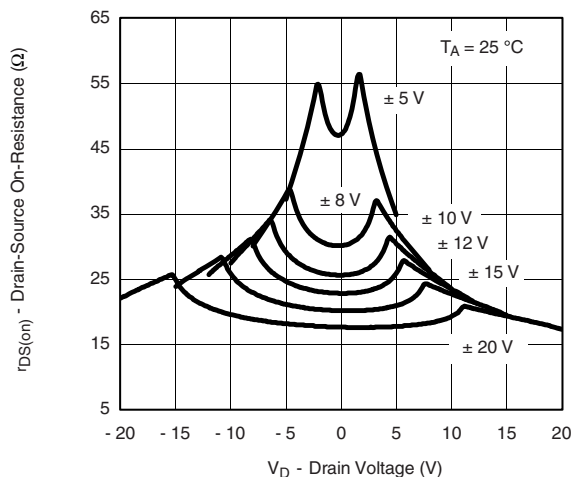
**Notes**

- 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 datasheet  
e. Guaranteed by design, not subject to production test  
f. V<sub>IN</sub> = input voltage to perform proper function

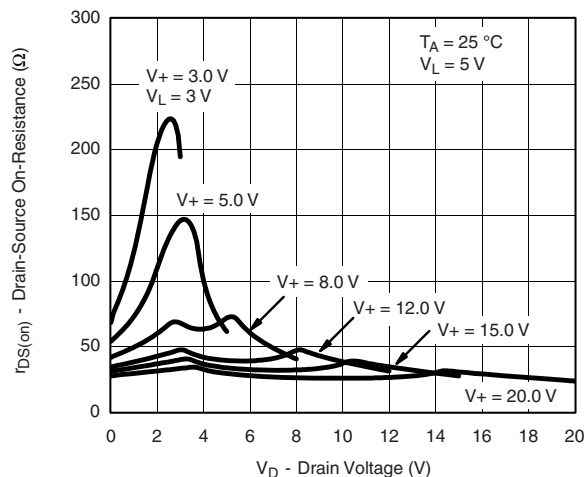
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



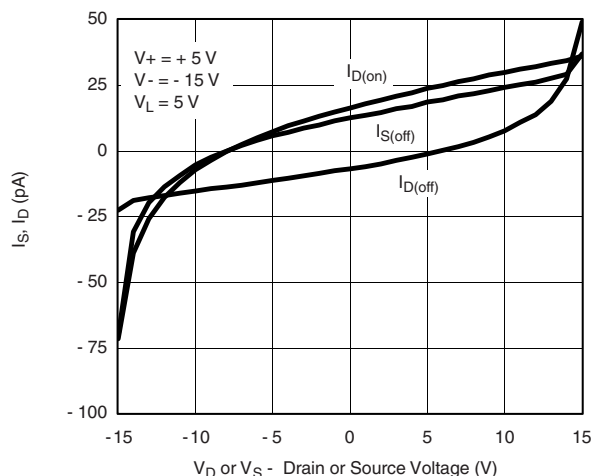
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



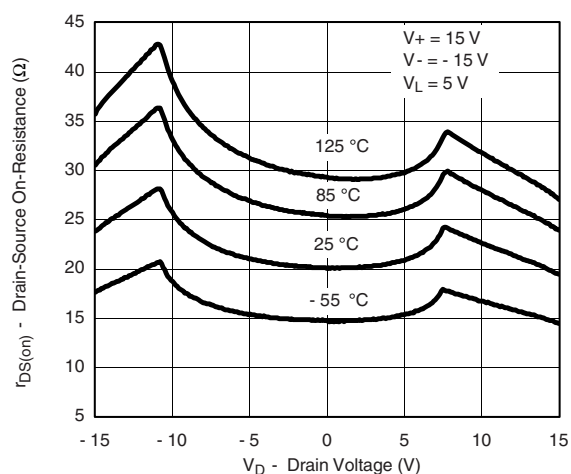
On-Resistance vs.  $V_D$  and Dual Supply Voltage



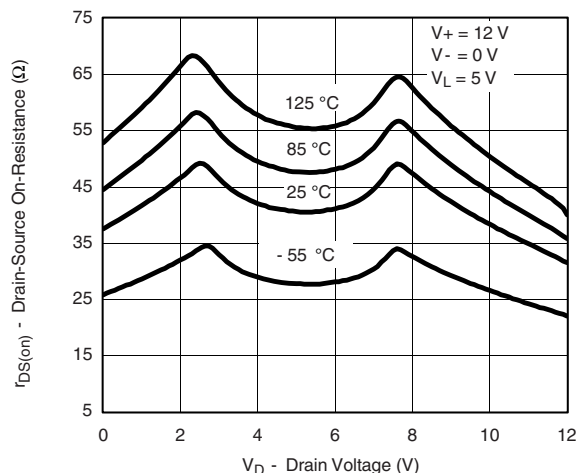
On-Resistance vs.  $V_D$  and Unipolar Supply Voltage



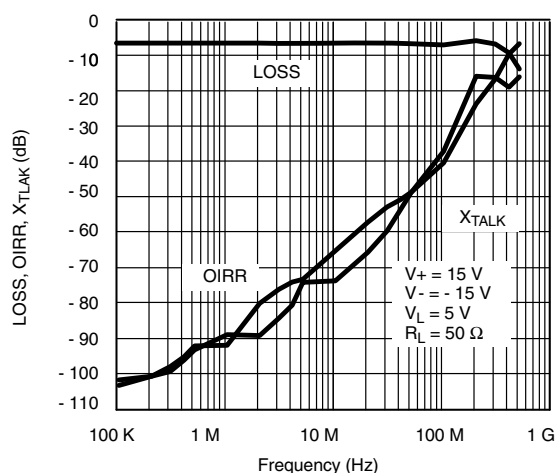
Leakage Current vs. Analog Voltage



On-Resistance vs.  $V_D$  and Temperature



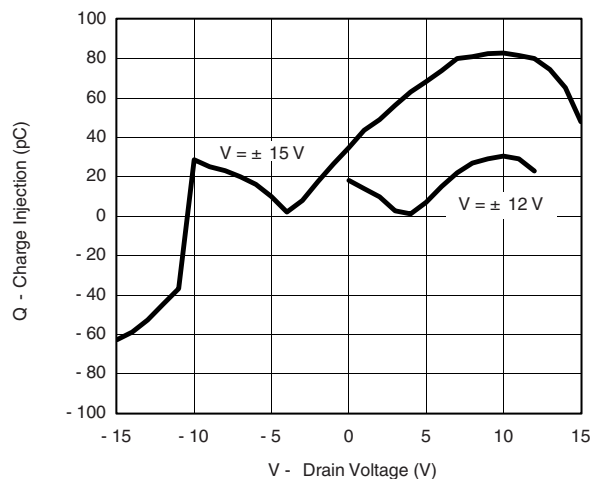
On-Resistance vs.  $V_D$  and Temperature



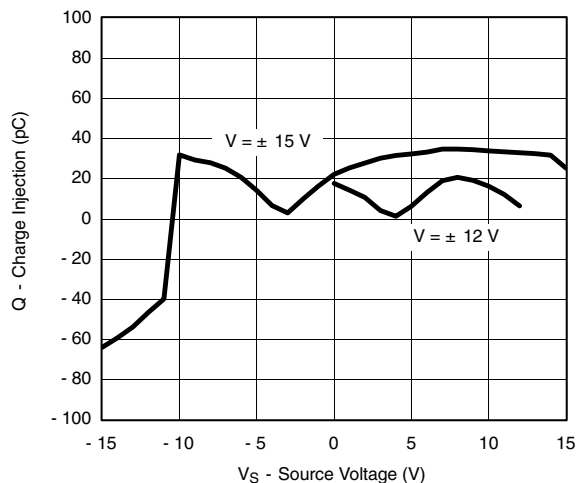
Insertion Loss, Off-Isolation, Crosstalk vs. Frequency



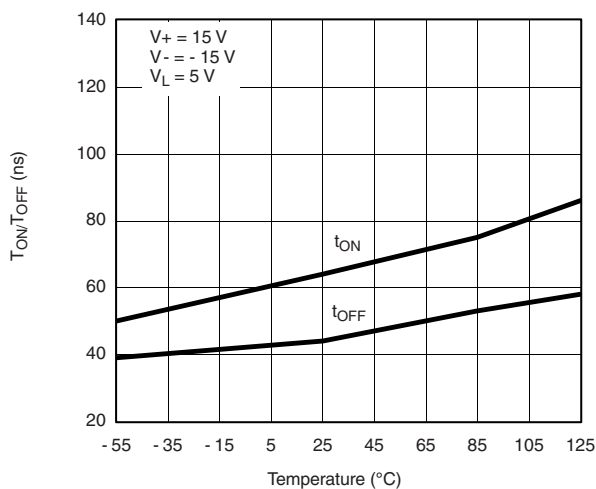
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



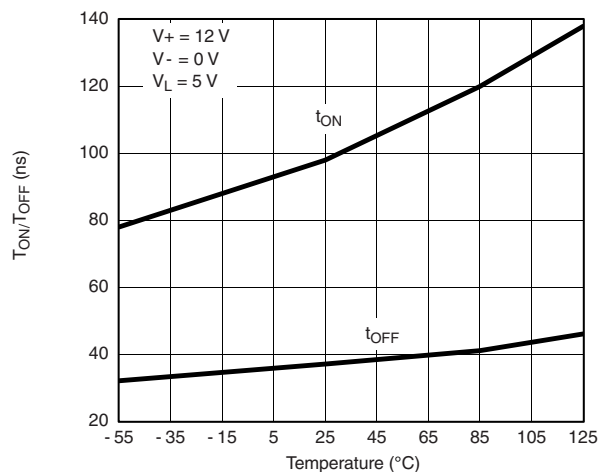
**Charge Injection vs. Analog Voltage**



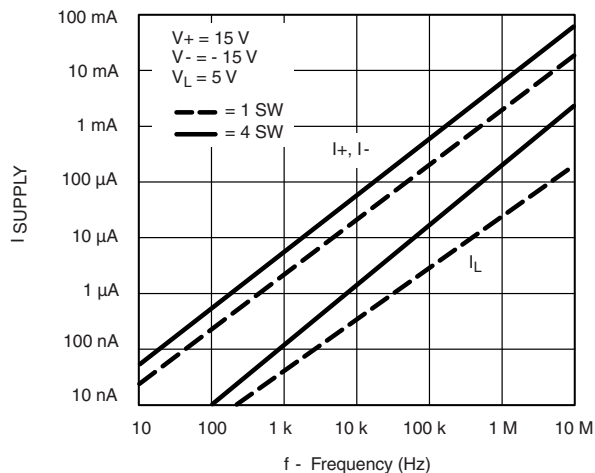
**Charge Injection vs. Analog Voltage**



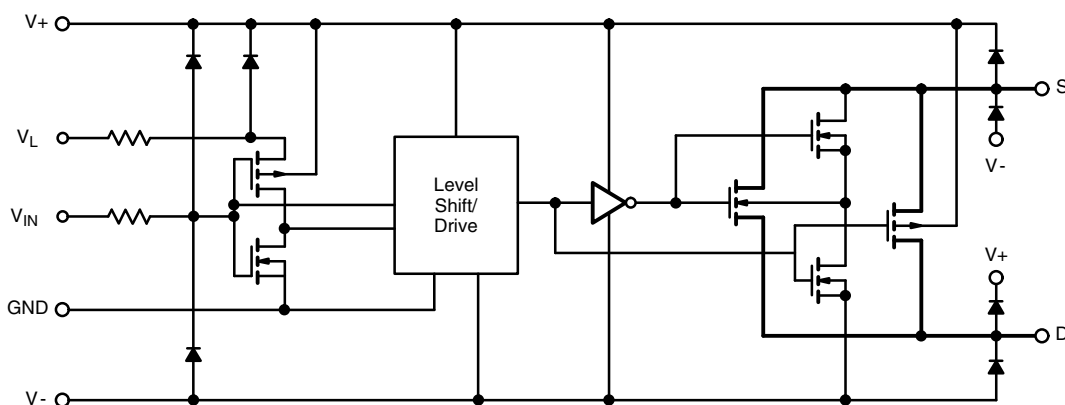
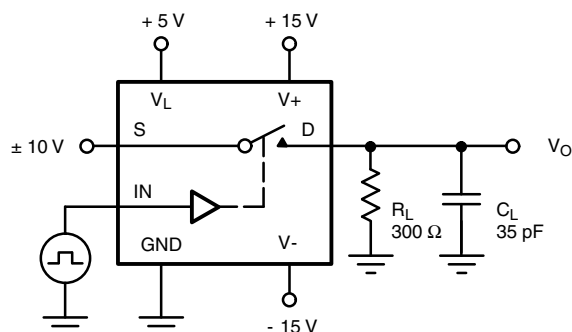
**Switching Time vs. Temperature**



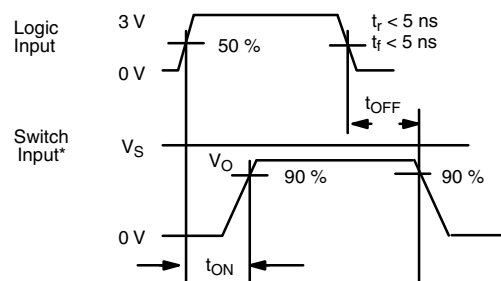
**Switching Time vs. Temperature**



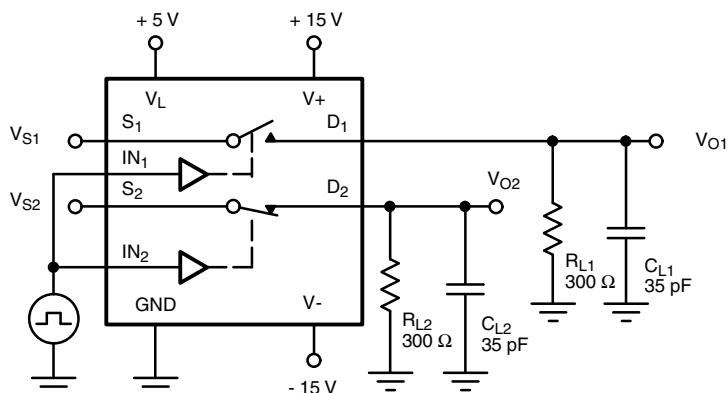
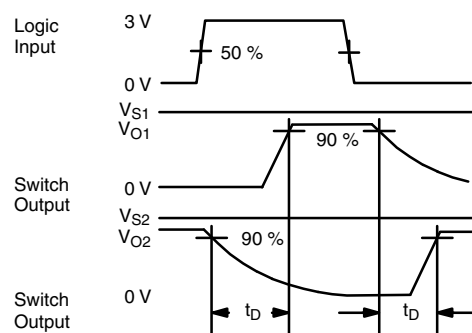
**Supply Current vs. Input Switching Frequency**

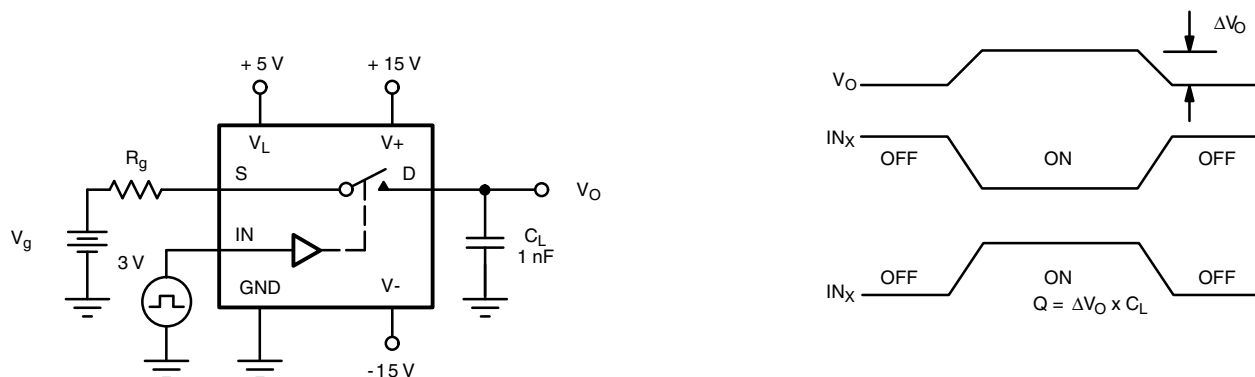
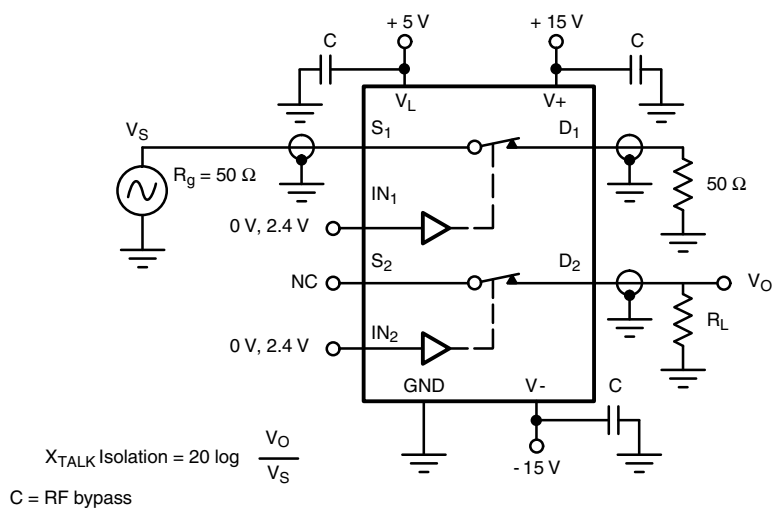
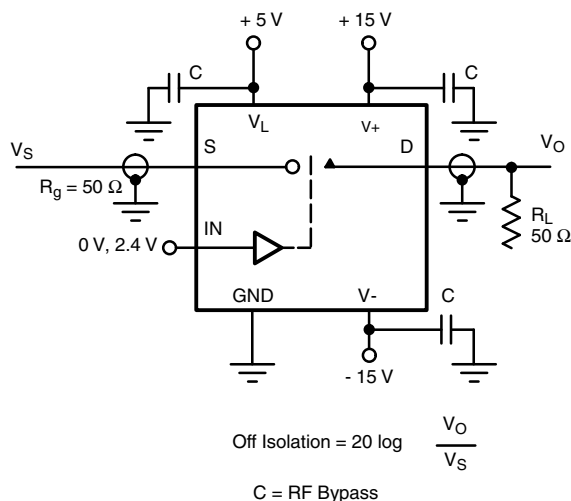
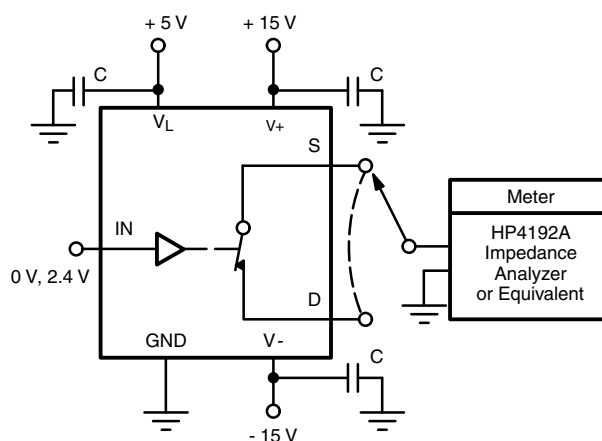
**SCHEMATIC DIAGRAM** (typical channel)

**Fig. 1**
**TEST CIRCUITS**

 $C_L$  (includes fixture and stray capacitance)

$$V_O = V_S \frac{R_L}{R_L + r_{DS(on)}}$$



Note: Logic input waveform is inverted for switches that have the opposite logic sense control

**Fig. 2 - Switching Time**

 $C_L$  (includes fixture and stray capacitance)

**Fig. 3 - Break-Before-Make (DG413HS)**

**TEST CIRCUITS**

**Fig. 4 - Charge Injection**

**Fig. 5 - Crosstalk**

**Fig. 6 - Off-Isolation**

**Fig. 7 - Source/Drain Capacitances**



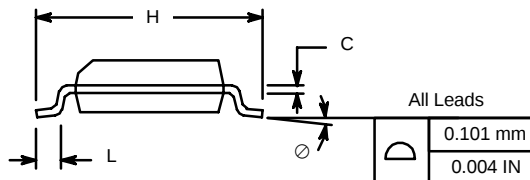
| PRODUCT SUMMARY                   |                                                        |                                                        |                                                        |                                                        |                                                        |                                                        |                                                        |
|-----------------------------------|--------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------|
| Part number                       | DG411HS                                                | DG411HS                                                | DG411HS                                                | DG412HS                                                | DG412HS                                                | DG413HS                                                | DG413HS                                                |
| Status code                       | 2                                                      | 2                                                      | 2                                                      | 2                                                      | 2                                                      | 2                                                      | 2                                                      |
| Configuration                     | SPST x 4, NC                                           | SPST x 4, NC                                           | SPST x 4, NC                                           | SPST x 4, NO                                           | SPST x 4, NO                                           | SPST x 4, comp                                         | SPST x 4, comp                                         |
| Single supply min. (V)            | 5                                                      | 5                                                      | 5                                                      | 5                                                      | 5                                                      | 5                                                      | 5                                                      |
| Single supply max. (V)            | 36                                                     | 36                                                     | 36                                                     | 36                                                     | 36                                                     | 36                                                     | 36                                                     |
| Dual supply min. (V)              | 5                                                      | 5                                                      | 5                                                      | 5                                                      | 5                                                      | 5                                                      | 5                                                      |
| Dual supply max. (V)              | 22                                                     | 22                                                     | 22                                                     | 22                                                     | 22                                                     | 22                                                     | 22                                                     |
| On-resistance ( $\Omega$ )        | 35                                                     | 35                                                     | 35                                                     | 35                                                     | 35                                                     | 35                                                     | 35                                                     |
| Charge injection (pC)             | 22                                                     | 22                                                     | 22                                                     | 22                                                     | 22                                                     | 22                                                     | 22                                                     |
| Source on capacitance (pF)        | 30                                                     | 30                                                     | 30                                                     | 30                                                     | 30                                                     | 30                                                     | 30                                                     |
| Source off capacitance (pF)       | 12                                                     | 12                                                     | 12                                                     | 12                                                     | 12                                                     | 12                                                     | 12                                                     |
| Leakage switch on typ. (nA)       | 0.1                                                    | 0.1                                                    | 0.1                                                    | 0.1                                                    | 0.1                                                    | 0.1                                                    | 0.1                                                    |
| Leakage switch off max. (nA)      | 0.25                                                   | 0.25                                                   | 0.25                                                   | 0.25                                                   | 0.25                                                   | 0.25                                                   | 0.25                                                   |
| -3 dB bandwidth (MHz)             | -                                                      | -                                                      | -                                                      | -                                                      | -                                                      | -                                                      | -                                                      |
| Package                           | Plastic DIP-16                                         | SO-16 (narrow) AS                                      | QFN-16 4 x 4                                           | Plastic DIP-16                                         | SO-16 (narrow) AS                                      | SO-16 (narrow) AS                                      | QFN-16 4 x 4                                           |
| Functional circuit / applications | Multi purpose, medical and healthcare, instrumentation | Multi purpose, medical and healthcare, instrumentation | Multi purpose, medical and healthcare, instrumentation | Multi purpose, medical and healthcare, instrumentation | Multi purpose, medical and healthcare, instrumentation | Multi purpose, medical and healthcare, instrumentation | Multi purpose, medical and healthcare, instrumentation |
| Interface                         | Parallel                                               | Parallel                                               | Parallel                                               | Parallel                                               | Parallel                                               | Parallel                                               | Parallel                                               |
| Single supply operation           | Yes                                                    | Yes                                                    | Yes                                                    | Yes                                                    | Yes                                                    | Yes                                                    | Yes                                                    |
| Dual supply operation             | Yes                                                    | Yes                                                    | Yes                                                    | Yes                                                    | Yes                                                    | Yes                                                    | Yes                                                    |
| Turn on time max. (ns)            | 105                                                    | 105                                                    | 105                                                    | 105                                                    | 105                                                    | 105                                                    | 105                                                    |
| Crosstalk and off isolation       | -91                                                    | -91                                                    | -91                                                    | -91                                                    | -91                                                    | -91                                                    | -91                                                    |

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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 |
| Ø              | 0°          | 8°    | 0°        | 8°    |

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

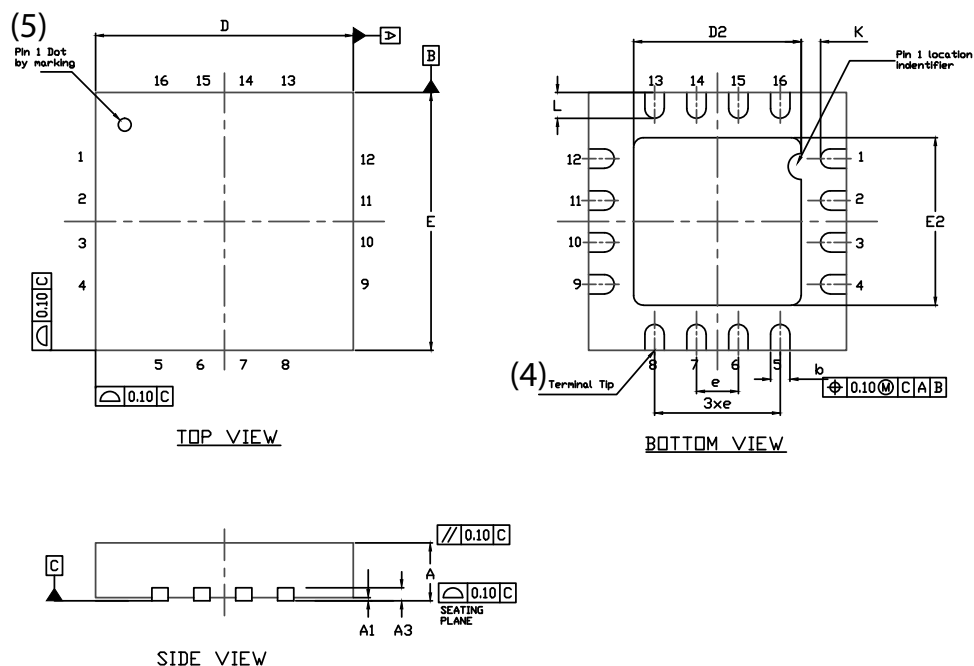


**PDIP: 16-LEAD**



| 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<br>DWG: 5482 |             |       |        |       |

## QFN 4x4-16L Case Outline



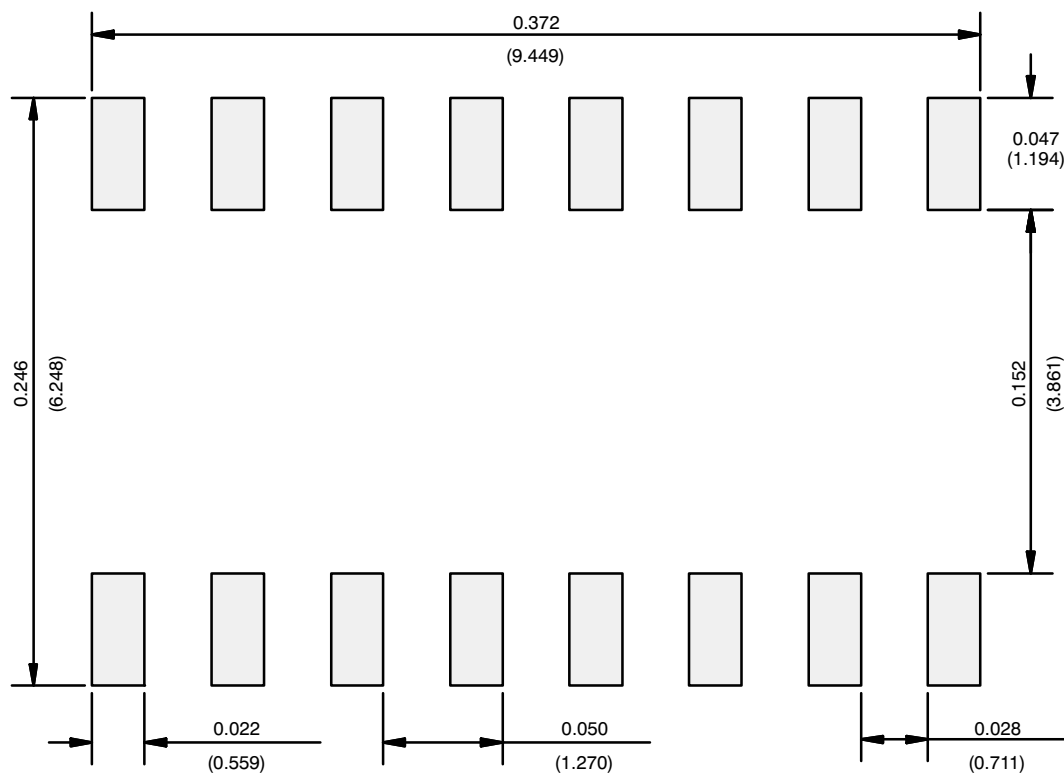
| DIM               | VARIATION 1                |      |      |            |       |       | VARIATION 2                |      |      |            |       |       |
|-------------------|----------------------------|------|------|------------|-------|-------|----------------------------|------|------|------------|-------|-------|
|                   | MILLIMETERS <sup>(1)</sup> |      |      | INCHES     |       |       | MILLIMETERS <sup>(1)</sup> |      |      | 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 <sup>(3)</sup>  | 16                         |      |      | 16         |       |       | 16                         |      |      | 16         |       |       |
| Nd <sup>(3)</sup> | 4                          |      |      | 4          |       |       | 4                          |      |      | 4          |       |       |
| Ne <sup>(3)</sup> | 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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