



# 17 Ω, +12 V / ± 5 V / +5 V / +3 V, 8-Ch / Dual 4-Ch High Performance Analog Multiplexers

## DESCRIPTION

The DG408LE, DG409LE are monolithic analog multiplexers / demultiplexers designed to operate on single and dual supplies. Single supply voltage ranges from 3 V to 16 V while dual supply operation is recommended with ± 3 V to ± 8 V.

The DG408LE is an 8 channel single-ended analog multiplexer designed to connect one of eight inputs to a common output as determined by a 3 bit binary address (A<sub>0</sub>, A<sub>1</sub>, A<sub>2</sub>). The DG409LE is a dual 4 channel differential analog multiplexer designed to connect one of four differential inputs to a common dual output as determined by its 2 bit binary address (A<sub>0</sub>, A<sub>1</sub>). Break-before-make switching action to protect against momentary crosstalk between adjacent channels.

An on channel conducts current equally well in both directions. In the off state each channel blocks voltages up to the power supply rails. An enable (EN) function allows the user to reset the multiplexer / demultiplexer to all switches off for stacking several devices. All control inputs, address (A<sub>x</sub>) and enable (EN) are TTL compatible over the full specified operating temperature range.

The DG408LE, DG409LE feature low on-resistance, fast switching time, and low leakage. They are ideal for data acquisition, control and automation, test instrument, and healthcare products. The DG408LE, DG409LE has an internal regulator powers the logic circuit. Such design reduces device power consumption and makes them ideal for battery operated applications.

The DG408LE, DG409LE are available in TSSOP16, SOIC16, and QFN16 packages.

## FEATURES

- Pin-for-pin compatibility with DG408, DG409, and DG508, DG509
- 3 V to 16 V single supply or ± 3 V to ± 8 V dual supply operation
- Low power consumption: 6 μA/max., EN = V<sub>X</sub> = 5 V
- Lower on-resistance: R<sub>DS(on)</sub> - 17 Ω typ.
- Fast switching: t<sub>ON</sub> - 55 ns, t<sub>OFF</sub> - 36 ns
- Break-before-make guaranteed
- Low leakage: I<sub>S(OFF)</sub> - 1 nA max.
- TTL, CMOS, LV logic (3 V) compatible
- -99 dB off-isolation and -98 dB crosstalk at 100 kHz
- Low parasitic capacitances: C<sub>S(OFF)</sub> = 5.5 pF, C<sub>D(ON)</sub> = 35 pF (DG408LE)
- ESD Protection: ± 2.5 kV human body model, ± 100 V machine model
- 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.

## BENEFITS

- High accuracy
- Single and dual power rail capacity
- Wide operating voltage range
- Simple logic interface

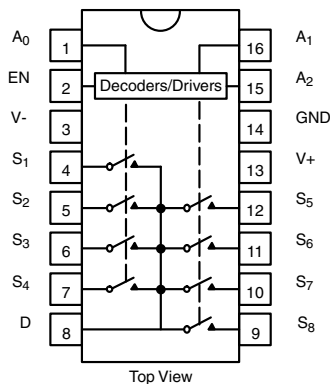
## APPLICATIONS

- Automatic test equipment
- Data acquisition systems
- Meters and instruments
- Medical and healthcare systems
- Communication systems
- Audio and video signal routing
- Relay replacement
- Battery powered systems
- Computer peripherals
- Audio and video signal routing

## FUNCTIONAL BLOCK DIAGRAMS AND PIN CONFIGURATIONS

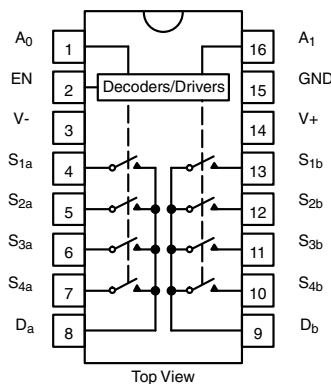
DG408LE

Dual-In- Line, SOIC and TSSOP



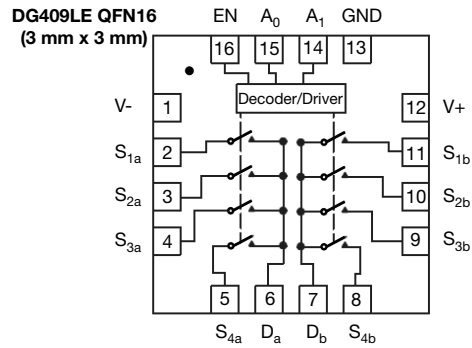
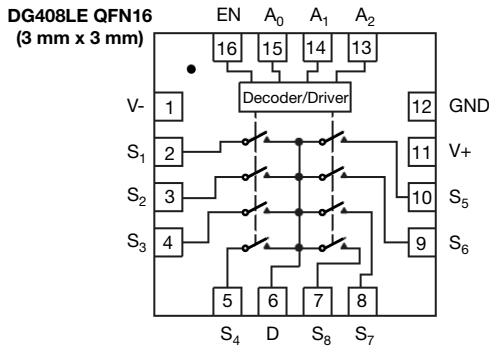
DG409LE

Dual-In- Line, SOIC and TSSOP





**QFN OUTLINE**



| TRUTH TABLE (DG408LE) |                |                |    |           |
|-----------------------|----------------|----------------|----|-----------|
| A <sub>2</sub>        | A <sub>1</sub> | A <sub>0</sub> | EN | ON SWITCH |
| X                     | X              | X              | 0  | None      |
| 0                     | 0              | 0              | 1  | 1         |
| 0                     | 0              | 1              | 1  | 2         |
| 0                     | 1              | 0              | 1  | 3         |
| 0                     | 1              | 1              | 1  | 4         |
| 1                     | 0              | 0              | 1  | 5         |
| 1                     | 0              | 1              | 1  | 6         |
| 1                     | 1              | 0              | 1  | 7         |
| 1                     | 1              | 1              | 1  | 8         |

| TRUTH TABLE (DG409LE) |                |    |           |
|-----------------------|----------------|----|-----------|
| A <sub>1</sub>        | A <sub>0</sub> | EN | ON SWITCH |
| X                     | X              | 0  | None      |
| 0                     | 0              | 1  | 1         |
| 0                     | 1              | 1  | 2         |
| 1                     | 0              | 1  | 3         |
| 1                     | 1              | 1  | 4         |

**Note**

- For low and high voltage levels for V<sub>AX</sub> and V<sub>EN</sub> consult “Digital Control” parameters for specific V+ operation.

| ORDERING INFORMATION          |  |  |                           |                             |
|-------------------------------|--|--|---------------------------|-----------------------------|
| TEMP. RANGE                   | CONFIGURATION                              | PACKAGE                                    | PART NUMBER               | MIN. ORDER / PACK. QUANTITY |
| -40 °C to +85 °C<br>Lead-free | 8 Channel<br>Single Ended<br>DG408LE       | 16-pin TSSOP                               | DG408LEDQ-GE3             | Tube 360 units              |
|                               |  |  | DG408LEDQ-T1-GE3          | Tape and reel, 3000 units   |
|                               |  | 16-pin SOIC                                | DG408LEDY-GE3             | Tube 500 units              |
|                               |  |  | DG408LEDY-T1-GE3          | Tape and reel, 2500 units   |
|                               |  | 16-pin QFN<br>(3 mm x 3 mm)<br>Variation 2 | DG408LEDN-T1-GE4          | Tape and reel, 2500 units   |
|                               |  | Dual 4 Channel<br>Differential<br>DG409LE  | 16-pin TSSOP              | DG409LEDQ-GE3               |
|                               | DG409LEDQ-T1-GE3                           |  |                           | Tape and reel, 3000 units   |
|                               | 16-pin SOIC                                |  | DG409LEDY-GE3             | Tube 500 units              |
|                               |  |  | DG409LEDY-T1-GE3          | Tape and reel, 2500 units   |
|                               | 16-pin QFN<br>(3 mm x 3 mm)<br>Variation 2 | DG409LEDN-T1-GE4                           | Tape and reel, 2500 units |                             |

**Note**

- T1 indicates tape and reel, -GE3 indicates lead (Pb)-free and RoHS-compliant, NO -GE3 indicates standard tin/lead finish.
- Exposed pad of QFN package can be connected to GND, V-, or left floating.



| ABSOLUTE MAXIMUM RATINGS  |                                   |                         |      |
|---|-----------------------------------|-------------------------|------|
| PARAMETER   |                                   | LIMIT                   | UNIT |
| V+ to V- <sup>e</sup>   |                                   | 18                      | V    |
| GND to V-   |                                   | -18                     |      |
| Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub>           |                                   | (V-) - 0.3 to (V) + 0.3 |      |
| Current (any terminal)  |                                   | 30                      | mA   |
| Peak Current, S or D (pulsed at 1 ms, 10 % duty cycle max.)             |                                   | 100                     |      |
| Storage Temperature   | (D suffix)                        | -65 to +125             | °C   |
| Power Dissipation (package) <sup>b</sup>                                | 16-pin plastic TSSOP <sup>c</sup> | 600                     | mW   |
|   | 16-pin narrow SOIC <sup>c</sup>   | 600                     |      |
|   | 16-pin miniQFN <sup>d</sup>       | 1385                    |      |
| ESD Human Body Model (HBM); per ANSI / ESDA / JEDEC <sup>®</sup> JS-001 |                                   | 2500                    | V    |
| Latch Up Current, per JESD78D   |                                   | 300                     | mA   |

Notes

- a. Signals on S<sub>x</sub>, D<sub>x</sub>, A<sub>x</sub>, or EN exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- b. All leads soldered or welded to PC board.
- c. Derate 8 mW/°C above 75 °C.
- d. Derate 17.3 mW/°C above 70 °C
- e. Also applies when V- = GND

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.



| SPECIFICATIONS (Single Supply 12 V)                        |                       |  |  |                   |                              |                   |      |   |    |
|--|-----------------------|--|--|-------------------|------------------------------|-------------------|------|---|----|
| PARAMETER  | SYMBOL                | TEST CONDITIONS<br>UNLESS OTHERWISE SPECIFIED<br>V+ = 12 V, ± 10 %, V- = 0 V<br>V <sub>EN</sub> = 0.8 V or 2.4 V <sup>f</sup>        | TEMP. <sup>b</sup>                                     | TYP. <sup>d</sup> | D SUFFIX<br>-40 °C to +85 °C |                   | UNIT |   |    |
|  |                       |  |  |                   | MIN. <sup>c</sup>            | MAX. <sup>c</sup> |      |   |    |
| <b>Analog Switch</b>                                       |                       |  |  |                   |                              |                   |      |   |    |
| Analog Signal Range <sup>e</sup>                           | V <sub>ANALOG</sub>   |  | Full   | -                 | 0                            | 12                | V    |   |    |
| Drain-Source On-Resistance                                 | R <sub>DS(on)</sub>   | V <sub>D</sub> = 10.8 V, V <sub>D</sub> = 2 V or 9 V, I <sub>S</sub> = 10 mA<br>sequence each switch on                              | Room   | 17                | -                            | 23                | Ω    |   |    |
|  |                       |  | Full   | -                 | -                            | 27                |      |   |    |
| R <sub>DS(on)</sub> Matching Between Channels <sup>g</sup> | ΔR <sub>DS</sub>      | V <sub>D</sub> = 10.8 V, V <sub>D</sub> = 2 V or 9 V<br>I <sub>S</sub> = 10 mA   | Room   | 1                 | -                            | 3                 | Ω    |   |    |
| On-Resistance Flatness                                     | R <sub>FLAT(on)</sub> |  | Room   | 3                 | -                            | 6.5               |      |   |    |
| Switch Off Leakage Current <sup>a</sup>                    | I <sub>S(off)</sub>   | V <sub>EN</sub> = 0 V, V <sub>D</sub> = 11 V or 1 V<br>V <sub>S</sub> = 1 V or 11 V  | Room   | -                 | -1                           | 1                 | nA   |   |    |
|  |                       |  | Full   | -                 | -5                           | 5                 |      |   |    |
|  | I <sub>D(on)</sub>    |  | Room   | -                 | -1                           | 1                 |      |   |    |
|  |                       |  | Full   | -                 | -5                           | 5                 |      |   |    |
| Channel On Leakage Current <sup>a</sup>                    | I <sub>D(on)</sub>    | V <sub>S</sub> = V <sub>D</sub> = 1 V or 11 V  | Room   | -                 | -1                           | 1                 |      |   |    |
|  |                       |  | Full   | -                 | -5                           | 5                 |      |   |    |
| <b>Digital Control</b>                                     |                       |  |  |                   |                              |                   |      |   |    |
| Logic High Input Voltage                                   | V <sub>INH</sub>      |  | Full   | -                 | 2.4                          | -                 | V    |   |    |
| Logic Low Input Voltage                                    | V <sub>INL</sub>      |  | Full   | -                 | -                            | 0.8               |      |   |    |
| Input Current <sup>a</sup>                                 | I <sub>IN</sub>       | V <sub>AX</sub> = V <sub>EN</sub> = 2.4 V or 0.8 V   | Full   | -                 | -1                           | 1                 | μA   |   |    |
| <b>Dynamic Characteristics</b>                             |                       |  |  |                   |                              |                   |      |   |    |
| Transition Time  | t <sub>TRANS</sub>    | V <sub>S1</sub> = 8 V, V <sub>S8</sub> = 0 V, (DG408LE)<br>V <sub>S1b</sub> = 8 V, V <sub>S4b</sub> = 0 V, (DG409LE)<br>see figure 2 | Room   | 85                | -                            | 100               | ns   |   |    |
|  |                       |  | Full   | -                 | -                            | 110               |      |   |    |
| Break-Before-Make Time                                     | t <sub>OPEN</sub>     | V <sub>S(all)</sub> = V <sub>DA</sub> = 5 V<br>see figure 4  | Room   | 34                | 1                            | -                 | ns   |   |    |
|  |                       |  | Full   | -                 | -                            | -                 |      |   |    |
| Enable Turn-On Time  | t <sub>ON(EN)</sub>   | V <sub>AX</sub> = 0 V, V <sub>S1</sub> = 5 V (DG408LE)<br>V <sub>AX</sub> = 0 V, V <sub>S1b</sub> = 5 V (DG409LE)<br>see figure 3    | Room   | 55                | -                            | 72                | ns   |   |    |
|  |                       |  | Full   | -                 | -                            | 82                |      |   |    |
| Enable Turn-Off Time                                       | t <sub>OFF(EN)</sub>  |  | Room   | 36                | -                            | 47                |      |   |    |
|  |                       |  | Full   | -                 | -                            | 50                |      |   |    |
| Charge Injection <sup>e</sup> (DG408LE)                    | Q                     | C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 6 V, R <sub>GEN</sub> = 0 Ω  | Room   | -11               | -                            | -                 | pC   |   |    |
| Charge Injection <sup>e</sup> (DG409LE)                    |                       |  | Room   | -10               | -                            | -                 |      |   |    |
| Off Isolation <sup>e, h</sup> (DG408LE)                    | OIRR                  | f = 100 kHz, R <sub>L</sub> = 50 Ω   | Room   | -99               | -                            | -                 | dB   |   |    |
| Off Isolation <sup>e, h</sup> (DG409LE)                    |                       |  | Room   | -87               | -                            | -                 |      |   |    |
| Crosstalk <sup>e</sup> (DG408LE)                           | X <sub>TALK</sub>     |  | Room   | -98               | -                            | -                 |      |   |    |
|  |                       |  | Room   | -109              | -                            | -                 |      |   |    |
| Source Off Capacitance <sup>e</sup> (DG408LE)              | C <sub>S(off)</sub>   |  | f = 1 MHz, V <sub>S</sub> = 0 V, V <sub>EN</sub> = 0 V | Room              | 5.5                          | -                 |      | - | pF |
| Source Off Capacitance <sup>e</sup> (DG409LE)              |                       |  |  | Room              | 5.5                          | -                 |      | - |    |
| Drain Off Capacitance <sup>e</sup> (DG408LE)               | C <sub>D(off)</sub>   | f = 1 MHz, V <sub>D</sub> = 2.4 V, V <sub>EN</sub> = 0 V   | Room   | 25                | -                            | -                 | pF   |   |    |
| Drain Off Capacitance <sup>e</sup> (DG409LE)               |                       |  | Room   | 13.5              | -                            | -                 |      |   |    |
| Drain On Capacitance (DG408LE)                             | C <sub>D(on)</sub>    | f = 1 MHz, V <sub>D</sub> = 0 V, V <sub>EN</sub> = 2.4 V<br>(DG409LE only)   | Room   | 35                | -                            | -                 | pF   |   |    |
| Drain On Capacitance <sup>e</sup> (DG409LE)                |                       |  | Room   | 23.5              | -                            | -                 |      |   |    |
| <b>Power Supplies</b>                                      |                       |  |  |                   |                              |                   |      |   |    |
| Power Supply Range   | V+                    |  |  | -                 | 3                            | 12                | V    |   |    |
| Power Supply Current                                       | I+                    | V <sub>EN</sub> = V <sub>A</sub> = 0 V or 5 V  | Room   | 3.5               | -                            | 6                 | μA   |   |    |

**Notes**

- a. Leakage parameters are guaranteed by worst case test condition and not subject to production test.
- b. Room = 25 °C, Full = as determined by the operating temperature suffix.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- d. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- e. Guaranteed by design, not subject to production test.
- f. V<sub>IN</sub> = input voltage to perform proper function.
- g. ΔR<sub>DS(on)</sub> = R<sub>DS(on)</sub> max. - R<sub>DS(on)</sub> min.
- h. Worst case isolation occurs on Channel 4 do to proximity to the drain pin.



| SPECIFICATIONS (Dual Supply $V_+ = 5\text{ V}$ , $V_- = -5\text{ V}$ ) |               |  |                    |                   |                              |                   |               |
|--|---------------|--|--------------------|-------------------|------------------------------|-------------------|---------------|
| PARAMETER  | SYMBOL        | TEST CONDITIONS<br>UNLESS OTHERWISE SPECIFIED<br>$V_+ = 5\text{ V}$ , $\pm 10\%$ , $V_- = -5\text{ V}$<br>$V_{EN} = 0.6\text{ V}$ or $2.4\text{ V}$ <sup>f</sup> | TEMP. <sup>b</sup> | TYP. <sup>d</sup> | D SUFFIX<br>-40 °C to +85 °C |                   | UNIT          |
|  |               |  |                    |                   | MIN. <sup>c</sup>            | MAX. <sup>c</sup> |               |
| <b>Analog Switch</b>   |               |  |                    |                   |                              |                   |               |
| Analog Signal Range <sup>e</sup>                                       | $V_{ANALOG}$  |  | Full               | -                 | -5                           | 5                 | V             |
| Drain-Source On-Resistance   | $R_{DS(on)}$  | $V_D = \pm 3.5\text{ V}$ , $I_S = 10\text{ mA}$<br>sequence each switch on   | Room               | 15                | -                            | 25                | $\Omega$      |
|  |               |  | Full               | -                 | -                            | 30                |               |
| Switch Off Leakage Current <sup>a</sup>                                | $I_{S(off)}$  | $V_+ = 5.5\text{ V}$ , $V_- = 5.5\text{ V}$<br>$V_{EN} = 0\text{ V}$ , $V_D = \pm 4.5\text{ V}$ , $V_S = \pm 4.5\text{ V}$                                       | Room               | -                 | -1                           | 1                 | nA            |
|  |               |  | Full               | -                 | -5                           | 5                 |               |
|  | Room          |  | -                  | -1                | 1                            |                   |               |
|  | Full          |  | -                  | -5                | 5                            |                   |               |
| Channel On Leakage Current <sup>a</sup>                                | $I_{D(on)}$   | $V_+ = 5.5\text{ V}$ , $V_- = -5.5\text{ V}$<br>$V_{EN} = 2.4\text{ V}$ , $V_D = \pm 4.5\text{ V}$ , $V_S = \pm 4.5\text{ V}$                                    | Room               | -                 | -1                           | 1                 |               |
|  |               |  | Full               | -                 | -5                           | 5                 |               |
| <b>Digital Control</b>   |               |  |                    |                   |                              |                   |               |
| Logic High Input Voltage   | $V_{INH}$     |  | Full               | -                 | 2.4                          | -                 | V             |
| Logic Low Input Voltage  | $V_{INL}$     |  | Full               | -                 | -                            | 0.6               |               |
| Input Current <sup>a</sup>   | $I_{IN}$      | $V_{AX} = V_{EN} = 2.4\text{ V}$ or $0.6\text{ V}$   | Full               | -                 | -1                           | 1                 | $\mu\text{A}$ |
| <b>Dynamic Characteristics</b>   |               |  |                    |                   |                              |                   |               |
| Transition Time  | $t_{TRANS}$   | $V_{S1} = 3.5\text{ V}$ , $V_{S8} = -3.5\text{ V}$ , (DG408LE)<br>$V_{S1b} = 3.5\text{ V}$ , $V_{S4b} = -3.5\text{ V}$ , (DG409LE)<br>see figure 2               | Room               | 87                | -                            | 100               | ns            |
|  |               |  | Full               | -                 | -                            | 120               |               |
| Break-Before-Make Time   | $t_{OPEN}$    | $V_{S(all)} = V_{DA} = 3.5\text{ V}$<br>see figure 4   | Room               | 84                | 1                            | -                 | ns            |
|  |               |  | Full               | -                 | -                            | -                 |               |
| Enable Turn-On Time  | $t_{ON(EN)}$  | $V_{AX} = 0\text{ V}$ , $V_{S1} = 3.5\text{ V}$ (DG408LE)<br>$V_{AX} = 0\text{ V}$ , $V_{S1b} = 3.5\text{ V}$ (DG409LE)<br>see figure 3                          | Room               | 58                | -                            | 73                | ns            |
|  |               |  | Full               | -                 | -                            | 80                |               |
| Enable Turn-Off Time   | $t_{OFF(EN)}$ |  | Room               | 31                | -                            | 46                |               |
|  |               |  | Full               | -                 | -                            | 51                |               |
| Source Off Capacitance <sup>e</sup><br>(DG408LE)                       | $C_{S(off)}$  | $f = 1\text{ MHz}$ , $V_S = 0\text{ V}$ , $V_{EN} = 0\text{ V}$  | Room               | 6                 | -                            | -                 | pF            |
| Source Off Capacitance <sup>e</sup><br>(DG409LE)                       |               |  | Room               | 5.5               | -                            | -                 |               |
| Drain Off Capacitance <sup>e</sup><br>(DG408LE)                        | $C_{D(off)}$  | $f = 1\text{ MHz}$ , $V_D = 0\text{ V}$ , $V_{EN} = 0\text{ V}$  | Room               | 26                | -                            | -                 |               |
| Drain Off Capacitance <sup>e</sup><br>(DG409LE)                        |               |  | Room               | 14                | -                            | -                 |               |
| Drain On Capacitance <sup>e</sup><br>(DG408LE)                         | $C_{D(on)}$   | $f = 1\text{ MHz}$ , $V_D = 0\text{ V}$ , $V_{EN} = 2.4\text{ V}$  | Room               | 36                | -                            | -                 |               |
| Drain On Capacitance <sup>e</sup><br>(DG409LE)                         |               |  | Room               | 24                | -                            | -                 |               |

**Notes**

- a. Leakage parameters are guaranteed by worst case test condition and not subject to production test.
- b. Room = 25 °C, full = as determined by the operating temperature suffix.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet.
- d. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- e. Guaranteed by design, not subject to production test.
- f.  $V_{IN}$  = input voltage to perform proper function.
- g.  $\Delta R_{DS(on)} = R_{DS(on)} \text{ max.} - R_{DS(on)} \text{ min.}$
- h. Worst case isolation occurs on channel 4 do to proximity to the drain pin.



| SPECIFICATIONS (Single Supply 5 V)                         |                       |  |                    |                   |                              |                   |      |
|--|-----------------------|--|--------------------|-------------------|------------------------------|-------------------|------|
| PARAMETER  | SYMBOL                | TEST CONDITIONS<br>UNLESS OTHERWISE SPECIFIED<br>V+ = 5 V, ± 10 %, V- = 0 V<br>VEN = 0.6 V or 2.4 V <sup>f</sup>                         | TEMP. <sup>b</sup> | TYP. <sup>d</sup> | D SUFFIX<br>-40 °C to +85 °C |                   | UNIT |
|  |                       |  |                    |                   | MIN. <sup>c</sup>            | MAX. <sup>c</sup> |      |
| <b>Analog Switch</b>                                       |                       |  |                    |                   |                              |                   |      |
| Analog Signal Range <sup>e</sup>                           | V <sub>ANALOG</sub>   |  | Full               | -                 | 0                            | 5                 | V    |
| Drain-Source On-Resistance                                 | R <sub>DS(on)</sub>   | V+ = 4.5 V, V <sub>D</sub> or V <sub>S</sub> = 1 V or 3.5 V,<br>I <sub>S</sub> = 5 mA  | Room               | 28                | -                            | 36                | Ω    |
|  |                       |  | Full               | -                 | -                            | 41                |      |
| R <sub>DS(on)</sub> Matching Between Channels <sup>g</sup> | ΔR <sub>DS</sub>      | V+ = 4.5 V, V <sub>D</sub> = 1 V or 3.5 V,<br>I <sub>S</sub> = 5 mA  | Room               | 1                 | -                            | 3                 | Ω    |
| On-Resistance Flatness                                     | R <sub>FLAT(on)</sub> |  | Room               | -                 | -                            | 4                 |      |
| Switch Off Leakage Current <sup>a</sup>                    | I <sub>S(off)</sub>   | V+ = 5.5 V, V <sub>S</sub> = 1 V or 4 V<br>V <sub>D</sub> = 4 V or 1 V   | Room               | -                 | -1                           | 1                 | nA   |
|  | I <sub>D(off)</sub>   |  | Full               | -                 | -5                           | 5                 |      |
| I <sub>D(on)</sub>   |                       |  | Room               | -                 | -1                           | 1                 |      |
|  | Full                  |  | -                  | -5                | 5                            |                   |      |
| Channel On Leakage Current <sup>a</sup>                    | I <sub>D(on)</sub>    | V+ = 5.5 V, V <sub>D</sub> = V <sub>S</sub> = 1 V or 4 V<br>sequence each switch on  | Room               | -                 | -1                           | 1                 | nA   |
|  |                       |  | Full               | -                 | -5                           | 5                 |      |
| <b>Digital Control</b>                                     |                       |  |                    |                   |                              |                   |      |
| Logic High Input Voltage                                   | V <sub>INH</sub>      | V+ = 5 V   | Full               | -                 | 2.4                          | -                 | V    |
| Logic Low Input Voltage                                    | V <sub>INL</sub>      |  | Full               | -                 | -                            | 0.6               |      |
| Input Current <sup>a</sup>                                 | I <sub>IN</sub>       | V <sub>AX</sub> = V <sub>EN</sub> = 2.4 V or 0.6 V   | Full               | -                 | -1                           | 1                 | μA   |
| <b>Dynamic Characteristics</b>                             |                       |  |                    |                   |                              |                   |      |
| Transition Time  | t <sub>TRANS</sub>    | V <sub>S1</sub> = 3.5 V, V <sub>S8</sub> = 0 V, (DG408LE)<br>V <sub>S1b</sub> = 3.5 V, V <sub>S4b</sub> = 0 V, (DG409LE)<br>see figure 2 | Room               | 113               | -                            | 135               | ns   |
|  |                       |  | Full               | -                 | -                            | 165               |      |
| Break-Before-Make Time                                     | t <sub>OPEN</sub>     | V <sub>S(all)</sub> = V <sub>DA</sub> = 3.5 V,<br>see figure 4   | Room               | 75                | 1                            | -                 | ns   |
|  |                       |  | Full               | -                 | -                            | -                 |      |
| Enable Turn-On Time  | t <sub>ON(EN)</sub>   | V <sub>AX</sub> = 0 V, V <sub>S1</sub> = 3.5 V (DG408LE)<br>V <sub>AX</sub> = 0 V, V <sub>S1b</sub> = 3.5 V (DG409LE)<br>see figure 3    | Room               | 77                | -                            | 89                | ns   |
|  |                       |  | Full               | -                 | -                            | 110               |      |
| Enable Turn-Off Time                                       | t <sub>OFF(EN)</sub>  |  | Room               | 43                | -                            | 50                |      |
|  |                       |  | Full               | -                 | -                            | 53                |      |
| Charge Injection <sup>e</sup> (DG408LE)                    | Q                     | C <sub>L</sub> = 1 nF, R <sub>GEN</sub> = 0 Ω, V <sub>GEN</sub> = 2.5 V  | Room               | -2                | -                            | -                 | pC   |
| Charge Injection <sup>e</sup> (DG409LE)                    |                       |  | Room               | -2                | -                            | -                 |      |
| Off Isolation <sup>e, h</sup> (DG408LE)                    | OIRR                  | f = 100 kHz, R <sub>L</sub> = 50 Ω   | Room               | -100              | -                            | -                 | dB   |
| Off Isolation <sup>e, h</sup> (DG409LE)                    |                       |  | Room               | -83               | -                            | -                 |      |
| Crosstalk <sup>e</sup> (DG408LE)                           | X <sub>TALK</sub>     |  | Room               | -101              | -                            | -                 |      |
| Crosstalk <sup>e</sup> (DG409LE)                           |                       |  | Room               | -108              | -                            | -                 |      |
| Source Off Capacitance <sup>e</sup> (DG408LE)              | C <sub>S(off)</sub>   | f = 1 MHz, V <sub>S</sub> = 0 V, V <sub>EN</sub> = 0 V   | Room               | 6.5               | -                            | -                 | pF   |
| Source Off Capacitance <sup>e</sup> (DG409LE)              |                       |  | Room               | 6.5               | -                            | -                 |      |
| Drain Off Capacitance <sup>e</sup> (DG408LE)               | C <sub>D(off)</sub>   | f = 1 MHz, V <sub>D</sub> = 0 V, V <sub>EN</sub> = 0 V   | Room               | 30                | -                            | -                 |      |
| Drain Off Capacitance <sup>e</sup> (DG409LE)               |                       |  | Room               | 16                | -                            | -                 |      |
| Drain On Capacitance <sup>e</sup> (DG408LE)                | C <sub>D(on)</sub>    | f = 1 MHz, V <sub>D</sub> = 0 V, V <sub>EN</sub> = 2.4 V   | Room               | 40                | -                            | -                 |      |
| Drain On Capacitance <sup>e</sup> (DG409LE)                |                       |  | Room               | 26.5              | -                            | -                 |      |

**Notes**

- a. Leakage parameters are guaranteed by worst case test condition and not subject to production test.
- b. Room = 25 °C, full = as determined by the operating temperature suffix.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- d. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- e. Guaranteed by design, not subject to production test.
- f. V<sub>IN</sub> = input voltage to perform proper function.
- g. ΔR<sub>DS(on)</sub> = R<sub>DS(on)</sub> max. - R<sub>DS(on)</sub> min.
- h. Worst case isolation occurs on channel 4 do to proximity to the drain pin.



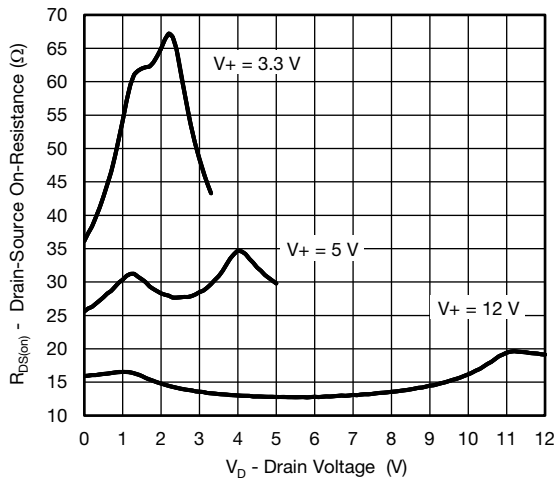
| SPECIFICATIONS (Single Supply 3 V)            |                      |  |                    |                   |                              |                   |      |
|---|----------------------|--|--------------------|-------------------|------------------------------|-------------------|------|
| PARAMETER                                     | SYMBOL               | TEST CONDITIONS<br>UNLESS OTHERWISE SPECIFIED<br>V+ = 3 V, ± 10 %, V- = 0 V<br>VEN = 0.4 V or 2 V <sup>f</sup>                           | TEMP. <sup>b</sup> | TYP. <sup>d</sup> | D SUFFIX<br>-40 °C to +85 °C |                   | UNIT |
|   |                      |  |                    |                   | MIN. <sup>c</sup>            | MAX. <sup>c</sup> |      |
| <b>Analog Switch</b>                          |                      |  |                    |                   |                              |                   |      |
| Analog Signal Range <sup>e</sup>              | V <sub>ANALOG</sub>  |  | Full               | -                 | 0                            | 3                 | V    |
| Drain-Source On-Resistance                    | R <sub>DS(on)</sub>  | V+ = 2.7 V, V <sub>D</sub> = 0.5 or 2.2 V,<br>I <sub>S</sub> = 5 mA  | Room               | 63                | -                            | 80                | Ω    |
|   |                      |  | Full               | -                 | -                            | 92                |      |
| Switch Off Leakage Current <sup>a</sup>       | I <sub>S(off)</sub>  | V+ = 3.3 V, V <sub>S</sub> = 2 or 1 V, V <sub>D</sub> = 1 or 2 V   | Room               | -                 | -1                           | 1                 | nA   |
|   |                      |  | Full               | -                 | -5                           | 5                 |      |
|   | I <sub>D(off)</sub>  |  | Room               | -                 | -1                           | 1                 |      |
|   |                      |  | Full               | -                 | -5                           | 5                 |      |
| Channel On Leakage Current <sup>a</sup>       | I <sub>D(on)</sub>   | V+ = 3.3 V, V <sub>D</sub> = V <sub>S</sub> = 1 V or 2 V<br>sequence each switch on  | Room               | -                 | -1                           | 1                 |      |
|   |                      |  | Full               | -                 | -5                           | 5                 |      |
| <b>Digital Control</b>                        |                      |  |                    |                   |                              |                   |      |
| Logic High Input Voltage                      | V <sub>INH</sub>     |  | Full               | -                 | 2                            | -                 | V    |
| Logic Low Input Voltage                       | V <sub>INL</sub>     |  | Full               | -                 | -                            | 0.4               |      |
| Input Current <sup>a</sup>                    | I <sub>IN</sub>      | V <sub>AX</sub> = V <sub>EN</sub> = 2.4 V or 0.4 V   | Full               | -                 | -1                           | 1                 | μA   |
| <b>Dynamic Characteristics</b>                |                      |  |                    |                   |                              |                   |      |
| Transition Time                               | t <sub>TRANS</sub>   | V <sub>S1</sub> = 1.5 V, V <sub>S8</sub> = 0 V, (DG408LE)<br>V <sub>S1b</sub> = 1.5 V, V <sub>S4b</sub> = 0 V, (DG409LE)<br>see figure 2 | Room               | 211               | -                            | 275               | ns   |
|   |                      |  | Full               | -                 | -                            | 300               |      |
| Break-Before-Make Time                        | t <sub>OPEN</sub>    | V <sub>S(all)</sub> = V <sub>DA</sub> = 1.5 V,<br>see figure 4   | Room               | 209               | 1                            | -                 | ns   |
|   |                      |  | Full               | -                 | -                            | -                 |      |
| Enable Turn-On Time                           | t <sub>ON(EN)</sub>  | V <sub>AX</sub> = 0 V, V <sub>S1</sub> = 1.5 V (DG408LE)<br>V <sub>AX</sub> = 0 V, V <sub>S1b</sub> = 1.5 V (DG409LE)<br>see figure 3    | Room               | 125               | -                            | 150               | ns   |
|   |                      |  | Full               | -                 | -                            | 180               |      |
| Enable Turn-Off Time                          | t <sub>OFF(EN)</sub> |  | Room               | 45                | -                            | 75                |      |
|   |                      |  | Full               | -                 | -                            | 95                |      |
| Charge Injection <sup>e</sup> (DG408LE)       | Q                    | C <sub>L</sub> = 1 nF, R <sub>GEN</sub> = 0 Ω, V <sub>GEN</sub> = 1.5 V  | Room               | 0                 | -                            | -                 | pC   |
| Charge Injection <sup>e</sup> (DG409LE)       |                      |  | Room               | -0.4              | -                            | -                 |      |
| Off Isolation <sup>e, h</sup> (DG408LE)       | OIRR                 | f = 100 kHz, R <sub>L</sub> = 50 Ω   | Room               | -90               | -                            | -                 | dB   |
| Off Isolation <sup>e, h</sup> (DG409LE)       |                      |  | Room               | -95               | -                            | -                 |      |
| Crosstalk <sup>e</sup> (DG408LE)              | X <sub>TALK</sub>    |  | Room               | -95               | -                            | -                 |      |
| Crosstalk <sup>e</sup> (DG409LE)              |                      |  | Room               | -93               | -                            | -                 |      |
| Source Off Capacitance <sup>e</sup> (DG408LE) | C <sub>S(off)</sub>  | f = 1 MHz, V <sub>S</sub> = 0 V, V <sub>EN</sub> = 0 V   | Room               | 7                 | -                            | -                 | pF   |
| Source Off Capacitance <sup>e</sup> (DG409LE) |                      |  | Room               | 7                 | -                            | -                 |      |
| Drain Off Capacitance <sup>e</sup> (DG408LE)  | C <sub>D(off)</sub>  | f = 1 MHz, V <sub>D</sub> = 0 V, V <sub>EN</sub> = 0 V   | Room               | 33                | -                            | -                 |      |
| Drain Off Capacitance <sup>e</sup> (DG409LE)  |                      |  | Room               | 18                | -                            | -                 |      |
| Drain On Capacitance <sup>e</sup> (DG408LE)   | C <sub>D(on)</sub>   | f = 1 MHz, V <sub>D</sub> = 0 V, V <sub>EN</sub> = 2 V   | Room               | 43                | -                            | -                 |      |
| Drain On Capacitance <sup>e</sup> (DG409LE)   |                      |  | Room               | 28                | -                            | -                 |      |

**Notes**

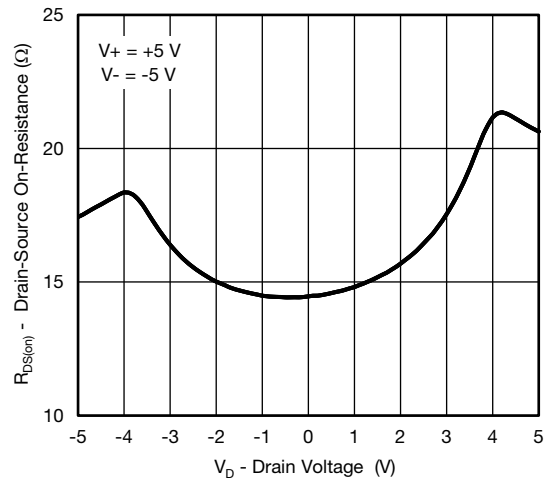
- a. Leakage parameters are guaranteed by worst case test condition and not subject to production test.
- b. Room = 25 °C, full = as determined by the operating temperature suffix.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- d. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- e. Guaranteed by design, not subject to production test.
- f. V<sub>IN</sub> = input voltage to perform proper function.
- g. ΔR<sub>DS(on)</sub> = R<sub>DS(on)</sub> max. - R<sub>DS(on)</sub> min.
- h. Worst case isolation occurs on channel 4 do to proximity to the drain pin.



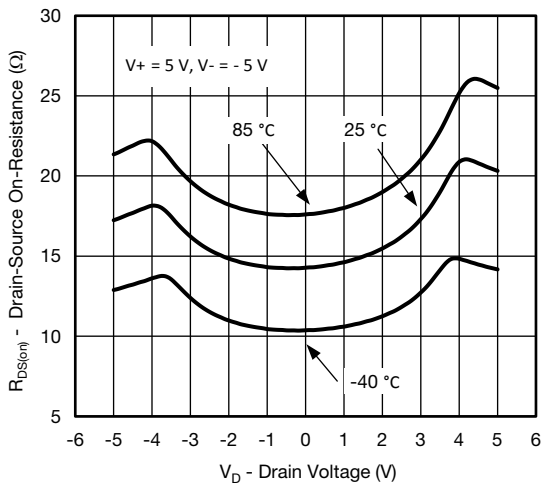
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



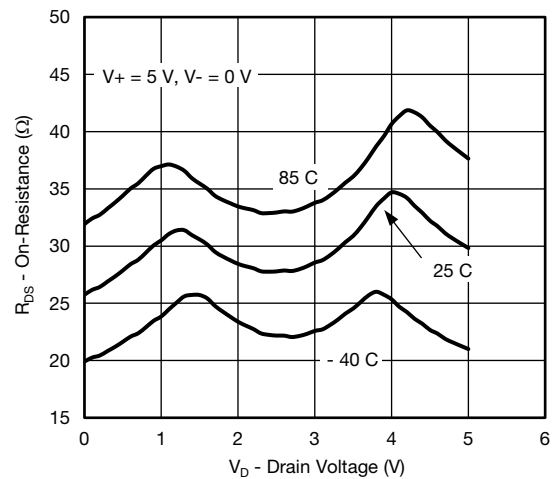
**R<sub>DS(on)</sub> vs. V<sub>D</sub> and Power Supply**



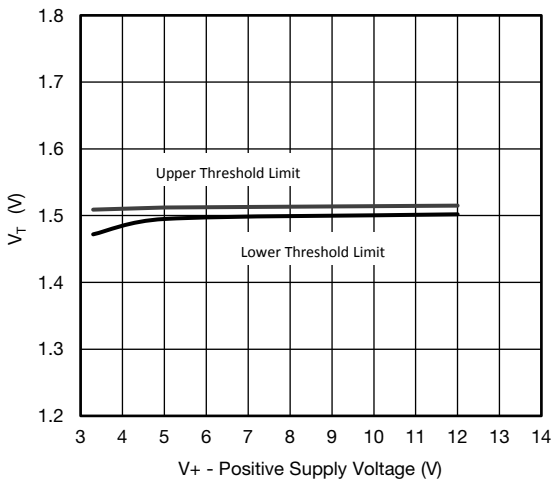
**R<sub>DS(on)</sub> vs. V<sub>D</sub> and Power Supply**



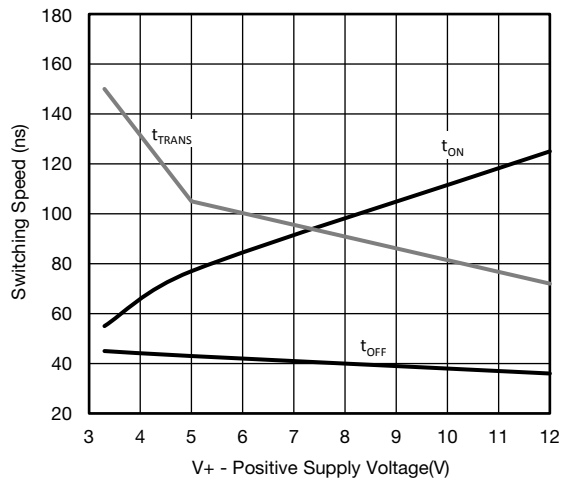
**R<sub>DS(on)</sub> vs. V<sub>D</sub> and Temperature (Dual Supply)**



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



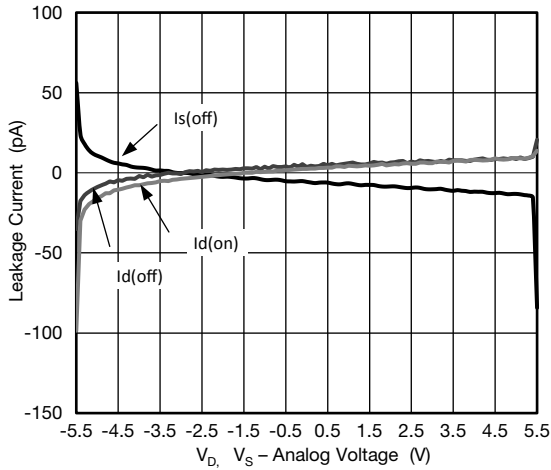
**Input Threshold vs. V<sub>+</sub> Supply Voltage**



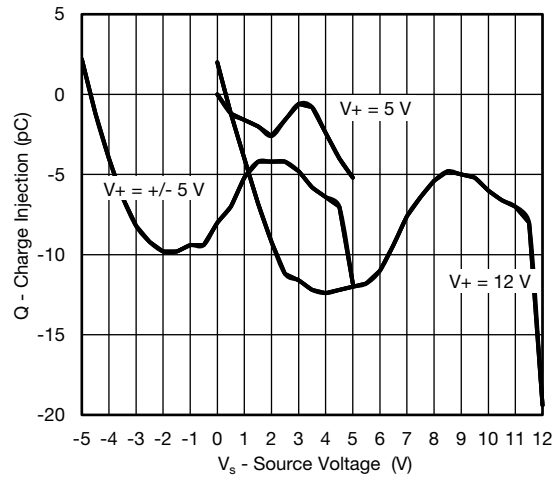
**Switching Time vs. Supply Voltage**



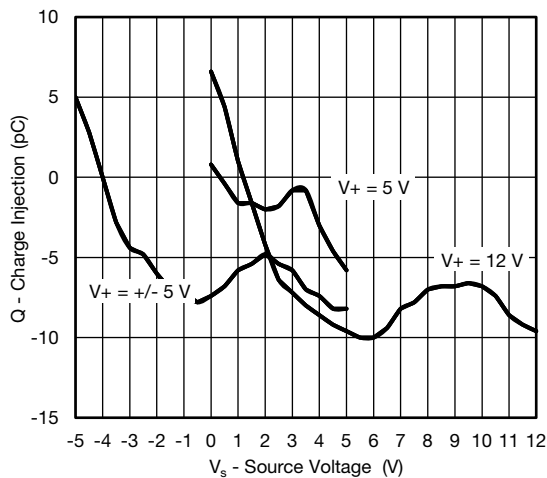
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



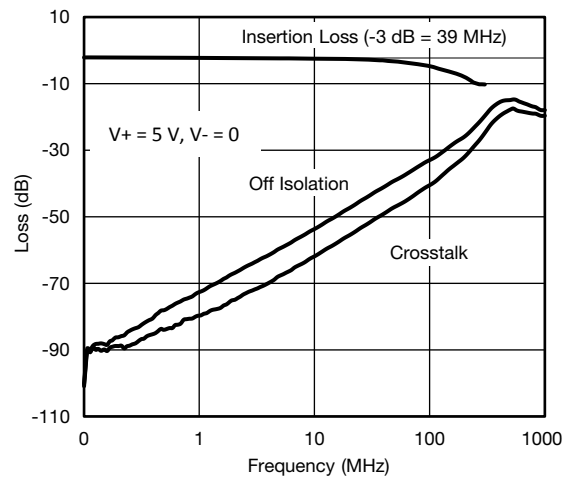
**Leakage Current vs. Analog Voltage**



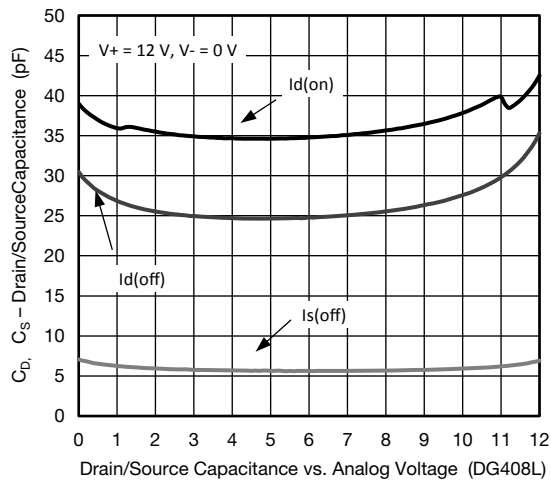
**Charge Injection vs. Analog Voltage (DG408LE)**



**Charge Injection vs. Analog Voltage (DG409LE)**



**Insertion Loss, Off Isolation, and Crosstalk vs. Frequency**



**Drain/Source Capacitance vs. Analog Voltage (DG408LE)**

**SCHEMATIC DIAGRAM** (Typical Channel)

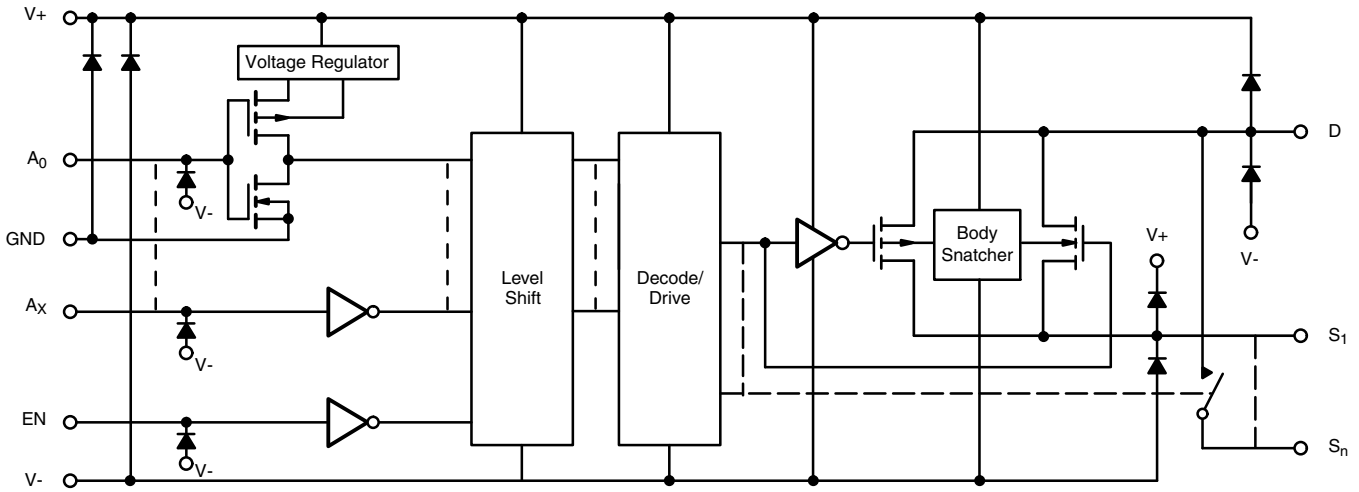


Fig. 1

**TEST CIRCUITS**

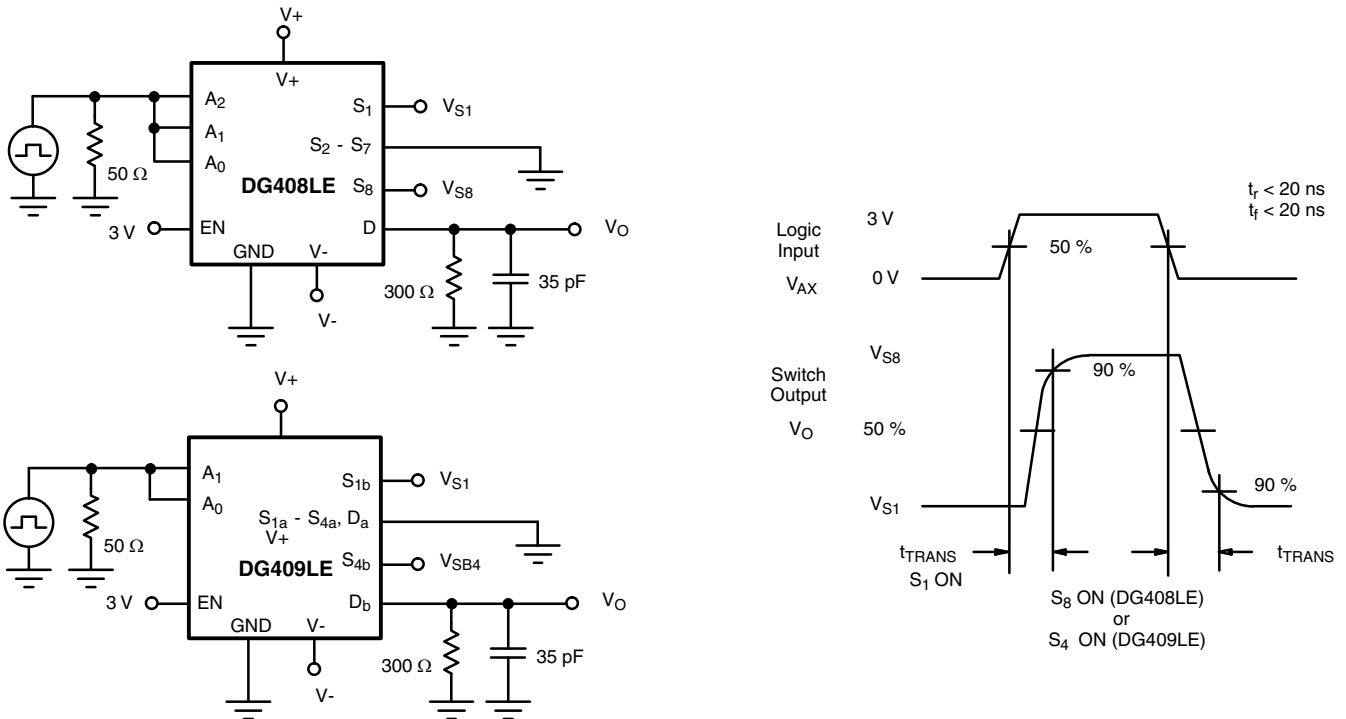


Fig. 2 - Transition Time

TEST CIRCUITS

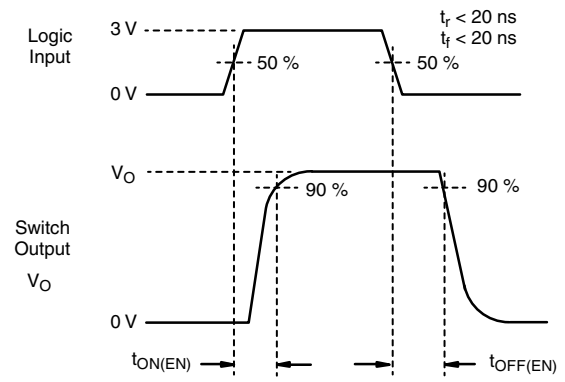
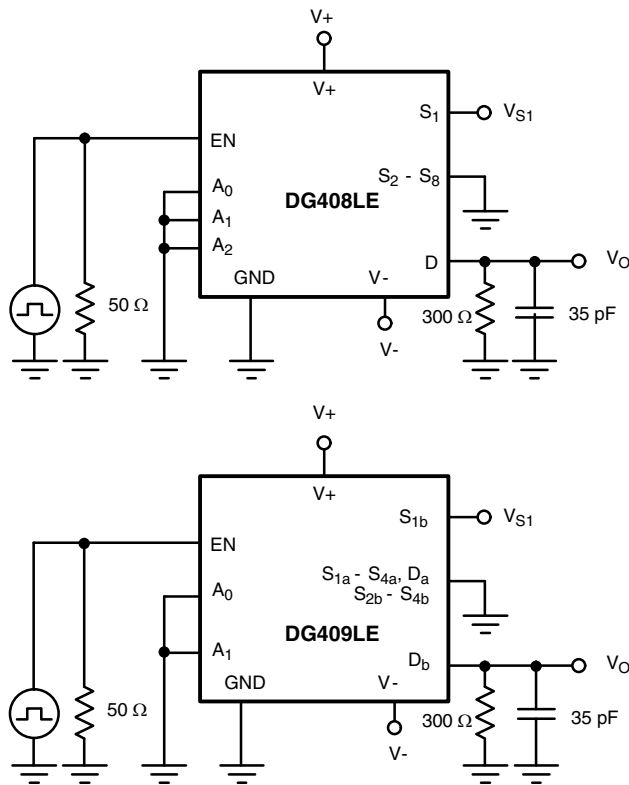


Fig. 3 - Enable Switching Time

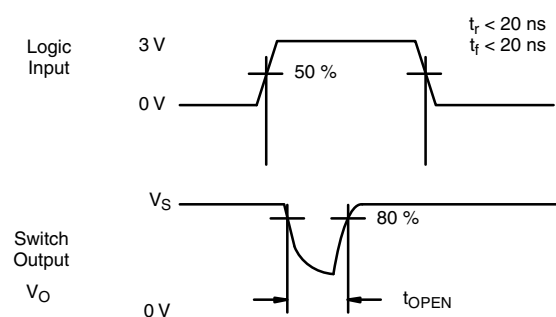
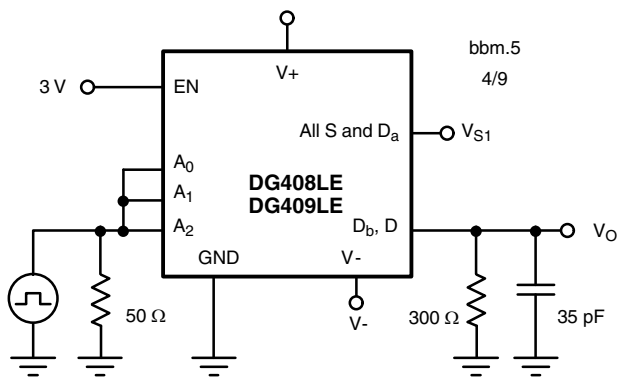


Fig. 4 - Break-Before-Make Interval

TEST CIRCUITS

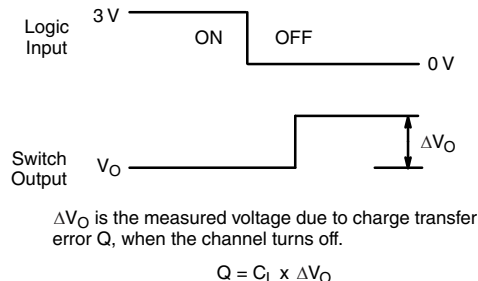
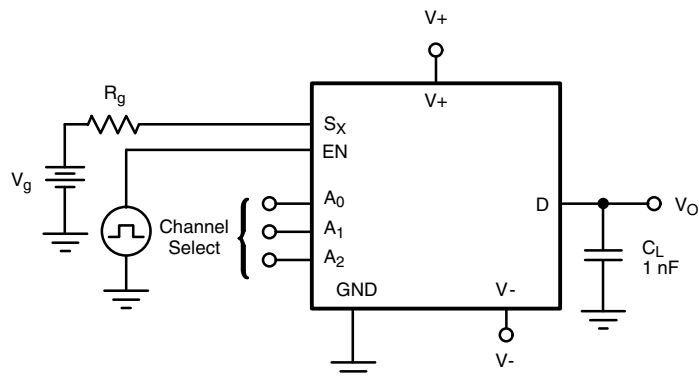


Fig. 5 - Charge Injection

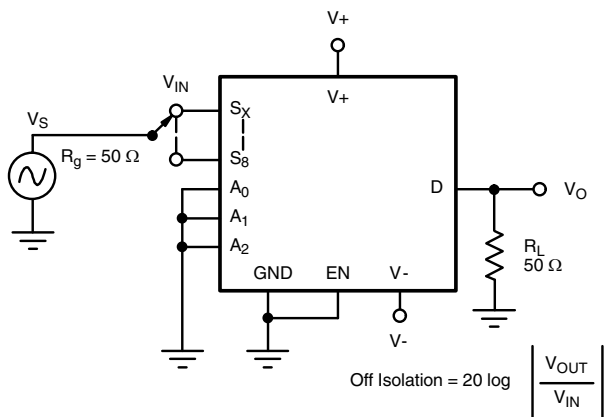


Fig. 6 - Off Isolation

$$\text{Off Isolation} = 20 \log \left| \frac{V_{OUT}}{V_{IN}} \right|$$

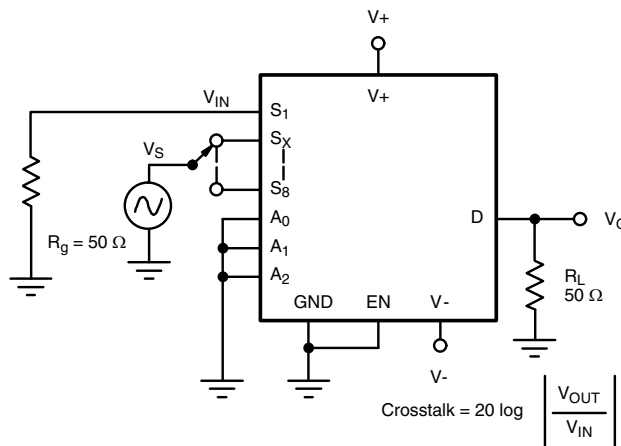


Fig. 7 - Crosstalk

$$\text{Crosstalk} = 20 \log \left| \frac{V_{OUT}}{V_{IN}} \right|$$

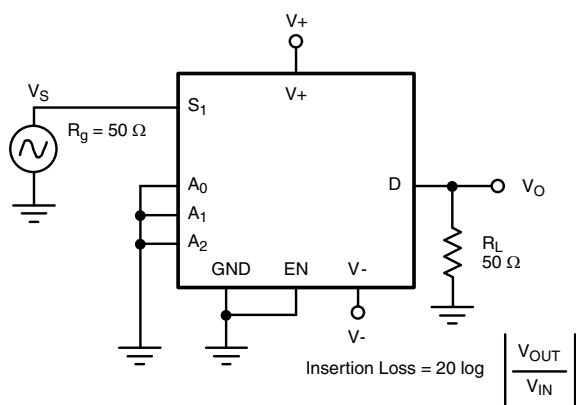


Fig. 8 - Insertion Loss

$$\text{Insertion Loss} = 20 \log \left| \frac{V_{OUT}}{V_{IN}} \right|$$

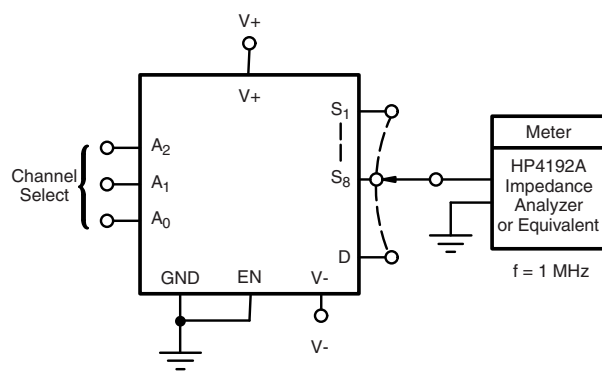
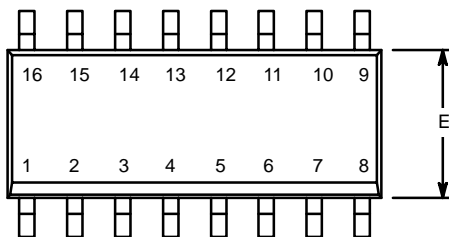


Fig. 9 - Source Drain Capacitance

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

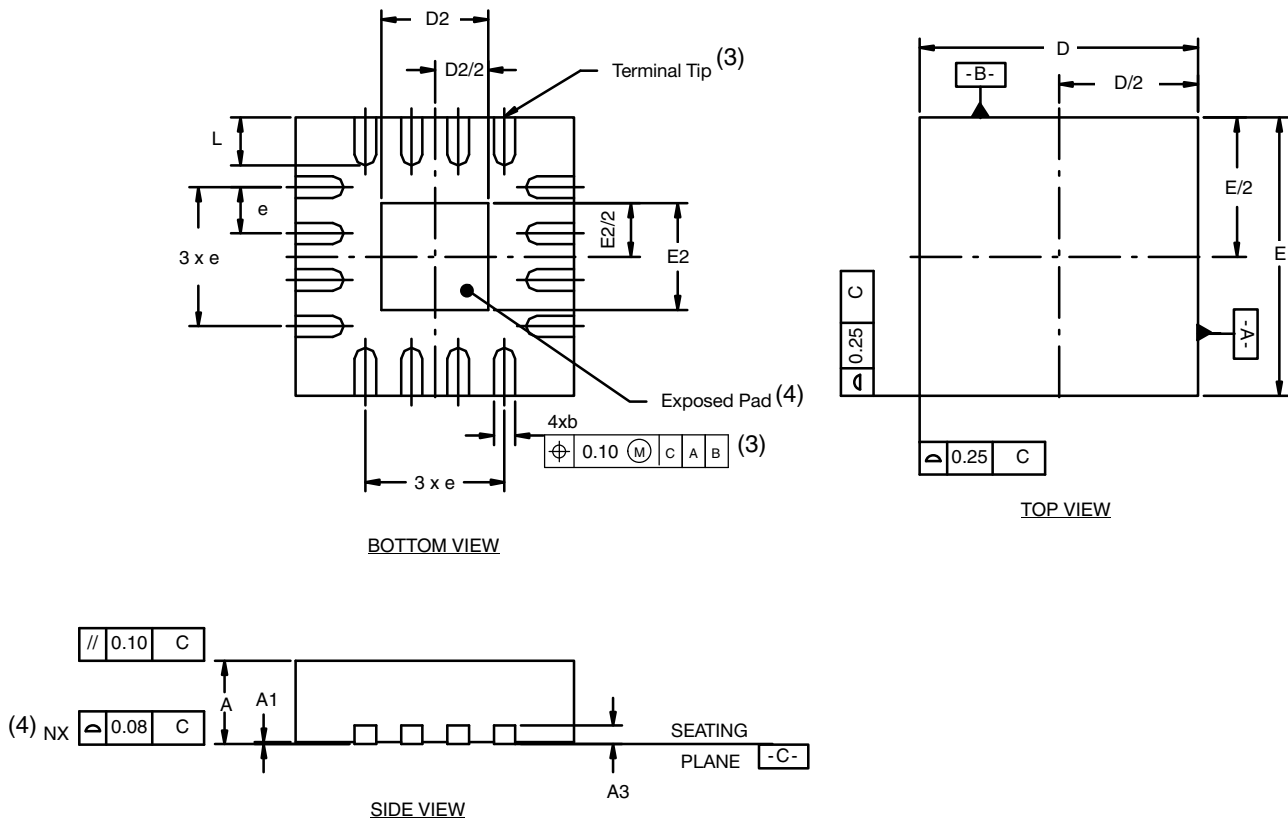


| Dim            | MILLIMETERS |       | INCHES    |       |
|----------------|-------------|-------|-----------|-------|
|                | Min         | Max   | Min       | Max   |
| A              | 1.35        | 1.75  | 0.053     | 0.069 |
| A <sub>1</sub> | 0.10        | 0.20  | 0.004     | 0.008 |
| B              | 0.38        | 0.51  | 0.015     | 0.020 |
| C              | 0.18        | 0.23  | 0.007     | 0.009 |
| D              | 9.80        | 10.00 | 0.385     | 0.393 |
| E              | 3.80        | 4.00  | 0.149     | 0.157 |
| e              | 1.27 BSC    |       | 0.050 BSC |       |
| H              | 5.80        | 6.20  | 0.228     | 0.244 |
| L              | 0.50        | 0.93  | 0.020     | 0.037 |
| ∅              | 0°          | 8°    | 0°        | 8°    |

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



### QFN-16 Lead (3 x 3)



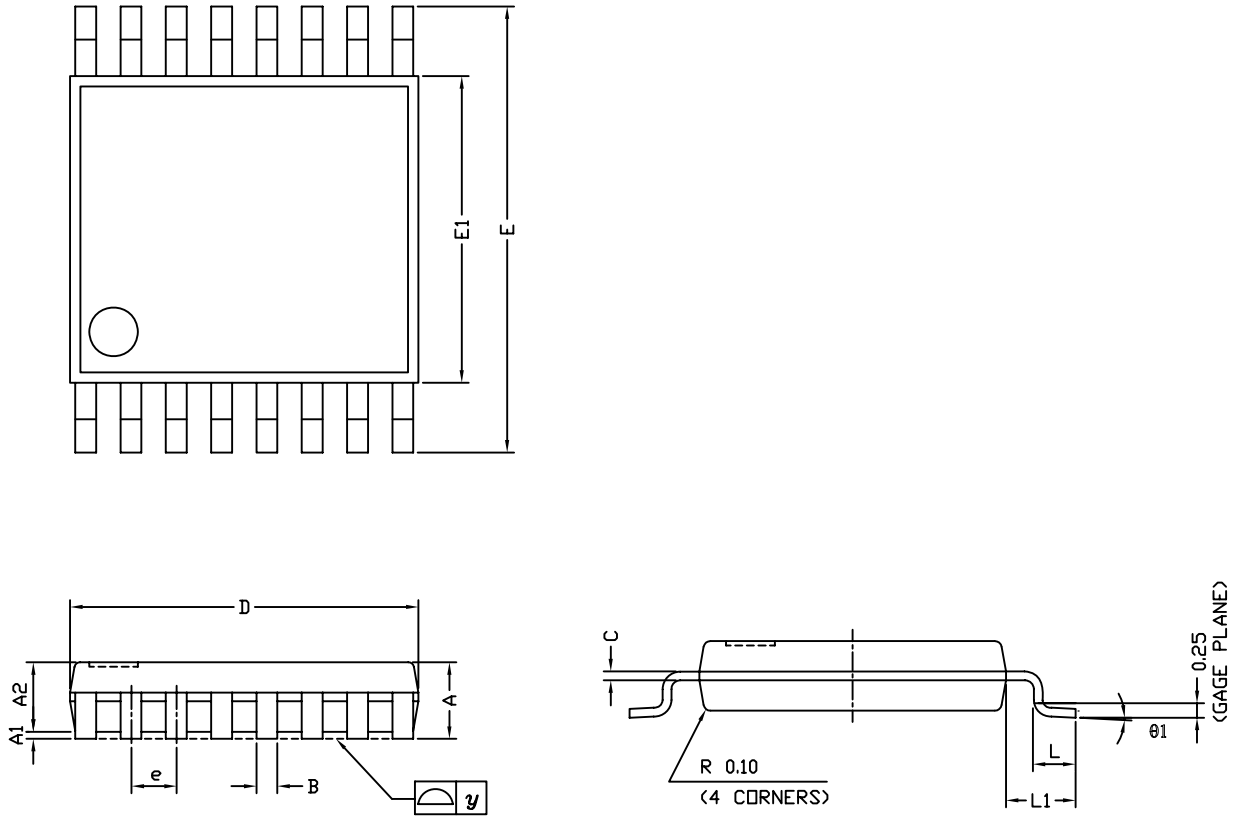
#### Notes

- (1) All dimensions are in millimeters.
- (2) N is the total number of terminals.
- (3) Dimension b applies to metallized terminal and is measured between 0.25 and 0.30 mm from terminal tip.
- (4) Coplanarity applies to the exposed heat sink slug as well as the terminal.
- (5) The pin #1 identifier may be either a mold or marked feature, it must be located within the zone indicated.

| DIM. | VARIATION 1 |      |      |           |       |       | VARIATION 2 |      |      |           |       |       |
|------|-------------|------|------|-----------|-------|-------|-------------|------|------|-----------|-------|-------|
|      | MILLIMETERS |      |      | INCHES    |       |       | MILLIMETERS |      |      | INCHES    |       |       |
|      | MIN.        | NOM  | MAX. | MIN.      | NOM   | MAX.  | MIN.        | NOM  | MAX. | MIN.      | NOM   | MAX.  |
| A    | 0.80        | 0.90 | 1.00 | 0.031     | 0.035 | 0.039 | 0.80        | 0.90 | 1.00 | 0.031     | 0.035 | 0.039 |
| b    | 0.18        | 0.23 | 0.30 | 0.007     | 0.009 | 0.012 | 0.18        | 0.25 | 0.30 | 0.007     | 0.010 | 0.012 |
| D    | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 |
| D2   | 1.00        | 1.15 | 1.25 | 0.039     | 0.045 | 0.049 | 1.50        | 1.70 | 1.80 | 0.059     | 0.067 | 0.071 |
| E    | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 |
| E2   | 1.00        | 1.15 | 1.25 | 0.039     | 0.045 | 0.049 | 1.50        | 1.70 | 1.80 | 0.059     | 0.067 | 0.071 |
| e    | 0.50 BSC    |      |      | 0.020 BSC |       |       | 0.50 BSC    |      |      | 0.020 BSC |       |       |
| L    | 0.30        | 0.40 | 0.50 | 0.012     | 0.016 | 0.020 | 0.30        | 0.40 | 0.50 | 0.012     | 0.016 | 0.020 |

ECN: T16-0233-Rev. D, 09-May-16  
DWG: 5899

## TSSOP: 16-LEAD

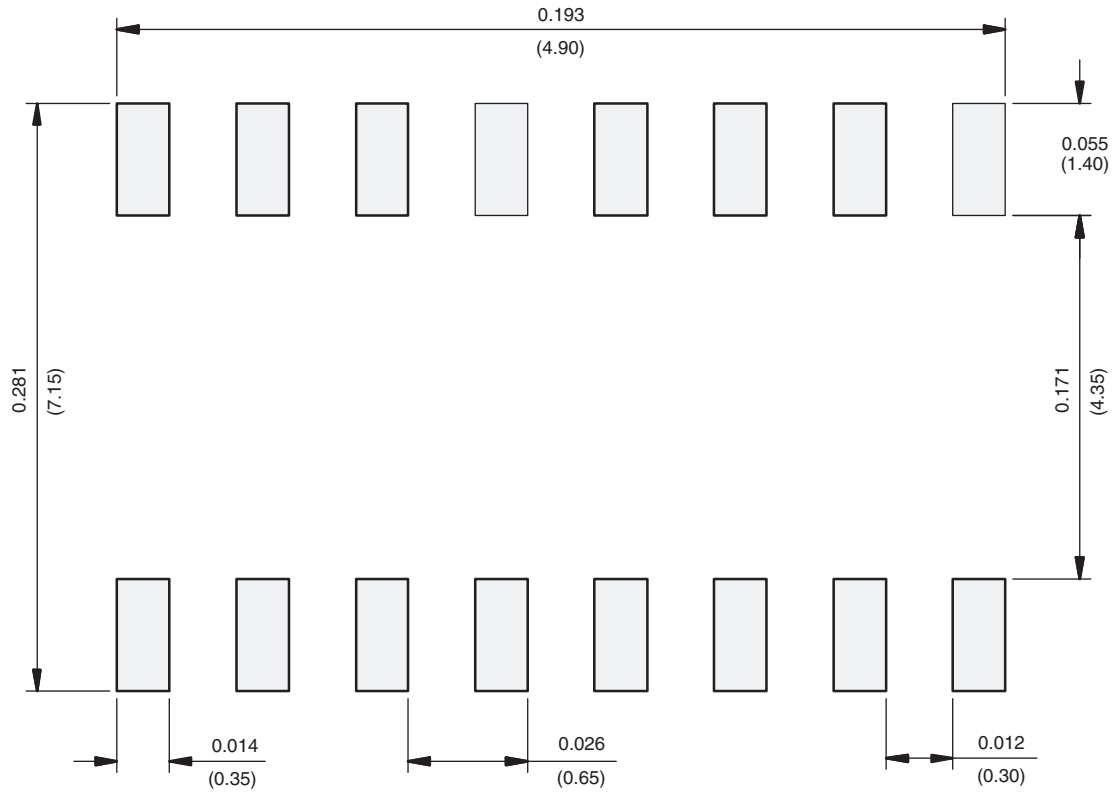


| Symbols | DIMENSIONS IN MILLIMETERS |       |      |
|---------|---------------------------|-------|------|
|         | Min                       | Nom   | Max  |
| A       | -                         | 1.10  | 1.20 |
| A1      | 0.05                      | 0.10  | 0.15 |
| A2      | -                         | 1.00  | 1.05 |
| B       | 0.22                      | 0.28  | 0.38 |
| C       | -                         | 0.127 | -    |
| D       | 4.90                      | 5.00  | 5.10 |
| E       | 6.10                      | 6.40  | 6.70 |
| E1      | 4.30                      | 4.40  | 4.50 |
| e       | -                         | 0.65  | -    |
| L       | 0.50                      | 0.60  | 0.70 |
| L1      | 0.90                      | 1.00  | 1.10 |
| y       | -                         | -     | 0.10 |
| θ1      | 0°                        | 3°    | 6°   |

ECN: S-61920-Rev. D, 23-Oct-06  
 DWG: 5624



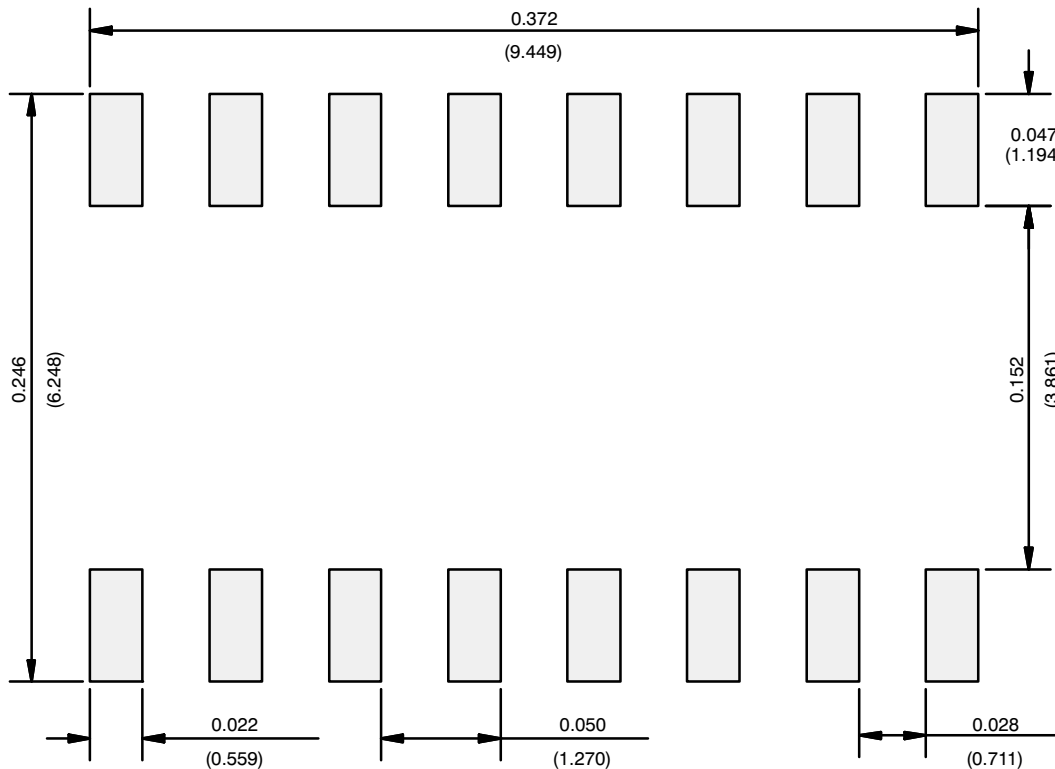
## RECOMMENDED MINIMUM PAD FOR TSSOP-16



Recommended Minimum Pads  
Dimensions in inches (mm)



## RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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