

# 1.0 pC Charge Injection, 100 pA Leakage, 4-Channel Multiplexer

## DESCRIPTION

The DG604 is an analog 4-channel CMOS, multiplexer, designed to operate from a +2.7 V to +12 V single supply or from  $\pm 2.7$  V to  $\pm 5$  V, dual supplies. The DG604 is fully specified at +3 V, +5 V and  $\pm 5$  V. All control logic inputs have guaranteed 2 V logic high limits when operating from +5 V or  $\pm 5$  V supplies and 1.4 V when operating from a 3 V supply. The DG604 switches conduct equally well in both directions and offer rail to rail analog signal handling. < 1 pC low charge injection, coupled with very low switch capacitance and leakage current makes this product ideal for use in precision instrumentation applications. Operating temperature range is specified from -40 °C to +125 °C. The DG604 is available in 14 lead TSSOP and the space saving 1.8 mm x 2.6 mm miniQFN package.

## FEATURES

- Halogen-free according to IEC 61249-2-21 Definition
- Ultra low charge injection ( $\pm 1$  pC, typ. over the full analog signal range)
- Leakage current < 0.5 nA max. at 85 °C (for DG604EQ-T1-E3)
- Low switch capacitance ( $C_{\text{soff}}$ , 3 pF typ.)
- Low  $R_{\text{DS(on)}}$  - 115  $\Omega$  max.
- Fully specified with single supply operation at 3 V, 5 V and dual supplies at  $\pm 5$  V
- Low voltage, 2.5 V CMOS/TTL compatible
- 400 MHz, -3 dB bandwidth
- Excellent isolation and crosstalk performance (typ. > -60 dB at 10 MHz)
- Fully specified from -40 °C to 85 °C and -40 °C to +125 °C
- 14 pin TSSOP and 16 pin miniQFN package
- Compliant to RoHS Directive 2002/95/EC

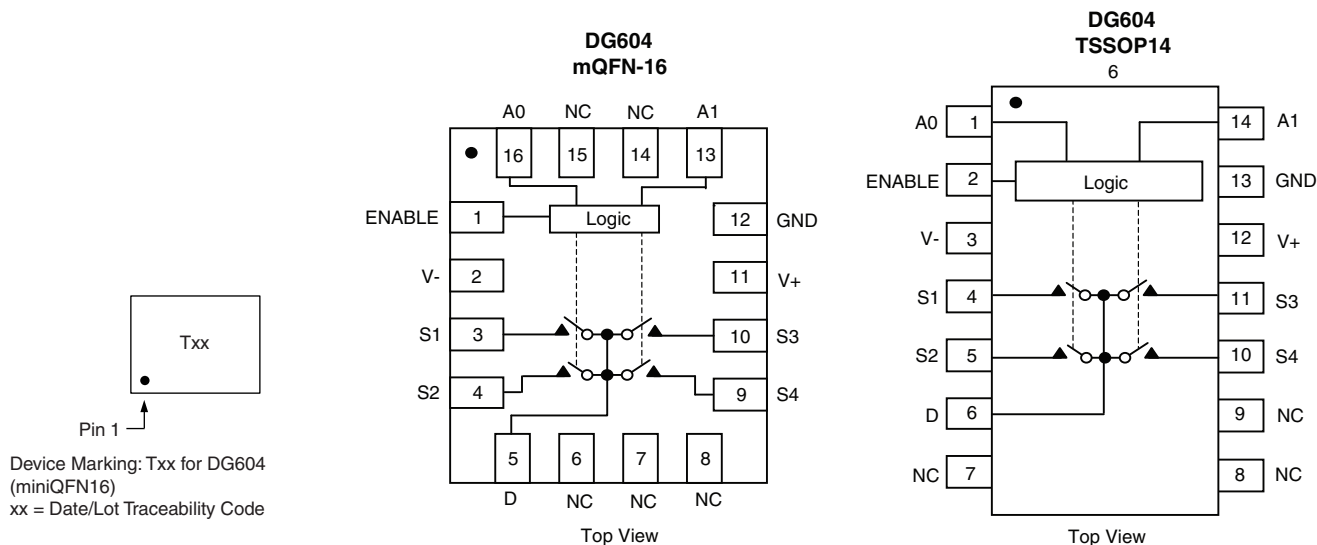


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

## APPLICATIONS

- High-end data acquisition
- Medical instruments
- Precision instruments
- High speed communications applications
- Automated test equipment
- Sample and hold applications

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



**TRUTH TABLE**

| Enable Input | Selected Input |    | On Switches       |
|--------------|----------------|----|-------------------|
|              | A1             | A0 | DG604             |
| L            | X              | X  | All Switches Open |
| H            | L              | L  | D to S1           |
| H            | L              | H  | D to S2           |
| H            | H              | L  | D to S3           |
| H            | H              | H  | D to S4           |

**ORDERING INFORMATION**

| Temp. Range                    | Package        | Part Number   |
|--------------------------------|----------------|---------------|
| - 40 °C to 125 °C <sup>a</sup> | 14 pin TSSOP   | DG604EQ-T1-E3 |
|                                | 16 pin miniQFN | DG604EN-T1-E4 |

Notes:

a. - 40 °C to 85 °C datasheet limits apply.

**ABSOLUTE MAXIMUM RATINGS**  $T_A = 25\text{ °C}$ , unless otherwise noted

| Parameter                                                     | Limit                                                        | Unit |
|---------------------------------------------------------------|--------------------------------------------------------------|------|
| V+ to V-                                                      | 14                                                           | V    |
| GND to V-                                                     | 7                                                            |      |
| Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub> | (V-) - 0.3 to (V+) + 0.3<br>or 30 mA, whichever occurs first |      |
| Continuous Current (Any Terminal)                             | 30                                                           | mA   |
| Peak Current, S or D (Pulsed 1 ms, 10 % Duty Cycle)           | 100                                                          |      |
| Storage Temperature                                           | - 65 to 150                                                  | °C   |
| Power Dissipation (Package) <sup>b</sup>                      | 14 pin TSSOP <sup>c</sup>                                    | mW   |
|                                                               | 16 pin miniQFN <sup>d, e</sup>                               |      |
| Thermal Resistance (Package) <sup>b</sup>                     | 14 pin TSSOP                                                 | C/W  |
|                                                               | 16 pin miniQFN                                               |      |

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 5.6 mW/°C above 70 °C.

d. Derate 6.6 mW/°C above 70 °C.

e. Manual soldering with iron is not recommended for leadless components. The miniQFN-16 is a leadless package. The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing. A solder fillet at the exposed copper lip cannot be guaranteed and is not required to ensure adequate bottom side solder interconnection.

**SPECIFICATIONS FOR DUAL SUPPLIES**

| Parameter                        | Symbol                | Test Conditions<br>Unless Otherwise Specified<br>V+ = 5 V, V- = - 5 V<br>VIN A0, A1 and ENABLE = 2 V, 0.8 V <sup>a</sup> | Temp. <sup>b</sup> | Typ. <sup>c</sup> | - 40 °C to 125 °C |                   | - 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               |                   | - 5               | 5                 | - 5               | 5                 | V    |
| On-Resistance                    | R <sub>DS(on)</sub>   | I <sub>S</sub> = 1 mA, V <sub>D</sub> = - 3 V, 0 V, + 3 V                                                                | Room Full          | 70                |                   | 115<br>160        |                   | 115<br>140        | Ω    |
| On-Resistance Match              | ΔR <sub>ON</sub>      | I <sub>S</sub> = 1 mA, V <sub>D</sub> = ± 3 V                                                                            | Room Full          | 1                 |                   | 5<br>6.5          |                   | 5<br>6.5          |      |
| On-Resistance Flatness           | R <sub>FLATNESS</sub> | I <sub>S</sub> = 1 mA, V <sub>D</sub> = - 3 V, 0 V, + 3 V                                                                | Room Full          | 10                |                   | 20<br>33          |                   | 20<br>22          |      |

**SPECIFICATIONS FOR DUAL SUPPLIES**

| Parameter                                          | Symbol              | Test Conditions<br>Unless Otherwise Specified<br>V <sub>+</sub> = 5 V, V <sub>-</sub> = - 5 V<br>V <sub>IN</sub> A0, A1 and ENABLE = 2 V, 0.8 V <sup>a</sup> | Temp. <sup>b</sup> | Typ. <sup>c</sup> | - 40 °C to 125 °C |                   | - 40 °C to 85 °C  |                   | Unit |
|----------------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------|
|                                                    |                     |                                                                                                                                                              |                    |                   | Min. <sup>d</sup> | Max. <sup>d</sup> | Min. <sup>d</sup> | Max. <sup>d</sup> |      |
| Analog Switch                                      |                     |                                                                                                                                                              |                    |                   |                   |                   |                   |                   |      |
| Switch Off Leakage Current<br>(for 14 pin TSSOP)   | I <sub>S(off)</sub> | V <sub>+</sub> = 5.5 V, V <sub>-</sub> = - 5.5 V<br>V <sub>D</sub> = ± 4.5 V, V <sub>S</sub> = ∓ 4.5 V                                                       | Room Full          | ± 0.01            | - 0.1<br>- 18     | 0.1<br>18         | - 0.1<br>- 0.5    | 0.1<br>0.5        | nA   |
|                                                    | I <sub>D(off)</sub> |                                                                                                                                                              | Room Full          | ± 0.01            | - 0.1<br>- 18     | 0.1<br>18         | - 0.1<br>- 0.5    | 0.1<br>0.5        |      |
| Channel On Leakage Current<br>(for 14 pin TSSOP)   | I <sub>D(on)</sub>  | V <sub>+</sub> = 5.5 V, V <sub>-</sub> = - 5.5 V,<br>V <sub>S</sub> = V <sub>D</sub> = ± 4.5 V                                                               | Room Full          | ± 0.01            | - 0.1<br>- 18     | 0.1<br>18         | - 0.1<br>- 0.5    | 0.1<br>0.5        |      |
| Switch Off Leakage Current<br>(for 16 pin miniQFN) | I <sub>S(off)</sub> | V <sub>+</sub> = 5.5 V, V <sub>-</sub> = - 5.5 V<br>V <sub>D</sub> = ± 4.5 V, V <sub>S</sub> = ∓ 4.5 V                                                       | Room Full          | ± 0.01            | - 1<br>- 18       | 1<br>18           | - 1<br>- 2        | 1<br>2            |      |
|                                                    | I <sub>D(off)</sub> |                                                                                                                                                              | Room Full          | ± 0.01            | - 1<br>- 18       | 1<br>18           | - 1<br>- 2        | 1<br>2            |      |
| Channel On Leakage Current<br>(for 16 pin miniQFN) | I <sub>D(on)</sub>  | V <sub>+</sub> = 5.5 V, V <sub>-</sub> = - 5.5 V,<br>V <sub>S</sub> = V <sub>D</sub> = ± 4.5 V                                                               | Room Full          | ± 0.01            | - 1<br>- 18       | 1<br>18           | - 1<br>- 2        | 1<br>2            |      |
| Digital Control                                    |                     |                                                                                                                                                              |                    |                   |                   |                   |                   |                   |      |
| Input Current, V <sub>IN</sub> Low                 | I <sub>IL</sub>     | V <sub>IN</sub> A0, A1 and ENABLE Under Test = 0.8 V                                                                                                         | Full               | 0.005             | - 0.1             | 0.1               | - 0.1             | 0.1               | μA   |
| Input Current, V <sub>IN</sub> High                | I <sub>IH</sub>     | V <sub>IN</sub> A0, A1 and ENABLE Under Test = 2 V                                                                                                           | Full               | 0.005             | - 0.1             | 0.1               | - 0.1             | 0.1               |      |
| Input Capacitance <sup>e</sup>                     | C <sub>IN</sub>     | f = 1 MHz                                                                                                                                                    | Room               | 3.4               |                   |                   |                   |                   | pF   |
| Dynamic Characteristics                            |                     |                                                                                                                                                              |                    |                   |                   |                   |                   |                   |      |
| Transition Time                                    | t <sub>TRANS</sub>  | V <sub>S(CLOSE)</sub> = 3 V, V <sub>S(OPEN)</sub> = 0 V,<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                                   | Room Full          | 20                |                   | 70<br>105         |                   | 70<br>80          | ns   |
| Turn-On Time                                       | t <sub>ON</sub>     | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = ± 3 V                                                                                     | Room Full          | 16                |                   | 60<br>90          |                   | 60<br>65          |      |
| Turn-Off Time                                      | t <sub>OFF</sub>    |                                                                                                                                                              | Room Full          | 15                |                   | 52<br>76          |                   | 52<br>56          |      |
| Break-Before-Make Time Delay                       | t <sub>D</sub>      | V <sub>S</sub> = 3 V<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                                                                       | Room Full          | 15                | 10                |                   | 10                |                   |      |
| Charge Injection <sup>e</sup>                      | Q                   | V <sub>g</sub> = 0 V, R <sub>g</sub> = 0 Ω, C <sub>L</sub> = 1 nF                                                                                            | Room               | 0.7               |                   |                   |                   |                   | pC   |
| Off Isolation <sup>e</sup>                         | OIRR                | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 10 MHz                                                                                                     | Room               | - 72              |                   |                   |                   |                   | dB   |
| Bandwidth <sup>e</sup>                             | BW                  | R <sub>L</sub> = 50 Ω                                                                                                                                        | Room               | 400               |                   |                   |                   |                   | MHz  |
| Channel-to-Channel Crosstalk <sup>e</sup>          | X <sub>TALK</sub>   | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 10 MHz                                                                                                     | Room               | - 81              |                   |                   |                   |                   | dB   |
| Source Off Capacitance <sup>e</sup>                | C <sub>S(off)</sub> | f = 1 MHz                                                                                                                                                    | Room               | 2.7               |                   |                   |                   |                   | pF   |
| Drain Off Capacitance <sup>e</sup>                 | C <sub>D(off)</sub> |                                                                                                                                                              | Room               | 7.3               |                   |                   |                   |                   |      |
| Channel On Capacitance <sup>e</sup>                | C <sub>D(on)</sub>  |                                                                                                                                                              | Room               | 13.8              |                   |                   |                   |                   |      |
| Total Harmonic Distortion <sup>e</sup>             | THD                 | Signal = 1 V <sub>RMS</sub> , 20 Hz to 20 kHz,<br>R <sub>L</sub> = 600 Ω                                                                                     | Room               | 0.01              |                   |                   |                   |                   | %    |
| Power Supplies                                     |                     |                                                                                                                                                              |                    |                   |                   |                   |                   |                   |      |
| Power Supply Current                               | I <sub>+</sub>      | V <sub>IN</sub> = 0 V, or V <sub>+</sub>                                                                                                                     | Room Full          | 0.001             |                   | 0.5<br>1          |                   | 0.5<br>1          | μA   |
| Negative Supply Current                            | I <sub>-</sub>      |                                                                                                                                                              | Room Full          | - 0.001           | - 0.5<br>- 1      |                   | - 0.5<br>- 1      |                   |      |
| Ground Current                                     | I <sub>GND</sub>    |                                                                                                                                                              | Room Full          | - 0.001           | - 0.5<br>- 1      |                   | - 0.5<br>- 1      |                   |      |

## SPECIFICATIONS FOR SINGLE SUPPLY

| Parameter                                          | Symbol               | Test Conditions<br>Unless Otherwise Specified<br>V+ = 5 V, V- = 0 V<br>VIN A0, A1 and ENABLE = 2 V, 0.8 V <sup>a</sup> | Temp. <sup>b</sup> | Typ. <sup>c</sup> | - 40 °C to 125 °C |                   | - 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               |                   |                   | 5                 |                   | 5                 | V    |
| On-Resistance                                      | R <sub>DS(on)</sub>  | I <sub>S</sub> = 1 mA, V <sub>D</sub> = + 3.5 V                                                                        | Room Full          | 120               |                   | 170<br>250        |                   | 170<br>200        | Ω    |
| On-Resistance Match                                | ΔR <sub>ON</sub>     | I <sub>S</sub> = 1 mA, V <sub>D</sub> = + 3.5 V                                                                        | Room Full          | 3                 |                   | 5<br>12           |                   | 5<br>10           |      |
| Switch Off Leakage Current<br>(for 14 pin TSSOP)   | I <sub>S(off)</sub>  | V+ = 5.5 V, V- = 0 V<br>V <sub>D</sub> = 1 V/4.5 V, V <sub>S</sub> = 4.5 V/1 V                                         | Room Full          | ± 0.01            | - 0.1<br>- 18     | 0.1<br>18         | - 0.1<br>- 0.5    | 0.1<br>0.5        | nA   |
|                                                    | I <sub>D(off)</sub>  |                                                                                                                        | Room Full          | ± 0.01            | - 0.1<br>- 18     | 0.1<br>18         | - 0.1<br>- 0.5    | 0.1<br>0.5        |      |
| Channel On Leakage Current<br>(for 14 pin TSSOP)   | I <sub>D(on)</sub>   | V+ = 5.5 V, V- = 0 V<br>V <sub>S</sub> = V <sub>D</sub> = 1 V/4.5 V                                                    | Room Full          | ± 0.01            | - 0.1<br>- 18     | 0.1<br>18         | - 0.1<br>- 0.5    | 0.1<br>0.5        |      |
| Switch Off Leakage Current<br>(for 16 pin miniQFN) | I <sub>S(off)</sub>  | V+ = 5.5 V, V- = - 5.5 V<br>V <sub>D</sub> = 1 V/4.5 V, V <sub>S</sub> = 4.5 V/1 V                                     | Room Full          | ± 0.01            | - 1<br>- 18       | 1<br>18           | - 1<br>- 2        | 1<br>2            |      |
|                                                    | I <sub>D(off)</sub>  |                                                                                                                        | Room Full          | ± 0.01            | - 1<br>- 18       | 1<br>18           | - 1<br>- 2        | 1<br>2            |      |
| Channel On Leakage Current<br>(for 16 pin miniQFN) | I <sub>D(on)</sub>   | V+ = 5.5 V, V- = 0 V,<br>V <sub>S</sub> = V <sub>D</sub> = 1 V/4.5 V                                                   | Room Full          | ± 0.01            | - 1<br>- 18       | 1<br>18           | - 1<br>- 2        | 1<br>2            |      |
| Digital Control                                    |                      |                                                                                                                        |                    |                   |                   |                   |                   |                   |      |
| Input Current, V <sub>IN</sub> Low                 | I <sub>L</sub>       | V <sub>IN</sub> A0, A1 and ENABLE<br>Under Test = 0.8 V                                                                | Full               | 0.005             | - 0.1             | 0.1               | - 0.1             | 0.1               | μA   |
| Input Current, V <sub>IN</sub> High                | I <sub>H</sub>       | V <sub>IN</sub> A0, A1 and ENABLE<br>Under Test = 2 V                                                                  | Full               | 0.005             | - 0.1             | 0.1               | - 0.1             | 0.1               |      |
| Input Capacitance                                  | C <sub>IN</sub>      | f = 1 MHz                                                                                                              | Room               | 4.3               |                   |                   |                   |                   | pF   |
| Dynamic Characteristics                            |                      |                                                                                                                        |                    |                   |                   |                   |                   |                   |      |
| Transition Time                                    | t <sub>TRANS</sub>   | V <sub>S(CLOSE)</sub> = 3 V, V <sub>S(OPEN)</sub> = 0 V,<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF             | Room Full          | 36                |                   | 75<br>120         |                   | 75<br>95          | ns   |
| Enable Turn-On Time                                | t <sub>ON(EN)</sub>  |                                                                                                                        | Room Full          | 30                |                   | 70<br>102         |                   | 70<br>80          |      |
| Enable Turn-Off Time                               | t <sub>OFF(EN)</sub> |                                                                                                                        | Room Full          | 17                |                   | 47<br>88          |                   | 47<br>63          |      |
| Break-Before-Make-Time                             | t <sub>BMM</sub>     |                                                                                                                        | Room Full          | 23                | 5                 |                   | 5                 |                   |      |
| Charge Injection                                   | Q                    | C <sub>L</sub> = 1 nF, R <sub>GEN</sub> = 0 Ω, V <sub>GEN</sub> = 0 V                                                  | Full               | 0.15              |                   |                   |                   |                   | pC   |
| Off-Isolation <sup>e</sup>                         | OIRR                 | f = 10 MHz, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF                                                               | Room               | - 58              |                   |                   |                   |                   | dB   |
| Crosstalk <sup>e</sup>                             | X <sub>TALK</sub>    |                                                                                                                        | Room               | - 81              |                   |                   |                   |                   |      |
| Bandwidth <sup>e</sup>                             | BW                   | R <sub>L</sub> = 50 Ω                                                                                                  | Room               | 330               |                   |                   |                   |                   | MHz  |
| Total Harmonic Distortion                          | THD                  | Signal = 1 V <sub>RMS</sub> , 20 Hz to 20 kHz,<br>R <sub>L</sub> = 600 Ω                                               | Room               | 0.009             |                   |                   |                   |                   | %    |
| Source Off Capacitance <sup>e</sup>                | C <sub>S(off)</sub>  | f = 1 MHz                                                                                                              | Room               | 3.1               |                   |                   |                   |                   | pF   |
| Drain Off Capacitance <sup>e</sup>                 | C <sub>D(off)</sub>  |                                                                                                                        |                    | 11.6              |                   |                   |                   |                   |      |
| Channel On Capacitance <sup>e</sup>                | C <sub>D(on)</sub>   |                                                                                                                        |                    | 16.2              |                   |                   |                   |                   |      |
| Power Supplies                                     |                      |                                                                                                                        |                    |                   |                   |                   |                   |                   |      |
| Power Supply Current                               | I+                   | V <sub>IN</sub> = 0 V, or V+                                                                                           | Room Full          | 0.001             |                   | 0.5<br>1          |                   | 0.5<br>1          | μA   |
| Negative Supply Current                            | I-                   |                                                                                                                        | Room Full          | - 0.001           | - 0.5<br>- 1      |                   | - 0.5<br>- 1      |                   |      |
| Ground Current                                     | I <sub>GND</sub>     |                                                                                                                        | Room Full          | - 0.001           | - 0.5<br>- 1      |                   | - 0.5<br>- 1      |                   |      |

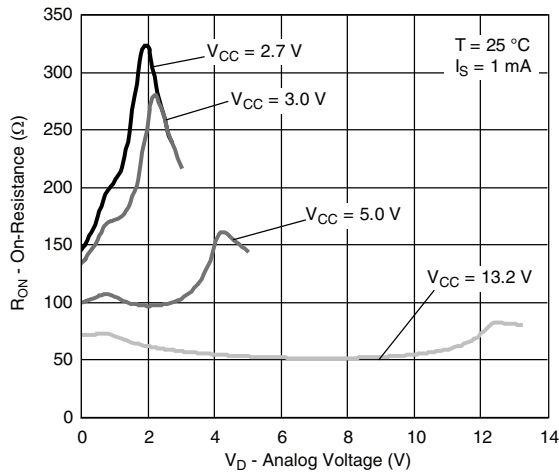


## SPECIFICATIONS FOR SINGLE SUPPLY

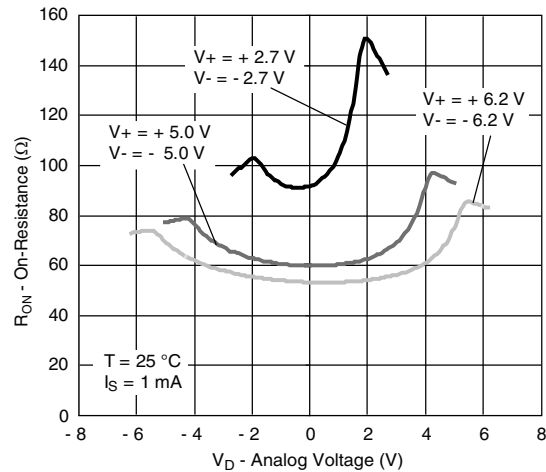
| Parameter                                          | Symbol               | Test Conditions<br>Unless Otherwise Specified<br>V+ = 3 V, V- = 0 V<br>VIN A0, A1 and ENABLE = 1.4 V, 0.6 V <sup>a</sup> | Temp. <sup>b</sup> | Typ. <sup>c</sup> | - 40 °C to + 125 °C |                   | - 40 °C to + 85 °C |                   | 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               |                   |                     | 3                 |                    | 3                 | V    |
| On-Resistance                                      | R <sub>DS(ON)</sub>  | I <sub>S</sub> = 1 mA, V <sub>D</sub> = + 1.5 V                                                                          | Room Full          | 200               |                     | 245<br>325        |                    | 245<br>290        | Ω    |
| On-Resistance Match                                | ΔR <sub>ON</sub>     | I <sub>S</sub> = 1 mA, V <sub>D</sub> = + 1.5 V                                                                          | Room Full          | 5                 |                     | 6<br>13           |                    | 11<br>6           |      |
| Switch Off Leakage Current<br>(for 14 pin TSSOP)   | I <sub>S(off)</sub>  | V+ = 3 V, V- = 0 V<br>V <sub>D</sub> = 1 V/3 V, V <sub>S</sub> = 3 V/1 V                                                 | Room Full          | ± 0.01            | - 0.1<br>- 18       | 0.1<br>18         | - 0.1<br>- 0.5     | 0.1<br>0.5        | nA   |
|                                                    | I <sub>D(off)</sub>  |                                                                                                                          | Room Full          | ± 0.01            | - 0.1<br>- 18       | 0.1<br>18         | - 0.1<br>- 0.5     | 0.1<br>0.5        |      |
| Channel On Leakage Current (for 14 pin TSSOP)      | I <sub>D(on)</sub>   | V+ = 3 V, V- = 0 V<br>V <sub>S</sub> = V <sub>D</sub> = 1 V/3 V                                                          | Room Full          | ± 0.01            | - 0.1<br>- 18       | 0.1<br>18         | - 0.1<br>- 0.5     | 0.1<br>0.5        |      |
| Switch Off Leakage Current<br>(for 16 pin miniQFN) | I <sub>S(off)</sub>  | V+ = 3.3 V, V- = 0 V<br>V <sub>D</sub> = 1 V/3 V, V <sub>S</sub> = 3 V/1 V                                               | Room Full          | ± 0.01            | - 1<br>- 18         | 1<br>18           | - 1<br>- 2         | 1<br>2            |      |
|                                                    | I <sub>D(off)</sub>  |                                                                                                                          | Room Full          | ± 0.01            | - 1<br>- 18         | 1<br>18           | - 1<br>- 2         | 1<br>2            |      |
| Channel On Leakage Current<br>(for 16 pin miniQFN) | I <sub>D(on)</sub>   | V+ = 3.3 V, V- = 0 V<br>V <sub>D</sub> = 1 V/3 V, V <sub>S</sub> = 3 V/1 V                                               | Room Full          | ± 0.01            | - 1<br>- 18         | 1<br>18           | - 1<br>- 2         | 1<br>2            |      |
| Digital Control                                    |                      |                                                                                                                          |                    |                   |                     |                   |                    |                   |      |
| Input Current, V <sub>IN</sub> Low                 | I <sub>L</sub>       | V <sub>IN</sub> A0, A1 and ENABLE Under Test = 0.6 V                                                                     | Full               | 0.005             | - 1                 | 1                 | - 1                | 1                 | μA   |
| Input Current, V <sub>IN</sub> High                | I <sub>H</sub>       | V <sub>IN</sub> A0, A1 and ENABLE Under Test = 1.4 V                                                                     | Full               | 0.005             | - 1                 | 1                 | - 1                | 1                 |      |
| Input Capacitance                                  | C <sub>IN</sub>      | f = 1 MHz                                                                                                                | Room               | 4.3               |                     |                   |                    |                   | pF   |
| Dynamic Characteristics                            |                      |                                                                                                                          |                    |                   |                     |                   |                    |                   |      |
| Transition Time                                    | t <sub>TRANS</sub>   | V <sub>S(CLOSE)</sub> = 3 V, V <sub>S(OPEN)</sub> = 0 V,<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF               | Room Full          | 95                |                     | 130<br>190        |                    | 130<br>160        | ns   |
| Enable Turn-On Time                                | t <sub>ON(EN)</sub>  |                                                                                                                          | Room Full          | 77                |                     | 108<br>161        |                    | 108<br>131        |      |
| Enable Turn-Off Time                               | t <sub>OFF(EN)</sub> |                                                                                                                          | Room Full          | 35                |                     | 76<br>112         |                    | 76<br>88          |      |
| Break-Before-Make-Time                             | t <sub>BMM</sub>     |                                                                                                                          | Room Full          | 45                | 5                   |                   | 5                  |                   |      |
| Charge Injection                                   | Q                    | C <sub>L</sub> = 1 nF, R <sub>GEN</sub> = 0 Ω, V <sub>GEN</sub> = 0 V                                                    | Full               | 0.1               |                     |                   |                    |                   | pC   |
| Off-Isolation <sup>e</sup>                         | OIRR                 | f = 10 MHz, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF                                                                 | Room               | - 58              |                     |                   |                    |                   | dB   |
| Crosstalk <sup>e</sup>                             | X <sub>TALK</sub>    |                                                                                                                          | Room               | - 90              |                     |                   |                    |                   |      |
| Bandwidth <sup>e</sup>                             | BW                   | R <sub>L</sub> = 50 Ω                                                                                                    | Room               | 290               |                     |                   |                    |                   | MHz  |
| Total Harmonic Distortion                          | THD                  | Signal = 1 V <sub>RMS</sub> , 20 Hz to 20 kHz,<br>R <sub>L</sub> = 600 Ω                                                 | Room               | 0.09              |                     |                   |                    |                   | %    |
| Source Off Capacitance <sup>e</sup>                | C <sub>S(off)</sub>  | f = 1 MHz                                                                                                                | Room               | 3.1               |                     |                   |                    |                   | pF   |
| Drain Off Capacitance <sup>e</sup>                 | C <sub>D(off)</sub>  |                                                                                                                          |                    | 11.7              |                     |                   |                    |                   |      |
| Channel On Capacitance <sup>e</sup>                | C <sub>D(on)</sub>   |                                                                                                                          |                    | 16.5              |                     |                   |                    |                   |      |
| Power Supplies                                     |                      |                                                                                                                          |                    |                   |                     |                   |                    |                   |      |
| Power Supply Current                               | I+                   | V <sub>IN</sub> = 0 V, or V+                                                                                             | Room Full          | 0.001             |                     | 0.5<br>1          |                    | 0.5<br>1          | μA   |
| Negative Supply Current                            | I-                   |                                                                                                                          | Room Full          | - 0.001           | - 0.5<br>- 1        |                   | - 0.5<br>- 1       |                   |      |
| Ground Current                                     | I <sub>GND</sub>     |                                                                                                                          | Room Full          | - 0.001           | - 0.5<br>- 1        |                   | - 0.5<br>- 1       |                   |      |

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.

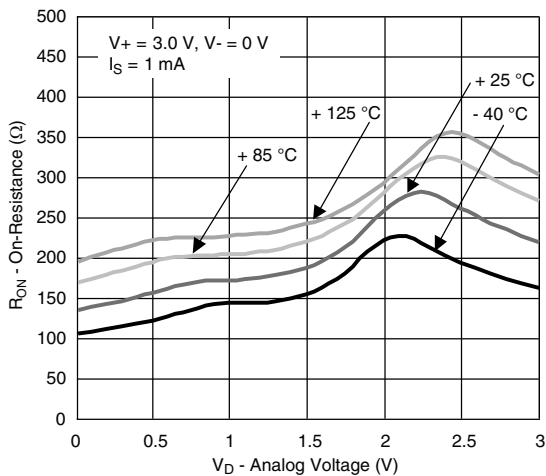
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



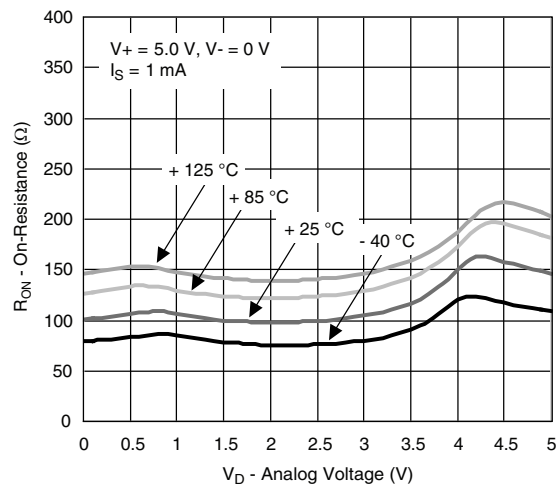
**On-Resistance vs.  $V_D$  (Single Supply Voltage)**



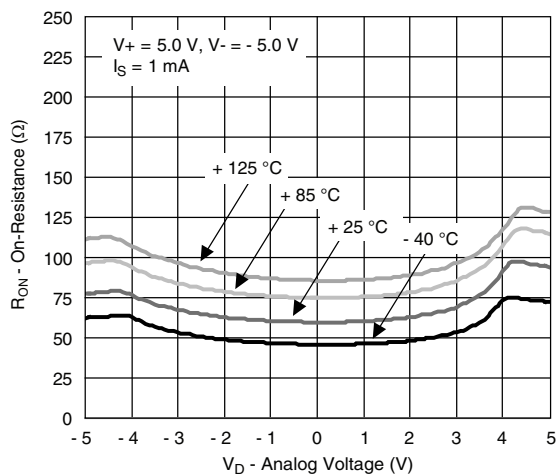
**On-Resistance vs.  $V_D$  (Dual Supply Voltage)**



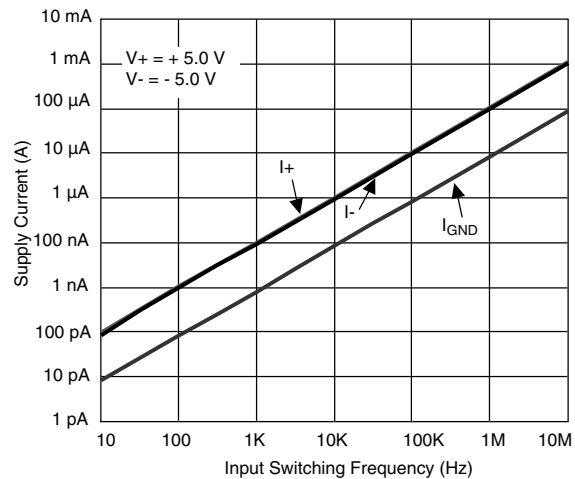
**On-Resistance vs. Analog Voltage and Temperature**



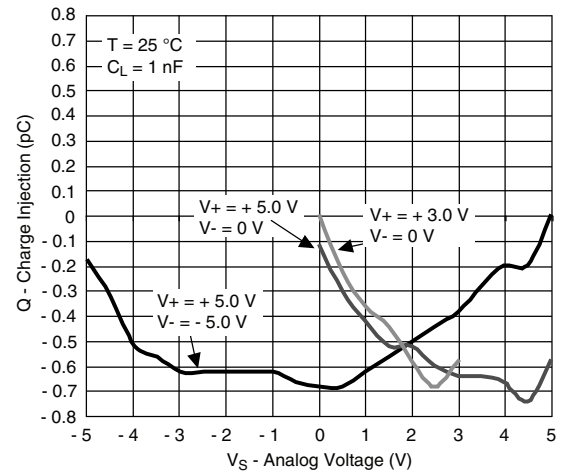
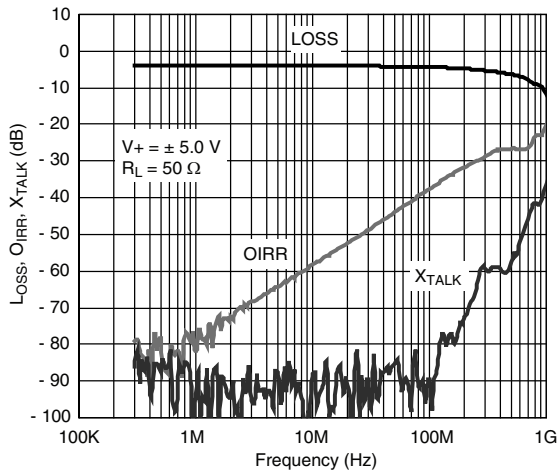
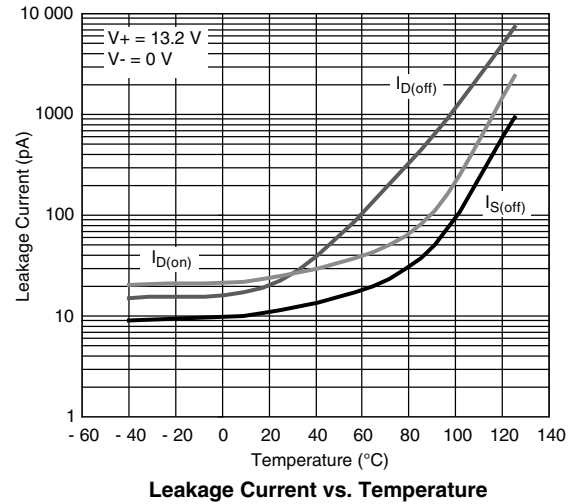
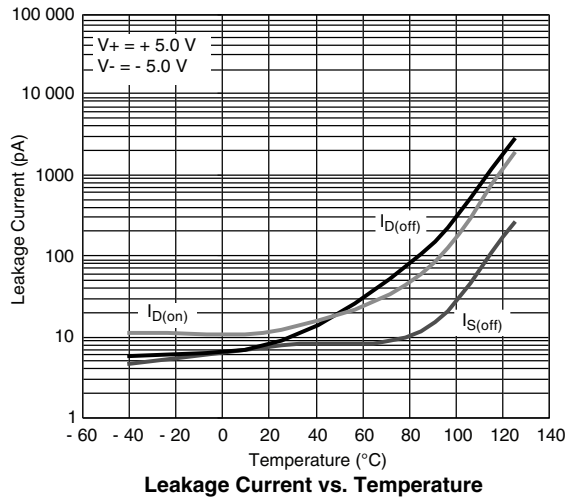
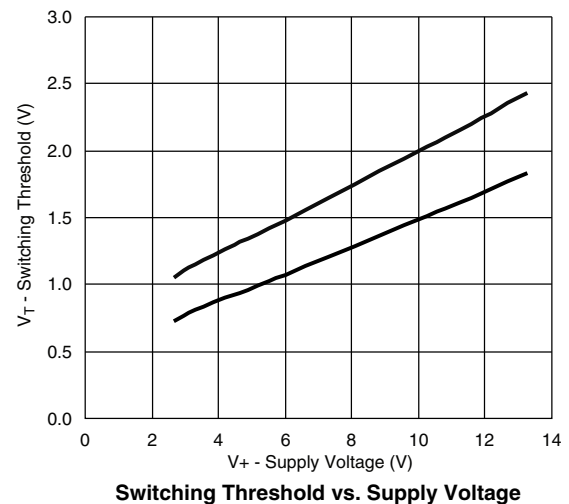
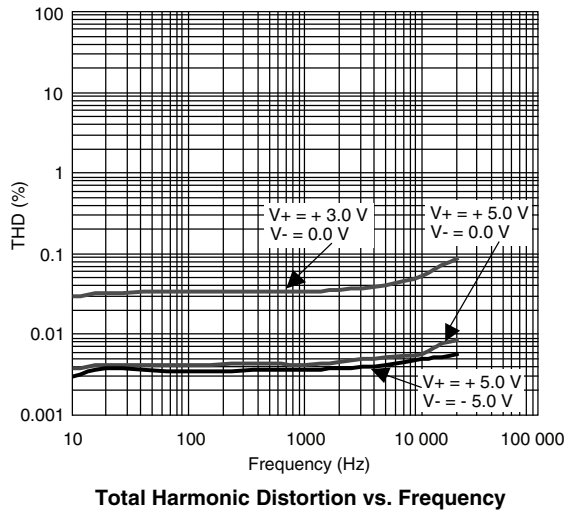
**On-Resistance vs. Analog Voltage and Temperature**



**On-Resistance vs. Analog Voltage and Temperature**



**Supply Current vs. Input Switching Frequency**

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

**Insertion Loss, Off-Isolation, Crosstalk vs. Frequency**
**Charge Injection vs. Analog Voltage**

**Total Harmonic Distortion vs. Frequency**
**Switching Threshold vs. Supply Voltage**

### TEST CIRCUITS

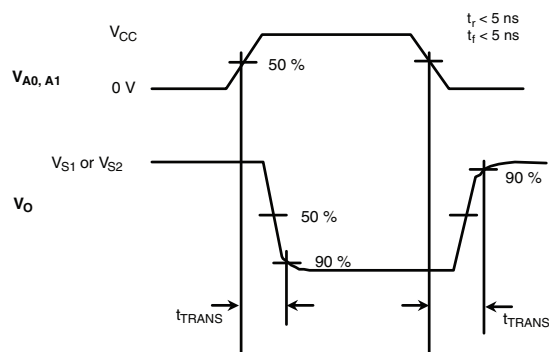
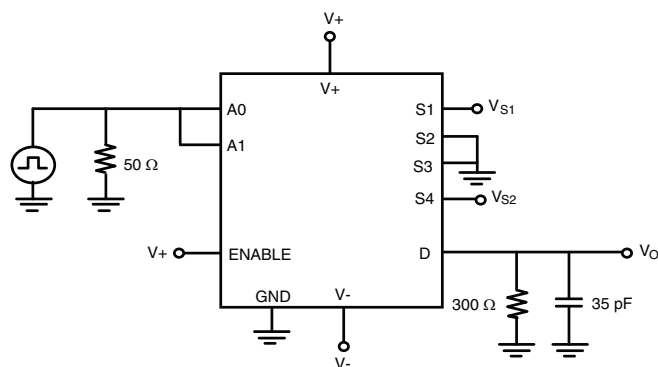


Figure 1. Transition Time

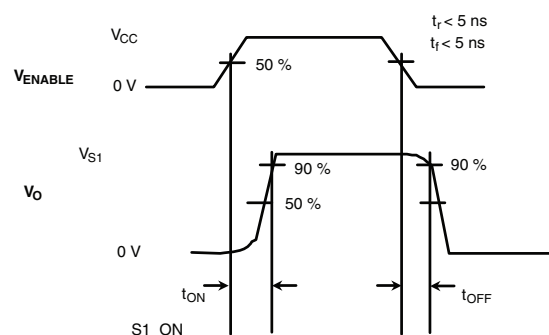
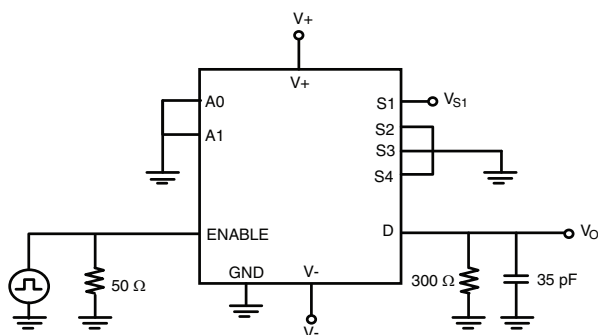


Figure 2. Enable Switching Time

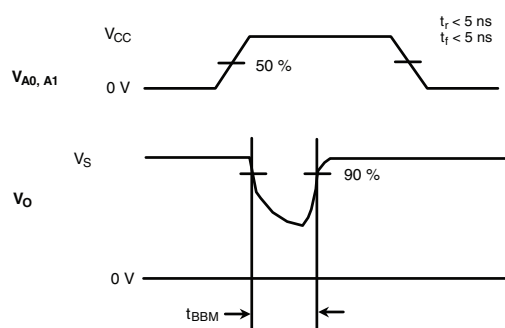
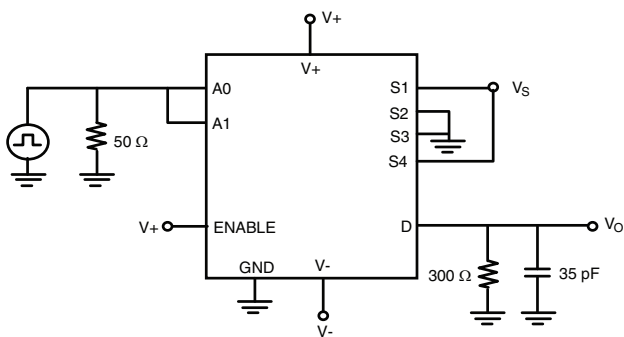


Figure 3. Break-Before-Make

## TEST CIRCUITS

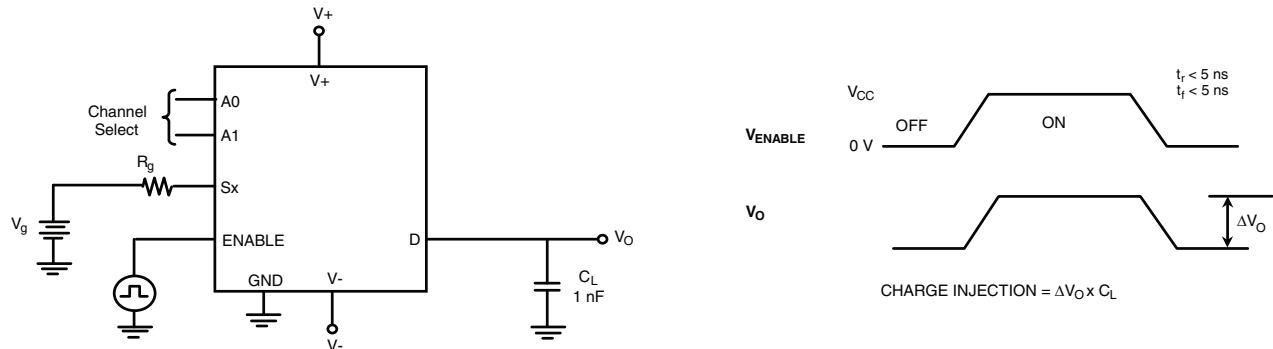


Figure 4. Charge Injection

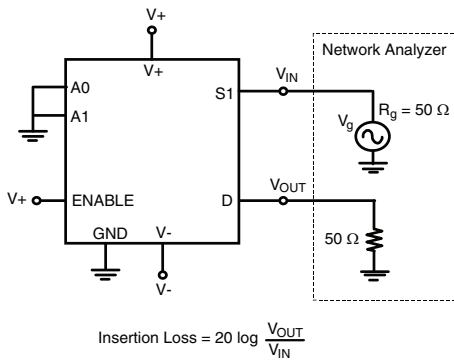


Figure 5. Insertion Loss

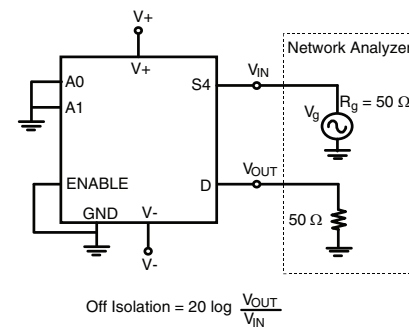


Figure 6. Off-Isolation

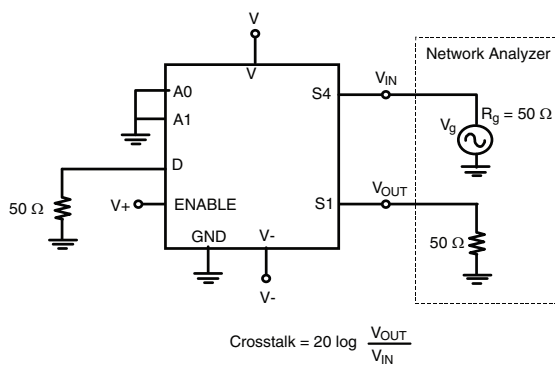


Figure 7. Crosstalk

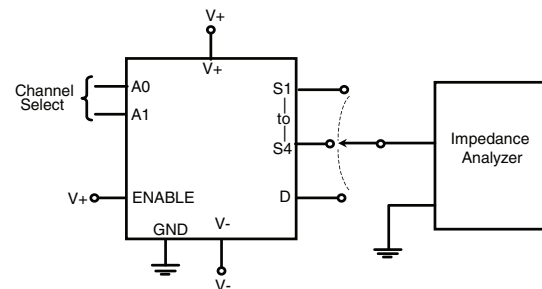
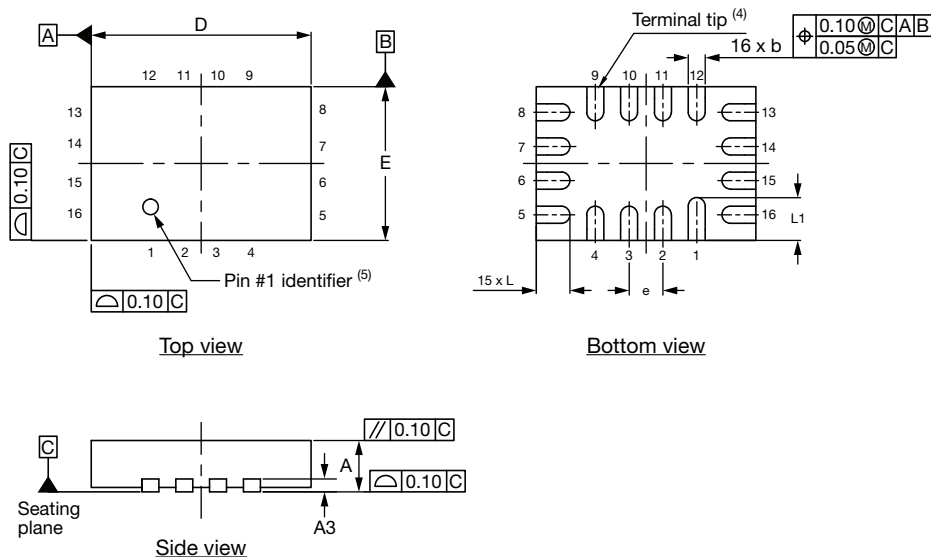


Figure 8. Source/Drain Capacitance

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see [www.vishay.com/ppg?69934](http://www.vishay.com/ppg?69934).

## Thin miniQFN16 Case Outline



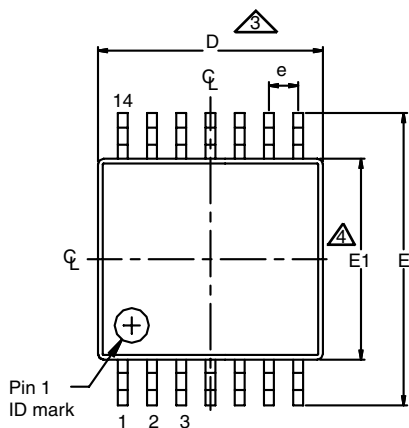
| DIMENSIONS        | MILLIMETERS <sup>(1)</sup> |      |      | INCHES     |       |       |
|-------------------|----------------------------|------|------|------------|-------|-------|
|                   | MIN.                       | NOM. | MAX. | MIN.       | NOM.  | MAX.  |
| A                 | 0.50                       | 0.55 | 0.60 | 0.020      | 0.022 | 0.024 |
| A1                | 0                          | -    | 0.05 | 0          | -     | 0.002 |
| A3                | 0.15 ref.                  |      |      | 0.006 ref. |       |       |
| b                 | 0.15                       | 0.20 | 0.25 | 0.006      | 0.008 | 0.010 |
| D                 | 2.50                       | 2.60 | 2.70 | 0.098      | 0.102 | 0.106 |
| e                 | 0.40 BSC                   |      |      | 0.016 BSC  |       |       |
| E                 | 1.70                       | 1.80 | 1.90 | 0.067      | 0.071 | 0.075 |
| L                 | 0.35                       | 0.40 | 0.45 | 0.014      | 0.016 | 0.018 |
| L1                | 0.45                       | 0.50 | 0.55 | 0.018      | 0.020 | 0.022 |
| N <sup>(3)</sup>  | 16                         |      |      | 16         |       |       |
| Nd <sup>(3)</sup> | 4                          |      |      | 4          |       |       |
| Ne <sup>(3)</sup> | 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.

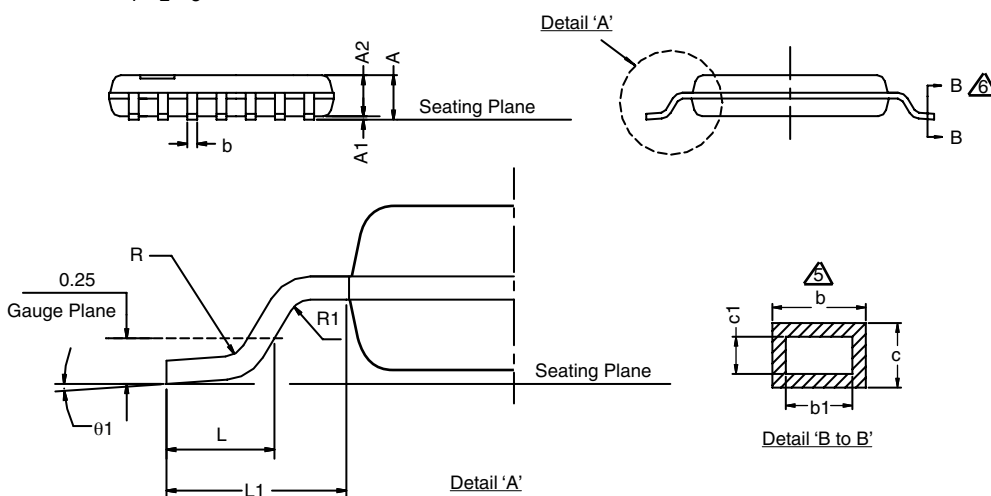
ECN: T16-0226-Rev. B, 09-May-16  
DWG: 6023

## 14L TSSOP



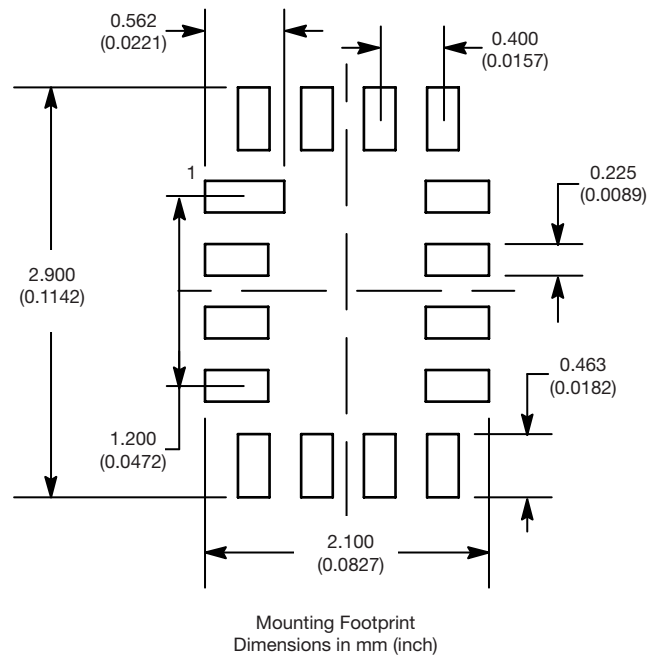
### Notes:

1. All dimensions are in millimeters (angles in degrees)
2. Dimensioning and tolerancing per ANSI Y14.5M-1982
3. Dimension 'D' does not include mold flash, protrusions or gate burrs
4. Dimension 'E1' does not include internal flash or protrusion
5. Dimension 'b' does not include dambar protrusion
6. Cross section B to B to be determined at 0.10 mm to 0.25 mm from the lead tip



| SYMBOL                                      | MINIMUM | NOMINAL  | MAXIMUM |
|---------------------------------------------|---------|----------|---------|
| A                                           | -       | -        | 1.20    |
| A1                                          | 0.05    | -        | 0.15    |
| A2                                          | 0.80    | 0.90     | 1.05    |
| D                                           | 4.9     | 5.0      | 5.1     |
| E1                                          | 4.3     | 4.4      | 4.5     |
| E                                           | 6.2     | 6.4      | 6.6     |
| L                                           | 0.45    | 0.60     | 0.75    |
| R                                           | 0.09    | -        | -       |
| R1                                          | 0.09    | -        | -       |
| b                                           | 0.19    | -        | 0.30    |
| b1                                          | 0.19    | 0.22     | 0.25    |
| c                                           | 0.09    | -        | 0.20    |
| c1                                          | 0.09    | -        | 0.16    |
| θ1                                          | 0°      | -        | 8°      |
| L1                                          |         | 1.0 ref. |         |
| e                                           |         | 0.65 BSC |         |
| ECN: T-07766-Rev. A, 14-Jan-08<br>DWG: 5962 |         |          |         |

## RECOMMENDED MINIMUM PADS FOR MINI QFN 16L





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