

# 0.3 pC Charge Injection, 100 pA Leakage CMOS $\pm 5\text{ V} / 5\text{ V} / 3\text{ V}$ 4-Channel Multiplexer

## DESCRIPTION

The DG604E is an analog 4-channel CMOS, multiplexer, designed to operate from a +3 V to +16 V single supply, or from  $\pm 3\text{ V}$  to  $\pm 8\text{ V}$ , dual supplies. The DG604E is fully specified at +3 V, +5 V and  $\pm 5\text{ V}$ .

The DG604E offers ultralow charge injection less than  $\pm 0.4\text{ pC}$  over the entire signal range and leakage currents of 16 pA typical at 25 °C. It offers on resistance of 64  $\Omega$  typ., and low parasitic capacitance of 4.2 pF source off, and 11 pF Drain on. The part is ideal for analog front end, data acquisition and sample and hold designs providing fast and precision signal switching.

The DG604E switches one of four inputs to a common output as determined by the 3-bit binary address lines: A0, A1, and EN. Each switch conducts equally well in both directions when on, blocks input voltages up to the supply level when off, and exhibits break before make switching action.

All control logic inputs have guaranteed 2 V logic high limits when operating from +5 V or  $\pm 5\text{ V}$  supplies and 1.4 V when operating from a 3 V supply.

The DG604E operating temperature range is specified from -40 °C to +125 °C. It is available in 14 lead TSSOP and the space saving 1.8 mm x 2.6 mm miniQFN package.

## FEATURES

- Ultra low charge injection (less than  $\pm 0.4\text{ pC}$ , typ. over the full analog signal range)
- Leakage current < 0.5 nA max. at 85 °C (for DG604EEQ-T1-GE4)
- Low switch capacitance ( $C_{S(off)}$ , 4.2 pF typ.)
- Fully specified with single supply operation at 3 V, 5 V, and dual supplies at  $\pm 5\text{ V}$
- CMOS / TTL compatible
- 414 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 (1.8 mm x 2.6 mm)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

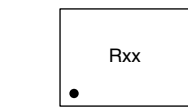


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

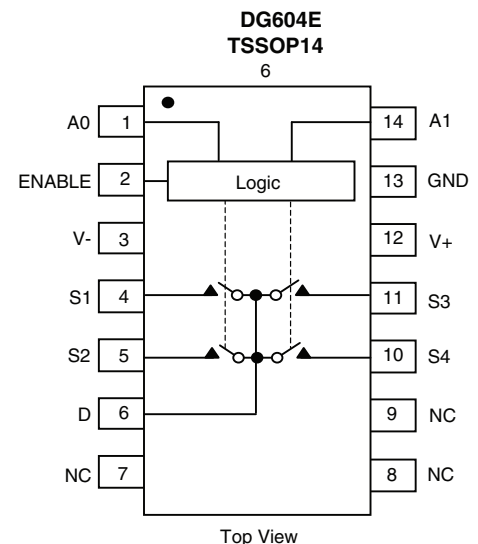
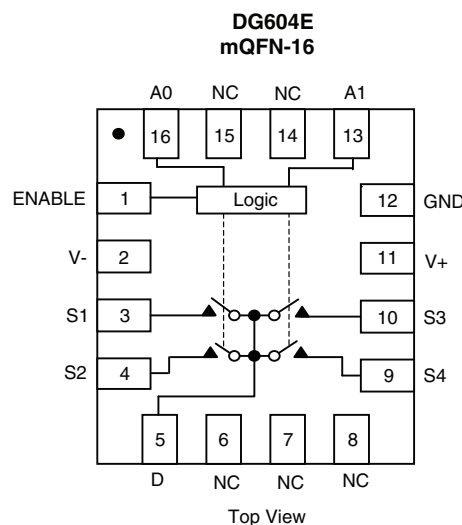
## APPLICATIONS

- Data acquisition systems
- Medical instruments
- Precision instruments
- Communications systems
- Automated test equipment
- Sample and hold circuit
- Relay replacement

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Device Marking: Rxx for DG604E (miniQFN16)  
xx = Date/Lot Traceability Code





| TRUTH TABLE  |                |    |                   |
|--------------|----------------|----|-------------------|
| ENABLE INPUT | SELECTED INPUT |    | ON SWITCHES       |
|              | A1             | A0 | DG604E            |
| 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   | DG604EEQ-T1-GE4 |
|                                | 16 pin miniQFN | DG604EEN-T1-GE4 |

**Note**

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

| ABSOLUTE MAXIMUM RATINGS ( $T_A = 25\text{ °C}$ , unless otherwise noted) |                                |  |      |
|---|--------------------------------|--|------|
| PARAMETER   |                                | LIMIT  | UNIT |
| V <sub>+</sub> to V <sub>-</sub>  |                                | -0.3 to +18  | V    |
| GND to V <sub>-</sub>   |                                | 18   |      |
| V <sub>S</sub> , V <sub>D</sub>   |                                | (V <sub>-</sub> ) -0.3 to (V <sub>+</sub> ) + 0.3 or 30 mA, whichever occurs first |      |
| Digital inputs <sup>a</sup>   |                                | (GND) -0.3 to (V <sub>+</sub> ) + 0.3  |      |
| 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>      | 450  | mW   |
|   | 16 pin miniQFN <sup>d, e</sup> | 525  |      |
| Thermal resistance (package) <sup>b</sup>                                 | 14 pin TSSOP                   | 178  | °C/W |
|   | 16 pin miniQFN                 | 152  |      |
| ESED / HBM  | EIA / JESD22-A114-A            | 2K   | V    |
| ESD / CDM   | EIA / JESD22-C101-A            | 1K   |      |
| Latch up  | JESD78                         | 300  | mA   |

**Notes**

- Signals on S<sub>x</sub>, D<sub>x</sub>, or IN<sub>x</sub> exceeding V<sub>+</sub> or V<sub>-</sub> will be clamped by internal diodes. Limit forward diode current to maximum current ratings
- All leads welded or soldered to PC board
- Derate 5.6 mW/°C above 70 °C
- Derate 6.6 mW/°C above 70 °C
- 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 (V+ = 5 V, V- = -5 V) |                       |   |                    |                   |                   |                   |                   |                   |      |
|--|-----------------------|---|--------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------|
| PARAMETER  | SYMBOL                | TEST CONDITIONS<br>UNLESS OTHERWISE<br>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> |      |
| <b>Analog Switch</b>                                   |                       |   |                    |                   |                   |                   |                   |                   |      |
| Analog signal range <sup>e</sup>                       | V <sub>ANALOG</sub>   |   | Full               | -                 | -5                | 5                 | -5                | 5                 | V    |
| Drain-source<br>On-resistance                          | R <sub>DS(on)</sub>   | I <sub>S</sub> = 1 mA, V <sub>D</sub> = -3 V, 0 V, +3 V   | Room               | 64                | -                 | 101               | -                 | 101               | Ω    |
|  |                       |   | Full               | -                 | -                 | 135               | -                 | 119               |      |
| On-resistance match                                    | ΔR <sub>DS(on)</sub>  | I <sub>S</sub> = 1 mA, V <sub>D</sub> = ± 3 V   | Room               | 0.5               | -                 | 5                 | -                 | 5                 |      |
|  |                       |   | Full               | -                 | -                 | 7                 | -                 | 6                 |      |
| On-resistance flatness                                 | R <sub>flat(on)</sub> | I <sub>S</sub> = 1 mA, V <sub>D</sub> = -3 V, 0 V, +3 V   | Room               | 15                | -                 | 20                | -                 | 20                |      |
|  |                       |   | Full               | -                 | -                 | 25                | -                 | 23                |      |
| Switch off<br>leakage current<br>(for 14 pin TSSOP)    | I <sub>S(off)</sub>   | V+ = 5.5 V, V- = -5.5 V<br>V <sub>D</sub> = ± 4.5 V, V <sub>S</sub> = ∓ 4.5 V   | Room               | ± 0.003           | -0.1              | 0.1               | -0.1              | 0.1               | nA   |
|  |                       |   | Full               | -                 | -18               | 18                | -0.5              | 0.5               |      |
|  | I <sub>D(off)</sub>   |   | Room               | ± 0.009           | -0.1              | 0.1               | -0.1              | 0.1               |      |
|  |                       |   | Full               | -                 | -18               | 18                | -0.5              | 0.5               |      |
| Switch on<br>leakage current<br>(for 14 pin TSSOP)     | I <sub>D(on)</sub>    | V+ = 5.5 V, V- = -5.5 V,<br>V <sub>D</sub> = V <sub>S</sub> = ± 4.5 V   | Room               | ± 0.016           | -0.1              | 0.1               | -0.1              | 0.1               |      |
|  |                       |   | Full               | -                 | -18               | 18                | -0.5              | 0.5               |      |
| Switch off<br>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> = ± 4.5 V, V <sub>S</sub> = ∓ 4.5 V   | Room               | ± 0.003           | -1                | 1                 | -1                | 1                 |      |
|  |                       |   | Full               | -                 | -18               | 18                | -2                | 2                 |      |
|  | I <sub>D(off)</sub>   |   | Room               | ± 0.009           | -1                | 1                 | -1                | 1                 |      |
|  |                       |   | Full               | -                 | -18               | 18                | -2                | 2                 |      |
| Switch on<br>leakage current<br>(for 16 pin miniQFN)   | I <sub>D(on)</sub>    | V+ = 5.5 V, V- = -5.5 V,<br>V <sub>D</sub> = V <sub>S</sub> = ± 4.5 V   | Room               | ± 0.016           | -1                | 1                 | -1                | 1                 |      |
|  |                       |   | Full               | -                 | -18               | 18                | -2                | 2                 |      |
| <b>Digital Control</b>                                 |                       |   |                    |                   |                   |                   |                   |                   |      |
| Input current, V <sub>IN</sub> low                     | I <sub>IL</sub>       | V <sub>IN</sub> A0, A1 and ENABLE<br>Under test = 0.8 V   | Full               | 0.00001           | -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<br>Under test = 2 V   | Full               | 0.00001           | -0.1              | 0.1               | -0.1              | 0.1               |      |
| Input capacitance                                      | C <sub>IN</sub>       | f = 1 MHz   | Room               | 5                 | -                 | -                 | -                 | -                 | pF   |
| <b>Dynamic Characteristics</b>                         |                       |   |                    |                   |                   |                   |                   |                   |      |
| 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               | 29                | -                 | 67                | -                 | 67                | ns   |
|  |                       |   | Full               | -                 | -                 | 87                | -                 | 82                |      |
| 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               | 26                | -                 | 54                | -                 | 54                |      |
|  |                       |   | Full               | -                 | -                 | 61                | -                 | 58                |      |
| Turn-off time  | t <sub>OFF</sub>      |   | Room               | 22                | -                 | 52                | -                 | 52                |      |
|  |                       |   | Full               | -                 | -                 | 70                | -                 | 57                |      |
| Break-before-make<br>time                              | t <sub>BBM</sub>      | V <sub>S</sub> = 3 V<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF  | Room               | 7                 | -                 | -                 | -                 | -                 |      |
|  |                       |   | Full               | -                 | 2                 | -                 | 2                 | -                 |      |
| Charge injection <sup>e</sup>                          | Q <sub>INJ</sub>      | V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω, C <sub>L</sub> = 1 nF   | Room               | -0.3              | -                 | -                 | -                 | -                 | pC   |
| Off isolation <sup>e</sup>                             | OIRR                  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 10 MHz  | Room               | -67               | -                 | -                 | -                 | -                 | dB   |
| Bandwidth <sup>e</sup>                                 | BW                    | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF  | Room               | 414               | -                 | -                 | -                 | -                 | MHz  |
| Channel-to-channel<br>crosstalk <sup>e</sup>           | X <sub>TALK</sub>     | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 10 MHz  | Room               | -65               | -                 | -                 | -                 | -                 | dB   |
| Source off capacitance <sup>e</sup>                    | C <sub>S(off)</sub>   | f = 1 MHz   | Room               | 4.2               | -                 | -                 | -                 | -                 | pF   |
| Drain off capacitance <sup>e</sup>                     | C <sub>D(off)</sub>   |   | Room               | 6.8               | -                 | -                 | -                 | -                 |      |
| Drain on capacitance <sup>e</sup>                      | C <sub>D(on)</sub>    |   | Room               | 11                | -                 | -                 | -                 | -                 |      |



| SPECIFICATIONS FOR DUAL SUPPLIES (V+ = 5 V, V- = -5 V) |        |   |                    |                   |                   |                   |                   |                   |      |
|--|--------|---|--------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------|
| PARAMETER  | SYMBOL | TEST CONDITIONS<br>UNLESS OTHERWISE<br>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> |      |
| <b>Power Supply</b>                                    |        |   |                    |                   |                   |                   |                   |                   |      |
| Power supply current                                   | I+     | VIN = 0 V or V+   | Room               | 0.0004            | -                 | 0.5               | -                 | 0.5               | μA   |
|  |        |   | Full               | -                 | -                 | 1                 | -                 | 1                 |      |
| Negative supply current                                | I-     |   | Room               | -0.0004           | -0.5              | -                 | -0.5              | -                 |      |
|  |        |   | Full               | -                 | -1                | -                 | -1                | -                 |      |
| Ground current   | IGND   |   | Room               | -0.0004           | -0.5              | -                 | -0.5              | -                 |      |
|  |        |   | Full               | -                 | -1                | -                 | -1                | -                 |      |

Notes

- a. Signals on S<sub>X</sub>, D<sub>X</sub>, or IN<sub>X</sub> 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 SINGLE SUPPLY (V+ = 5 V, V- = 0 V) |                       |  |   |                   |                   |                   |                   |                   |      |    |    |
|---|-----------------------|--|---|-------------------|-------------------|-------------------|-------------------|-------------------|------|----|----|
| PARAMETER   | SYMBOL                | TEST CONDITIONS<br>UNLESS OTHERWISE<br>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> |      |    |    |
| <b>Analog Switch</b>                                  |                       |  |   |                   |                   |                   |                   |                   |      |    |    |
| Analog signal range <sup>e</sup>                      | V <sub>ANALOG</sub>   |  | Full  | -                 | 0                 | 5                 | 0                 | 5                 | V    |    |    |
| Drain-source<br>On-resistance                         | R <sub>DS(on)</sub>   | I <sub>S</sub> = 1 mA, V <sub>D</sub> = +3.5 V   | Room  | 134               | -                 | 181               | -                 | 181               | Ω    |    |    |
|   |                       |  | Full  | -                 | -                 | 232               | -                 | 208               |      |    |    |
| On-resistance match                                   | ΔR <sub>DS(on)</sub>  | I <sub>S</sub> = 1 mA, V <sub>D</sub> = +3.5 V   | Room  | 1.4               | -                 | 7                 | -                 | 7                 | Ω    |    |    |
|   |                       |  | Full  | -                 | -                 | 9                 | -                 | 8                 |      |    |    |
| On-resistance flatness                                | R <sub>flat(on)</sub> | I <sub>S</sub> = 1 mA, V <sub>D</sub> = 0 V, +3.5 V  | Room  | 36                | -                 | 50                | -                 | 50                | Ω    |    |    |
|   |                       |  | Full  | -                 | -                 | 54                | -                 | 52                |      |    |    |
| Switch off<br>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,<br>V <sub>S</sub> = 4.5 V / 1 V                                      | Room  | ± 0.002           | -0.1              | 0.1               | -0.1              | 0.1               | nA   |    |    |
|   |                       |  | Full  | -                 | -18               | 18                | -0.5              | 0.5               |      |    |    |
|   | I <sub>D(off)</sub>   |  | Room  | ± 0.007           | -0.1              | 0.1               | -0.1              | 0.1               |      |    |    |
|   |                       |  | Full  | -                 | -18               | 18                | -0.5              | 0.5               |      |    |    |
| Switch on<br>leakage current<br>(for 14 pin TSSOP)    | I <sub>D(on)</sub>    | V+ = 5.5 V, V- = 0 V<br>V <sub>D</sub> = V <sub>S</sub> = 1 V / 4.5 V  | Room  | ± 0.01            | -0.1              | 0.1               | -0.1              | 0.1               |      |    |    |
|   |                       |  | Full  | -                 | -18               | 18                | -0.5              | 0.5               |      |    |    |
| Switch off<br>leakage current<br>(for 16 pin miniQFN) | I <sub>S(off)</sub>   |  | V+ = 5.5 V, V- = 0 V<br>V <sub>D</sub> = 1 V / 4.5 V,<br>V <sub>S</sub> = 4.5 V / 1 V | Room              | ± 0.002           | -1                | 1                 | -1                |      | 1  |    |
|   |                       |  |   | Full              | -                 | -18               | 18                | -2                |      | 2  |    |
| I <sub>D(off)</sub>                                   | Room                  | ± 0.007  |   | -1                | 1                 | -1                | 1                 |                   |      |    |    |
|   | Full                  | -  |   | -18               | 18                | -2                | 2                 |                   |      |    |    |
| Switch on<br>leakage current<br>(for 16 pin miniQFN)  | I <sub>D(on)</sub>    | V+ = 5.5 V, V- = 0 V,<br>V <sub>D</sub> = V <sub>S</sub> = 1 V / 4.5 V   | Room  | ± 0.01            | -1                | 1                 | -1                | 1                 |      |    |    |
|   |                       |  | Full  | -                 | -18               | 18                | -2                | 2                 |      |    |    |
| <b>Digital Control</b>                                |                       |  |   |                   |                   |                   |                   |                   |      |    |    |
| Input current, V <sub>IN</sub> low                    | I <sub>IL</sub>       |  | V <sub>IN</sub> A0, A1, and ENABLE<br>Under test = 0.8 V                              | Full              | 0.00001           | -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<br>Under test = 2 V   | Full  | 0.00001           | -0.1              | 0.1               | -0.1              | 0.1               | μA   |    |    |
| Input capacitance                                     | C <sub>IN</sub>       | f = 1 MHz  | Room  | 5                 | -                 | -                 | -                 | -                 | pF   |    |    |
| <b>Dynamic Characteristics</b>                        |                       |  |   |                   |                   |                   |                   |                   |      |    |    |
| 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  | 47                | -                 | 70                | -                 | 70                | ns   |    |    |
|   |                       |  | Full  | -                 | -                 | 116               | -                 | 91                |      |    |    |
| Turn-on time  | t <sub>ON</sub>       |  | Room  | 32                | -                 | 52                | -                 | 52                |      |    |    |
|   |                       |  | Full  | -                 | -                 | 63                | -                 | 57                |      |    |    |
| Turn-off time   | t <sub>OFF</sub>      |  | Room  | 26                | -                 | 46                | -                 | 46                |      |    |    |
|   |                       |  | Full  | -                 | -                 | 61                | -                 | 55                |      |    |    |
| Break-before-make-time                                | t <sub>BMM</sub>      |  | Room  | 22                | -                 | -                 | -                 | -                 |      |    |    |
|   |                       |  | Full  | -                 | 3                 | -                 | 3                 | -                 |      |    |    |
| Charge injection <sup>e</sup>                         | Q <sub>INJ</sub>      |  | C <sub>L</sub> = 1 nF, R <sub>GEN</sub> = 0 Ω, V <sub>GEN</sub> = 0 V                 | Full              | -0.03             | -                 | -                 | -                 |      | -  | pC |
| Off-isolation <sup>e</sup>                            | OIRR                  |  | f = 10 MHz, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF                              | Room              | -66               | -                 | -                 | -                 |      | -  | dB |
| Channel-to-channel<br>crosstalk <sup>e</sup>          | X <sub>TALK</sub>     | Room   |   | -64               | -                 | -                 | -                 | -                 |      |    |    |
| Bandwidth <sup>e</sup>                                | BW                    | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF   | Room  | 358               | -                 | -                 | -                 | -                 | MHz  |    |    |
| Source off capacitance <sup>e</sup>                   | C <sub>S(off)</sub>   | f = 1 MHz  | Room  | 4.4               | -                 | -                 | -                 | -                 | pF   |    |    |
| Drain off capacitance <sup>e</sup>                    | C <sub>D(off)</sub>   |  |   | 7.3               | -                 | -                 | -                 | -                 |      |    |    |
| Drain on capacitance <sup>e</sup>                     | C <sub>D(on)</sub>    |  |   | 12                | -                 | -                 | -                 | -                 |      |    |    |



| SPECIFICATIONS FOR SINGLE SUPPLY (V+ = 5 V, V- = 0 V) |        |  |                    |                   |                   |                   |                   |                   |      |
|---|--------|--|--------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------|
| PARAMETER   | SYMBOL | TEST CONDITIONS<br>UNLESS OTHERWISE<br>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> |      |
| <b>Power Supply</b>                                   |        |  |                    |                   |                   |                   |                   |                   |      |
| Power supply current                                  | I+     | VIN = 0 V or V+  | Room               | 0.0002            | -                 | 0.5               | -                 | 0.5               | μA   |
|   |        |  | Full               | -                 | -                 | 1                 | -                 | 1                 |      |
| Negative supply current                               | I-     |  | Room               | -0.0002           | -0.5              | -                 | -0.5              | -                 |      |
|   |        |  | Full               | -                 | -1                | -                 | -1                | -                 |      |
| Ground current  | IGND   |  | Room               | -0.0002           | -0.5              | -                 | -0.5              | -                 |      |
|   |        |  | Full               | -                 | -1                | -                 | -1                | -                 |      |

Notes

- a. Signals on S<sub>X</sub>, D<sub>X</sub>, or IN<sub>X</sub> 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 SINGLE SUPPLY (V+ = 3 V, V- = 0 V) |                      |  |   |                   |                   |                   |                   |                   |      |    |
|---|----------------------|--|---|-------------------|-------------------|-------------------|-------------------|-------------------|------|----|
| PARAMETER   | SYMBOL               | TEST CONDITIONS<br>UNLESS OTHERWISE<br>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> |      |    |
| <b>Analog Switch</b>                                  |                      |  |   |                   |                   |                   |                   |                   |      |    |
| Analog signal range <sup>e</sup>                      | V <sub>ANALOG</sub>  |  | Full  | -                 | -                 | 3                 | -                 | 3                 | V    |    |
| Drain-source<br>On-resistance                         | R <sub>DS(on)</sub>  | I <sub>S</sub> = 1 mA, V <sub>D</sub> = +1.5 V   | Room  | 319               | -                 | 416               | -                 | 416               | Ω    |    |
|   |                      |  | Full  | -                 | -                 | 478               | -                 | 453               |      |    |
| On-resistance match                                   | ΔR <sub>DS(on)</sub> | I <sub>S</sub> = 1 mA, V <sub>D</sub> = +1.5 V   | Room  | 7                 | -                 | 15                | -                 | 15                | Ω    |    |
|   |                      |  | Full  | -                 | -                 | 17                | -                 | 16                |      |    |
| Switch off<br>leakage current<br>(for 14 pin TSSOP)   | I <sub>S(off)</sub>  | V+ = 3.3 V, V- = 0 V<br>V <sub>D</sub> = 1 V / 3 V,<br>V <sub>S</sub> = 3 V / 1 V  | Room  | ± 0.001           | -0.1              | 0.1               | -0.1              | 0.1               | nA   |    |
|   |                      |  | Full  | -                 | -18               | 18                | -0.5              | 0.5               |      |    |
|   | I <sub>D(off)</sub>  |  | Room  | ± 0.006           | -0.1              | 0.1               | -0.1              | 0.1               |      |    |
|   |                      |  | Full  | -                 | -18               | 18                | -0.5              | 0.5               |      |    |
| Switch on<br>leakage current<br>(for 14 pin TSSOP)    | I <sub>D(on)</sub>   | V+ = 3.3 V, V- = 0 V<br>V <sub>D</sub> = V <sub>S</sub> = 1 V / 3 V  | Room  | ± 0.006           | -0.1              | 0.1               | -0.1              | 0.1               |      |    |
|   |                      |  | Full  | -                 | -18               | 18                | -0.5              | 0.5               |      |    |
| Switch off<br>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,<br>V <sub>S</sub> = 3 V / 1 V | Room              | ± 0.001           | -1                | 1                 | -1                |      | 1  |
|   |                      |  |   | Full              | -                 | -18               | 18                | -2                |      | 2  |
| I <sub>D(off)</sub>                                   | Room                 | ± 0.006  |   | -1                | 1                 | -1                | 1                 |                   |      |    |
|   | Full                 | -  |   | -18               | 18                | -2                | 2                 |                   |      |    |
| Switch on<br>leakage current<br>(for 16 pin miniQFN)  | I <sub>D(on)</sub>   | V+ = 3.3 V, V- = 0 V,<br>V <sub>D</sub> = V <sub>S</sub> = 1 V / 3 V   | Room  | ± 0.006           | -1                | 1                 | -1                | 1                 |      |    |
|   |                      |  | Full  | -                 | -18               | 18                | -2                | 2                 |      |    |
| <b>Digital Control</b>                                |                      |  |   |                   |                   |                   |                   |                   |      |    |
| Input current, V <sub>IN</sub> low                    | I <sub>IL</sub>      |  | V <sub>IN</sub> A0, A1 and ENABLE<br>under test = 0.6 V                           | Full              | 0.000008          | -1                | 1                 | -1                | 1    | μA |
| Input current, V <sub>IN</sub> high                   | I <sub>IH</sub>      | V <sub>IN</sub> A0, A1 and ENABLE<br>under test = 1.4 V  | Full  | 0.000008          | -1                | 1                 | -1                | 1                 | μA   |    |
| Input capacitance                                     | C <sub>IN</sub>      | f = 1 MHz  | Room  | 5                 | -                 | -                 | -                 | -                 | pF   |    |
| <b>Dynamic Characteristics</b>                        |                      |  |   |                   |                   |                   |                   |                   |      |    |
| 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  | 138               | -                 | 163               | -                 | 163               | ns   |    |
|   |                      |  | Full  | -                 | -                 | 197               | -                 | 195               |      |    |
| Turn-on time  | t <sub>ON</sub>      |  | Room  | 95                | -                 | 117               | -                 | 117               |      |    |
|   |                      |  | Full  | -                 | -                 | 145               | -                 | 135               |      |    |
| Turn-off time   | t <sub>OFF</sub>     |  | Room  | 55                | -                 | 76                | -                 | 76                |      |    |
|   |                      |  | Full  | -                 | -                 | 98                | -                 | 90                |      |    |
| Break-before-make-time                                | t <sub>BMM</sub>     |  | Room  | 58                | -                 | -                 | -                 | -                 |      |    |
|   |                      |  | Full  | -                 | 5                 | -                 | 5                 | -                 |      |    |
| Charge injection <sup>e</sup>                         | Q <sub>INJ</sub>     |  | C <sub>L</sub> = 1 nF, R <sub>GEN</sub> = 0 Ω, V <sub>GEN</sub> = 0 V             | Full              | 0.01              | -                 | -                 | -                 | -    | pC |
| Off-isolation <sup>e</sup>                            | OIRR                 |  | f = 10 MHz, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF                          | Room              | -66               | -                 | -                 | -                 | -    | dB |
| Channel-to-channel<br>crosstalk <sup>e</sup>          | X <sub>TALK</sub>    | Room   |   | -64               | -                 | -                 | -                 | -                 |      |    |
| Bandwidth <sup>e</sup>                                | BW                   | Room   |   | 318               | -                 | -                 | -                 | -                 | MHz  |    |
| Source off<br>capacitance <sup>e</sup>                | C <sub>S(off)</sub>  | f = 1 MHz  | Room  | 4.6               | -                 | -                 | -                 | -                 | pF   |    |
| Drain off capacitance <sup>e</sup>                    | C <sub>D(off)</sub>  |  | Room  | 7.7               | -                 | -                 | -                 | -                 |      |    |
| Channel on<br>capacitance <sup>e</sup>                | C <sub>D(on)</sub>   |  | Room  | 12.6              | -                 | -                 | -                 | -                 |      |    |



**SPECIFICATIONS FOR SINGLE SUPPLY (V+ = 3 V, V- = 0 V)**

| PARAMETER               | SYMBOL | TEST CONDITIONS<br>UNLESS OTHERWISE<br>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> |      |
| <b>Power Supply</b>     |        |  |                    |                   |                   |                   |                   |                   |      |
| Power supply current    | I+     | VIN = 0 V or V+  | Room               | 0.0001            | -                 | 0.5               | -                 | 0.5               | μA   |
|                         |        |  | Full               | -                 | -                 | 1                 | -                 | 1                 |      |
| Negative supply current | I-     |  | Room               | -0.0001           | -0.5              | -                 | -0.5              | -                 |      |
|                         |        |  | Full               | -                 | -1                | -                 | -1                | -                 |      |
| Ground current          | IGND   |  | Room               | -0.0001           | -0.5              | -                 | -0.5              | -                 |      |
|                         |        |  | Full               | -                 | -1                | -                 | -1                | -                 |      |

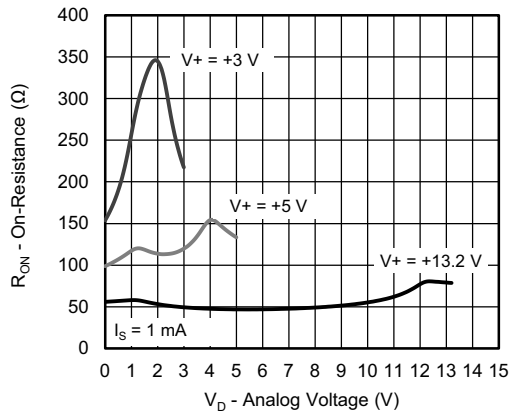
**Notes**

- a. Signals on S<sub>X</sub>, D<sub>X</sub>, or IN<sub>X</sub> 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

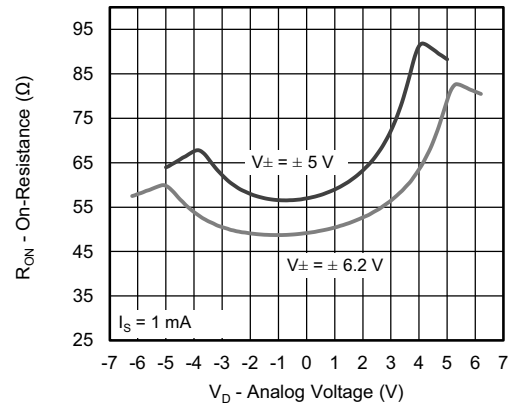
*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



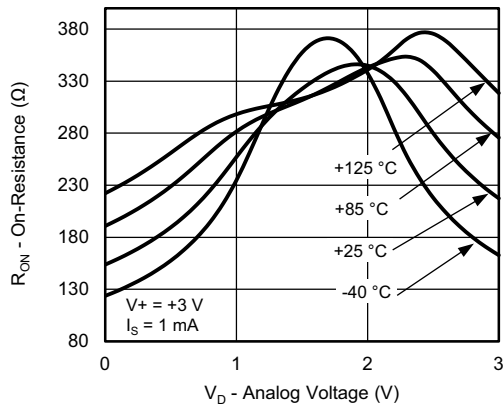
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



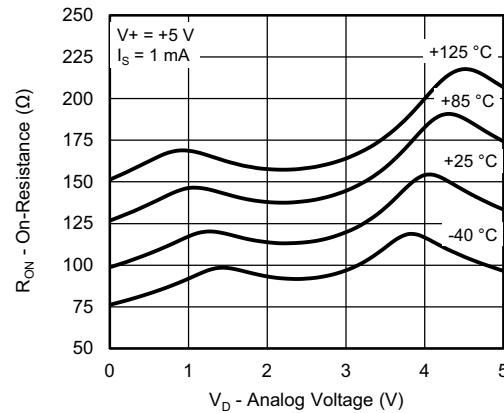
**On-Resistance vs.  $V_D$  (Single Supply Voltage)**



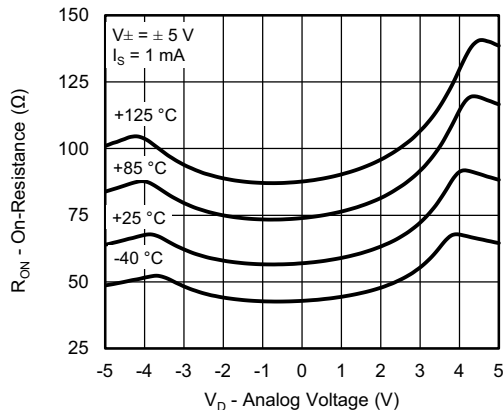
**On-Resistance vs.  $V_D$  (Dual Supply Voltage)**



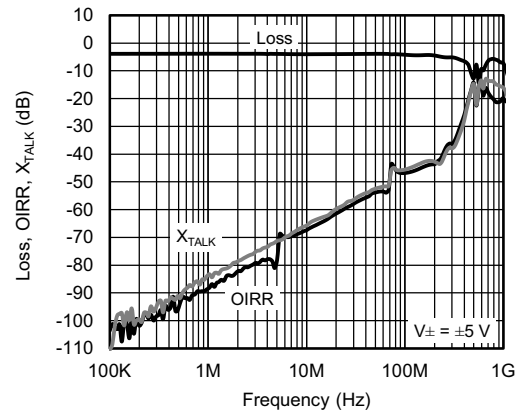
**On-Resistance vs. Analog Voltage and Temperature**



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

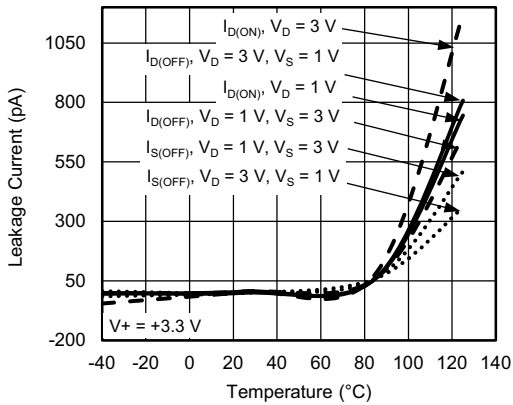


**On-Resistance vs. Analog Voltage and Temperature**

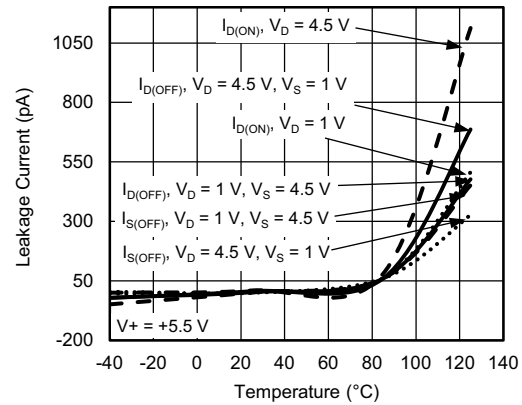


**Insertion Loss, Off-Isolation, Crosstalk vs. Frequency**

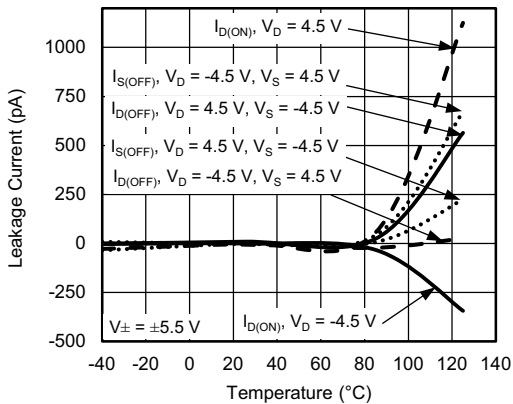
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



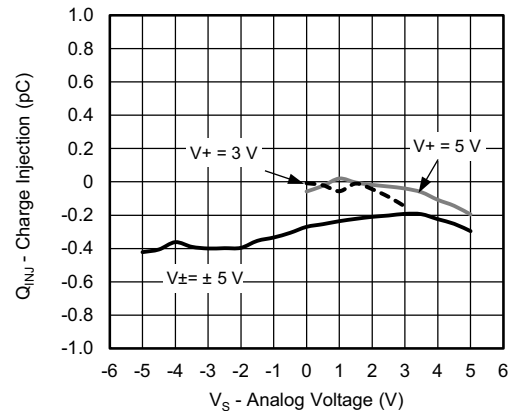
**Leakage Current vs. Temperature**



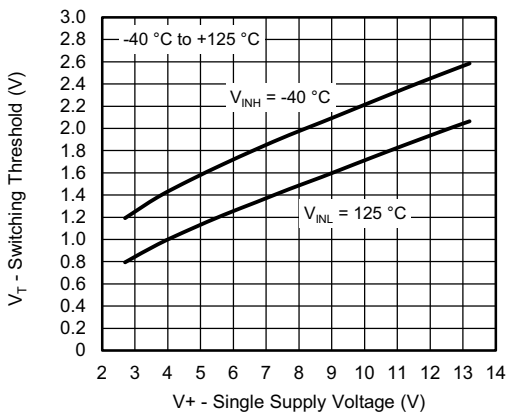
**Leakage Current vs. Temperature**



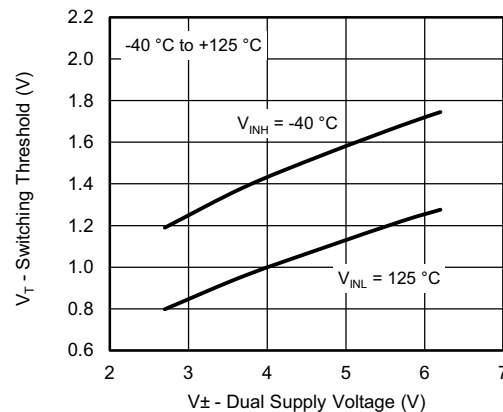
**Leakage Current vs. Temperature**



**Charge Injection vs. Analog Voltage**



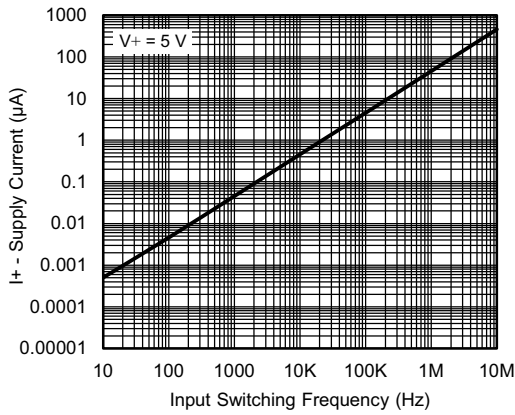
**Switching Threshold vs. Supply Voltage**



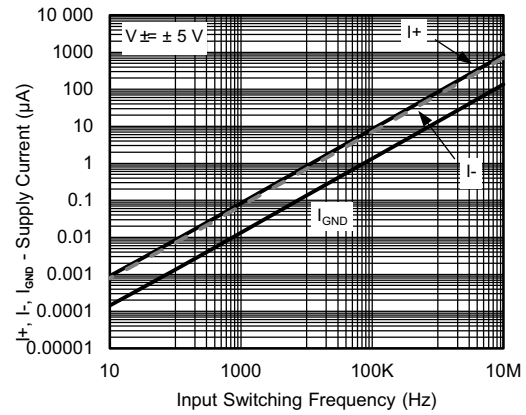
**Switching Threshold vs. Supply Voltage**



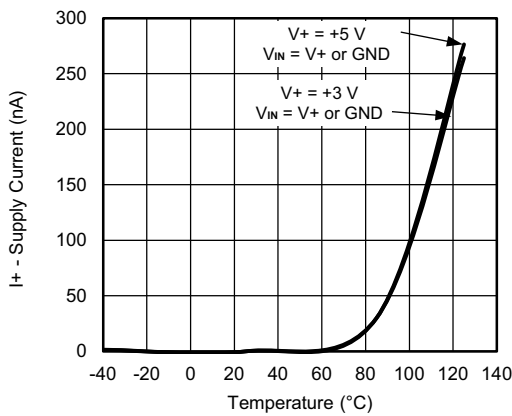
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



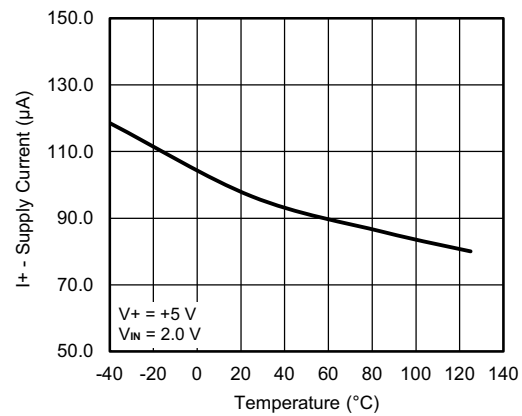
**Supply Current vs. Switching Frequency**



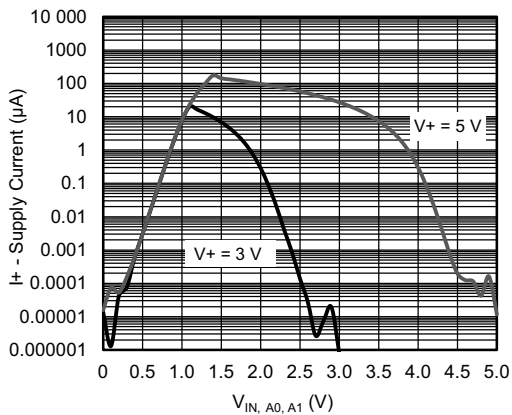
**Supply Current vs. Switching Frequency**



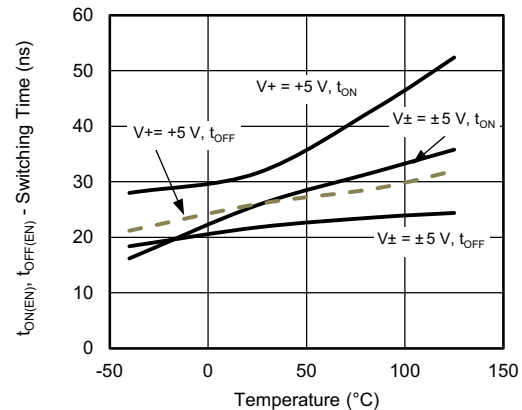
**Supply Current vs. Temperature**



**Supply Current vs. Temperature**



**Supply Current vs. Enable Input Voltage**



**Switching Time vs. Temperature**

TEST CIRCUITS

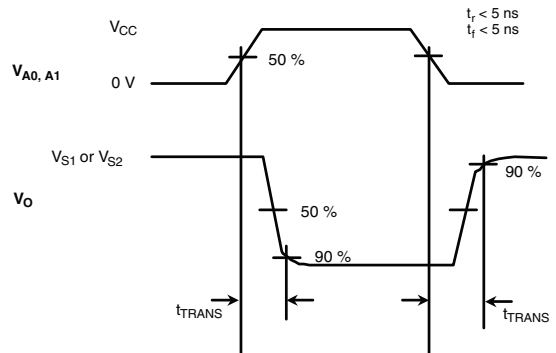
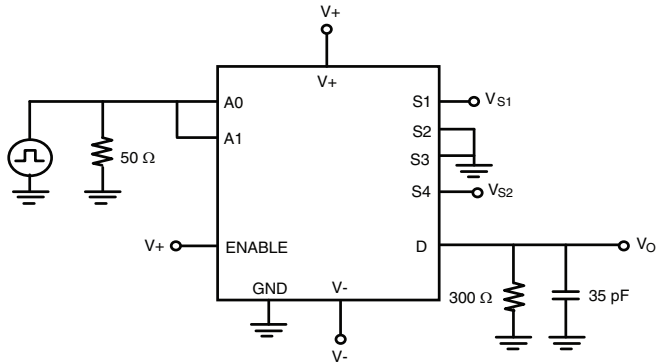


Fig. 1 - Transition Time

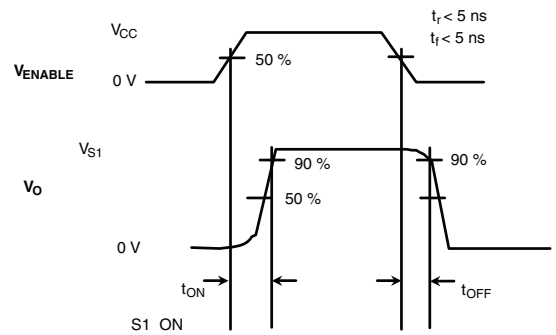
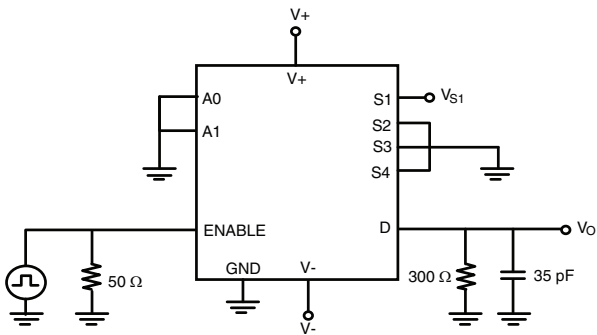


Fig. 2 - Enable Switching Time

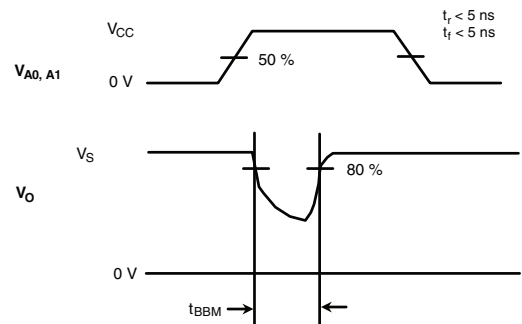
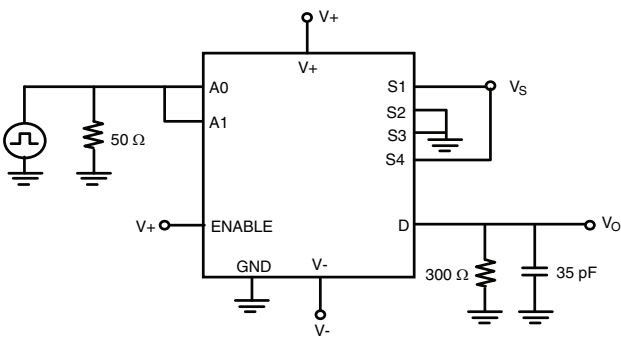


Fig. 3 - Break-Before-Make

TEST CIRCUITS

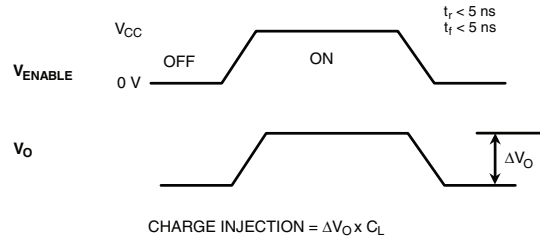
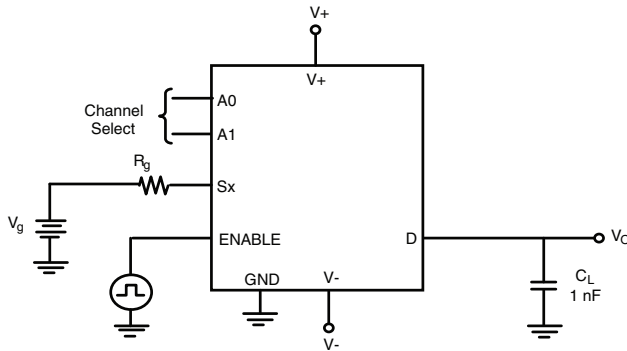
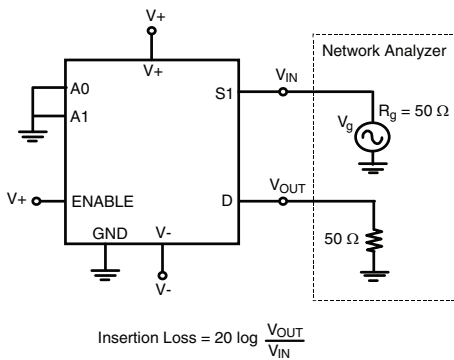
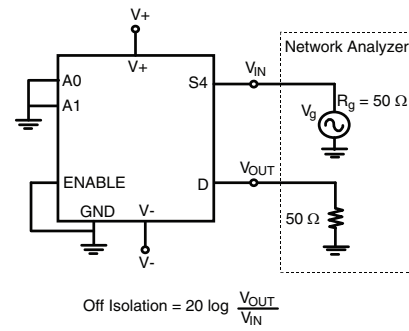


Fig. 4 - Charge Injection



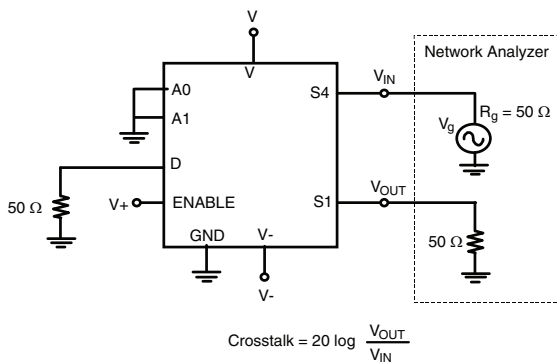
$$\text{Insertion Loss} = 20 \log \frac{V_{OUT}}{V_{IN}}$$

Fig. 5 - Insertion Loss



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

Fig. 6 - Off-Isolation



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

Fig. 7 - Crosstalk

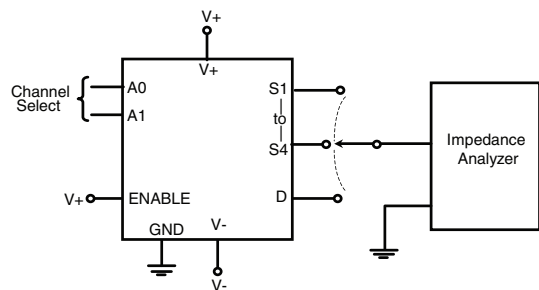
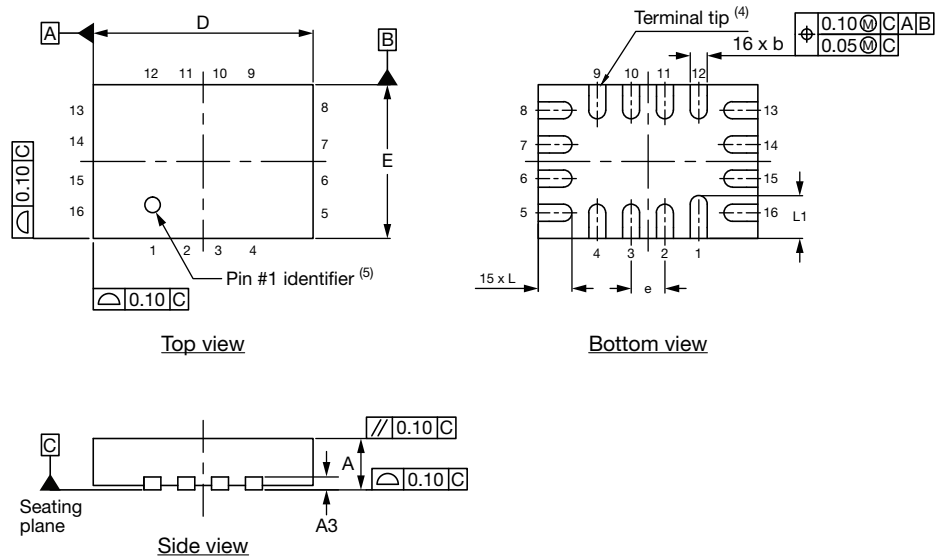


Fig. 8 - Source / Drain Capacitance

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?75612](http://www.vishay.com/ppg?75612).

## Thin miniQFN16 Case Outline



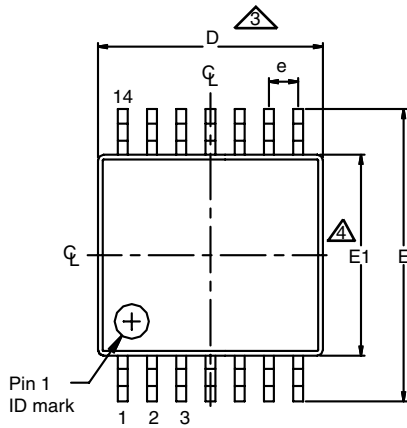
| DIMENSIONS        | MILLIMETERS <sup>(1)</sup> |      |      | INCHES     |       |       |
|-------------------|----------------------------|------|------|------------|-------|-------|
|                   | MIN.                       | NOM. | MAX. | MIN.       | NOM.  | MAX.  |
| A                 | 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.

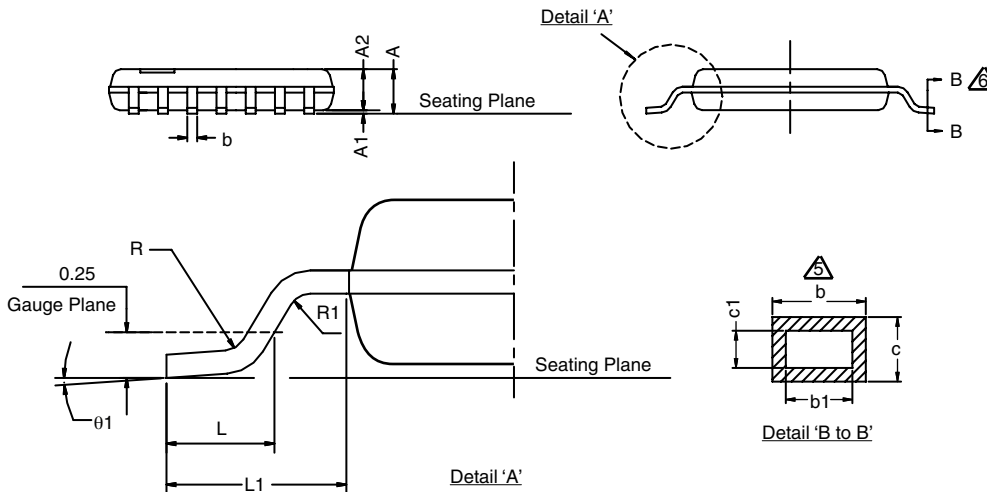
ECN: T16-0226-Rev. B, 09-May-16  
DWG: 6023

### 14L TSSOP



**Notes:**

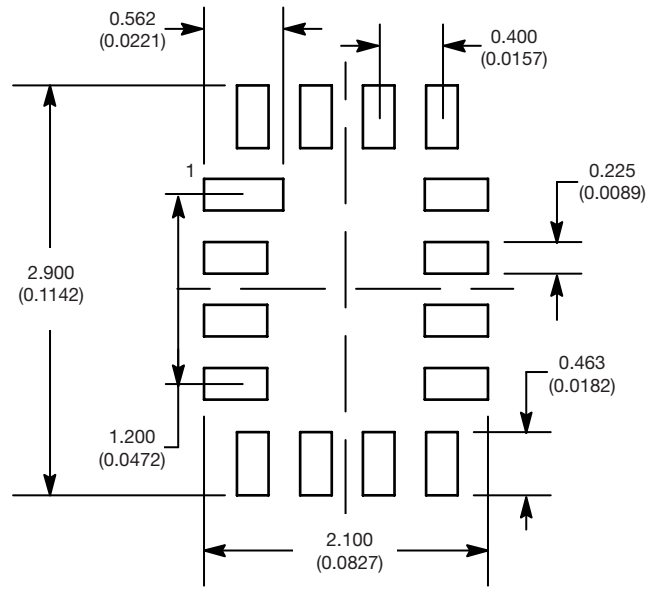
1. All dimensions are in millimeters (angles in degrees)
2. Dimensioning and tolerancing per ANSI Y14.5M-1982
- ⚠ Dimension 'D' does not include mold flash, protrusions or gate burrs
- ⚠ Dimension 'E1' does not include internal flash or protrusion
- ⚠ Dimension 'b' does not include dambar protrusion
- ⚠ 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 |         |

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**RECOMMENDED MINIMUM PADS FOR MINI QFN 16L**



Mounting Footprint  
Dimensions in mm (inch)





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