# Automotive 125 °C Analog Switch
# Dual DPDT / Quad SPDT, 0.37 Ω, 338 MHz Bandwidth

## DESCRIPTION

The DGQ2788A, is a four-channel single-pole double-throw (SPDT) analog switch with two control inputs. It is also known as a two-channel double-pole double-throw (DPDT) configuration. The part is designed to operate from 1.8 V to 5.5 V single power rail. All switches conduct equally well in both directions, offering rail to rail signal witching and can be used both as multiplexers as well as de-multiplexers.

The DGQ2788A offers low parasitic capacitance and highly matched low and flat switch resistance over the full signal range. It features break-before-make switching and low control logic threshold. The part supports rail to rail fast edge pulsing signals and have 0.1 ns/typ. propagation delay. It is ideal for both analog and digital signal switching in space constrain applications requiring high performance and efficient use of board space.

The DGQ2788A comes in a small miniQFN-16 lead package of 2.6 mm x 1.8 mm x 0.55 mm.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

## FEATURES

- 1.8 V to 5.5 V single supply operation
- Low resistance: 0.37 Ω/typ. at 2.7 V
- Highly flat and matched $R_{ON}$
- Low parasitic capacitance, $C_{ON}$ = 26 pF, $C_{OFF}$ = 14.5 pF
- High bandwidth: 338 MHz
- 0.1 ns/typ. propagation delay for rail to rail fast edge pulsing signal
- Guaranteed logic high 1.2 V, logic low 0.3 V
- Break before make switching
- Signal swing over V+ capable
- Power down protection
- Latch up current: 300 mA (JESD78)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

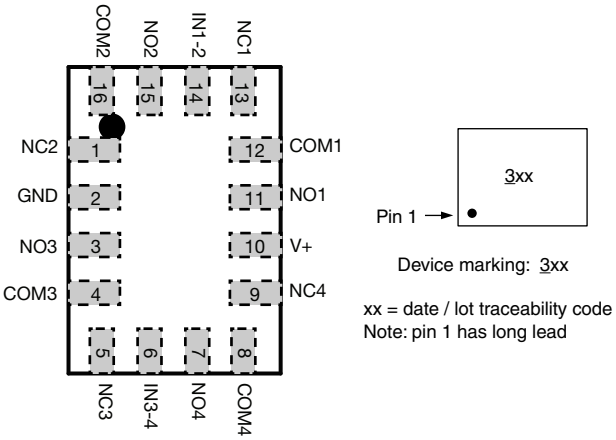
## BENEFITS

- Low and flat resistance
- High bandwidth
- Low parasitic capacitance
- Fault protection

## APPLICATIONS

- Automotive infotainment
- Audio, video, and bus routing
- Industrial automation
- Medical imaging
- Network and telecommunication

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION







Device marking: 3xx

xx = date / lot traceability code
Note: pin 1 has long lead

| TRUTH TABLE | | |
|---|---|---|
| LOGIC | NC1, 2, 3 and 4 | NO1, 2, 3 and 4 |
| 0 | On | Off |
| 1 | Off | On |

| ORDERING INFORMATION | | | |
|---|---|---|---|
| TEMPERATURE RANGE | PACKAGE | PART NUMBER | MIN. ORDER / PACK. QUANTITY |
| -40 °C to +125 °C lead (Pb)-free | miniQFN-16 | DGQ2788AEN-T1-GE4 | Tape and reel, 3000 units |



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| **ABSOLUTE MAXIMUM RATINGS** ($T_A$ = 25 °C, unless otherwise noted) | | | | |
|---|---|---|---|---|
| **PARAMETER** | | **SYMBOL** | **LIMIT** | **UNIT** |
| Reference to GND | V+ | | -0.3 to +6 | V |
| | IN, COM, NC, NO [a] | | -0.3 to (V+ + 0.3) | |
| Current (any terminal except NO, NC, or COM) | | | 30 | mA |
| Continuous current (NO, NC, or COM) | | | ± 300 | |
| Peak current (pulsed at 1 ms, 10 % duty cycle) | | | ± 500 | |
| Storage temperature (D suffix) | | | -65 to +150 | °C |
| Package solder reflow conditions [d] | miniQFN-16 | | 250 | |
| Power dissipation (packages) [b] | miniQFN-16 [c] | | 525 | mW |
| Latch-up, per AEC Q100-004 | | | 300 | mA |
| ESD human body model, per AEC Q100-002 | | | 2000 | V |
| ESD charged device model, per AEC Q100-011 | | | 1500 | |

**Notes**

a. Signals on NC, NO, or COM, or IN exceeding V+ will be clamped by internal diodes. Limit forward diode current to maximum current ratings
b. All leads welded or soldered to PC board
c. Derate 6.6 mW/°C above 70 °C
d. 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


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| SPECIFICATIONS (V+ = 3 V) | | | | | | | |
|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS unless otherwise specified V+ = 3 V, ± 10 %, $V_{IN}$ = 0.5 or 1.4 V [e] | TEMP.[a] | LIMITS -40 °C to +125 °C | | | UNIT |
| | | | | MIN. [b] | TYP. [c] | MAX. [b] | |
| **Analog Switch** | | | | | | | |
| Analog signal range [d] | $V_{NO}$, $V_{NC}$, $V_{COM}$ | | Full | 0 | - | V+ | V |
| On-resistance | $R_{ON}$ | V+ = 2.7 V, $V_{COM}$ = 0 to 2.7 V, $I_{NO}$, $I_{NC}$ = 100 mA | Room | - | 0.37 | 0.5 | Ω |
| | | | Full | - | - | 0.65 | |
| $R_{ON}$ flatness [d] | $R_{ON}$ flatness | V+ = 2.7 V, $V_{COM}$ = 0 to V+, $I_{NO}$, $I_{NC}$ = 100 mA | Room | - | 0.01 | 0.05 | |
| $R_{ON}$ match [d] | $\Delta R_{ON}$ | | Room | - | 0.05 | - | |
| Switch off leakage current | $I_{NO(off)}$, $I_{NC(off)}$ | V+ = 5.5 V, $V_{NO}$, $V_{NC}$ = 0.5 V / 4 V, $V_{COM}$ = 4 V / 0.5 V | Room | -0.1 | - | 0.1 | µA |
| | | | Full | -0.5 | - | 0.5 | |
| | $I_{COM(off)}$ | | Room | -1.2 | - | 1.2 | |
| | | | Full | -2 | - | 2 | |
| Channel-on leakage current | $I_{COM(on)}$ | V+ = 5.5 V, $V_{NO}$, $V_{NC}$ = $V_{COM}$ = 0.5 V / 4 V | Room | -1.2 | - | 1.2 | |
| | | | Full | -2 | - | 2 | |
| **Digital Control** | | | | | | | |
| Input high voltage | $V_{INH}$ | | Full | 1.2 | - | - | V |
| Input low voltage | $V_{INL}$ | | Full | - | - | 0.3 | |
| Input capacitance | $C_{IN}$ | | Full | - | 5 | - | pF |
| Input current | $I_{INL}$ or $I_{INH}$ | $V_{IN}$ = 0 or V+ | Full | -1 | - | 1 | µA |
| **Dynamic Characteristics** | | | | | | | |
| Turn-on time | $t_{ON}$ | $V_{NO}$ or $V_{NC}$ = 1.5 V, $R_L$ = 50 Ω, $C_L$ = 35 pF | Room | - | 30 | 50 | µs |
| | | | Full | - | - | 150 | |
| Turn-off time | $t_{OFF}$ | | Room | - | 0.35 | 1 | |
| | | | Full | - | - | 3 | |
| Break-before-make time | $t_d$ | | Full | 1 | - | - | |
| Charge injection [d] | $Q_{INJ}$ | $C_L$ = 1 nF, $V_{GEN}$ = 1.5 V, $R_{GEN}$ = 0 Ω | Room | - | -245 | - | pC |
| -3 dB bandwidth | BW | $R_L$ = 50 Ω, $C_L$ = 5 pF | Room | - | 338 | - | MHz |
| Off-isolation [d] | OIRR | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 100 kHz | Room | - | -82 | - | dB |
| | | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 1 MHz | | - | -56 | - | |
| Crosstalk [d, f] | $X_{TALK}$ | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 100 kHz | | - | -87 | - | |
| | | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 1 MHz | | - | -61 | - | |
| Total harmonic distortion and noise | THD+N | $R_L$ = 50 Ω, 1 $V_{p-p}$, f = 1 kHz | Room | - | -104.1 | - | dB |
| NO, NC off capacitance [d] | $C_{NO(off)}$ | f = 1 MHz | Room | - | 14.5 | - | pF |
| | $C_{NC(off)}$ | | Room | - | 14.5 | - | |
| Channel-on capacitance [d] | $C_{NO(on)}$ | | Room | - | 26 | - | |
| | $C_{NC(on)}$ | | Room | - | 26 | - | |
| **Power Supply** | | | | | | | |
| Power supply range | V+ | | | 1.8 | - | 5.5 | V |
| Power supply current | I+ | $V_{IN}$ = 0 or V+ | Full | - | 24 | 60 | µA |

**Notes**

a. Room = 25 °C, full = as determined by the operating suffix
b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet
c. Typical values are for design aid only, not guaranteed nor subject to production testing
d. Guarantee by design, not subjected to production test
e. $V_{IN}$ = input voltage to perform proper function
f. Crosstalk measured between channels

*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.*


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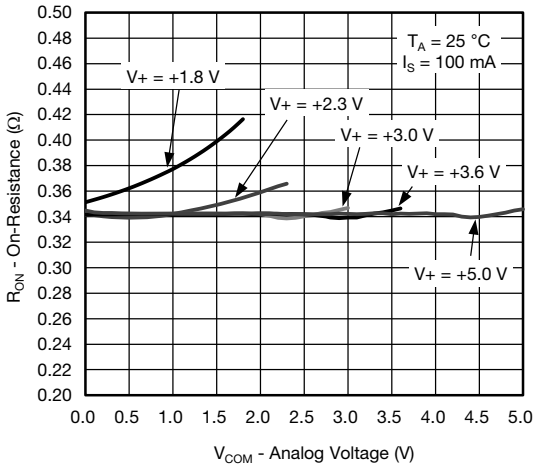
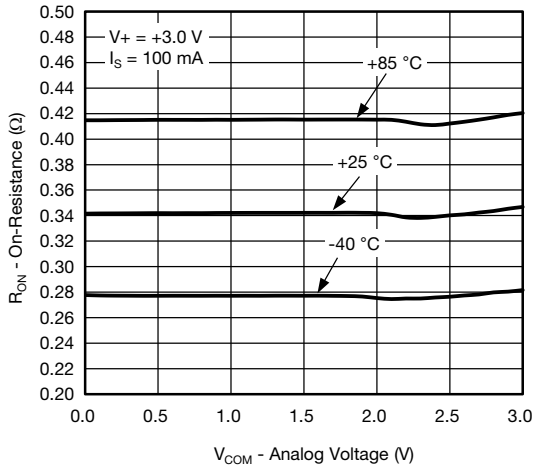
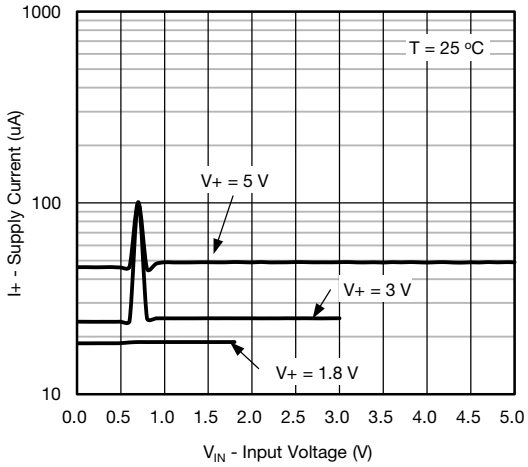


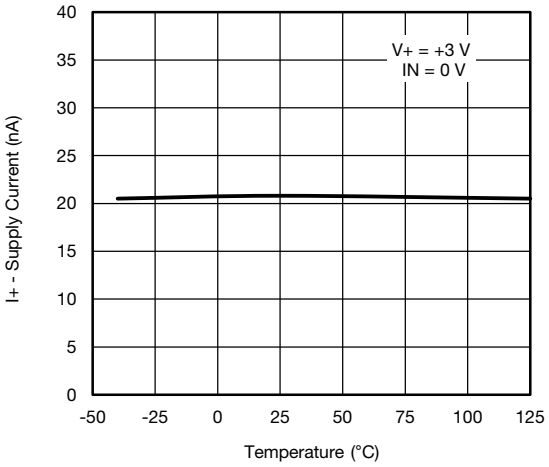

**$R_{ON}$ vs. $V_{COM}$ and Supply Voltage**



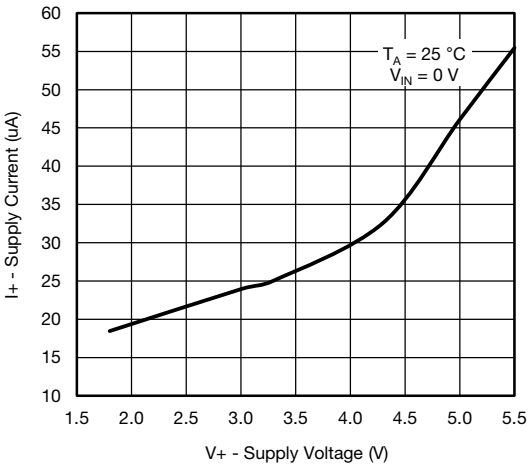

**$R_{ON}$ vs. Analog Voltage and Temperature**



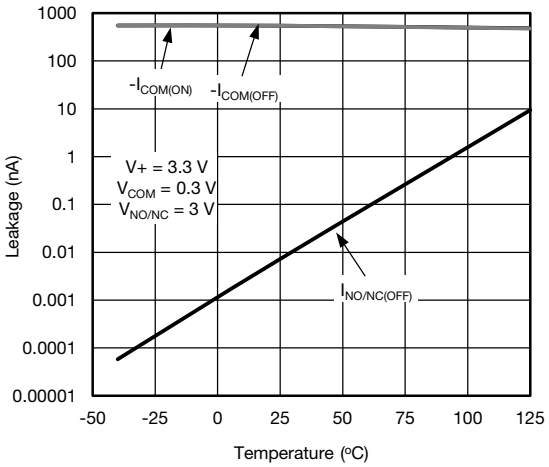

**Supply Current vs. Input Voltage**




**Supply Current vs. Temperature**




**Supply Current vs. Supply Voltage**




**Leakage Current vs. Temperature**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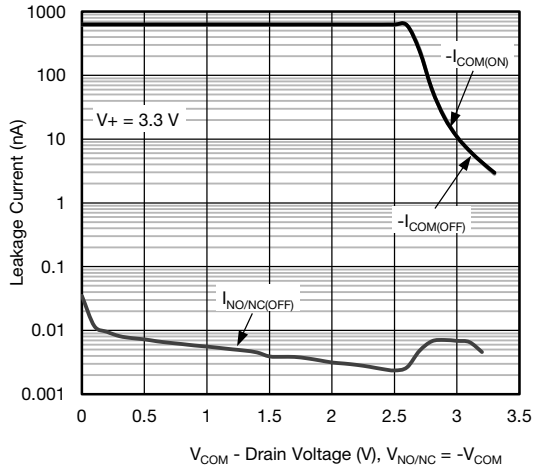
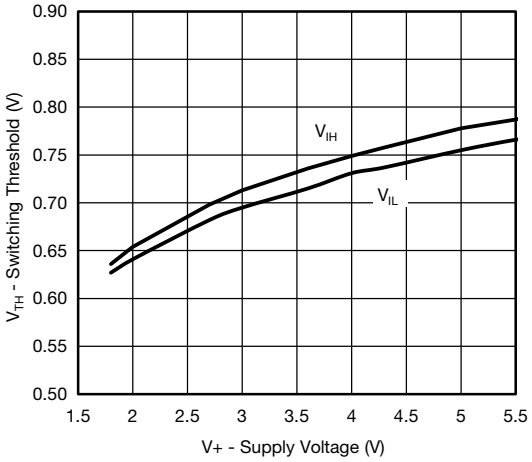
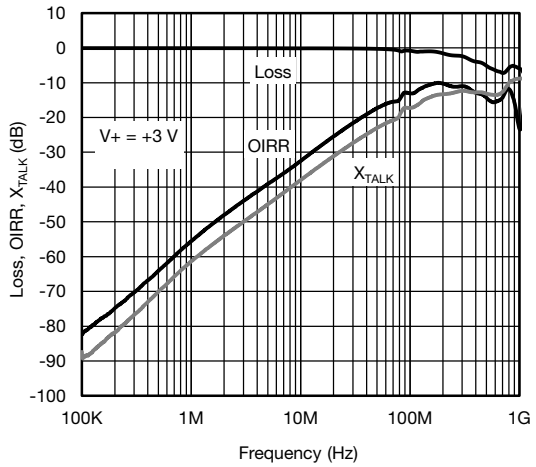


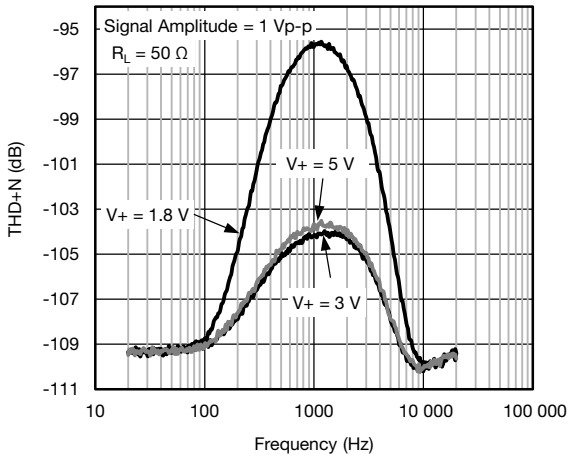

**Leakage Current vs. Drain Voltage**



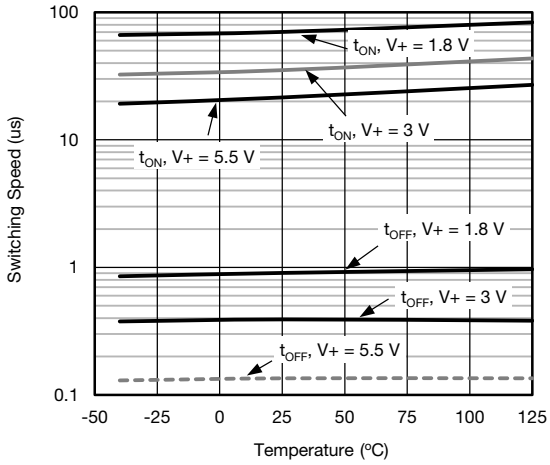

**Switching Threshold vs. Supply Voltage**



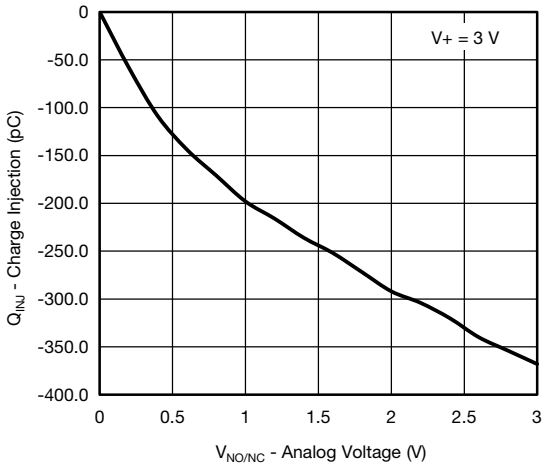

**Insertion Loss, Off-Isolation Crosstalk vs. Frequency**




**Total Harmonic Distortion and Noise vs. Frequency**




**Switching Time vs. Temperature**




**Charge Injection vs. Analog Voltage**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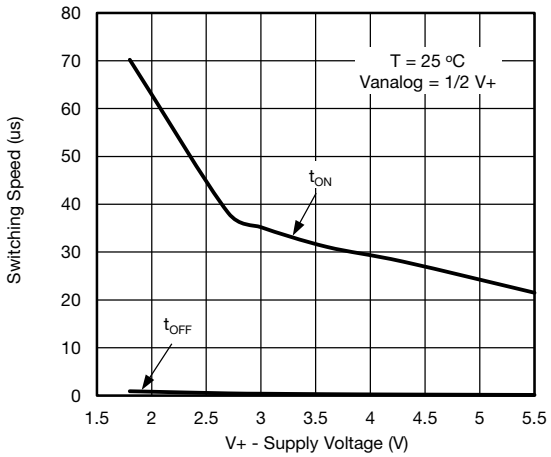
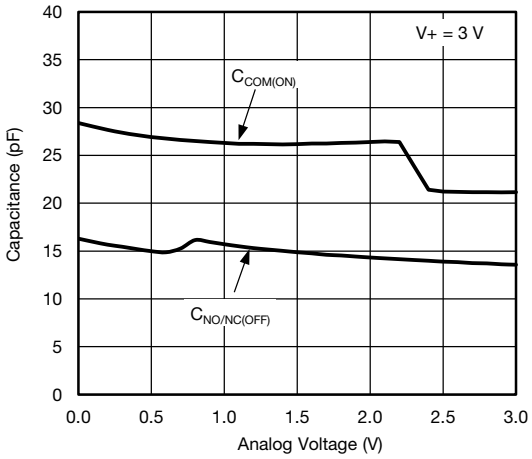
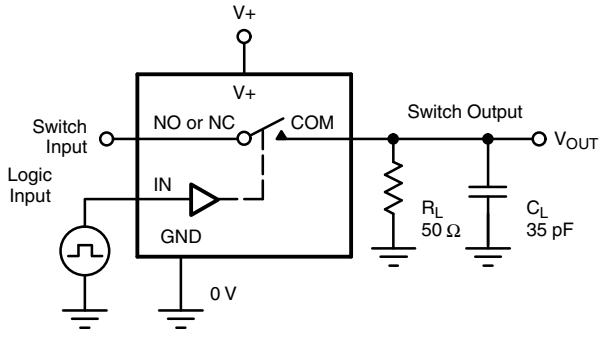



**Switching Time vs. Supply Voltage**



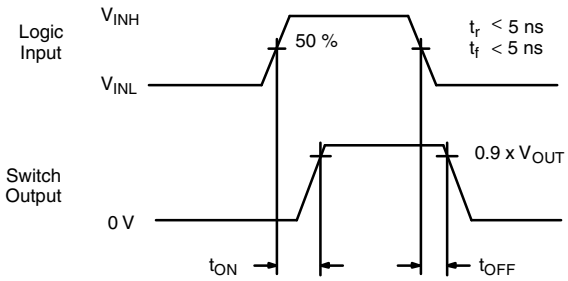

**Capacitance vs. Analog Voltage**

## TEST CIRCUITS



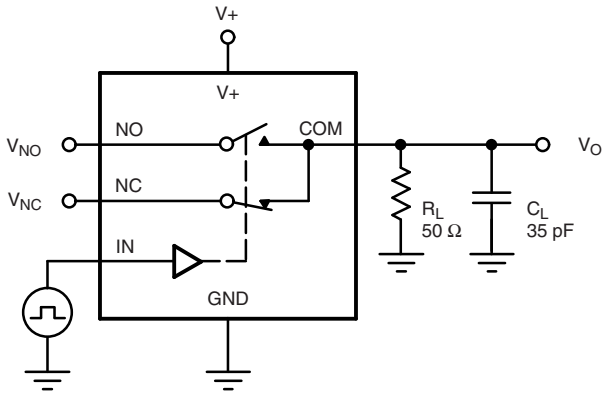

$C_L$ (includes fixture and stray capacitance)

$$V_{OUT} = V_{COM}\left(\frac{R_L}{R_L + R_{ON}}\right)$$




Logic "1" = Switch On
Logic input waveforms inverted for switches that have the opposite logic sense.

**Fig. 1 - Switching Time**




$C_L$ (includes fixture and stray capacitance)

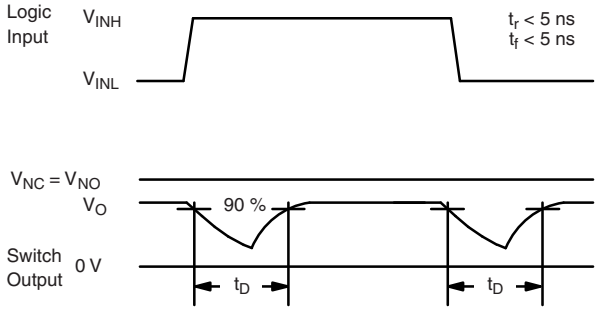



**Fig. 2 - Break-Before-Make Interval**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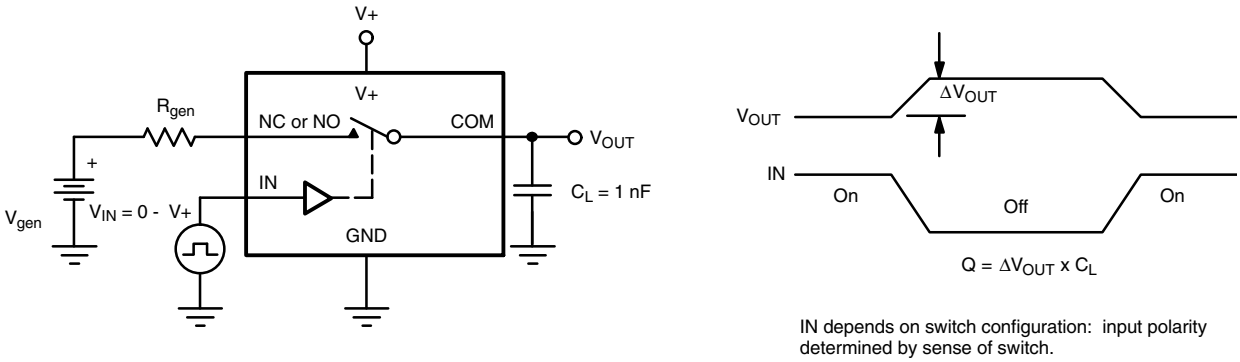


**Fig. 3 - Charge Injection**

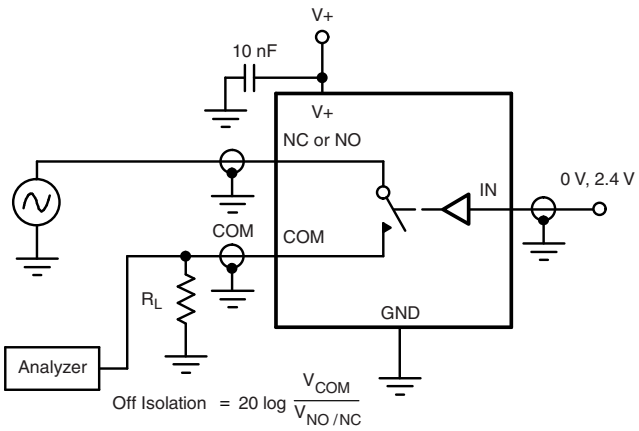


**Fig. 4 - Off-Isolation**

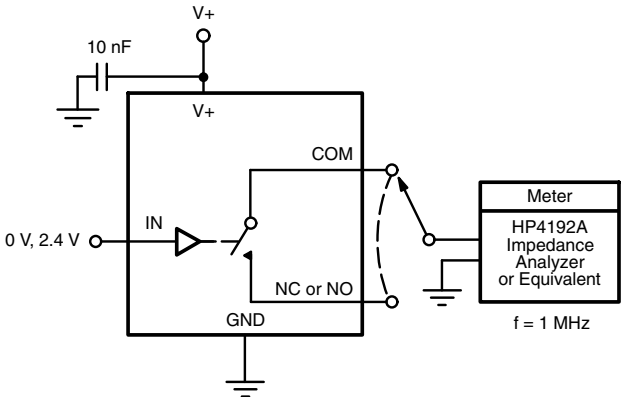


**Fig. 5 - Channel Off / On Capacitance**

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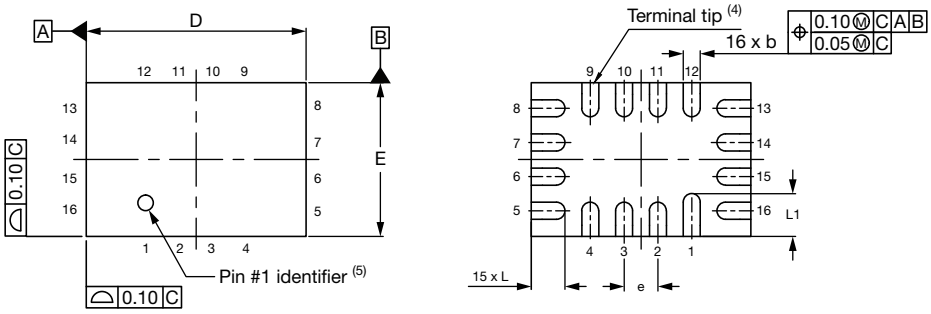
# Thin miniQFN16 Case Outline




| DIMENSIONS | MILLIMETERS (1) | | | 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 (3) | 16 | | | 16 | | |
| Nd (3) | 4 | | | 4 | | |
| Ne (3) | 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



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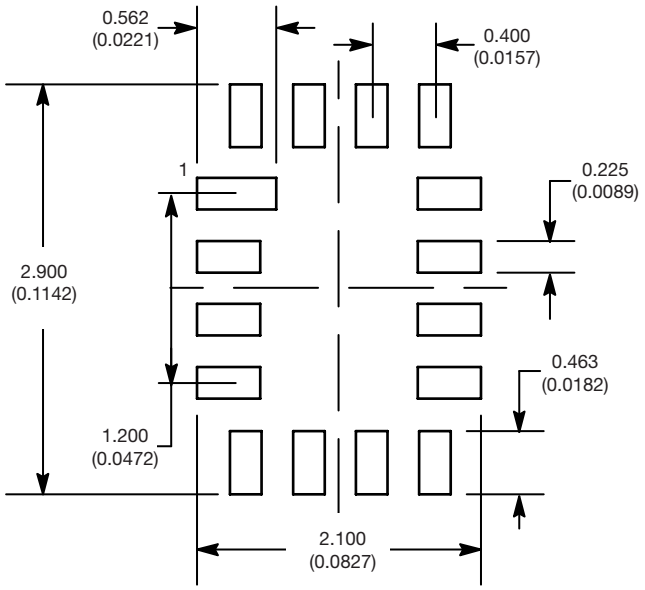
**RECOMMENDED MINIMUM PADS FOR MINI QFN 16L**




Mounting Footprint
Dimensions in mm (inch)

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