# 0.5Ω, Low Voltage Quad, SPDT Analog Switch

## GENERAL DESCRIPTION

The SGM3699 is a quad, low on-resistance, low voltage, bidirectional, single-pole/double-throw (SPDT) CMOS analog switch that is designed to operate from a single +1.8V to +4.2V power supply. Targeted applications include battery powered equipment that benefit from low $R_{ON}$ (0.5Ω) and fast switching speeds ($t_{ON}$ = 52ns, $t_{OFF}$ = 25ns).

The SGM3699 consists of four SPDT switches. It is configured as a dual double-pole/double-throw (DPDT) device with two logic control inputs that control two SPDT switches each. The configuration can be used as a dual differential 2-to-1 multiplexer/demultiplexer.

SGM3699 is available in a TQFN-16 package.

## APPLICATIONS

Communication Systems
Cell Phones
Portable Instrumentation
Audio Signal Routing
Audio and Video Switching
PCMCIA Cards
Computer Peripherals
Modems
PDAs

## FUNCTION TABLE

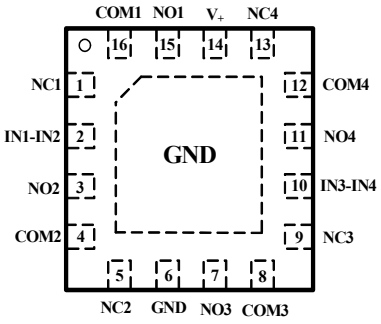
| IN1-IN2 | Function | |
|---|---|---|
| | NC1 and NC2 | NO1 and NO2 |
| 0 | ON | OFF |
| 1 | OFF | ON |

| IN3-IN4 | Function | |
|---|---|---|
| | NC3 and NC4 | NO3 and NO4 |
| 0 | ON | OFF |
| 1 | OFF | ON |

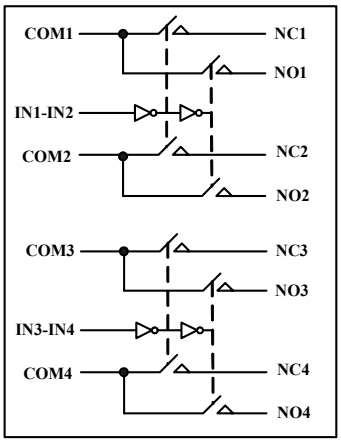
## FEATURES

- **Low Voltage Operation: 1. 8V to 4. 2V**
- **Low On-Resistance: 0. 5Ω(TYP)**
- **Low On-Resistance Flatness**
- **–3dB Bandwidth: 70MHz**
- **Fast Switching Times (4.2V)**
  - **$t_{ON}$ 52ns**
  - **$t_{OFF}$ 25ns**
- **Rail-to-Rail Operation**
- **Typical Power Consumption (<0.01 μW)**
- **TTL/CMOS Compatible**
- **Lead (Pb) Free TQFN-16 Package (3.0mm x 3.0mm)**

## PIN CONFIGURATION (TOP VIEW)




## BLOCK DIAGRAM



## ORDERING INFORMATION

| MODEL | PIN-PACKAGE | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKAGE OPTION |
|---|---|---|---|---|---|
| SGM3699 | TQFN-16 | -40°C to +85°C | SGM3699YTQ16/TR | 3699TQ | Tape and Reel, 3000 |

## ABSOLUTE MAXIMUM RATINGS

$V_+$ to GND.....0V to +4.6V
Analog, Digital voltage range(1)..... - 0.3V to $V_+$ + 0.3V
Continuous Current NO, NC, or COM .....±200mA
Peak Current NO, NC, or COM .....±350mA
Operating Temperature Range.....-40°C to +85°C
Junction Temperature.....+150°C
Storage Temperature.....- 65°C to +150°C
Lead Temperature (soldering, 10s).....260°C
ESD Susceptibility
HBM.....4000V
MM.....400V

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.
(1) Signals on NC, NO, or COM or INx exceeding V+ will be clamped by internal diodes. Limit forward diode current to maximum current ratings.

## PIN DESCRIPTION

| NAME | PIN | FUNCTION |
|---|---|---|
| $V_+$ | 14 | Power supply |
| GND | 6 | Ground |
| INx | 2,10 | Digital control pin to connect the COM terminal to the NO or NC terminals |
| COMx | 4, 8, 12, 16 | Common terminal |
| NOx | 3, 7, 11, 15 | Normally-open terminal |
| NCx | 1, 5, 9, 13 | Normally-closed terminal |

Note: NOx, NCx and COMx terminal may be an input or output.

# ELECTRICAL CHARACTERISTICS

($V_+$ = +4.2V, GND = 0V, $V_{IH}$ = +1.6 V, $V_{IL}$ = +0.6V, $T_A$ = -40°C to +85°C. Typical values are at $V_+$ = +4.2V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | TEMP | MIN | TPY | MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| **ANALOG SWITCH** | | | | | | | | |
| Analog Signal Range | $V_{NO}$, $V_{NC}$, $V_{COM}$ | | | -40°C to +85°C | 0 | | $V_+$ | V |
| On-Resistance | $R_{ON}$ | $V_+$ = 4.2V, $V_{NO}$ or $V_{NC}$ = 1V, $I_{COM}$ = -100mA, Test Circuit 1 | | +25°C | | 0.5 | 0.75 | Ω |
| | | | | -40°C to +85°C | | | 0.85 | Ω |
| On-Resistance Match Between Channels | $\Delta R_{ON}$ | $V_+$ = 4.2V, $V_{NO}$ or $V_{NC}$ = 1V, $I_{COM}$ = -100mA, Test Circuit 1 | | +25°C | | 0.05 | 0.15 | Ω |
| | | | | -40°C to +85°C | | 0.1 | 0.2 | Ω |
| On-Resistance Flatness | $R_{FLAT(ON)}$ | $V_+$ = 4.2V, $V_{NO}$ or $V_{NC}$ = 1V, 2.5V, $I_{COM}$ = -100mA, Test Circuit 1 | | +25°C | | 0.1 | 0.22 | Ω |
| | | | | -40°C to +85°C | | | 0.26 | Ω |
| Source OFF Leakage Current | $I_{NC(OFF)}$, $I_{NO(OFF)}$ | $V_+$ = 4.2V, $V_{NO}$ or $V_{NC}$ = 3.3V/ 0.3V, $V_{COM}$ = 0.3V/ 3.3V | | -40°C to +85°C | | | 1 | μA |
| Channel ON Leakage Current | $I_{NC(ON)}$, $I_{NO(ON)}$, $I_{COM(ON)}$ | $V_+$ = 4.2V, $V_{COM}$ = 0.3V/ 3.3V, $V_{NO}$ or $V_{NC}$ = 0.3V/ 3.3V, or floating | | -40°C to +85°C | | | 1 | μA |
| **DIGITAL INPUTS** | | | | | | | | |
| Input High Voltage | $V_{INH}$ | | | -40°C to +85°C | 1.6 | | | V |
| Input Low Voltage | $V_{INL}$ | | | -40°C to +85°C | | | 0.5 | V |
| Input Leakage Current | $I_{IN}$ | $V_+$ = 4.2V, $V_{IN}$ = 0V or 4.2V | | -40°C to +85°C | | | 1 | μA |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | |
| Turn-On Time | $t_{ON}$ | $V_+$ = 4.2V, $V_{NO}$ or $V_{NC}$ = 2.0V, $R_L$ = 50Ω, $C_L$ = 35pF, Test Circuit 2 | | +25°C | | 52 | | ns |
| Turn-Off Time | $t_{OFF}$ | | | +25°C | | 25 | | ns |
| Charge Injection | Q | $C_L$ = 1.0nF, $V_G$ = 0V, $R_G$ = 0Ω, Test Circuit 3 | | +25°C | | 30 | | pC |
| Break-Before-Make Time Delay | $t_D$ | $V_{NO}$ or $V_{NC}$ = 1.5V, $R_L$ = 50Ω, $C_L$ = 35pF, Test Circuit 4 | | +25°C | | 8 | | ns |
| Off Isolation | $O_{ISO}$ | Signal = 0dBm, $V_{NO}$ or $V_{NC}$ centered between $V_+$ and GND, $R_L$ = 50Ω, Test Circuit 5 | f = 100kHz | +25°C | | -75 | | dB |
| | | | f = 1MHz | +25°C | | -55 | | |
| Channel-to-Channel Crosstalk | $X_{TALK}$ | Signal = 0dBm, Test Circuit 6 | f = 1MHz | +25°C | | -103 | | dB |
| | | | f = 10MHz | +25°C | | -65 | | |
| –3dB Bandwidth | BW | Signal = 0dBm, Test Circuit 7 | | +25°C | | 70 | | MHz |
| Channel ON Capacitance | $C_{NC(ON)}$, $C_{NO(ON)}$, $C_{COM(ON)}$ | f = 1MHz | | +25°C | | 80 | | pF |
| **POWER REQUIREMENTS** | | | | | | | | |
| Power Supply Range | $V_+$ | | | -40°C to +85°C | 1.8 | | 4.2 | V |
| Power Supply Current | $I_+$ | $V_+$ = 4.2V, $V_{IN}$ = 0V or $V_+$ | | -40°C to +85°C | | | 1 | μA |

Specifications subject to changes without notice.

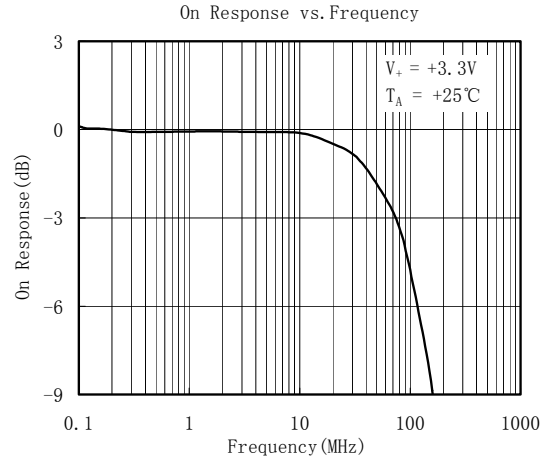
# ELECTRICAL CHARACTERISTICS

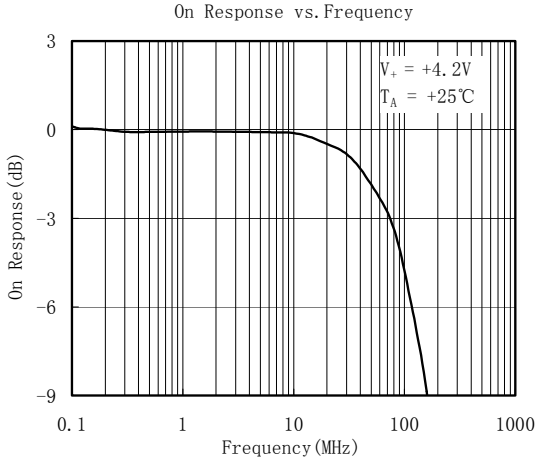
($V_+$ = +2.7 to +3.6V, GND = 0V, $V_{IH}$ = +1.6 V, $V_{IL}$ = +0.4V, $T_A$ = -40°C to +85°C. Typical values are at $V_+$ = +3.0V, $T_A$ = +25°C, unless otherwise noted.)

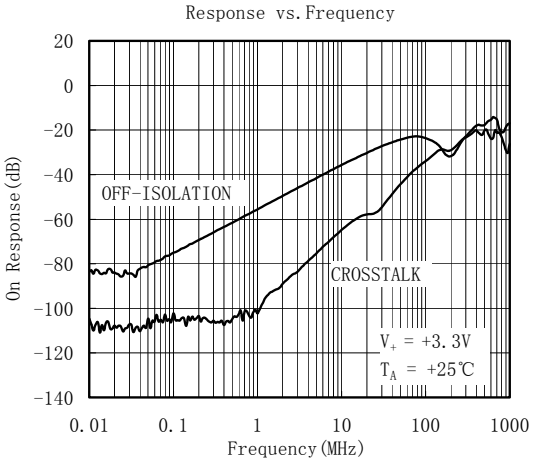
| PARAMETER | SYMBOL | CONDITIONS | | TEMP | MIN | TPY | MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| **ANALOG SWITCH** | | | | | | | | |
| Analog Signal Range | $V_{NO}$, $V_{NC}$, $V_{COM}$ | | | -40°C to +85°C | 0 | | $V_+$ | V |
| On-Resistance | $R_{ON}$ | $V_+$ = 2.7V, $V_{NO}$ or $V_{NC}$ = 1V, $I_{COM}$ = -100mA, Test Circuit 1 | | +25°C | | 0.6 | 0.9 | Ω |
| | | | | -40°C to +85°C | | | 1 | Ω |
| On-Resistance Match Between Channels | $\Delta R_{ON}$ | $V_+$ = 2.7V, $V_{NO}$ or $V_{NC}$ = 1V, $I_{COM}$ = -100mA, Test Circuit 1 | | +25°C | | 0.15 | 0.2 | Ω |
| | | | | -40°C to +85°C | | 0.15 | 0.24 | Ω |
| On-Resistance Flatness | $R_{FLAT(ON)}$ | $V_+$ = 2.7V, $V_{NO}$ or $V_{NC}$ = 1V, 2.5V, $I_{COM}$ = -100mA, Test Circuit 1 | | +25°C | | 0.05 | 0.15 | Ω |
| | | | | -40°C to +85°C | | 0.1 | 0.2 | Ω |
| Source OFF Leakage Current | $I_{NC(OFF)}$, $I_{NO(OFF)}$ | $V_+$ = 3.6V, $V_{NO}$ or $V_{NC}$ = 3.3V/ 0.3V, $V_{COM}$ = 0.3V/ 3.3V | | -40°C to +85°C | | | 1 | μA |
| Channel ON Leakage Current | $I_{NC(ON)}$, $I_{NO(ON)}$, $I_{COM(ON)}$ | $V_+$ = 3.6V, $V_{COM}$ = 0.3V/ 3.3V, $V_{NO}$ or $V_{NC}$ = 0.3V/ 3.3V, or floating | | -40°C to +85°C | | | 1 | μA |
| **DIGITAL INPUTS** | | | | | | | | |
| Input High Voltage | $V_{INH}$ | | | -40°C to +85°C | 1.5 | | | V |
| Input Low Voltage | $V_{INL}$ | | | -40°C to +85°C | | | 0.4 | V |
| Input Leakage Current | $I_{IN}$ | $V_+$ = 2.7V, $V_{IN}$ = 0V or 2.7V | | -40°C to +85°C | | | 1 | μA |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | |
| Turn-On Time | $t_{ON}$ | $V_+$ = 3.3V, $V_{NO}$ or $V_{NC}$ = 2.0V, $R_L$ = 50Ω, $C_L$ = 35pF, Test Circuit 2 | | +25°C | | 54 | | ns |
| Turn-Off Time | $t_{OFF}$ | | | +25°C | | 38 | | ns |
| Charge Injection | Q | $C_L$ = 1.0nF, $V_G$ = 0V, $R_G$ = 0Ω Test Circuit 3 | | +25°C | | 26 | | pC |
| Break-Before-Make Time Delay | $t_D$ | $V_{NO}$ or $V_{NC}$ = 1.5V, $R_L$ = 50Ω, $C_L$ = 35pF, Test Circuit 4 | | +25°C | | 12 | | ns |
| Off Isolation | $O_{ISO}$ | Signal = 0dBm, $V_{NO}$ or $V_{NC}$ centered between $V_+$ and GND, $R_L$ = 50Ω, Test Circuit 5 | f = 100kHz | +25°C | | -75 | | dB |
| | | | f = 1MHz | +25°C | | -55 | | |
| Channel-to-Channel Crosstalk | $X_{TALK}$ | Signal = 0dBm, Test Circuit 6 | f = 1MHz | +25°C | | -103 | | dB |
| | | | f = 10MHz | +25°C | | -65 | | |
| –3dB Bandwidth | BW | Signal = 0dBm, Test Circuit 7 | | +25°C | | 70 | | MHz |
| Channel ON Capacitance | $C_{NC(ON)}$, $C_{NO(ON)}$, $C_{COM(ON)}$ | f = 1MHz | | +25°C | | 80 | | pF |

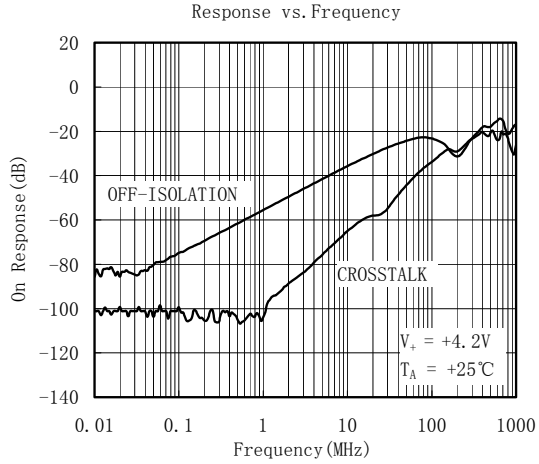
Specifications subject to changes without notice.

# TYPICAL PERFORMANCE CHARACTERISTICS

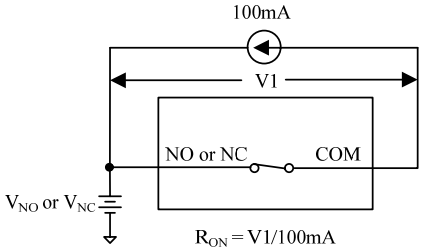


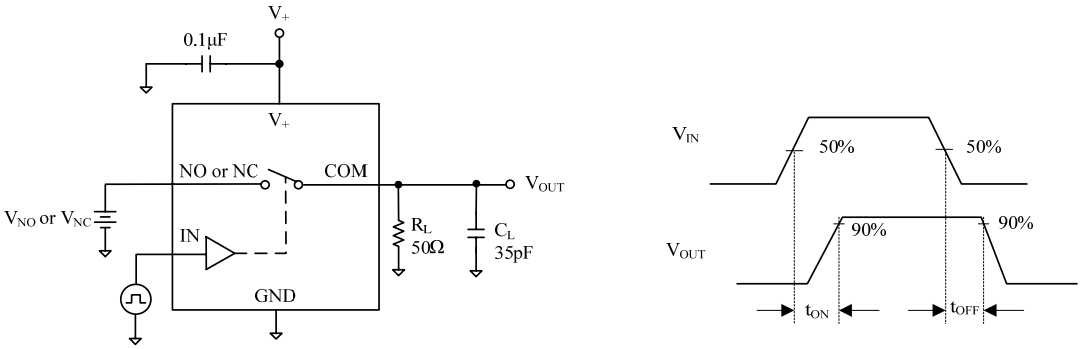



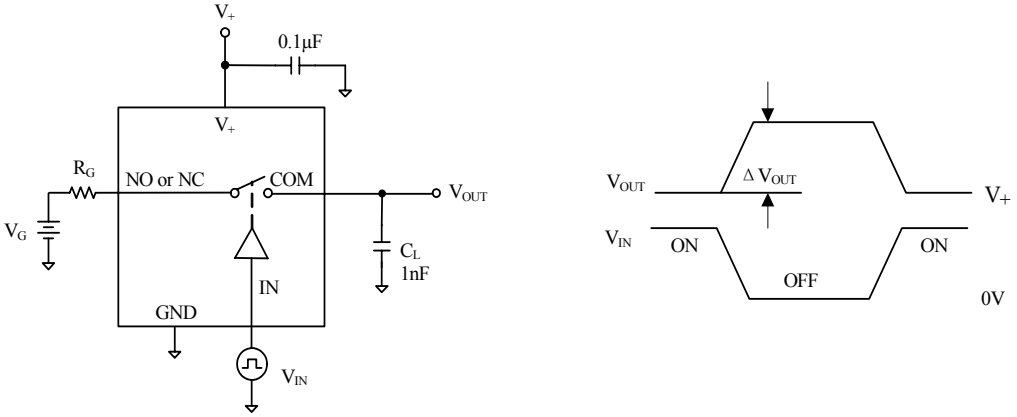
# TEST CIRCUITS




Test Circuit 1. On Resistance

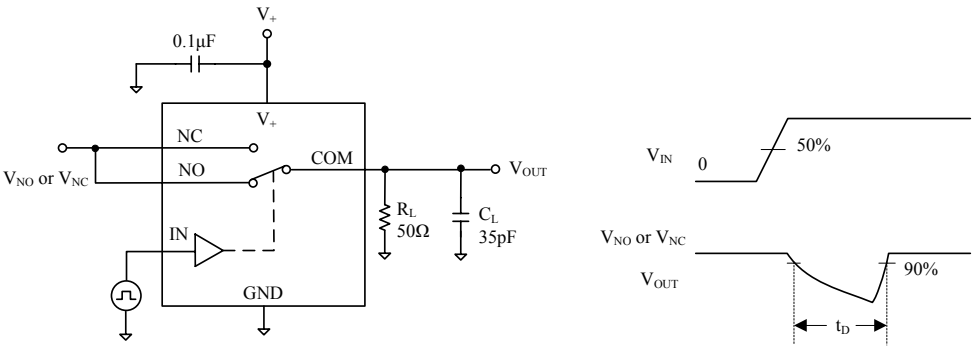



Test Circuit 2. Switching Times

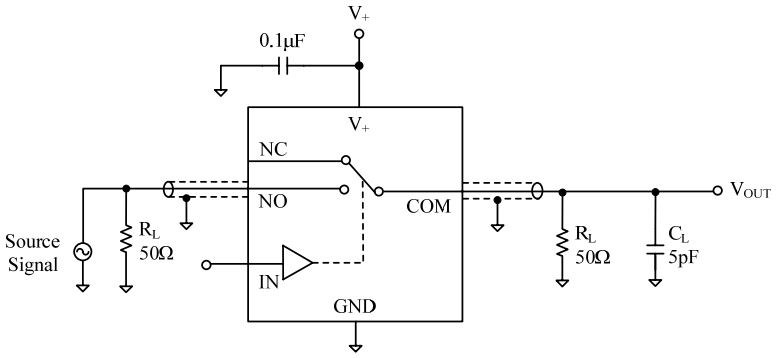



Test Circuit 3. Charge Injection

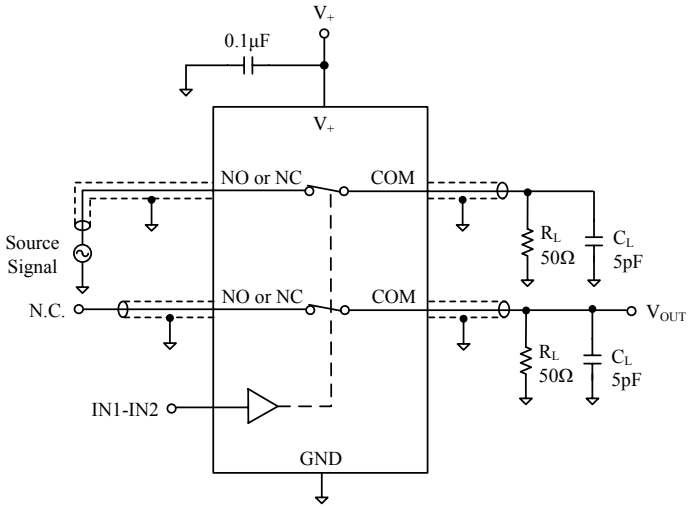
## TEST CIRCUITS (Cont.)




Test Circuit 4. Break-Before-Make Time Delay, $t_D$



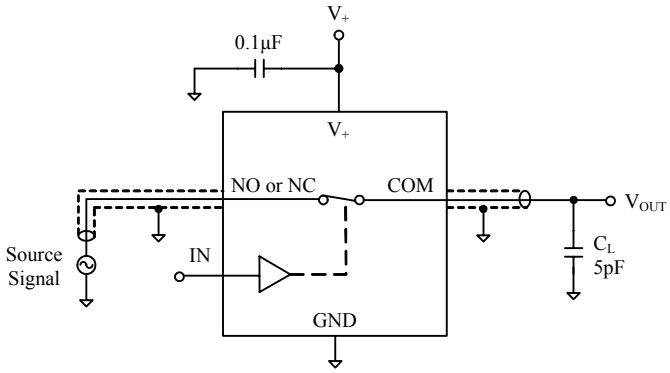

Test Circuit 5. Off Isolation




$$\text{Channel To Channel Crosstalk} = -20 \times \log \frac{V_{NO} \text{ or } V_{NC}}{V_{OUT}}$$

Test Circuit 6. Channel-to-Channel Crosstalk

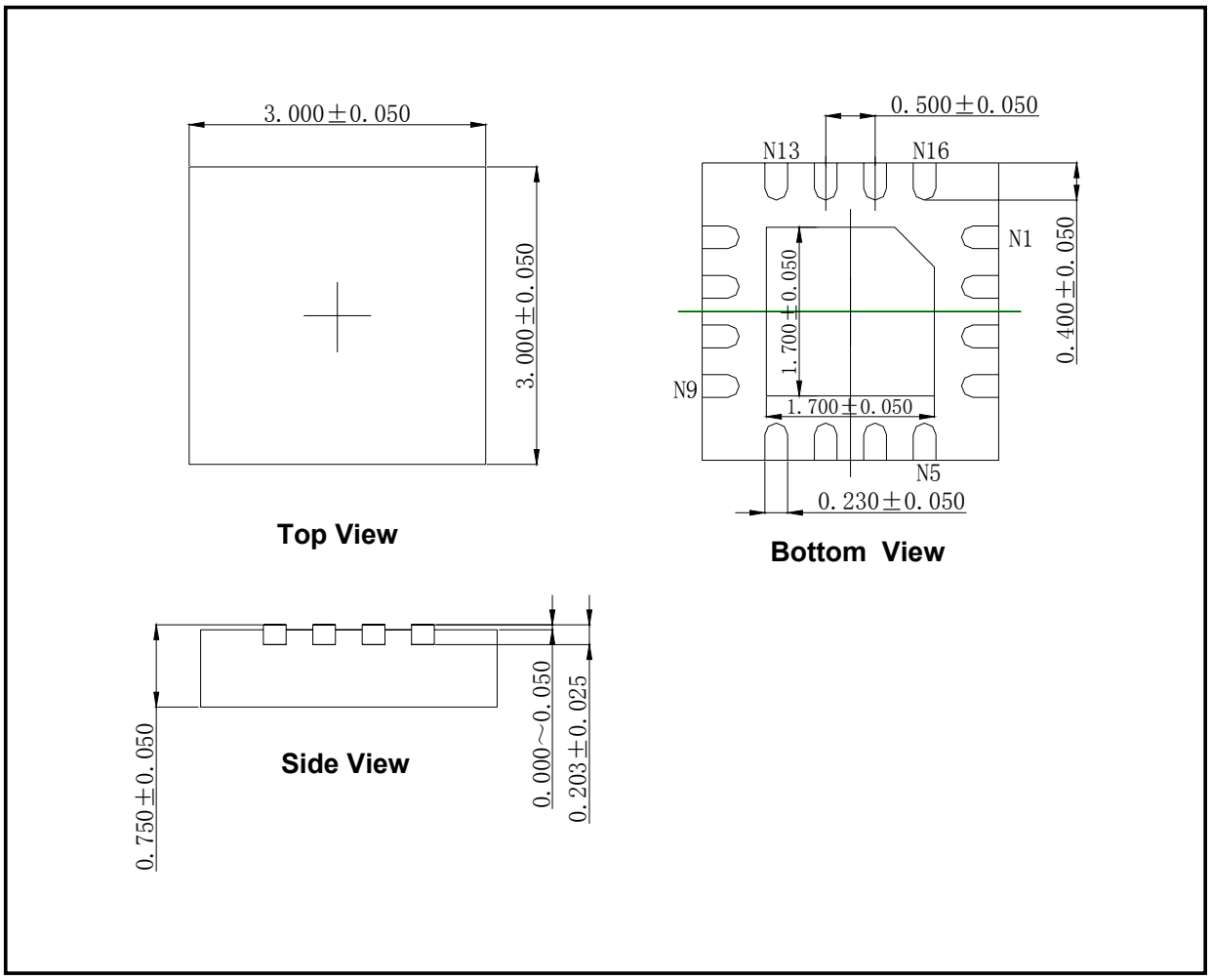
## TEST CIRCUITS (Cont.)




Test Circuit 7. -3dB Bandwidth

# PACKAGE OUTLINE DIMENSIONS

## TQFN-16




Note: All linear dimensions are in millimeters.

# REVISION HISTORY

| Location | Page |
|---|---|

**10/2007— Data Sheet changed from Preliminary data sheet to REV. A**

Changes to ELECTRICAL CHARACTERISTICS about Source OFF Leakage current . . . . . 3, 4

**10/2007— Data Sheet changed from REV. A to REV. B**

Changes to TYPICAL PERFORMANCE CHARACTERISTICS . . . . . 5

**05/2008— Data Sheet changed from REV. B to REV. B. 1**

Changes to ELECTRICAL CHARACTERISTICS . . . . . 3, 4

Changes to TEST CIRCUITS . . . . . 6, 7