BURR - BROWN®

# OPA2107

# Precision Dual *Difet* ® OPERATIONAL AMPLIFIER

## FEATURES

- VERY LOW NOISE: 8nV/√Hz at 10kHz
- LOW $V_{os}$: 500μV max
- LOW DRIFT: 5μV/°C max
- LOW $I_B$: 5pA max
- FAST SETTLING TIME: 2μs to 0.01%
- UNITY-GAIN STABLE

## APPLICATIONS

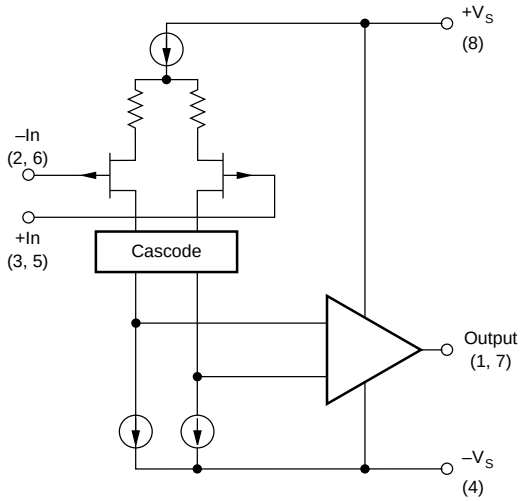
- DATA ACQUISITION
- DAC OUTPUT AMPLIFIER
- OPTOELECTRONICS
- HIGH-IMPEDANCE SENSOR AMPS
- HIGH-PERFORMANCE AUDIO CIRCUITRY
- MEDICAL EQUIPMENT, CT SCANNERS

## DESCRIPTION

The OPA2107 dual operational amplifier provides precision ***Difet*** performance with the cost and space savings of a dual op amp. It is useful in a wide range of precision and low-noise analog circuitry and can be used to upgrade the performance of designs currently using BIFET® type amplifiers.

The OPA2107 is fabricated on a proprietary dielectrically isolated (***Difet***) process. This holds input bias currents to very low levels without sacrificing other important parameters, such as input offset voltage, drift and noise. Laser-trimmed input circuitry yields excellent DC performance. Superior dynamic performance is achieved, yet quiescent current is held to under 2.5mA per amplifier. The OPA2107 is unity-gain stable.

The OPA2107 is available in plastic DIP, metal TO-99, and SOIC packages. Industrial and Military temperature range versions are available.

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# SPECIFICATIONS

$T_A$ = +25°C, $V_S$ = ±15V unless otherwise noted.

| PARAMETER | CONDITION | OPA2107AM, SM, AP, AU | | | OPA2107BM | | | UNITS |
|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| **OFFSET VOLTAGE**[1] | | | | | | | | |
| Input Offset Voltage | $V_{CM}$ = 0V | | 100 | 1mV | | 50 | 500 | µV |
| Over Specified Temperature | | | 0.5 | 2 | | 0.2 | 1 | mV |
| SM Grade | | | 0.8 | 2.5 | | | | mV |
| Average Drift Over Specified Temperature | | | 3 | 10 | | 2 | 5 | µV/°C |
| Power Supply Rejection | $V_S$ = ±10 to ±18V | 80 | 96 | | 84 | 100 | | dB |
| **INPUT BIAS CURRENT**[1] | | | | | | | | |
| Input Bias Current | $V_{CM}$ = 0V | | 4 | 10 | | 2 | 5 | pA |
| Over Specified Temperature | | | 0.25 | 1.5 | | 0.15 | 1 | nA |
| SM Grade | | | 4 | 35 | | | | nA |
| Input Offset Current | $V_{CM}$ = 0V | | 1 | 8 | | 0.5 | 3 | pA |
| Over Specified Temperature | | | | 1 | | | 0.5 | nA |
| SM Grade | | | 1 | 28 | | | | nA |
| **INPUT NOISE** | | | | | | | | |
| Voltage: f = 10Hz | $R_S$ = 0 | | 30 | | | * | | nV/√Hz |
| f = 100Hz | | | 12 | | | * | | nV/√Hz |
| f = 1kHz | | | 9 | | | * | | nV/√Hz |
| f = 10kHz | | | 8 | | | * | | nV/√Hz |
| BW = 0.1 to 10Hz | | | 1.2 | | | * | | µVp-p |
| BW = 10 to 10kHz | | | 0.85 | | | * | | µVrms |
| Current: f = 0.1Hz thru 20kHz | | | 1.2 | | | 0.9 | | fA/√Hz |
| BW = 0.1Hz to 10Hz | | | 23 | | | 17 | | fAp-p |
| **INPUT IMPEDANCE** | | | | | | | | |
| Differential | | | $10^{13}$ \|\| 2 | | | * | | Ω \|\| pF |
| Common-Mode | | | $10^{14}$ \|\| 4 | | | * | | Ω \|\| pF |
| **INPUT VOLTAGE RANGE** | | | | | | | | |
| Common-Mode Input Range | | ±10.5 | ±11 | | * | * | | V |
| Over Specified Temperature | | ±10.2 | ±10.5 | | * | * | | V |
| SM Grade | | ±10 | ±10.3 | | | | | V |
| Common-Mode Rejection | $V_{CM}$ = ±10V | 80 | 94 | | 84 | 100 | | dB |
| **OPEN-LOOP GAIN** | | | | | | | | |
| Open-Loop Voltage Gain | $V_O$ = ±10V, $R_L$ = 2kΩ | 82 | 96 | | 84 | 100 | | dB |
| Over Specified Temperature | | 80 | 94 | | 82 | 96 | | dB |
| SM Grade | | 80 | 92 | | | | | dB |
| **DYNAMIC RESPONSE** | | | | | | | | |
| Slew Rate | G = +1 | 13 | 18 | | * | * | | V/µs |
| Settling Time: 0.1% | G = –1, 10V Step | | 1.5 | | | * | | µs |
| 0.01% | | | 2 | | | * | | µs |
| Gain-Bandwidth Product | G = 100 | | 4.5 | | | * | | MHz |
| THD + Noise | G = +1, f = 1kHz | | 0.001 | | | * | | % |
| Channel Separation | f = 100Hz, $R_L$ = 2kΩ | | 120 | | | * | | dB |
| **POWER SUPPLY** | | | | | | | | |
| Specified Operating Voltage | | | ±15 | | | * | | V |
| Operating Voltage Range | | ±4.5 | | ±18 | * | | * | V |
| Current | | | ±4.5 | ±5 | | * | * | mA |
| **OUTPUT** | | | | | | | | |
| Voltage Output | $R_L$ = 2kΩ | ±11 | ±12 | | * | * | | V |
| Over Specified Temperature | | ±10.5 | ±11.5 | | * | * | | V |
| SM Grade | | ±10.2 | ±11.3 | | | | | V |
| Short Circuit Current | | ±10 | ±40 | | * | * | | mA |
| Output Resistance, Open-Loop | 1MHz | | 70 | | | * | | Ω |
| Capacitive Load Stability | G = +1 | | 1000 | | | * | | pF |
| **TEMPERATURE RANGE** | | | | | | | | |
| Specification | | | | | | | | |
| AP, AU, AM, BM | | –25 | | +85 | * | | * | °C |
| SM | | –55 | | +125 | | | | °C |
| Operating | | | | | | | | |
| AP, AU | | –25 | | +85 | | | | °C |
| AM, BM, SM | | –55 | | +125 | * | | * | °C |
| Storage | | | | | | | | |
| AP, AU | | –40 | | +125 | | | | °C |
| AM, BM, SM | | –65 | | +150 | * | | * | °C |
| Thermal Resistance ($\theta_{J-A}$) | | | | | | | | |
| AP | | | 90 | | | | | °C/W |
| AU | | | 175 | | | | | °C/W |
| AM, BM, SM | | | 200 | | | * | | °C/W |

* Specifications same as OPA2107AM. NOTE: (1) Specified with devices fully warmed up.

## ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Supply Voltage | ±18V |
| Input Voltage Range | $\pm V_S$ ±2V |
| Differential Input Voltage | Total $V_S$ ±4V |
| Operating Temperature | |
| M Package | –55°C to +125°C |
| P and U Packages | –25°C to + 85°C |
| Storage Temperature | |
| M Package | –65°C to +150°C |
| P and U Packages | –40°C to +125°C |
| Output Short Circuit to Ground ($T_A$ = +25°C) | Continuous |
| Junction Temperature | +175°C |
| Lead Temperature | |
| M and P Packages (soldering, 10s) | +300°C |
| U Package, SOIC (3s) | +260°C |

## PACKAGE INFORMATION

| MODELS | PACKAGE | PACKAGE DRAWING NUMBER(1) |
|---|---|---|
| OPA2107AP | Plastic DIP | 006 |
| OPA2107AM | Metal TO-99 | 001 |
| OPA2107BM | Metal TO-99 | 001 |
| OPA2107SM | Metal TO-99 | 001 |
| OPA2107AU | SO-8 SOIC | 182 |

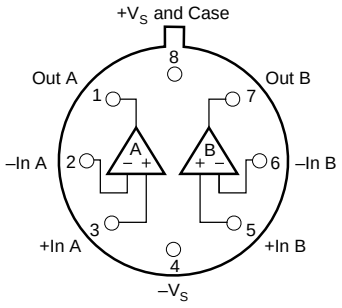
NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

## ORDERING INFORMATION

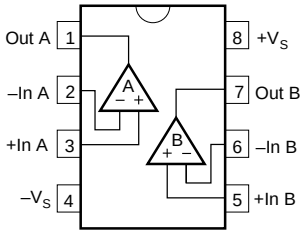
| MODELS | PACKAGE | SPECIFICATION TEMPERATURE RANGE |
|---|---|---|
| OPA2107AP | Plastic DIP | –25 to +85°C |
| OPA2107AM | Metal TO-99 | –25 to +85°C |
| OPA2107BM | Metal TO-99 | –25 to +85°C |
| OPA2107SM | Metal TO-99 | –55 to +125°C |
| OPA2107AU | SO-8 SOIC | –25 to +85°C |

## PIN CONFIGURATIONS

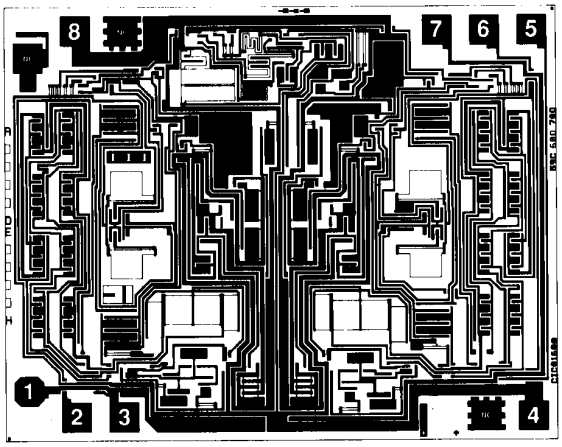
**Top View – M Package**




**Top View – P & U Packages**




## DICE INFORMATION




**OPA2107 DIE TOPOGRAPHY**

| PAD | FUNCTION |
|---|---|
| 1 | Out A |
| 2 | –In A |
| 3 | +In A |
| 4 | –$V_S$ |
| 5 | +In B |
| 6 | –In B |
| 7 | Out B |
| 8 | +$V_S$ |

**Substrate Bias:** –$V_S$

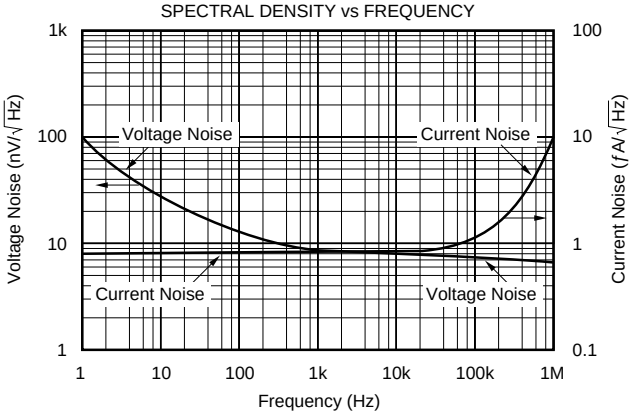
## MECHANICAL INFORMATION

| | MILS (0.001") | MILLIMETERS |
|---|---|---|
| Die Size | 97 x 77 ±3 | 2.46 x 1.96 ±0.13 |
| Die Thickness | 20 ±3 | 0.51 ±0.08 |
| Min. Pad Size | 4 x 4 | 0.10 x 0.10 |
| Transistor Count | | 53 |
| Backing | | None |

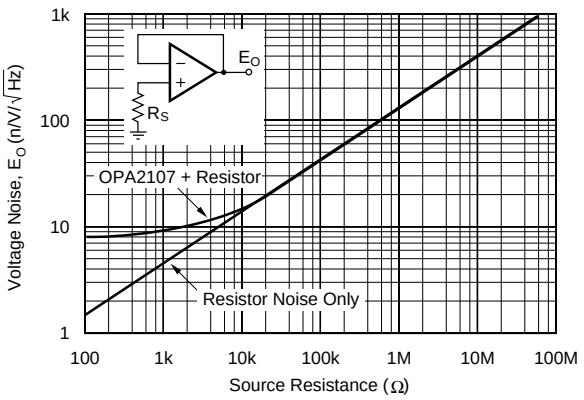
# TYPICAL PERFORMANCE CURVES

$T_A$ = +25°C, $V_S$ = ±15V unless otherwise noted.

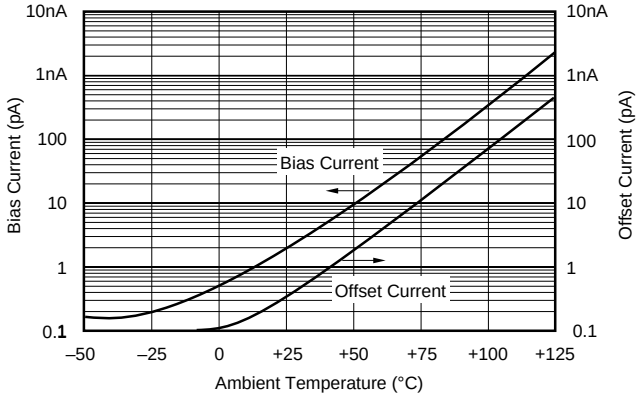
INPUT VOLTAGE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY



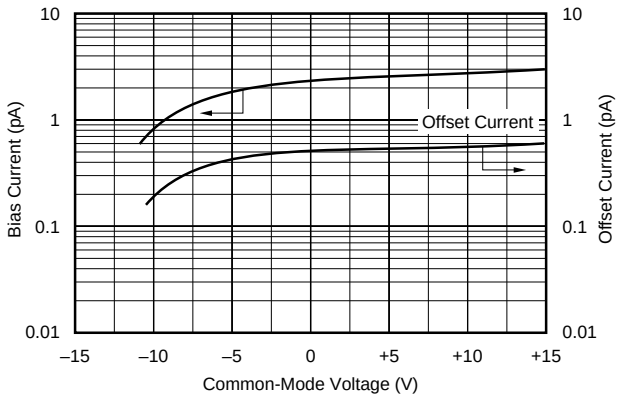

TOTAL INPUT VOLTAGE NOISE SPECTRAL DENSITY at 1kHz vs SOURCE RESISTANCE



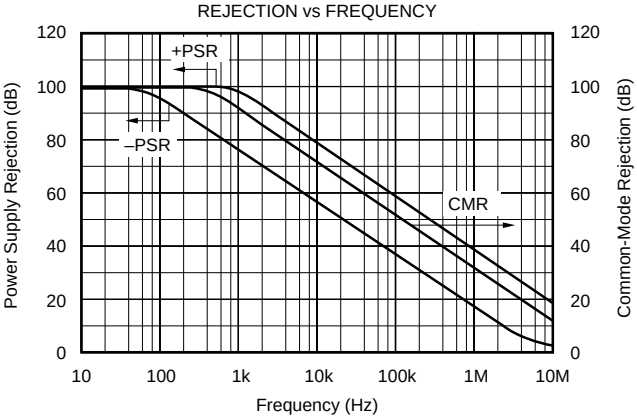

BIAS AND OFFSET CURRENT vs TEMPERATURE



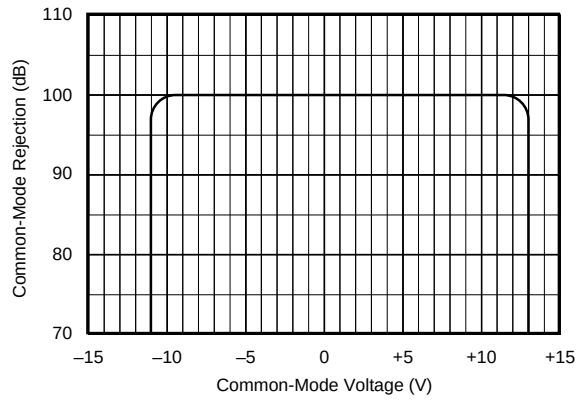

BIAS AND OFFSET CURRENT vs INPUT COMMON-MODE VOLTAGE




POWER SUPPLY AND COMMON-MODE REJECTION vs FREQUENCY



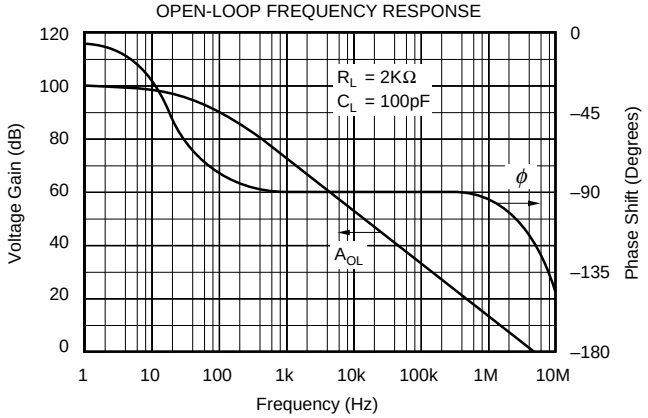

COMMON-MODE REJECTION vs INPUT COMMON-MODE VOLTAGE



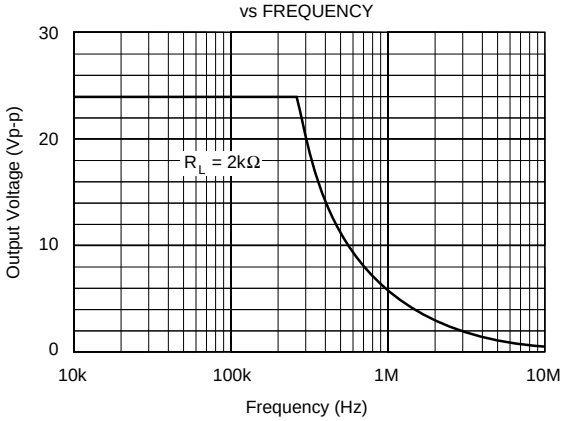
# TYPICAL PERFORMANCE CURVES (CONT)

$T_A$ = +25°C, $V_S$ = ±15V unless otherwise noted.

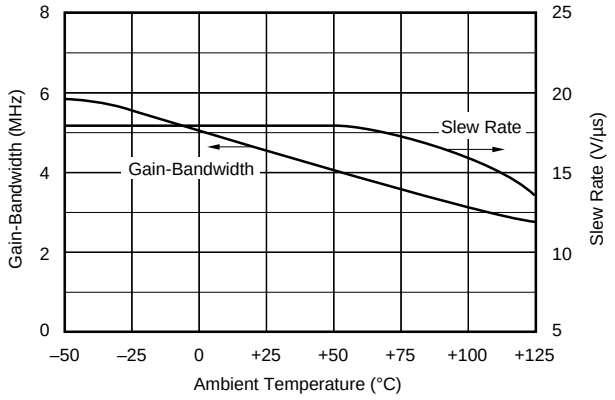
OPEN-LOOP FREQUENCY RESPONSE



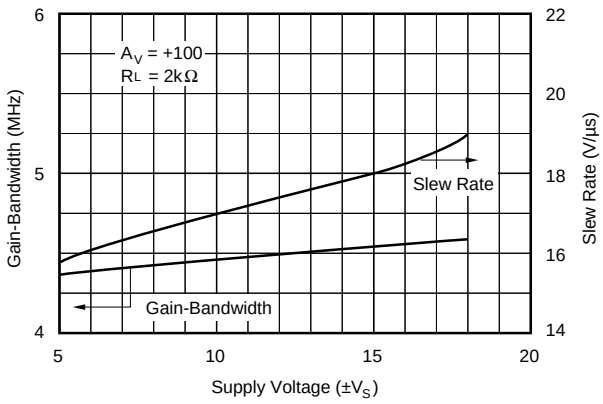

MAXIMUM OUTPUT VOLTAGE SWING vs FREQUENCY



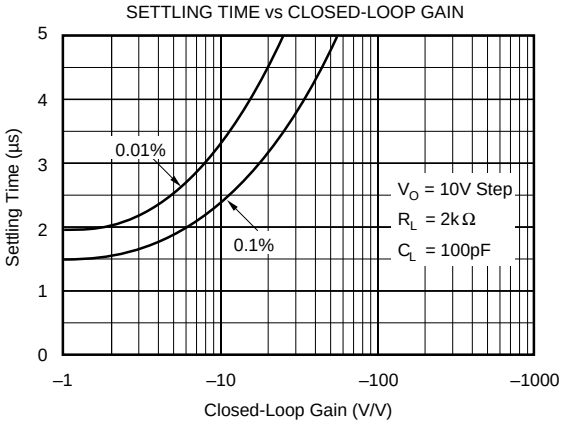

GAIN-BANDWIDTH AND SLEW RATE vs TEMPERATURE



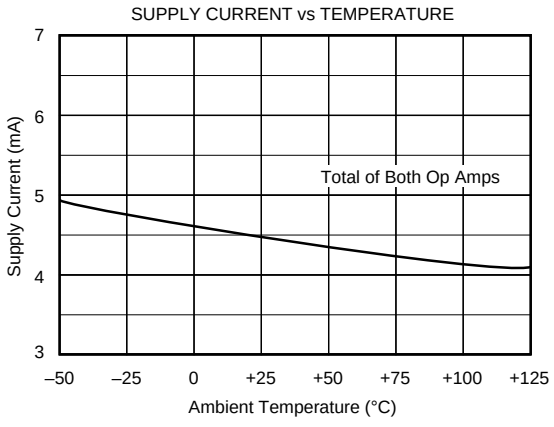

GAIN-BANDWIDTH AND SLEW RATE vs SUPPLY VOLTAGE




SETTLING TIME vs CLOSED-LOOP GAIN



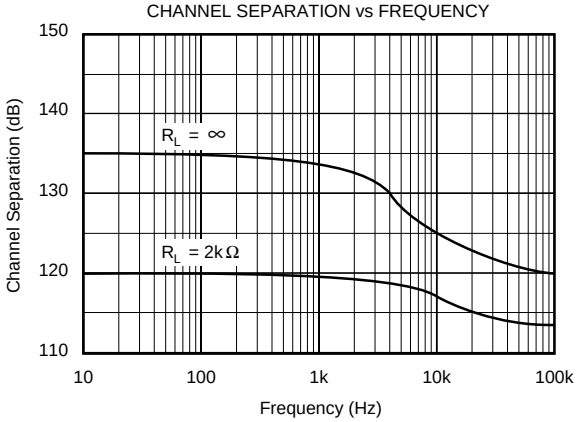

SUPPLY CURRENT vs TEMPERATURE



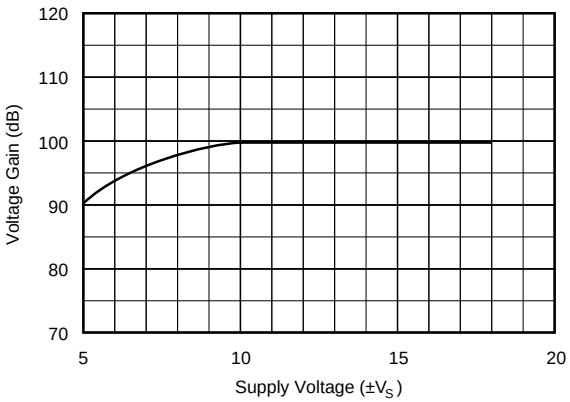
# TYPICAL PERFORMANCE CURVES (CONT)

$T_A$ = +25°C, $V_S$ = ±15V unless otherwise noted.

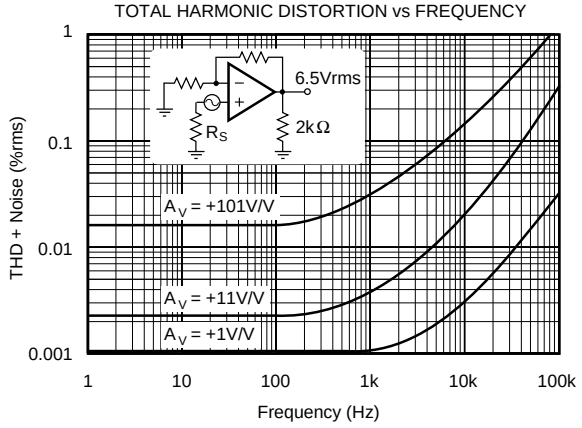
CHANNEL SEPARATION vs FREQUENCY



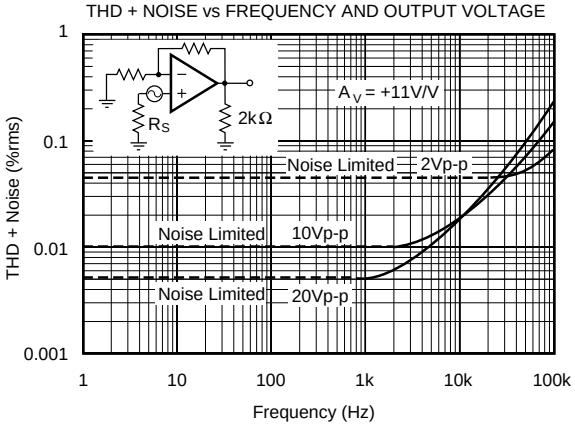

OPEN-LOOP GAIN vs SUPPLY VOLTAGE



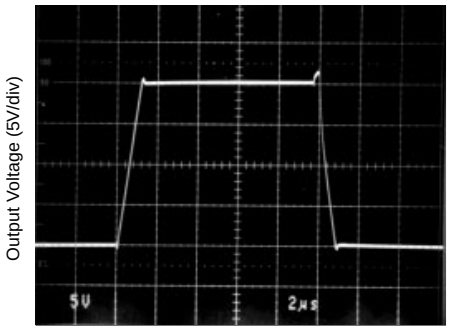

TOTAL HARMONIC DISTORTION vs FREQUENCY



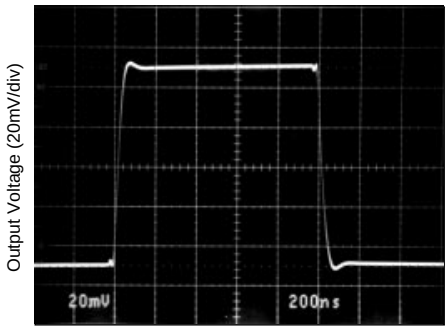

THD + NOISE vs FREQUENCY AND OUTPUT VOLTAGE




OPA2107 LARGE-SIGNAL RESPONSE




OPA2107 SMALL-SIGNAL RESPONSE



# APPLICATIONS INFORMATION AND CIRCUITS

The OPA2107 is unity-gain stable and has excellent phase margin. This makes it easy to use in a wide variety of applications.

Power supply connections should be bypassed with capacitors positioned close to the amplifier pins. In most cases, 0.1µF ceramic capacitors are adequate. Applications with larger load currents and fast transient signals may need up to 1µF tantalum bypass capacitors.

### INPUT BIAS CURRENT

The OPA2107's ***Difet*** input stages have very low input bias current—an order of magnitude lower than BIFET op amps. Circuit board leakage paths can significantly degrade performance. This is especially evident with the SO-8 surface-mount package where pin-to-pin dimensions are particularly small. Residual soldering flux, dirt, and oils, which conduct leakage current, can be removed by proper cleaning. In most instances a two-step cleaning process is adequate using a clean organic solvent rinse followed by de-ionized water. Each rinse should be followed by a 30-minute bake at 85°C.

A circuit board guard pattern effectively reduces errors due to circuit board leakage (Figure 1). By encircling critical high impedance nodes with a low impedance connection at the same circuit potential, any leakage currents will flow harmlessly to the low impedance node. Guard traces should be placed on all levels of a multiple-layer circuit board.

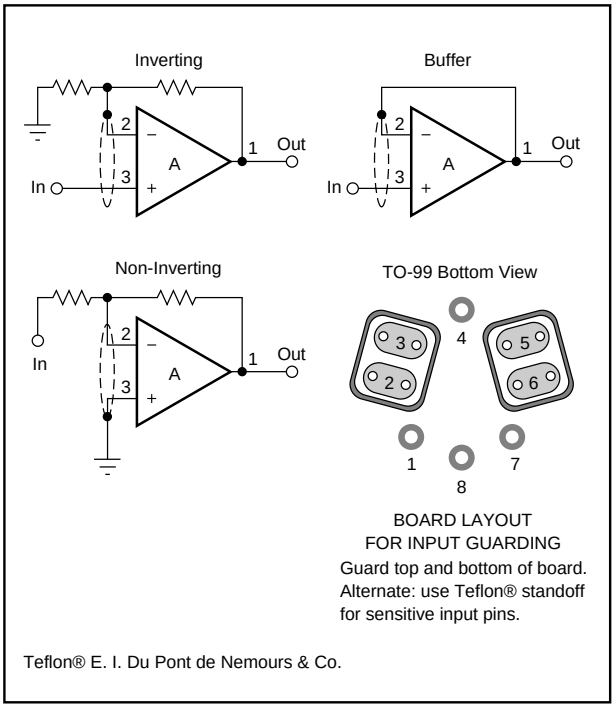



FIGURE 1. Connection of Input Guard.

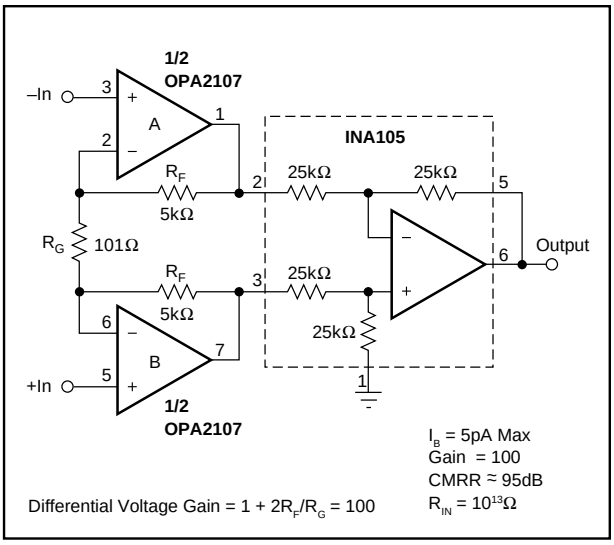



FIGURE 2. FET Input Instrumentation Amplifier.

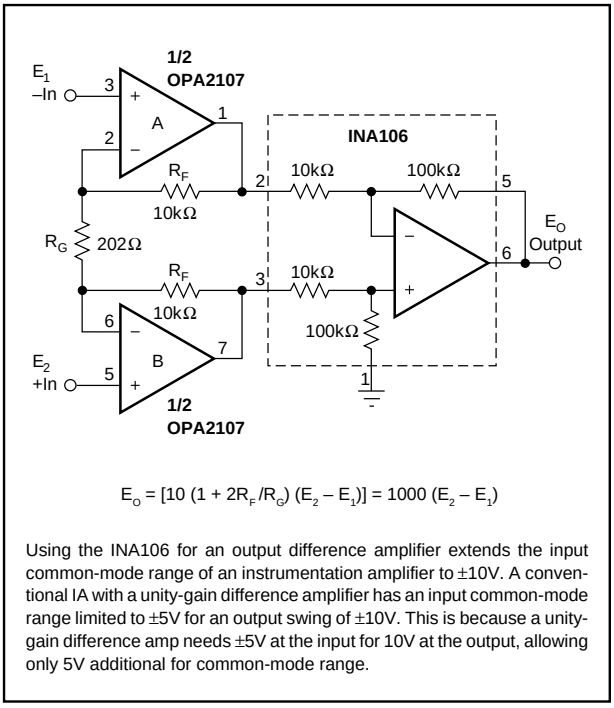



FIGURE 3. Precision Instrumentation Amplifier.