# SGM620A
# Low Power, Low Noise, Rail-to-Rail Output, Instrumentation Amplifier

## GENERAL DESCRIPTION

The SGM620A is a high accuracy, high voltage instrumentation amplifier, which is designed to set any gain from 1 to 10000 with one external resistor. The device works well in battery-powered applications due to the low power consumption of 1.3mA typical quiescent current. The SGM620A provides SOIC-8 and TDFN-3×3-8L packages which are much smaller than discrete classical-three-OPAs circuits.

The SGM620A provides 120ppm (MAX) non-linearity and 80μV (MAX) low input offset voltage. The device also features low noise, low bias current and low power. The combination of these characteristics makes it a good choice for applications requiring excellent DC performance.

The SGM620A offers 6nV/$\sqrt{Hz}$ low input voltage noise, 300fA/$\sqrt{Hz}$ input current noise at 1kHz, and 0.4μ$V_{P-P}$ in the 0.1Hz to 10Hz band. It is suitable for pre-amplifier applications. The 10μs settling time to 0.01% makes SGM620A appropriate for multiplexed applications.

The SGM620A is available in Green SOIC-8 and TDFN-3×3-8L packages. It is specified over the extended -40℃ to +125℃ temperature range.

## FEATURES

- **Single External Resistor Gain Set (Set Gain from 1 to 10000)**
- **Input Offset Voltage: 80μV (MAX)**
- **Input Bias Current: 15nA (TYP)**
- **Common Mode Rejection Ratio: 120dB (TYP) (G = 10)**
- **Input Voltage Noise: 6nV/$\sqrt{Hz}$ at 1kHz**
- **0.1Hz to 10Hz Voltage Noise: 0.4μ$V_{P-P}$**
- **Bandwidth: 140kHz (G = 100)**
- **Settling Time to 0.01%: 10μs (G = 100)**
- **Rail-to-Rail Output**
- **Support Single or Dual Power Supplies: 4.6V to 36V or ±2.3V to ±18V**
- **Low Power Supply Current: 1.3mA (TYP)**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in Green SOIC-8 and TDFN-3×3-8L Packages**

## APPLICATIONS

Precision Current Measurement
Pressure Measurement

## PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM620A | SOIC-8 | -40℃ to +125℃ | SGM620AXS8G/TR | SGM<br>620AXS8<br>XXXXX | Tape and Reel, 4000 |
| | TDFN-3×3-8L | -40℃ to +125℃ | SGM620AXTDB8G/TR | SGM<br>620ADB<br>XXXXX | Tape and Reel, 4000 |

### MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code.

X X X X X

Vendor Code

Trace Code

Date Code - Year

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

### ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$ ............................................... 40V
Input Common Mode Voltage .......................................... $\pm V_S$
Junction Temperature ................................................. +150℃
Storage Temperature Range........................ -65℃ to +150℃
Lead Temperature (Soldering, 10s) ............................ +260℃
ESD Susceptibility
HBM............................................................................. 7000V
CDM ............................................................................ 1000V

### RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range ..................... -40℃ to +125℃

### OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

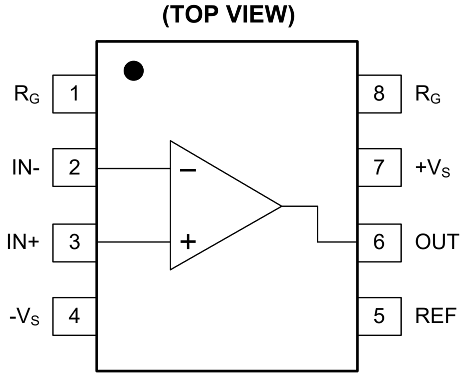
### ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

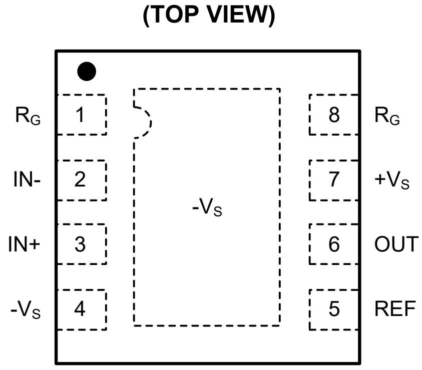
### DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

## PIN CONFIGURATIONS



SOIC-8



TDFN-3×3-8L

## PIN DESCRIPTION

| PIN | NAME | FUNCTION |
|---|---|---|
| 1, 8 | $R_G$ | Gain Setting Pin. The gain can be set by placing the resistor across $R_G$. $G = 1 + (49.4k\Omega/R_G)$. |
| 2 | IN- | Inverting Input Pin. |
| 3 | IN+ | Non-Inverting Input Pin. |
| 4 | $-V_S$ | Negative Power Supply Pin. |
| 5 | REF | Voltage Reference Pin. A voltage source with low impedance can be placed to supply this terminal in order to shift the output level. |
| 6 | OUT | Output Pin. |
| 7 | $+V_S$ | Positive Power Supply Pin. |
| Exposed Pad | $-V_S$ | For TDFN-3×3-8L package, connect exposed pad to $-V_S$. |

## ELECTRICAL CHARACTERISTICS

($V_S$ = ±15V, $R_L$ = 2kΩ, Full = -40℃ to +125℃, typical values are at $T_A$ = +25℃, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | TEMP | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| **Gain (G = 1 + (49.4kΩ/$R_G$))** | | | | | | | | |
| Gain Range | | | | | 1 | | 10000 | |
| Gain Error [1] | GE | $V_{OUT}$ = -10V to +10V | G = 1 | +25℃ | | 0.01 | 0.05 | % |
| | | | | Full | | | 0.1 | |
| | | | G = 10 | +25℃ | | 0.1 | 0.2 | |
| | | | | Full | | | 0.5 | |
| | | | G = 100 | +25℃ | | 0.1 | 0.2 | |
| | | | | Full | | | 0.5 | |
| | | | G = 1000 | +25℃ | | 0.1 | 0.2 | |
| | | | | Full | | | 0.5 | |
| Gain Temperature Coefficient | | | G = 1 | Full | | 1 | | ppm/℃ |
| | | | G > 1 | Full | | 20 | | |
| Non-Linearity | | $V_{OUT}$ = -10V to +10V | G = 1 | +25℃ | | 10 | 70 | ppm |
| | | | | Full | | | 100 | |
| | | | G = 10 | +25℃ | | 10 | 70 | |
| | | | | Full | | | 100 | |
| | | | G = 100 | +25℃ | | 10 | 70 | |
| | | | | Full | | | 100 | |
| | | | G = 1000 | +25℃ | | 20 | 120 | |
| | | | | Full | | | 170 | |
| **Voltage Offset (Total RTI Error = $V_{OSI}$ + $V_{OSO}$/G)** | | | | | | | | |
| Input Offset Voltage | $V_{OSI}$ | $V_S$ = ±5V to ±15V | | +25℃ | | 30 | 80 | μV |
| | | | | Full | | | 160 | |
| Input Offset Voltage Drift | $\Delta V_{OSI}/\Delta T$ | | | Full | | 0.2 | | μV/℃ |
| Output Offset Voltage | $V_{OSO}$ | $V_S$ = ±5V to ±15V | | +25℃ | | 200 | 700 | μV |
| | | | | Full | | | 1200 | |
| Output Offset Voltage Drift | $\Delta V_{OSO}/\Delta T$ | | | Full | | 1.5 | | μV/℃ |
| Offset Referred to the Input vs. Supply | PSRR | $V_S$ = ±2.3V to ±18V | G = 1 | +25℃ | 110 | 120 | | dB |
| | | | | Full | 105 | | | |
| | | | G = 10 | +25℃ | 125 | 130 | | |
| | | | | Full | 122 | | | |
| | | | G = 100 | +25℃ | 128 | 140 | | |
| | | | | Full | 125 | | | |
| | | | G = 1000 | +25℃ | 128 | 140 | | |
| | | | | Full | 125 | | | |
| **Input Current** | | | | | | | | |
| Input Bias Current | $I_B$ | | | +25℃ | | 15 | 28 | nA |
| | | | | Full | | | 40 | |
| Average Temperature Coefficient of Input Bias Current | $\Delta I_B/\Delta T$ | | | Full | | 0.15 | | nA/℃ |
| Input Offset Current | $I_{OS}$ | | | +25℃ | | 5 | 15 | nA |
| | | | | Full | | | 20 | |
| Average Temperature Coefficient of Input Offset Current | $\Delta I_{OS}/\Delta T$ | | | Full | | 0.05 | | nA/℃ |

NOTE: 1. Effects of external resistor $R_G$ is not included.

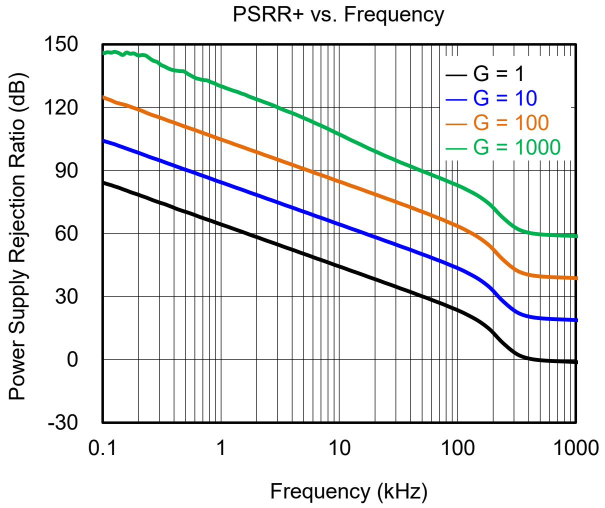
## ELECTRICAL CHARACTERISTICS (continued)

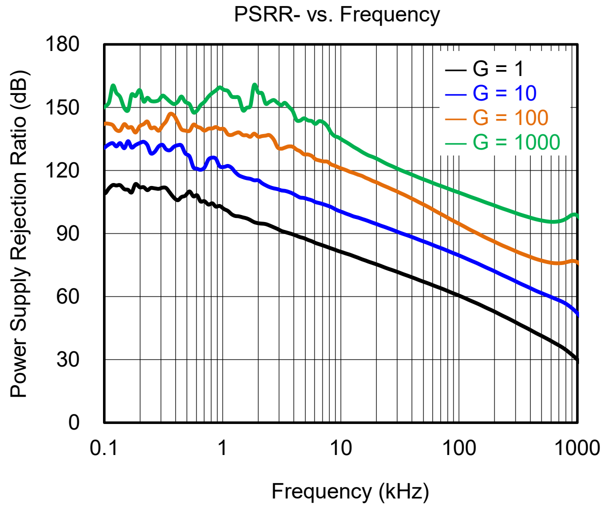
($V_S$ = ±15V, $R_L$ = 2kΩ, Full = -40℃ to +125℃, typical values are at $T_A$ = +25℃, unless otherwise noted.)

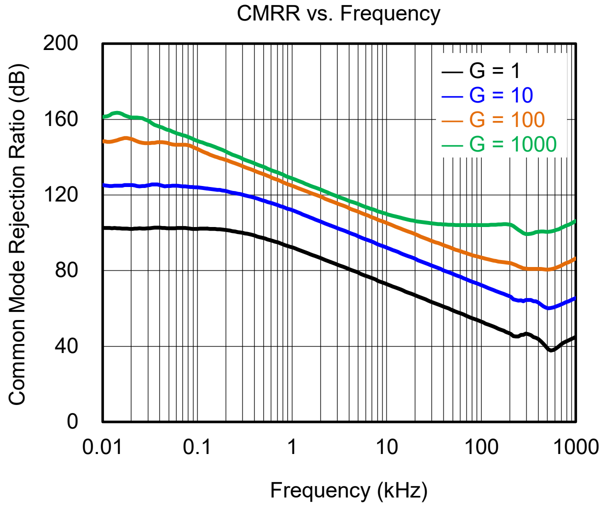
| PARAMETER | | SYMBOL | CONDITIONS | | TEMP | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | | | |
| Input Impedance | Differential | $Z_{DIFF}$ | | | +25℃ | | 10 \|\| 4 | | GΩ \|\| pF |
| | Common Mode | $Z_{CM}$ | | | +25℃ | | 10 \|\| 4 | | |
| Input Voltage Range | | | $V_S$ = ±2.3V to ±5V | | +25℃ | $(-V_S) + 1.9$ | | $(+V_S) - 1.2$ | V |
| | | | | | Full | $(-V_S) + 2.1$ | | $(+V_S) - 1.3$ | |
| | | | $V_S$ = ±5V to ±18V | | +25℃ | $(-V_S) + 1.9$ | | $(+V_S) - 1.4$ | |
| | | | | | Full | $(-V_S) + 2.1$ | | $(+V_S) - 1.4$ | |
| Common Mode Rejection Ratio with 1kΩ Source Imbalance | | CMRR | $V_{CM}$ = -10V to +10V | G = 1 | +25℃ | 80 | 100 | | dB |
| | | | | | Full | 77 | | | |
| | | | | G = 10 | +25℃ | 100 | 120 | | |
| | | | | | Full | 92 | | | |
| | | | | G = 100 | +25℃ | 105 | 130 | | |
| | | | | | Full | 102 | | | |
| | | | | G = 1000 | +25℃ | 105 | 130 | | |
| | | | | | Full | 102 | | | |
| **Reference Input** | | | | | | | | | |
| Reference Input Resistance | | $R_{REF}$ | | | +25℃ | | 18 | | kΩ |
| Reference Input Current | | $I_{REF}$ | $V_{IN+} = V_{IN-}$ = 0V, $V_{REF}$ = 0V | | +25℃ | | 30 | 40 | μA |
| | | | | | Full | | | 50 | |
| **Output Characteristics** | | | | | | | | | |
| Output Voltage Swing | | $V_{OH}$ | $V_S$ = ±18V, $R_L$ = 2kΩ | | +25℃ | | 310 | 400 | mV |
| | | | | | Full | | | 600 | |
| | | $V_{OL}$ | $V_S$ = ±18V, $R_L$ = 2kΩ | | +25℃ | | 150 | 220 | |
| | | | | | Full | | | 300 | |
| Short-Circuit Current | | $I_{SC}$ | $V_S$ = ±2.3V to ±18V, $R_L$ = 50Ω to $V_S$/2 | | +25℃ | 19 | 24 | | mA |
| | | | | | Full | 14 | | | |
| **Power Supply** | | | | | | | | | |
| Quiescent Current | | $I_Q$ | $V_S$ = ±2.3V to ±18V, $I_{OUT}$ = 0A | | +25℃ | | 1.3 | 1.7 | mA |
| | | | | | Full | | | 2.2 | |
| **Dynamic Response** | | | | | | | | | |
| Small-Signal -3dB Bandwidth | | BW | | G = 1 | +25℃ | | 3900 | | kHz |
| | | | | G = 10 | +25℃ | | 1000 | | |
| | | | | G = 100 | +25℃ | | 140 | | |
| | | | | G = 1000 | +25℃ | | 17 | | |
| Slew Rate | | SR | $V_{OUT}$ = 1$V_{P-P}$ Step | G = 1 | +25℃ | | 1.2 | | V/μs |
| Settling Time to 0.01% | | $t_S$ | $V_{OUT}$ = 10$V_{P-P}$ Step | G = 1 to 100 | +25℃ | | 10 | | μs |
| | | | | G = 1000 | +25℃ | | 51 | | |
| **Noise** | | | | | | | | | |
| Input Voltage Noise Density | | $e_{ni}$ | f = 1kHz | | +25℃ | | 6 | | nV/√Hz |
| Output Voltage Noise Density | | $e_{no}$ | f = 1kHz | | +25℃ | | 80 | | nV/√Hz |
| 0.1Hz to 10Hz Voltage Noise, RTI | | | f = 0.1Hz to 10Hz | G = 1 | +25℃ | | 6 | | μ$V_{P-P}$ |
| | | | | G = 10 | +25℃ | | 1 | | |
| | | | | G = 100 | +25℃ | | 0.4 | | |
| | | | | G = 1000 | +25℃ | | 0.4 | | |
| Input Current Noise Density, RTI | | $i_n$ | f = 1kHz | | +25℃ | | 300 | | fA/√Hz |
| 0.1Hz to 10Hz Current Noise, RTI | | | f = 0.1Hz to 10Hz | | +25℃ | | 15 | | p$A_{P-P}$ |

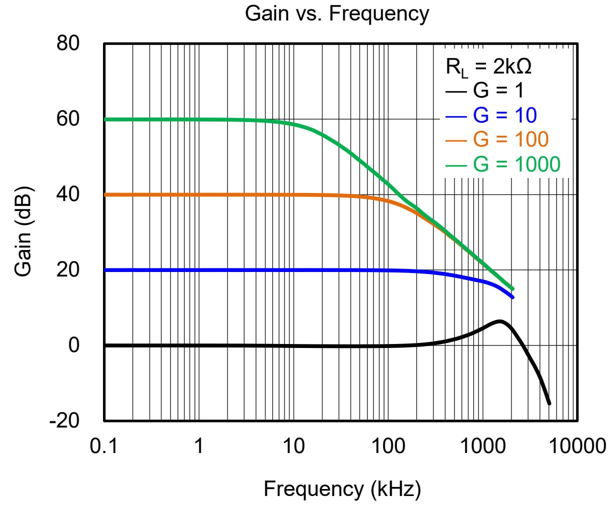
## TYPICAL PERFORMANCE CHARACTERISTICS

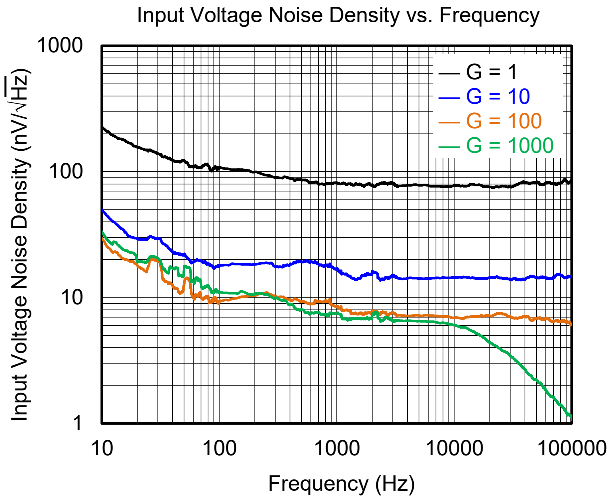
At $T_A$ = +25℃, $V_S$ = ±15V, unless otherwise noted.

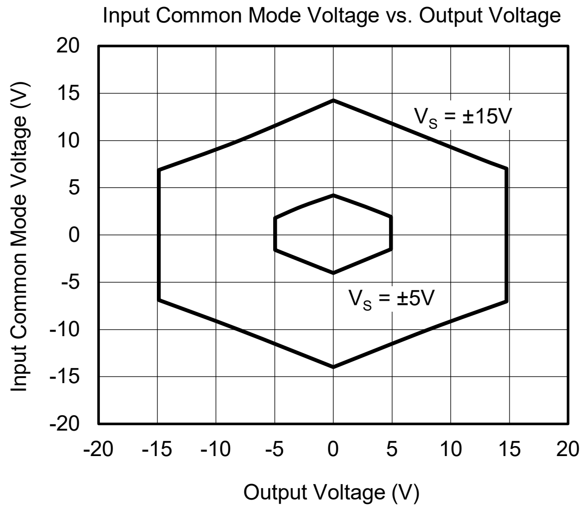


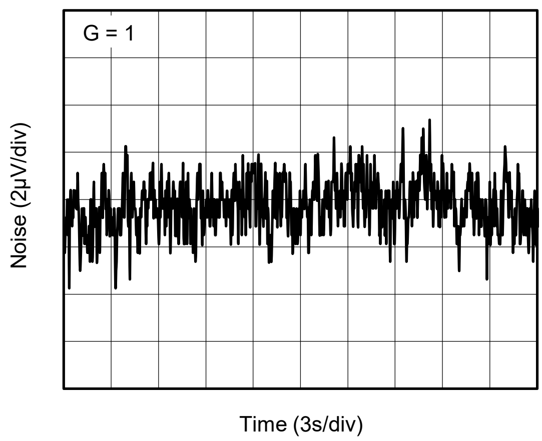



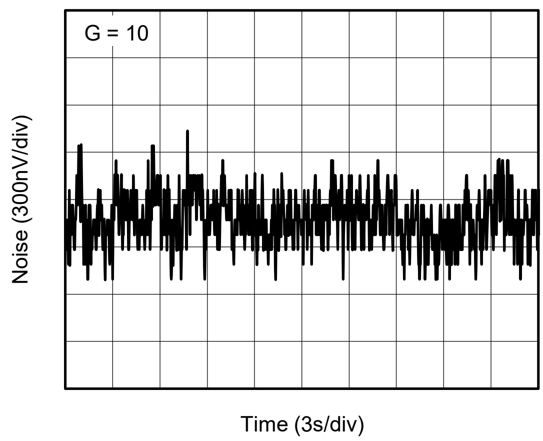
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A$ = +25℃, $V_S$ = ±15V, unless otherwise noted.

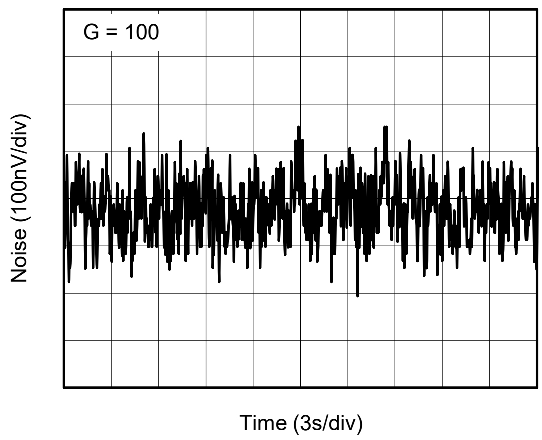
0.1Hz to 10Hz Input Voltage Noise



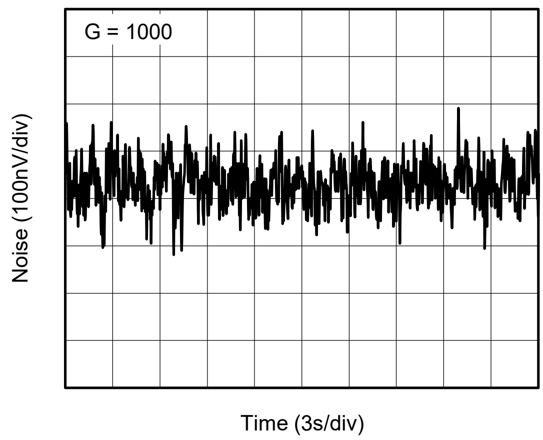

0.1Hz to 10Hz Input Voltage Noise



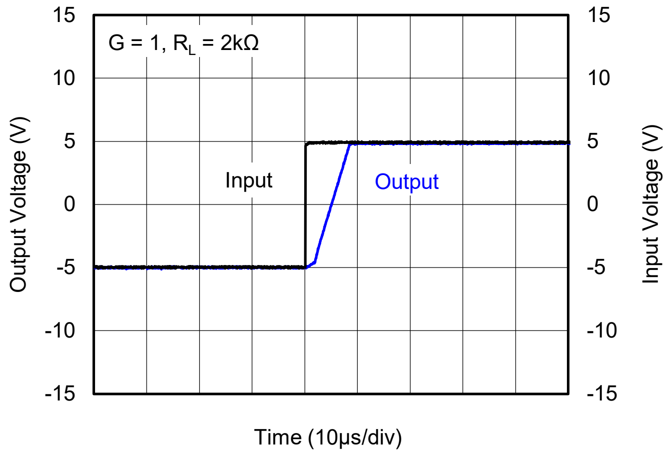

0.1Hz to 10Hz Input Voltage Noise



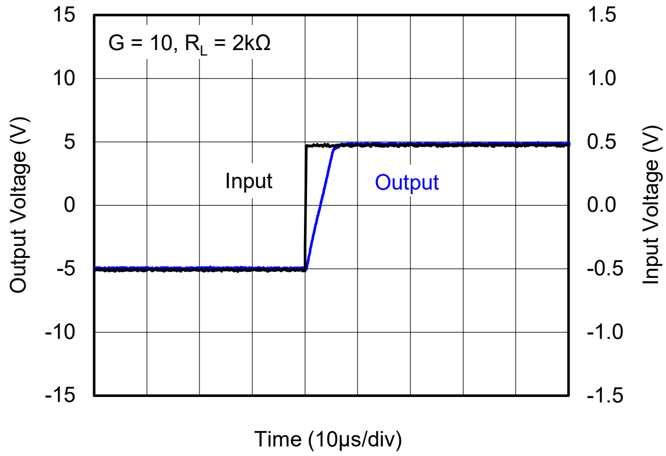

0.1Hz to 10Hz Input Voltage Noise




Settling Time



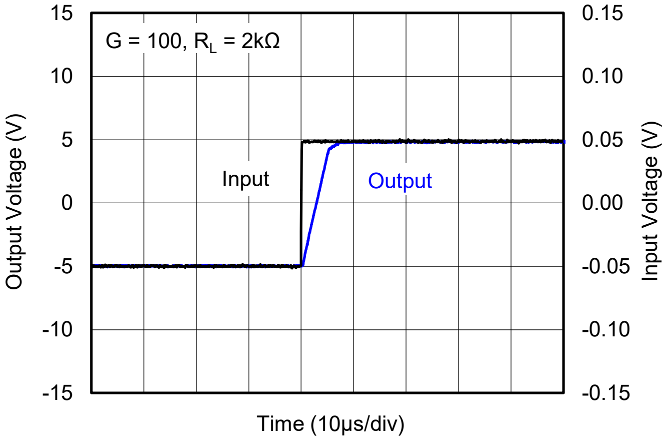

Settling Time



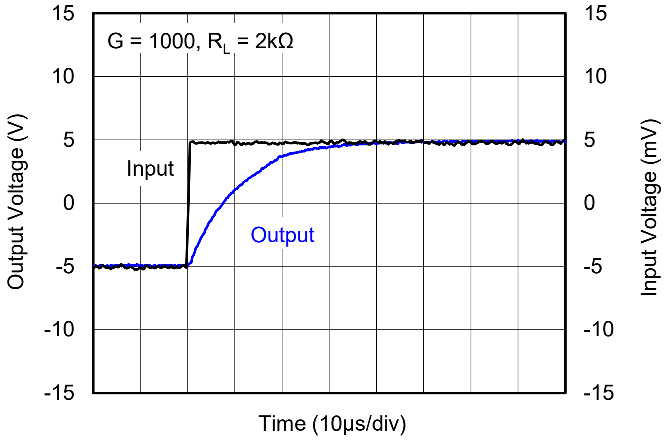
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A$ = +25℃, $V_S$ = ±15V, unless otherwise noted.

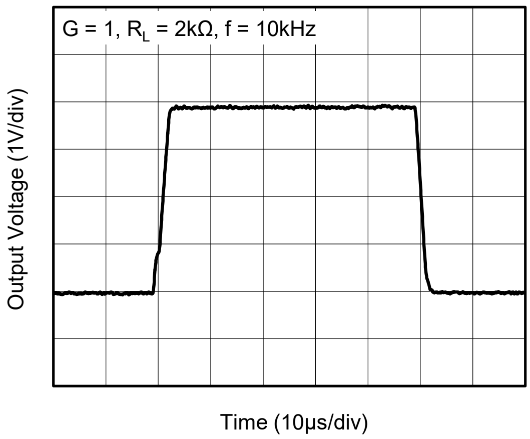
Settling Time



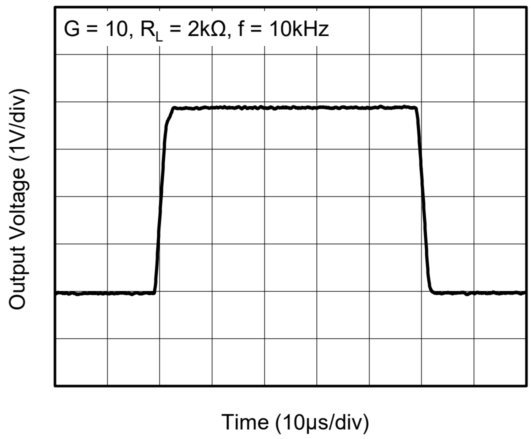

Settling Time



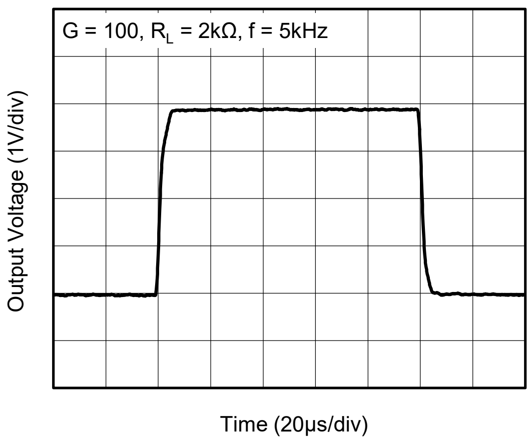

Large-Signal Step Response



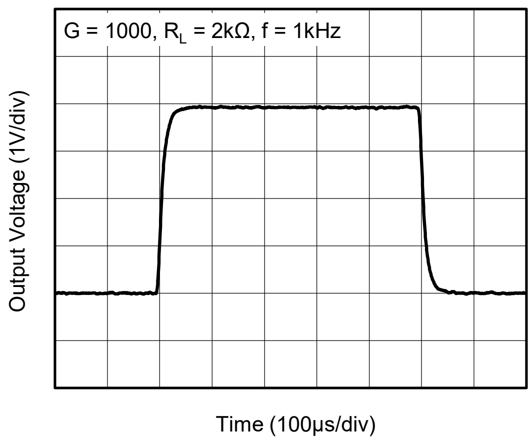

Large-Signal Step Response




Large-Signal Step Response



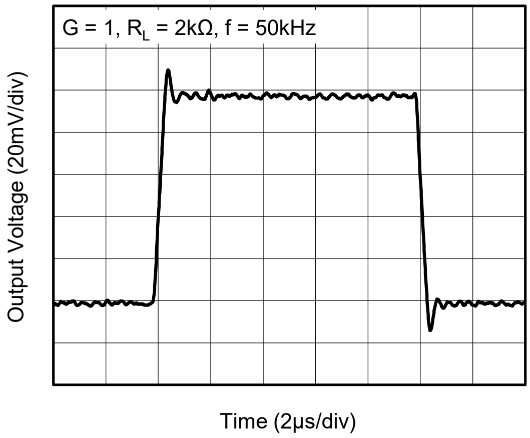

Large-Signal Step Response



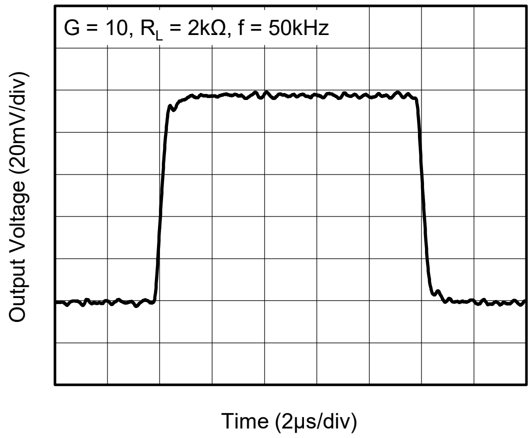
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

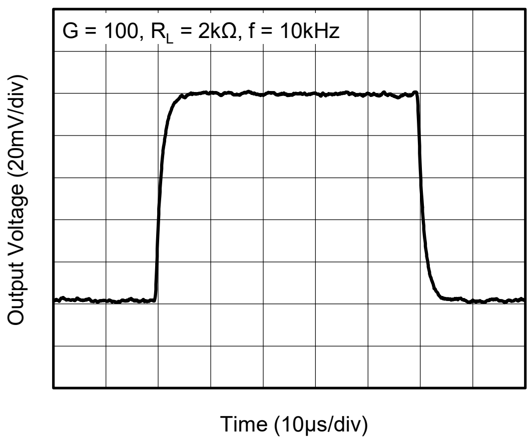
Small-Signal Step Response



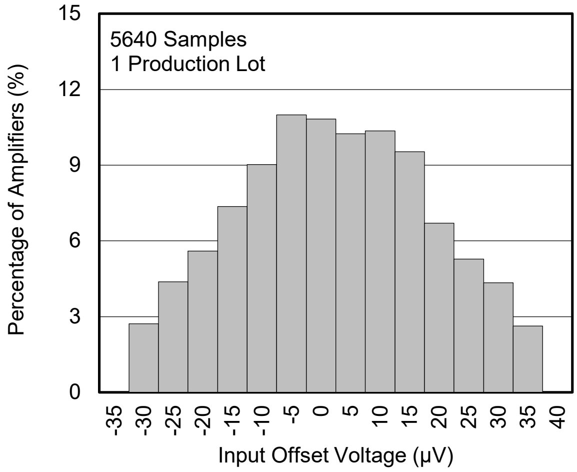

Small-Signal Step Response



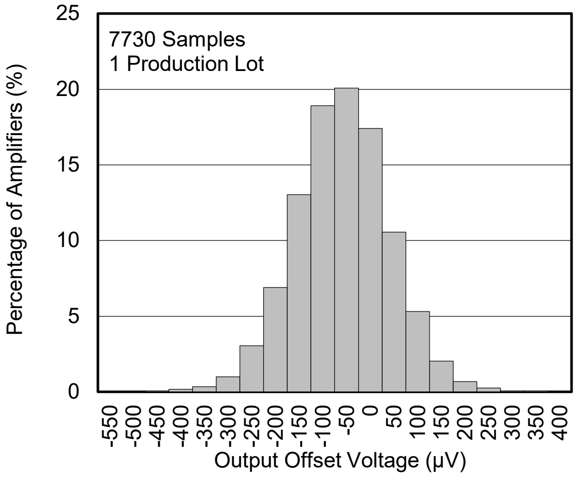

Small-Signal Step Response



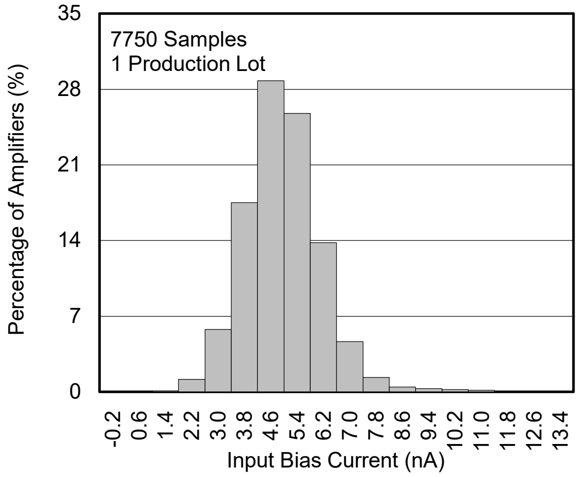

Input Offset Voltage Production Distribution




Output Offset Voltage Production Distribution




Input Bias Current Production Distribution



# OPERATION THEORY

The SGM620A is modified with the classic three-op-amp and it is a holistic instrumentation amplifier.

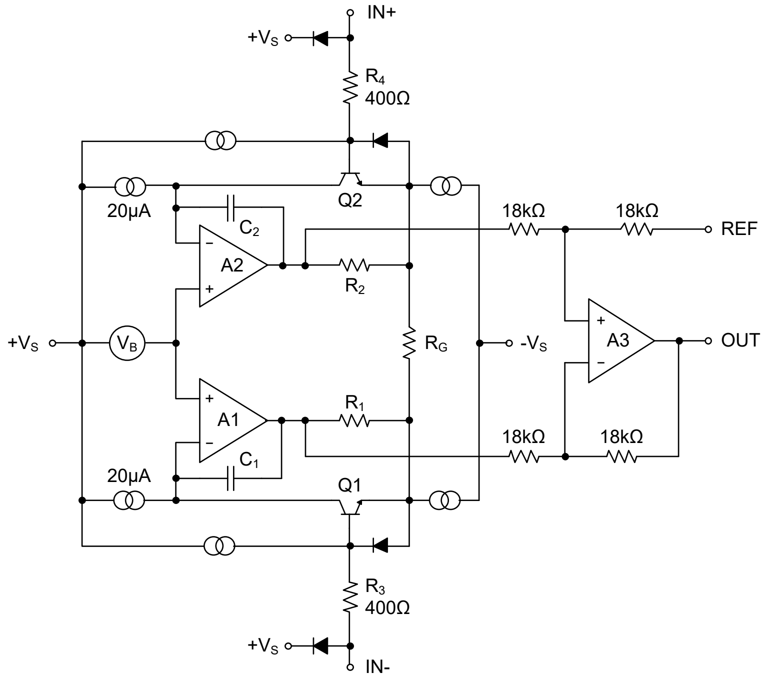



**Figure 1. Simplified Schematic**

The high precision input is provided by the two input transistor Q1 and Q2 (Figure 1) and this results in 10 × lower bias current of the input pins. The constant collector current of Q1 and Q2 is maintained by the two loops Q1-A1-R1 and Q2-A2-R2, so the input voltage is impressed across the gain setting resistor $R_G$ of the amplifier. The differential gain from A1/A2 outputs can be expressed by $G = 1 + (R_1+R_2)/R_G$. The unity-gain subtractor (A3) can reject the common mode signal so that SGM620A produces a single-ended output with REF pin biased.

The transconductance of the pre-amplifier is determined by the resistance of $R_G$. The transconductance will increase gradually to that of the input transistors if the resistance of $R_G$ is reduced for larger gains. The important benefits are shown below:

- Boosting the open-loop gain can also increase the programmed gain, so that the related error of gain is reduced.
- The gain-bandwidth product which is determined by the two capacitors $C_1$, $C_2$ and the transconductance of the pre-amplifier can increase with programmed gain, so that the frequency response is enhanced.
- Reducing the input voltage noise to $6nV/\sqrt{Hz}$, and it is determined by the base resistance and the collector current of the input.

The integrated resistors ($R_1$ and $R_2$) inside the SGM620A are set to 24.7kΩ, so that the gain can be programmed with the external resistor $R_G$.

The equation of gain is shown as below:

$$G = \frac{49.4k\Omega}{R_G} + 1$$

$$R_G = \frac{49.4k\Omega}{G - 1}$$

# APPLICATION INFORMATION

## Pressure Measurement

SGM620A is widely used in the application of bridge, such as measuring the pressure in weigh scales. It is also suitable for detecting the pressure sensor with higher resistance due to high input impedance.

Figure 2 shows the pressure transducer bridge of 5kΩ which is powered by a 5V single supply. In such a circuit, the bridge consumes only 1mA. The buffered voltage divider and SGM620A can condition the output signal with typical 3.3mA supply current.

The advantage of small size for SGM620A is attractive for the transducers of pressure. Because of the low noise and drift, it can also be used in the application of diagnostic non-invasive blood pressure measurement.

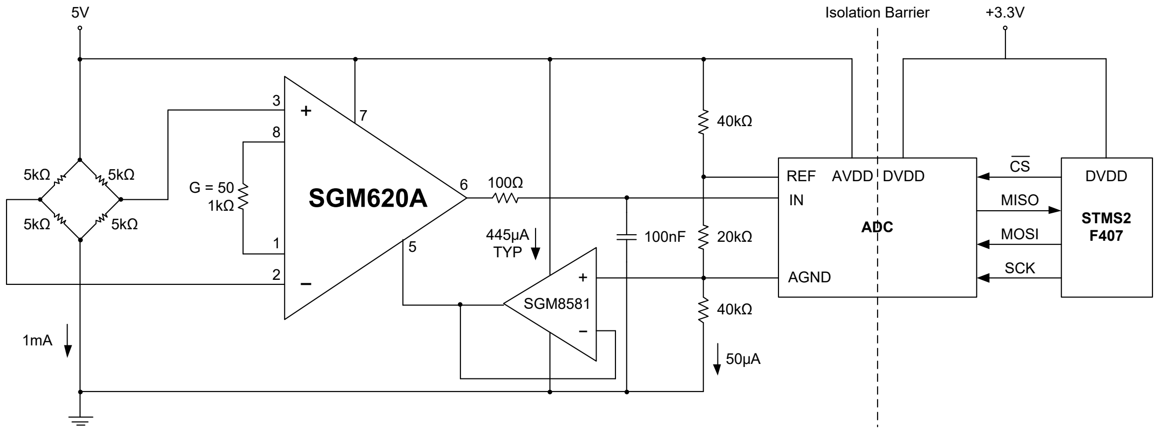



Figure 2. The Operation of the Pressure Monitor Circuit with 5V Single Supply

## Medical ECG Amplifier

Because of the advantage of low current noise, SGM620A can be used in ECG monitors (Figure 3) where the source resistances can reach 1MΩ or higher. It is the best choice to use SGM620A in the battery-powered data recorders as it can operate on the condition of low supply voltage, low power and space-saving packages.

Moreover, for better performance, combining with the advantages of low voltage noise, low current and low bias currents can enhance the dynamic range of SGM620A.

The stability of the right leg drive loop can be maintained by the capacitor $C_1$. Moreover, for protecting the patient from the possible harm, the isolation safeguards should be added between the patient and the circuit part.

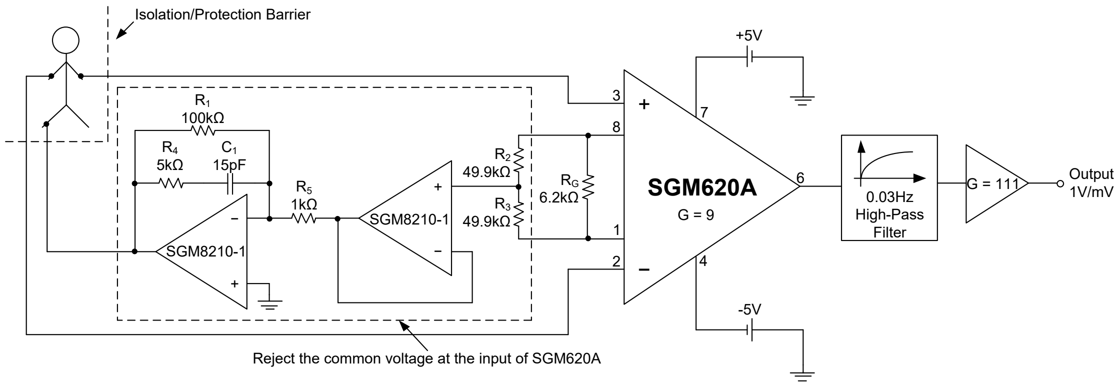



Figure 3. The Circuit of Medical ECG Monitor

# APPLICATION INFORMATION (continued)

## Precision V-I Converter

It's easy to realize a precision current source (Figure 4) utilizing one SGM620A, another operational amplifier and two resistors. To obtain a better CMRR of SGM620A, a buffer should be placed between the REF pin and the OUT pin of the amplifier. The equation which is shown in Figure 4 illustrates the output current of the circuit.

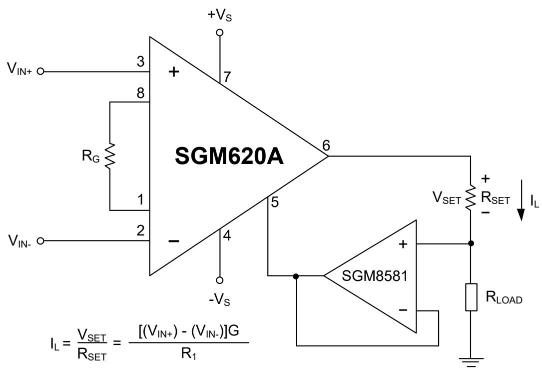



**Figure 4. Precision Voltage-to-Current Converter**

## Input and Output Offset Voltage

Two main sources which are error of input and output result in the low errors of SGM620A. When referred to the input, the output error should be divided by the gain of the instrumentation amplifier. From the equations which are shown as below, the input error takes a leading position at large gains while the output error takes a leading position at small gains.

Total Error Referred to Input (RTI) = Input Error + (Output Error/G)

Total Error Referred to Output (RTO) = (Input Error × G) + Output Error

## Terminal of Reference

Potential of the reference terminal defines the zero output voltage. It becomes extremely useful while the load is not tied to the precise ground of the rest of the system. The reference terminal provides one way to bias a precise voltage to the output, and the reference voltage should be in the range of 2V within the supply voltages. On top of these, to keep better CMRR, the parasitic resistor at this pin should be low.

## Selection of Gain

The gain of the instrumentation amplifier is determined by the external resistor $R_G$. The accuracy of the external resistor $R_G$ is important as it may influence the error of gain. It is recommended that selecting the resistor with 0.1% or 1% precision is a good choice. The following table shows the gain effect with the selection of 1% or 0.1% precision resistor. Also, leaving the pin 1 and pin 8 (the place of $R_G$) open can make the gain of SGM620A equals to 1.

$$R_G = \frac{49.4k\Omega}{G - 1}$$

As mentioned before, the gain error can be minimized by equivalent parasitic resistor in series with $R_G$. Moreover, low TC of 1ppm/℃ is required for the selection of $R_G$ to avoid the gain drift of SGM620A.

**Table 1. Different Values for Gain Resistor**

| 1% STD Table Value of $R_G$ (Ω) | Calculated Gain | 0.1% STD Table Value of $R_G$ (Ω) | Calculated Gain |
|---|---|---|---|
| 49.9k | 1.990 | 49.3k | 2.002 |
| 12.4k | 4.984 | 12.4k | 4.984 |
| 5.49k | 9.998 | 5.49k | 9.998 |
| 2.61k | 19.93 | 2.61k | 19.93 |
| 1.00k | 50.40 | 1.01k | 49.91 |
| 499 | 100.0 | 499 | 100.0 |
| 249 | 199.4 | 249 | 199.4 |
| 100 | 495.0 | 98.8 | 501.0 |
| 49.9 | 991.0 | 49.3 | 1003.0 |

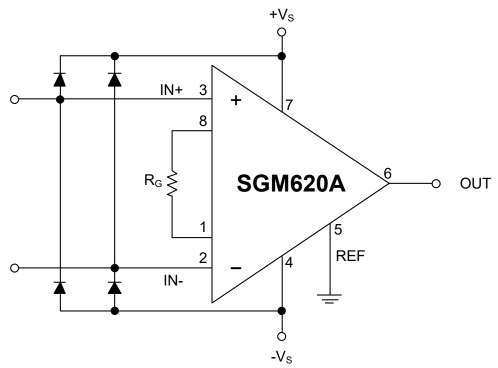



**Figure 5. Diode for Protecting $V_{IN}$ from Larger than $V_S$**

# APPLICATION INFORMATION (continued)

## RF Interference

One of the characteristics of instrumentation amplifier is rectifying the small signal which is out of the band. This kind of disturbance can be described as the small biased voltage. All of the high frequency components can be filtered by the R-C network which is placed in the input position of the instrumentation amplifier, as shown in Figure 6. The following equation shows the equation of filtering frequency for the differential and common mode part of the input signal.

$$FilterFreq_{DIFF} = \frac{1}{2\pi R(2C_D + C_C)}$$

$$FilterFreq_{CM} = \frac{1}{2\pi RC_C}$$

$C_D \geq 10C_C$ is required in the above equation.

The capacitor $C_D$ influences the quality of the differential signal, while $C_C$ influences the quality of the common mode signal. The common mode rejection ratio would be reduced if the R × $C_C$ is mismatched. To reduce this negative influence and obtain a good CMRR, it is recommended that the capacitance of $C_D$ should be 10 times larger than $C_C$. To conclude, the larger the ratio of $C_D$:$C_C$ is, the less negative influence to the circuit.

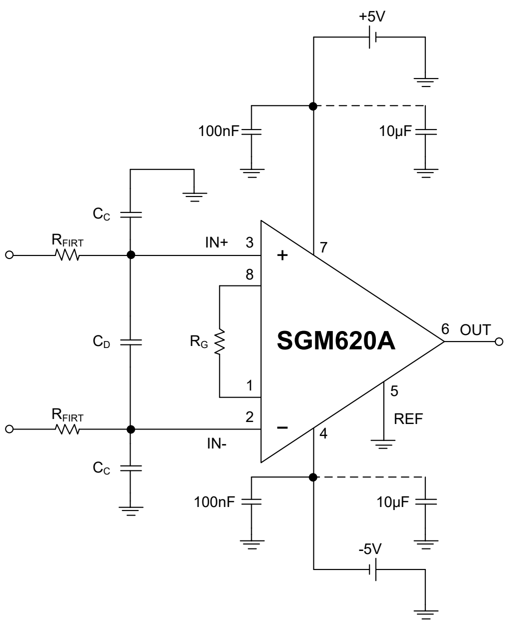



**Figure 6. One Method to Reduce the Interference of RF**

## Common Mode Rejection

The common mode rejection ratio of the instrumentation amplifier is high as it can measure the differential signal between the two inputs when both IN+ and IN- increase or decrease equally. Also, this specification can be defined in the whole range of input voltage.

To obtain a best CMRR, it is recommended that the REF pin should be connected to a low impedance input and the difference of impedance between two inputs should be as small as possible. Also, using shielded cable can effectively reduce the noise of the circuit, and it should be driven properly for better value of CMRR. The following two figures (Figure 7 and Figure 8) illustrate the method to increase the CMRR for alternating circuit by bootstrapping the capacitance of the shielded cable, and this kind of method can also reduce the mismatching of capacitance at the inputs.

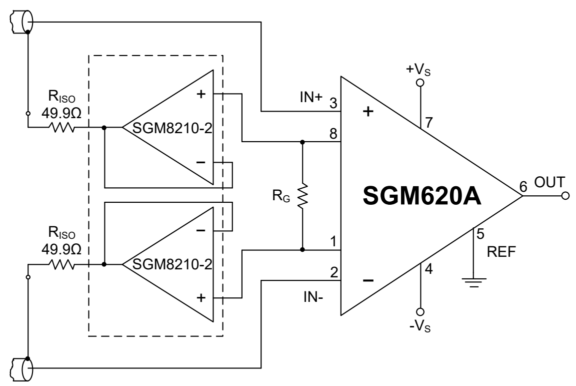



**Figure 7. Differential Input Shield Driving**

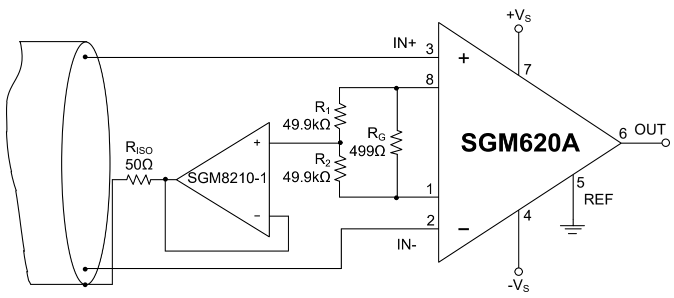



**Figure 8. Common Mode Input Shield Driving**

## APPLICATION INFORMATION (continued)

### Isolation of Grounding

For solving the problems of grounding, REF pin should be connected to the "local ground" as the output of the instrumentation amplifier is biased with $V_{REF}$.

Because of the noisy environment of the digital circuit, the component of data-acquisition such as Analog Digital Converter (ADC) has two pins which are AGND and DGND. Also, the isolation can be made by using a single line or 0Ω resistor. However, each returns of ground should be separated so that the current flow from the sensitive point could be minimized. Also, the ground returns between analog and digital should be tied together with one point, which is shown in ADC part of Figure 9.

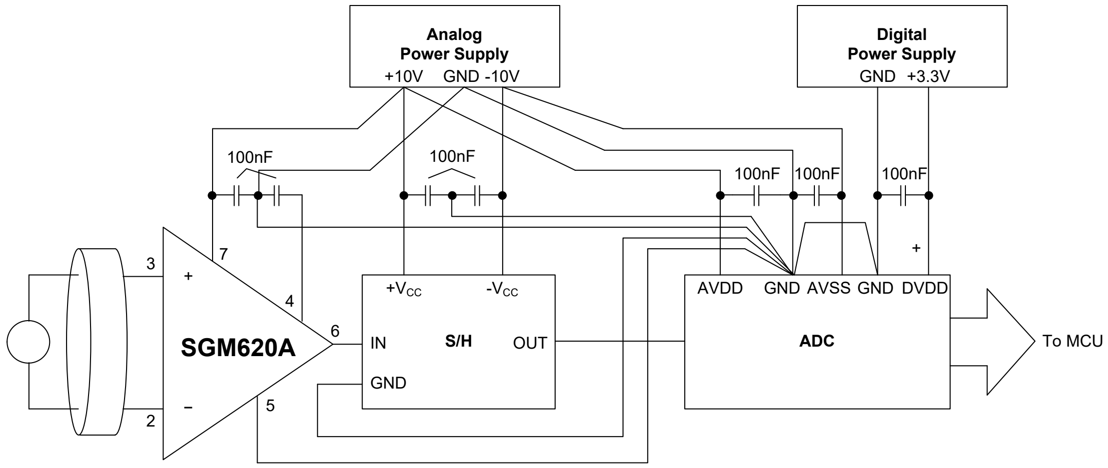



**Figure 9. Isolation of Grounding**

### Return of Grounding for $I_B$

The bias current ($I_B$) at the inputs is needed for operating and biasing the transistor at the input stage of the instrumentation amplifier, so it is also necessary to design a ground return path for the bias current. For example, for operating the floating inputs of the amplifier (see Figure 10 ~ 12), such as AC-coupled transformer, there should be an electrical line between the input and the ground for ground return of bias current.

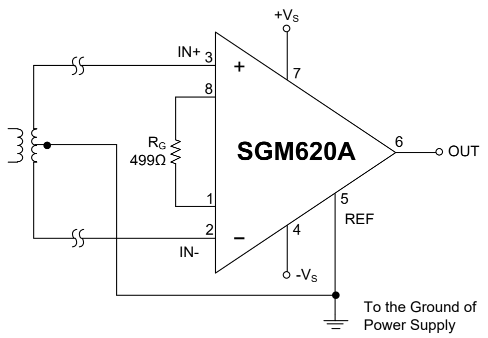



**Figure 10. Return of Grounding for $I_B$ with Transformer-Coupled Inputs**

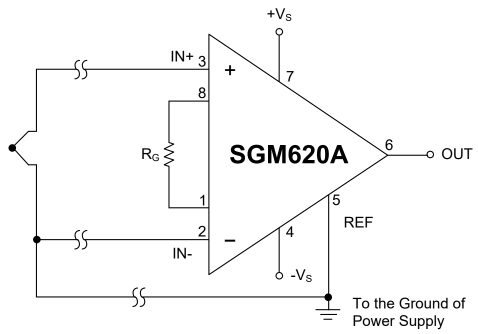



**Figure 11. Return of Grounding for $I_B$ with Thermocouple Inputs**

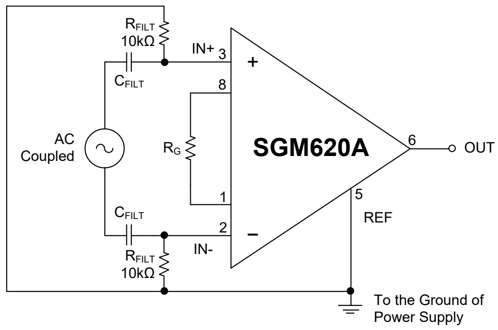



**Figure 12. Return of Grounding for $I_B$ with AC-Coupled Input**

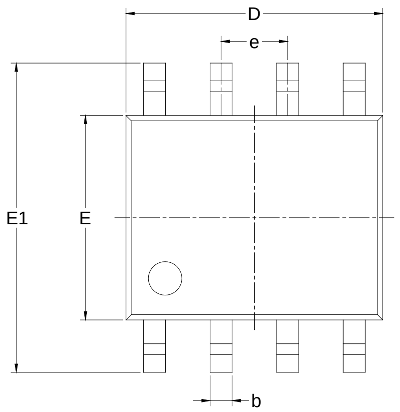
# REVISION HISTORY

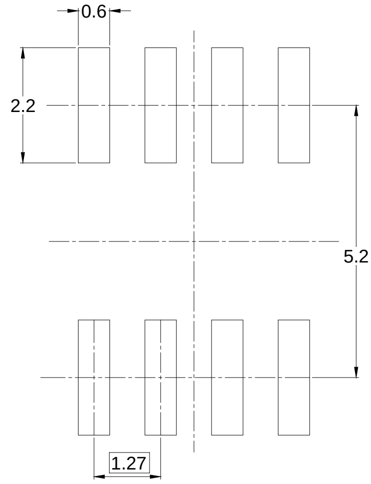
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Original (MARCH 2024) to REV.A | Page |
| --- | --- |
| Changed from product preview to production data | All |

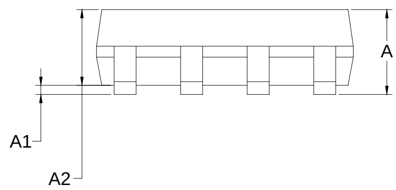
# PACKAGE OUTLINE DIMENSIONS

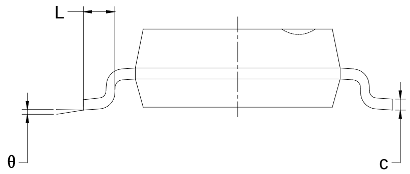
## SOIC-8




**RECOMMENDED LAND PATTERN** (Unit: mm)



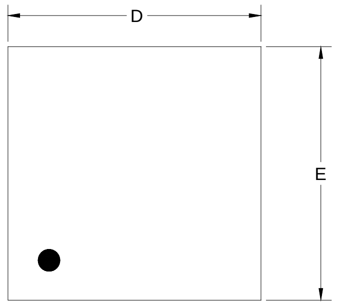




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | **MIN** | **MAX** | **MIN** | **MAX** |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.006 | 0.010 |
| D | 4.700 | 5.100 | 0.185 | 0.200 |
| E | 3.800 | 4.000 | 0.150 | 0.157 |
| E1 | 5.800 | 6.200 | 0.228 | 0.244 |
| e | 1.27 BSC | | 0.050 BSC | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

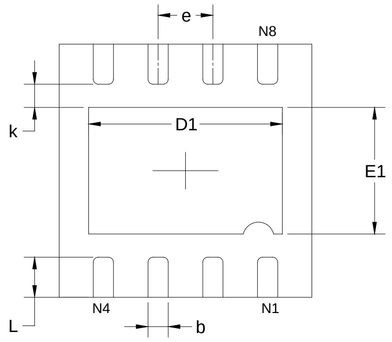
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

# PACKAGE OUTLINE DIMENSIONS

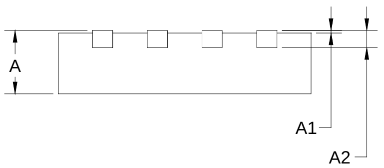
## TDFN-3×3-8L



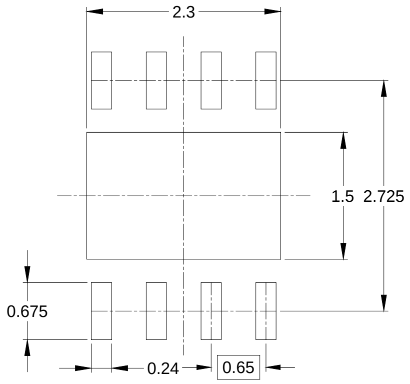

**TOP VIEW**




**BOTTOM VIEW**




**SIDE VIEW**



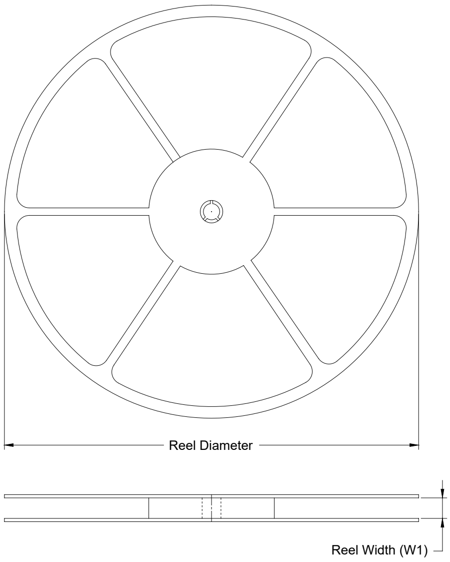

**RECOMMENDED LAND PATTERN** (Unit: mm)

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A2 | 0.203 REF | | 0.008 REF | |
| D | 2.900 | 3.100 | 0.114 | 0.122 |
| D1 | 2.200 | 2.400 | 0.087 | 0.094 |
| E | 2.900 | 3.100 | 0.114 | 0.122 |
| E1 | 1.400 | 1.600 | 0.055 | 0.063 |
| k | 0.200 MIN | | 0.008 MIN | |
| b | 0.180 | 0.300 | 0.007 | 0.012 |
| e | 0.650 TYP | | 0.026 TYP | |
| L | 0.375 | 0.575 | 0.015 | 0.023 |

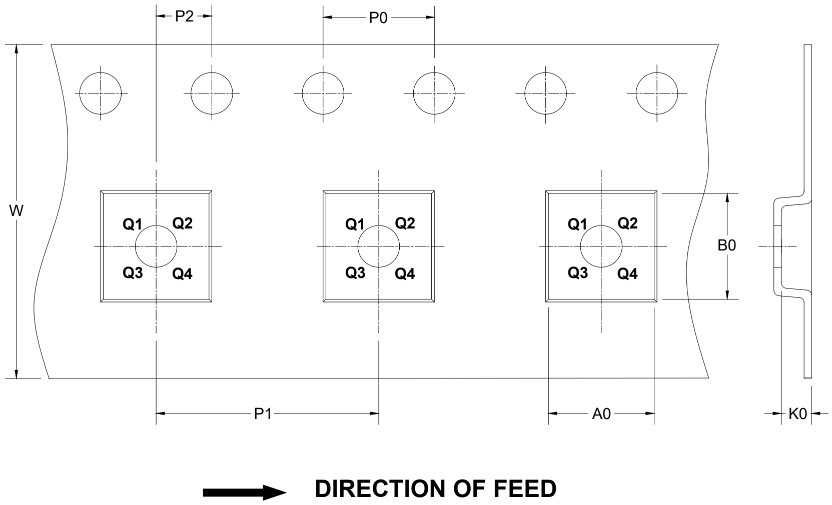
NOTE: This drawing is subject to change without notice.

# TAPE AND REEL INFORMATION

## REEL DIMENSIONS




## TAPE DIMENSIONS



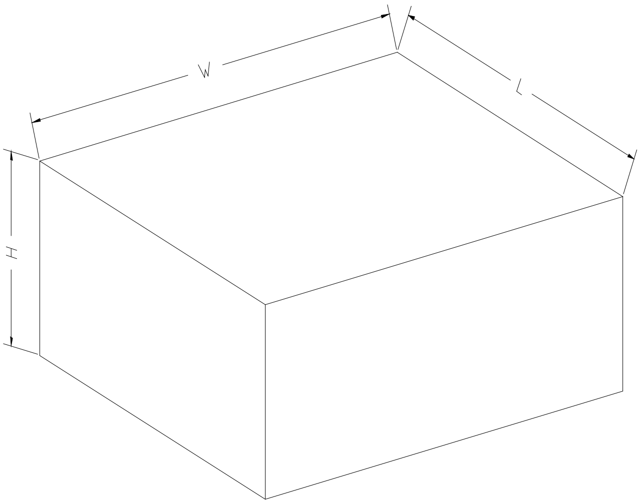

NOTE: The picture is only for reference. Please make the object as the standard.

## KEY PARAMETER LIST OF TAPE AND REEL

| Package Type | Reel Diameter | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|
| SOIC-8 | 13″ | 12.4 | 6.40 | 5.40 | 2.10 | 4.0 | 8.0 | 2.0 | 12.0 | Q1 |
| TDFN-3×3-8L | 13″ | 12.4 | 3.35 | 3.35 | 1.13 | 4.0 | 8.0 | 2.0 | 12.0 | Q1 |

DD0001

## CARTON BOX DIMENSIONS




NOTE: The picture is only for reference. Please make the object as the standard.

## KEY PARAMETER LIST OF CARTON BOX

| Reel Type | Length (mm) | Width (mm) | Height (mm) | Pizza/Carton |
|---|---|---|---|---|
| 13″ | 386 | 280 | 370 | 5 |

DD0002