



SGM620

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

GENERAL DESCRIPTION

The SGM620 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 SGM620 provides a SOIC-8 package which is much smaller than discrete classical-three-OPAs circuits.

The SGM620 provides 120ppm (MAX) non-linearity and 150 μ V (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 SGM620 offers 6nV/ $\sqrt{\text{Hz}}$ low input voltage noise, 300fA/ $\sqrt{\text{Hz}}$ input current noise at 1kHz, and 0.4 μ V_{P-P} in the 0.1Hz to 10Hz band. It is suitable for pre-amplifier applications. The 10 μ s settling time to 0.01% makes SGM620 appropriate for multiplexed applications.

The SGM620 is available in a Green SOIC-8 package. It is specified over the extended -40°C to +125°C temperature range.

FEATURES

- **Single External Resistor Gain Set (Set Gain from 1 to 10000)**
- **Input Offset Voltage: 150 μ V (MAX)**
- **Input Bias Current: 15nA (TYP)**
- **Common Mode Rejection Ratio: 105dB (TYP) (G = 10)**
- **Input Voltage Noise: 6nV/ $\sqrt{\text{Hz}}$ at 1kHz**
- **0.1Hz to 10Hz Voltage Noise: 0.4 μ V_{P-P}**
- **Bandwidth: 140kHz (G = 100)**
- **Settling Time to 0.01%: 10 μ s (G = 100)**
- **Rail-to-Rail Output**
- **Support Single or Dual Power Supplies: 4.6V to 36V or \pm 2.3V to \pm 18V**
- **Low Power Supply Current: 1.3mA (TYP)**
- **-40°C to +125°C Operating Temperature Range**
- **Available in a Green SOIC-8 Package**

APPLICATIONS

Precision Current Measurement
Pressure Measurement

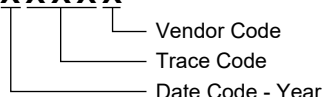
PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|--------|---------------------|-----------------------------|-----------------|------------------------|---------------------|
| SGM620 | SOIC-8 | -40°C to +125°C | SGM620XS8G/TR | SGM 620XS8 XXXXX | Tape and Reel, 4000 |

MARKING INFORMATION

XXXXX = Date Code, Trace Code and Vendor Code.

XXXXX



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°C
 Storage Temperature Range -65°C to +150°C
 Lead Temperature (Soldering, 10s) +260°C
 ESD Susceptibility
 HBM 7000V
 CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range -40°C to +125°C

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.

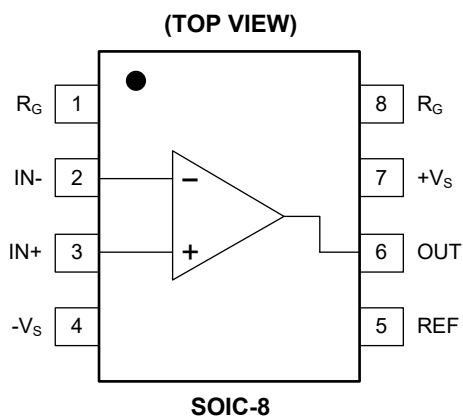
ESD SENSITIVITY CAUTION

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 CONFIGURATION



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. |

ELECTRICAL CHARACTERISTICS

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

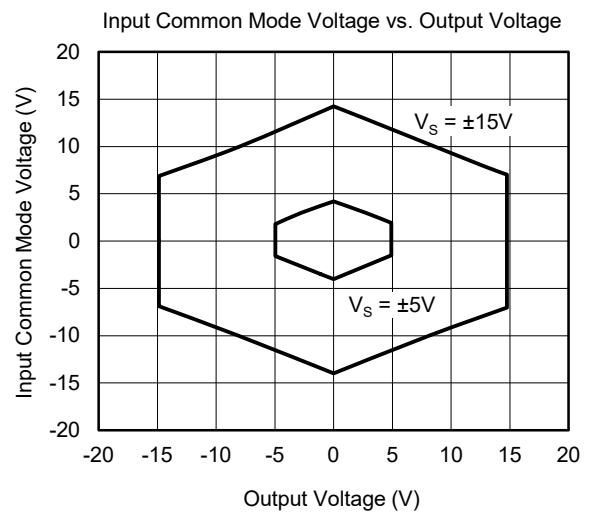
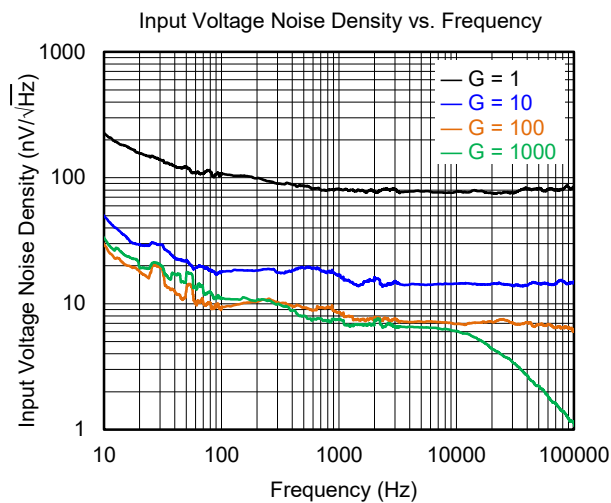
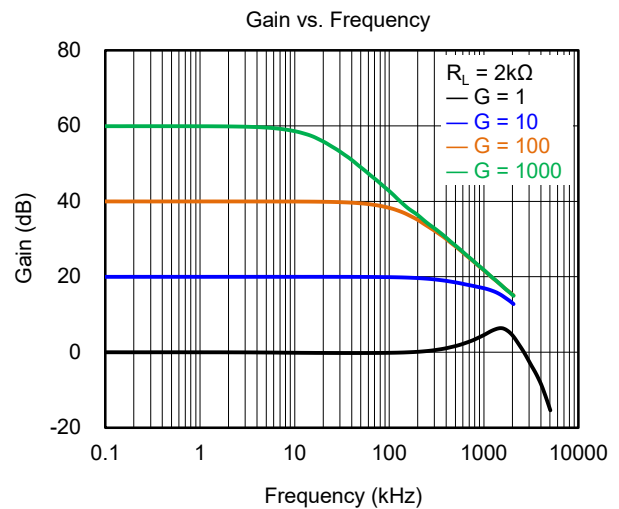
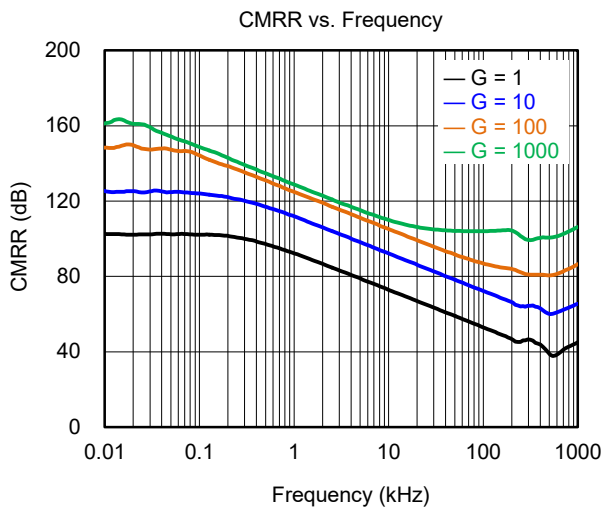
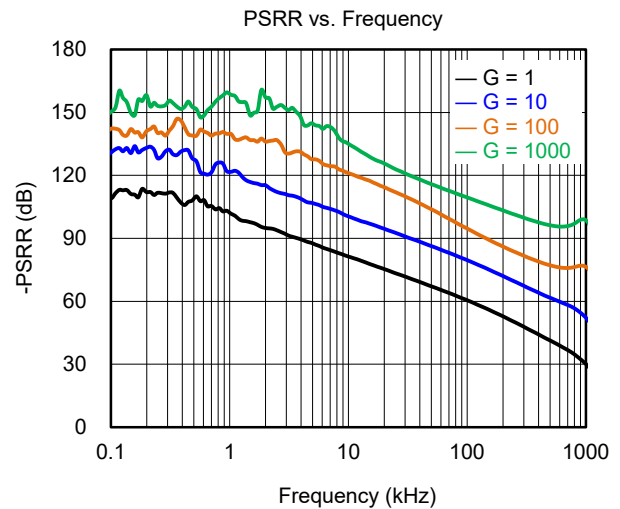
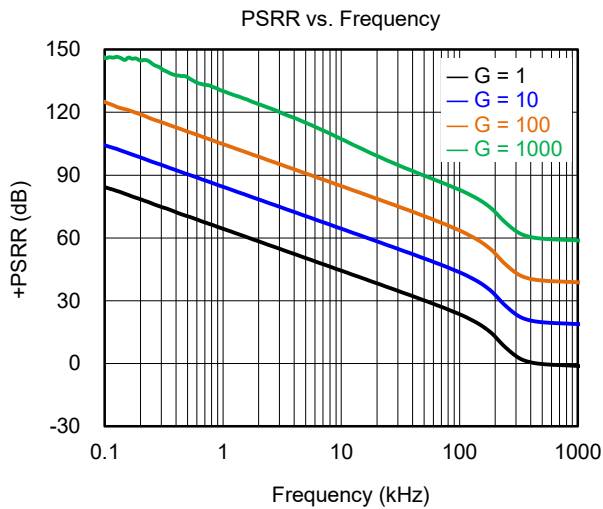
| PARAMETER | SYMBOL | CONDITIONS | | TEMP | MIN | TYP | MAX | UNITS |
|---|-----------------------|---------------------------------|----------|-------|-----|------|-------|--------|
| Gain (G = 1 + (49.4kΩ/R _G)) | | | | | | | | |
| Gain Range | | | | | 1 | | 10000 | |
| Gain Error ⁽¹⁾ | GE | V _{OUT} = -10V to +10V | G = 1 | +25°C | | 0.01 | 0.1 | % |
| | | | | Full | | | 0.15 | |
| | | | G = 10 | +25°C | | 0.15 | 0.3 | |
| | | | | Full | | | 0.6 | |
| | | | G = 100 | +25°C | | 0.15 | 0.3 | |
| | | | | Full | | | 0.6 | |
| | | | G = 1000 | +25°C | | 0.15 | 0.6 | |
| | | | | Full | | | 0.8 | |
| Gain Temperature Coefficient | | | G = 1 | Full | | 1 | | ppm/°C |
| | | | G > 1 | Full | | 20 | | |
| Non-Linearity | | V _{OUT} = -10V to +10V | G = 1 | +25°C | | 10 | 70 | ppm |
| | | | | Full | | | 100 | |
| | | | G = 10 | +25°C | | 10 | 70 | |
| | | | | Full | | | 100 | |
| | | | G = 100 | +25°C | | 10 | 70 | |
| | | | | Full | | | 100 | |
| | | | G = 1000 | +25°C | | 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°C | | 50 | 150 | μV |
| | | | | Full | | | 200 | |
| Input Offset Voltage Drift | ΔV _{OSI} /ΔT | | | Full | | 0.2 | | μV/°C |
| Output Offset Voltage | V _{OSO} | V _S = ±5V to ±15V | | +25°C | | 400 | 1200 | μV |
| | | | | Full | | | 1600 | |
| Output Offset Voltage Drift | ΔV _{OSO} /ΔT | | | Full | | 1.5 | | μV/°C |
| Offset Referred to the Input vs. Supply | PSRR | V _S = ±2.3V to ±18V | G = 1 | +25°C | 105 | 110 | | dB |
| | | | | Full | 102 | | | |
| | | | G = 10 | +25°C | 125 | 130 | | |
| | | | | Full | 122 | | | |
| | | | G = 100 | +25°C | 128 | 140 | | |
| | | | | Full | 125 | | | |
| | | | G = 1000 | +25°C | 128 | 140 | | |
| | | | | Full | 125 | | | |
| Input Current | | | | | | | | |
| Input Bias Current | I _B | | | +25°C | | 15 | 25 | nA |
| | | | | Full | | | 35 | |
| Average Temperature Coefficient of Input Bias Current | ΔI _B /ΔT | | | Full | | 0.15 | | nA/°C |
| Input Offset Current | I _{OS} | | | +25°C | | 5 | 20 | nA |
| | | | | Full | | | 25 | |
| Average Temperature Coefficient of Input Offset Current | ΔI _{OS} /ΔT | | | Full | | 0.05 | | nA/°C |

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

ELECTRICAL CHARACTERISTICS (continued)(V_S = ±15V, R_L = 2kΩ, Full = -40°C to +125°C, typical values are at T_A = +25°C, unless otherwise noted.)

| PARAMETER | | SYMBOL | CONDITIONS | | TEMP | MIN | TYP | MAX | UNITS | |
|---|--------------|-------------------|---|--|--------------|--------------------------|---------|--------------------------|-------------------|-------------------|
| Input | | | | | | | | | | |
| Input Impedance | Differential | Z _{DIFF} | | | +25°C | | 10 4 | | GΩ pF | |
| | Common Mode | Z _{CM} | | | +25°C | | 10 4 | | GΩ pF | |
| Input Voltage Range | | | V _S = ±2.3V to ±5V | | +25°C | (-V _S) + 1.9 | | (+V _S) - 1.2 | V | |
| | | | | | Full | (-V _S) + 2.1 | | (+V _S) - 1.3 | | |
| | | | V _S = ±5V to ±18V | | +25°C | (-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°C | 70 | 85 | | dB |
| | | | | | | Full | 67 | | | |
| | | | | | G = 10 | +25°C | 90 | 105 | | |
| | | | | | | Full | 87 | | | |
| | | | | | G = 100 | +25°C | 103 | 120 | | |
| | | | | | | Full | 100 | | | |
| | | | | | G = 1000 | +25°C | 103 | 120 | | |
| | | | | | | Full | 100 | | | |
| Reference Input | | | | | | | | | | |
| Reference Input Resistance | | R _{REF} | | | +25°C | | 18 | | kΩ | |
| Reference Input Current | | I _{REF} | V _{IN+} = V _{IN-} = 0V, V _{REF} = 0V | | +25°C | | 30 | 40 | μA | |
| | | | | | Full | | | 50 | | |
| Output Characteristics | | | | | | | | | | |
| Output Voltage Swing | | V _{OH} | R _L = 2kΩ, V _S = ±18V | | +25°C | | 310 | 400 | mV | |
| | | | | | Full | | | 600 | | |
| | | V _{OL} | R _L = 2kΩ, V _S = ±18V | | +25°C | | 150 | 220 | | |
| | | | | | Full | | | 300 | | |
| Short-Circuit Current | | I _{SC} | V _S = ±2.3V to ±18V, R _L = 50Ω to V _S /2 | | +25°C | 19 | 24 | | mA | |
| | | | | | Full | 14 | | | | |
| Power Supply | | | | | | | | | | |
| Quiescent Current | | I _Q | V _S = ±2.3V to ±18V, I _{OUT} = 0A | | +25°C | | 1.3 | 1.7 | mA | |
| | | | | | Full | | | 2.2 | | |
| Dynamic Response | | | | | | | | | | |
| Small-Signal -3dB Bandwidth | | BW | | | G = 1 | +25°C | | 3900 | | kHz |
| | | | | | G = 10 | +25°C | | 1000 | | |
| | | | | | G = 100 | +25°C | | 140 | | |
| | | | | | G = 1000 | +25°C | | 17 | | |
| Slew Rate | | SR | V _{OUT} = 1V _{P-P} Step | | G = 1 | +25°C | | 1.2 | | V/μs |
| Settling Time to 0.01% | | t _s | V _{OUT} = 10V _{P-P} Step | | G = 1 to 100 | +25°C | | 10 | | μs |
| | | | | | G = 1000 | +25°C | | 51 | | |
| Noise | | | | | | | | | | |
| Input Voltage Noise Density | | e _{ni} | f = 1kHz | | +25°C | | 6 | | nV/√Hz | |
| Output Voltage Noise Density | | e _{no} | f = 1kHz | | +25°C | | 80 | | nV/√Hz | |
| 0.1Hz to 10Hz Voltage Noise, RTI | | | f = 0.1Hz to 10Hz | | G = 1 | +25°C | | 6 | | μV _{P-P} |
| | | | | | G = 10 | +25°C | | 1 | | |
| | | | | | G = 100 | +25°C | | 0.4 | | |
| | | | | | G = 1000 | +25°C | | 0.4 | | |
| Input Current Noise Density, RTI | | i _n | f = 1kHz | | +25°C | | 300 | | fA/√Hz | |
| 0.1Hz to 10Hz Current Noise, RTI | | | f = 0.1Hz to 10Hz | | +25°C | | 15 | | pA _{P-P} | |

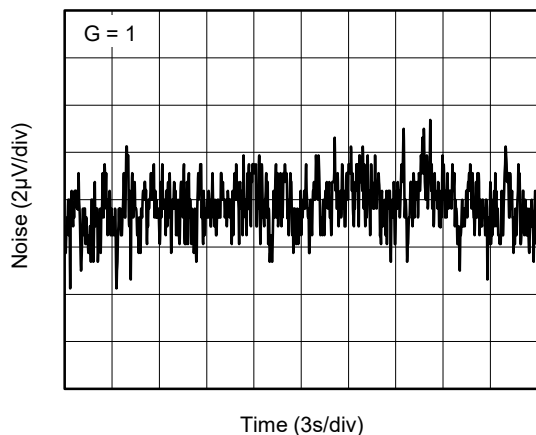
TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = \pm 15\text{V}$, unless otherwise noted.

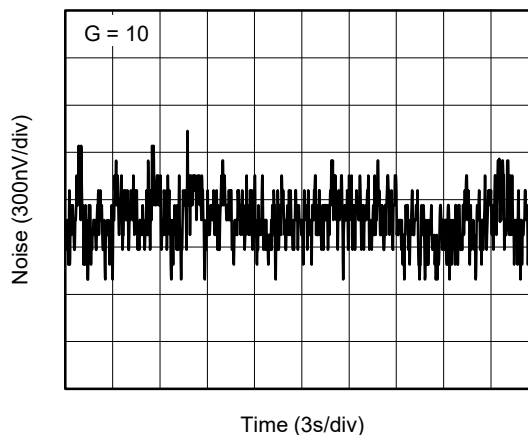
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = \pm 15\text{V}$, unless otherwise noted.

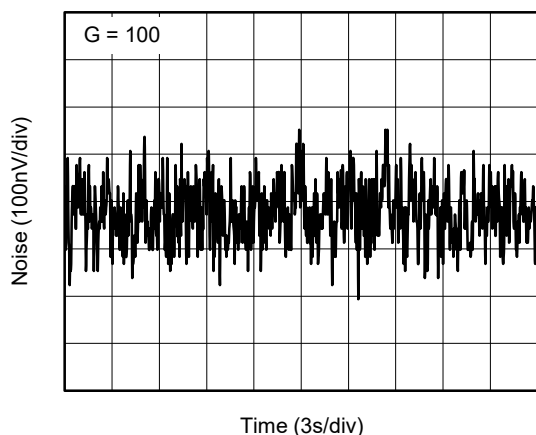
0.1Hz to 10Hz Input Voltage Noise



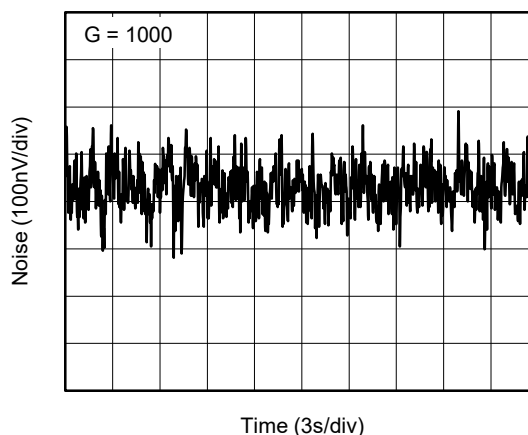
0.1Hz to 10Hz Input Voltage Noise



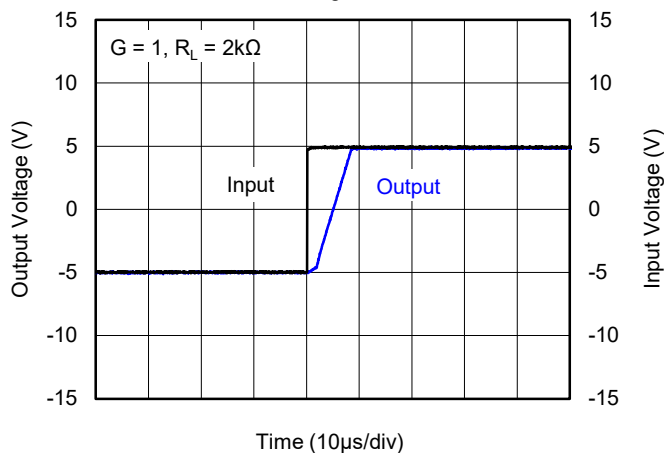
0.1Hz to 10Hz Input Voltage Noise



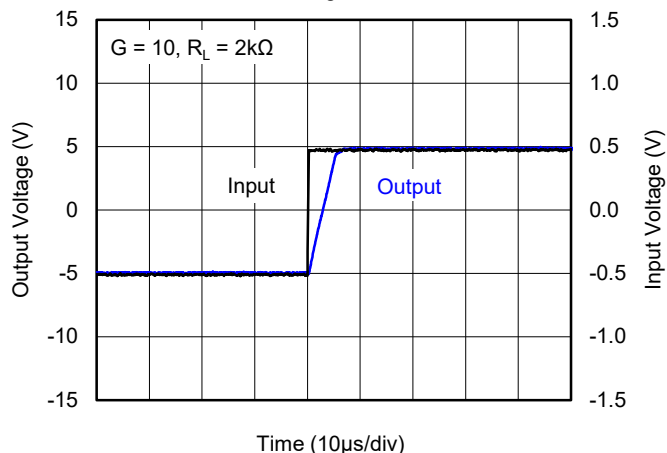
0.1Hz to 10Hz Input Voltage Noise



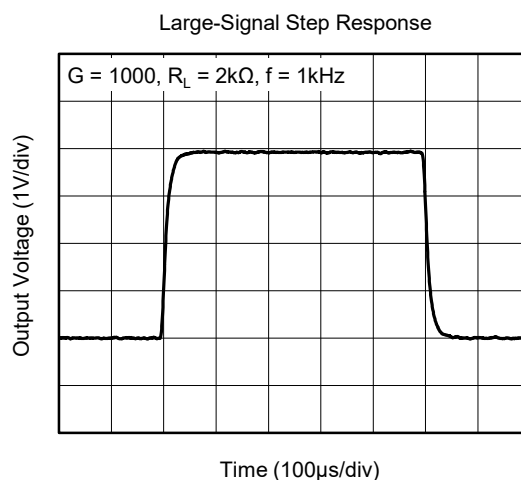
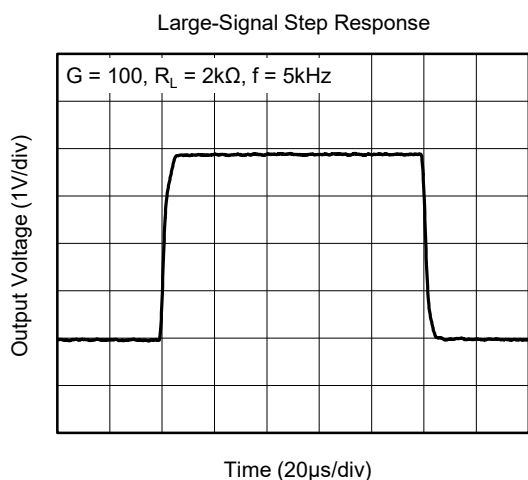
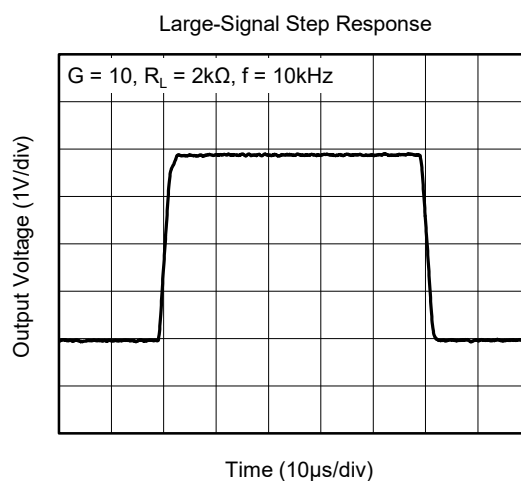
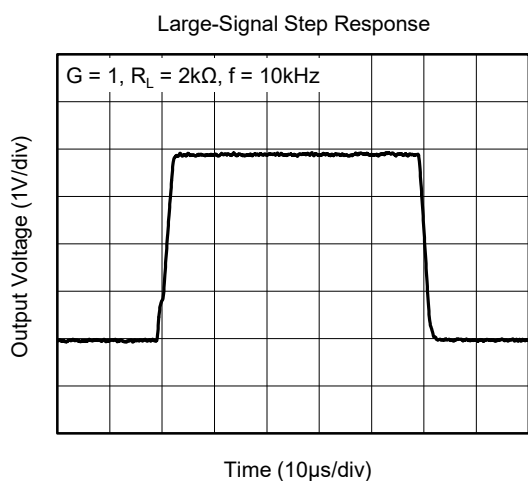
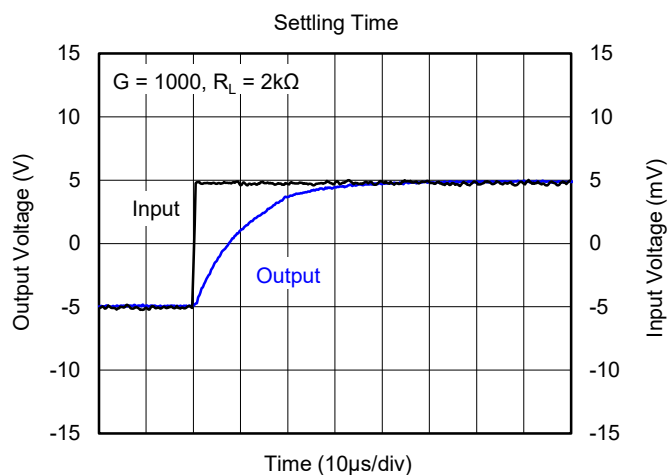
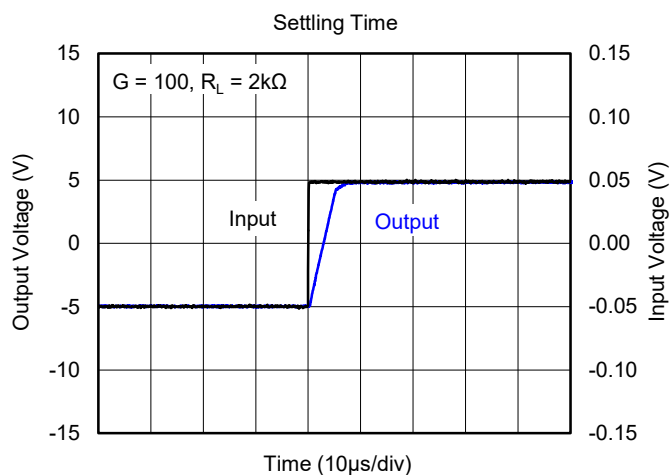
Settling Time



Settling Time



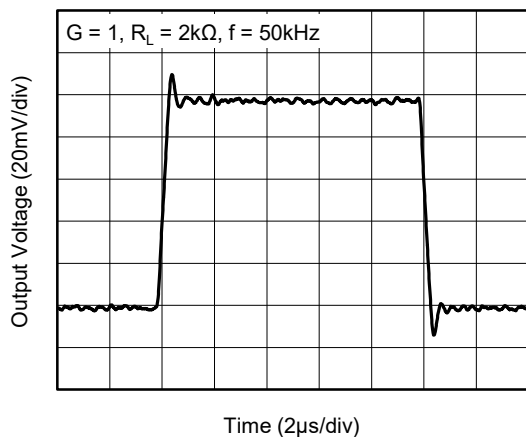
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = \pm 15\text{V}$, unless otherwise noted.

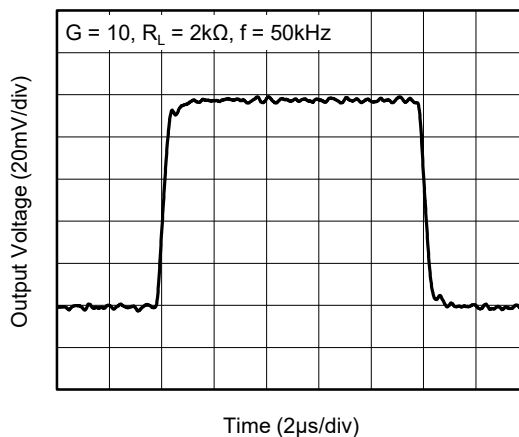
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = \pm 15\text{V}$, unless otherwise noted.

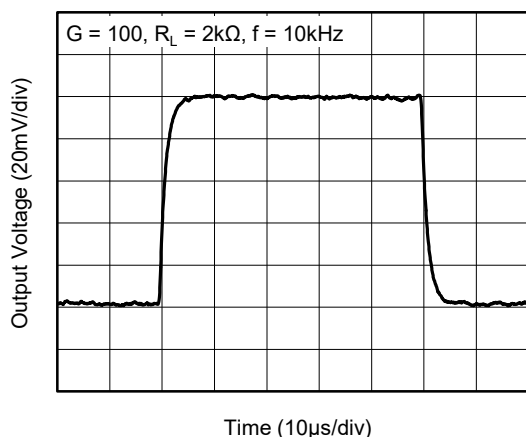
Small-Signal Step Response



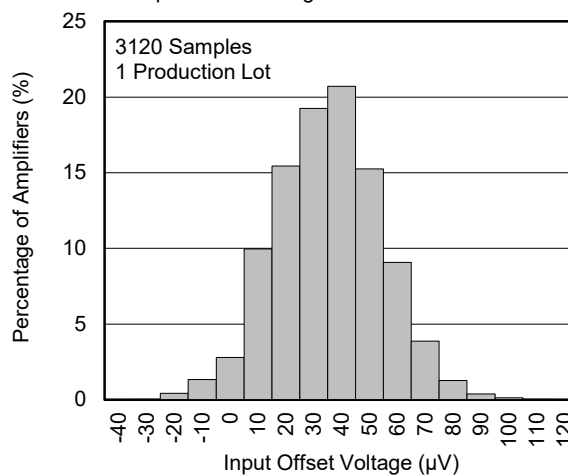
Small-Signal Step Response



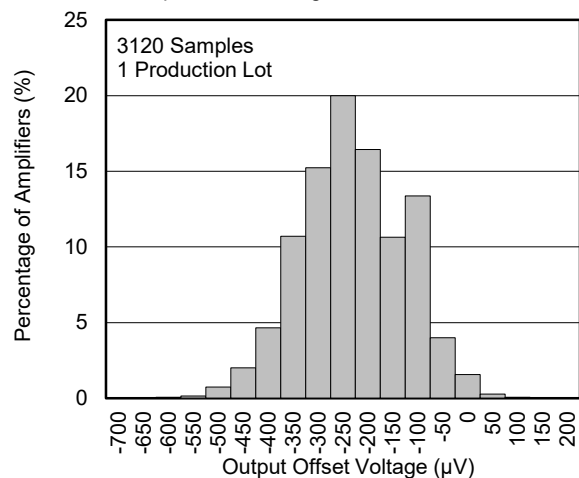
Small-Signal Step Response



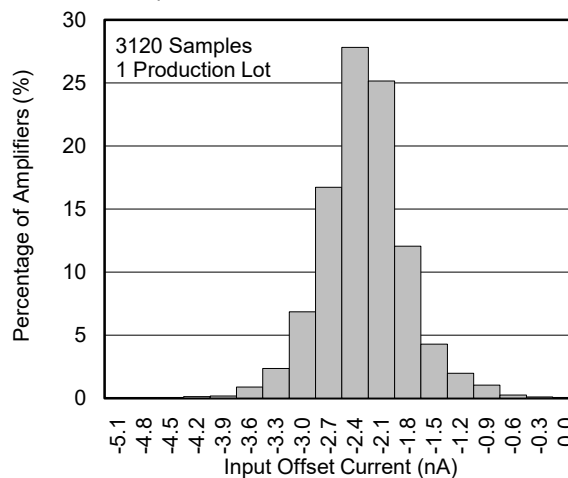
Input Offset Voltage Production Distribution



Output Offset Voltage Production Distribution

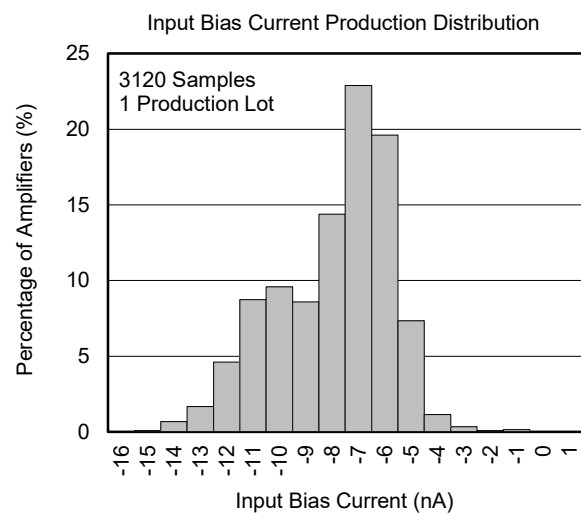


Input Offset Current Production Distribution



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = \pm 15\text{V}$, unless otherwise noted.



OPERATION THEORY

The SGM620 is modified with the classic three-op-amp and it is a holistic instrumentation amplifier.

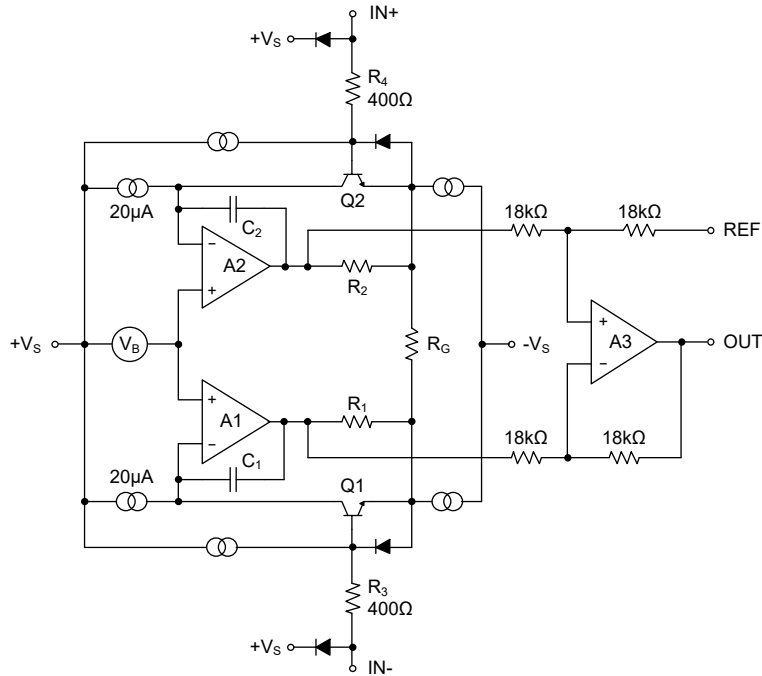


Figure 1. Simplified Schematic

The high precision input is provided by the two input transistor Q1 and Q2 (Figure 1) and this results in $10 \times$ 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 SGM620 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 $6\text{nV}/\sqrt{\text{Hz}}$, 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 SGM620 are set to $24.7\text{k}\Omega$, so that the gain can be programmed with the external resistor R_G .

The equation of gain is shown as below:

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

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

Pressure Measurement

Figure 2 shows the pressure transducer bridge of 5k Ω which is powered by a 5V single supply. In such a circuit, the bridge consumes only 1mA. The buffered voltage divider and SGM620 can condition the output signal with typical 3.3mA supply current.

The schematic diagram illustrates the internal circuitry of the SGM620 and SGM8581. The SGM620 is a precision current source, and the SGM8581 is a precision voltage source. The SGM620 is driven by a 5V supply and a 1mA current source. Its output is connected to the SGM8581, which is configured as a precision voltage source. The SGM8581 output is connected to the ADC (Analog-to-Digital Converter) of the STMS2 F407. The circuit includes an isolation barrier and a +3.3V supply.

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

Because of the advantage of low current noise, SGM620 can be used in ECG monitors (Figure 3) where the source resistances can reach 1M Ω or higher. It is the best choice to use SGM620 in the battery-powered data recorders as it can operate on the condition of low supply voltage, low power and space-saving package.

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.

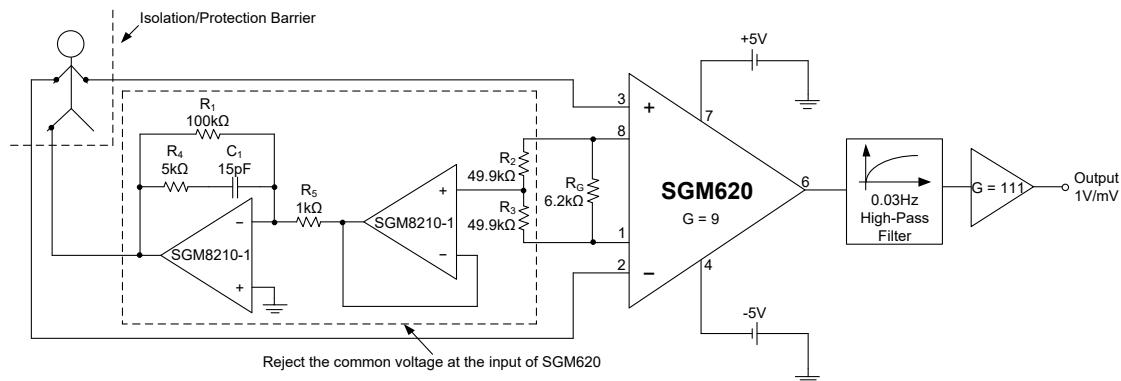


Figure 3. The Circuit of Medical ECG Monitor

APPLICATION INFORMATION (continued)

Precision V-I Converter

It's easy to realize a precision current source (Figure 4) utilizing one SGM620, another operational amplifier and two resistors. To obtain a better CMRR of SGM620, 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.

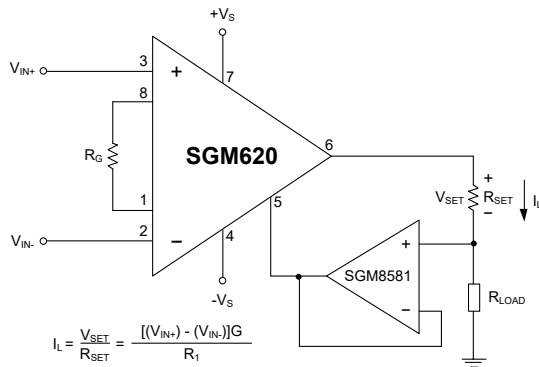


Figure 4. Precision Voltage-to-Current Converter

Input and Output Offset Voltage

Two main sources which are error of input and output result in the low errors of SGM620. 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

If the load does not support a precision GND, the REF pin is useful here since it can add a DC bias voltage directly at the output of the SGM620, and the permitted range of V_{REF} should be lower than 2V (or less than V_S if $V_S < 2V$). On top of these, to keep better CMRR, the parasitic resistor at this pin should be low.

Selection of Gain

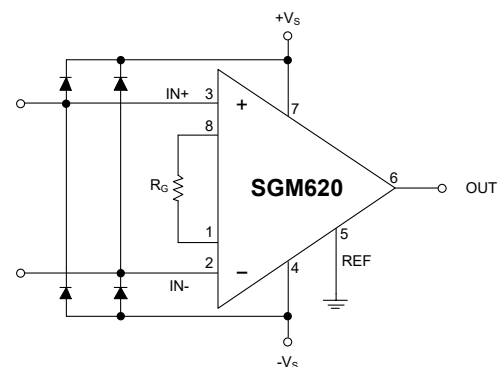
The gain of the instrumentation amplifier is determined by the external resistor R_G . The accuracy of the external resistor R_G is important as it may influence the error of gain. It is recommended that selecting the resistor with 0.1% or 1% precision is a good choice. The following table shows the 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 SGM620 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/°C is required for the selection of R_G to avoid the gain drift of SGM620.

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.

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

$$\text{FilterFreq}_{\text{CM}} = \frac{1}{2\pi RC_C}$$

$C_D \geq 10C_C$ 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 $R \times C_C$ 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.

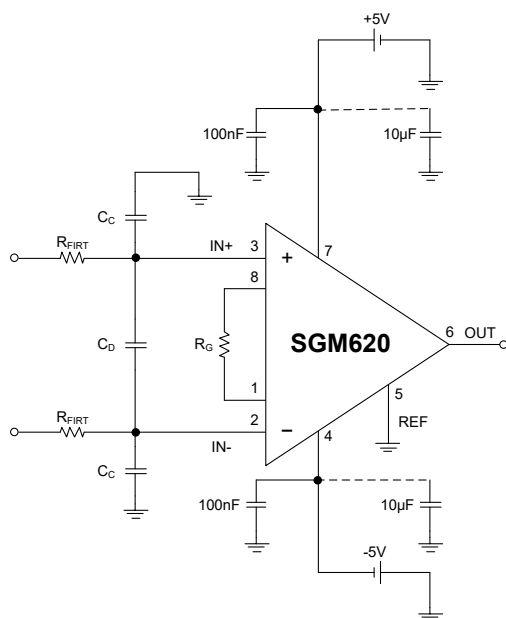


Figure 6. One Method to Reduce the Interference of RF

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.

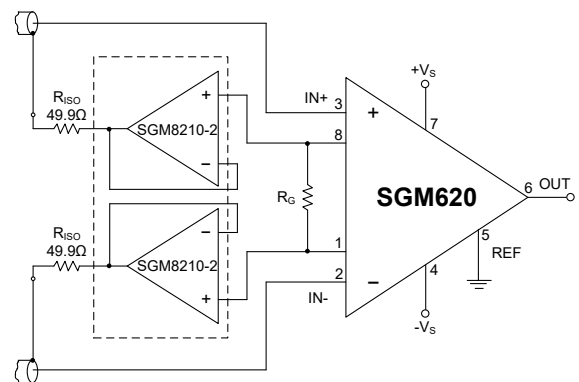


Figure 7. Differential Input Shield Driving

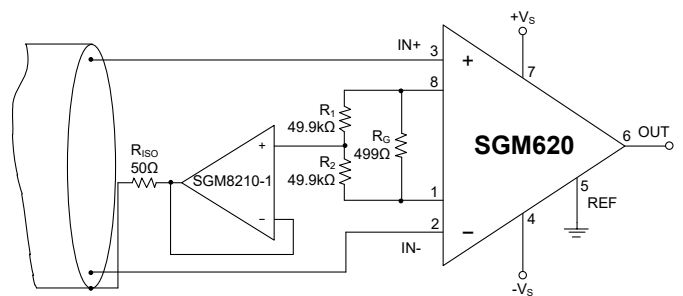


Figure 8. Common Mode Input Shield Driving

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.

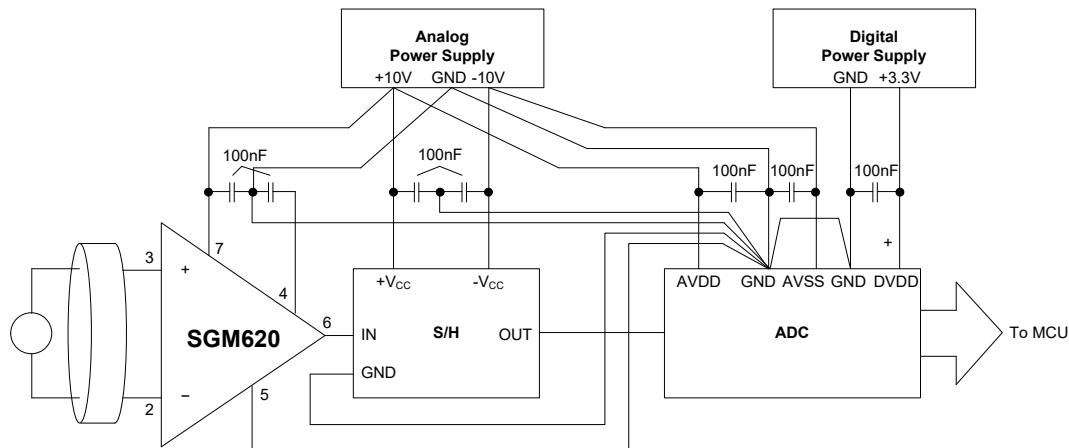
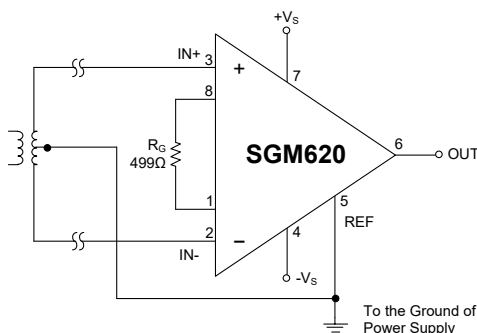
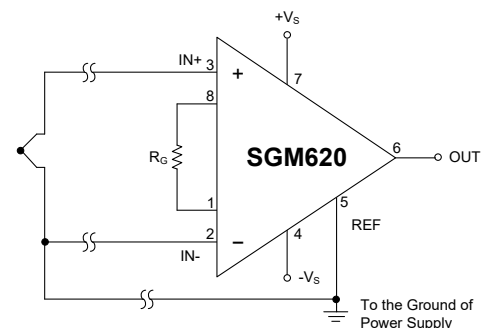
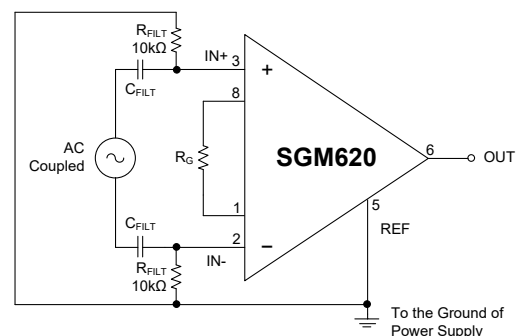


Figure 9. Isolation of Grounding

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 InputsFigure 11. Return of Grounding for I_B with Thermocouple InputsFigure 12. Return of Grounding for I_B with AC-Coupled Input

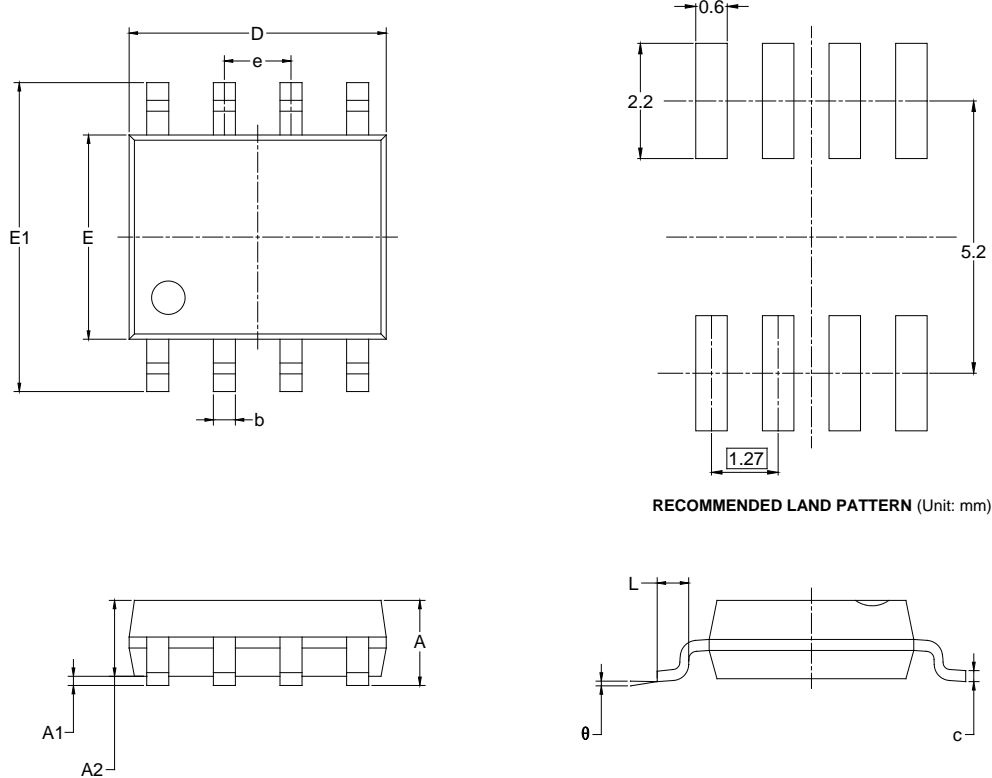
REVISION HISTORY

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

| MARCH 2022 – REV.A to REV.A.1 | | Page |
|--|--|------|
| Updated Electrical Characteristics section | | 5 |
| Changes from Original (MARCH 2022) to REV.A | | Page |
| Changed from product preview to production data..... | | All |

PACKAGE OUTLINE DIMENSIONS

SOIC-8



| 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° |

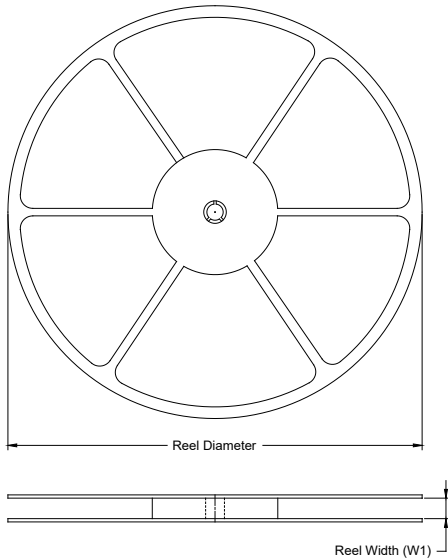
NOTES:

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

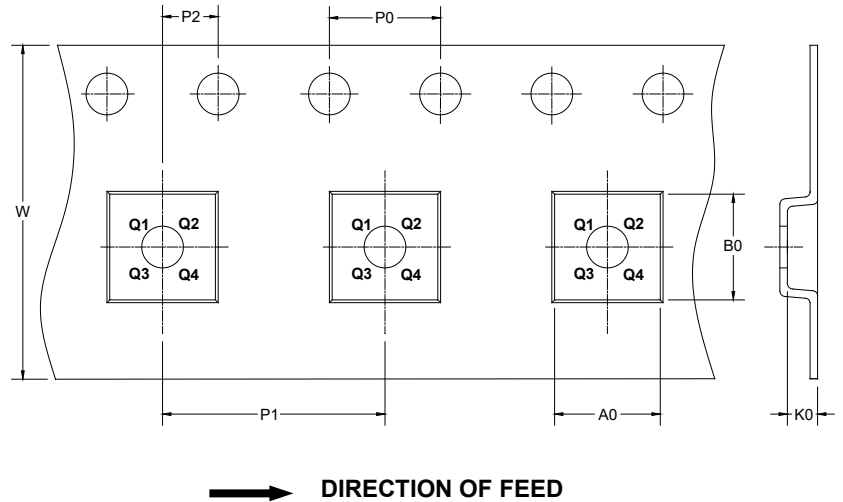
PACKAGE INFORMATION

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 |

DD00001

PACKAGE INFORMATION

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