

### GENERAL DESCRIPTION

The SGM8199 series is a voltage output, bidirectional current shunt monitor, which is designed to sense voltage drops across the shunt at common mode voltage range without being affected by the supply voltage. The device features a wide common mode voltage range from -0.1V to 26V. It also offers a low offset, which allows 10mV full-scale maximum drops across the shunt when sensing current.

The SGM8199 series provides three fixed gains: 20V/V, 50V/V and 100V/V. It operates from 2.7V to 26V single supply, consuming only 85µA quiescent current.

The SGM8199 series is available in a Green SC70-6 package. It is specified over the extended -40°C to +125°C temperature range.

### APPLICATIONS

- Laptops
- Mobile Phones
- Telecom Equipment
- Power Managements
- Charging Systems
- Welding Equipment

### FEATURES

- **Wide Input Common Mode Range: -0.1V to 26V**
- **Low Input Offset Voltage:**  
**SGM8199A0: 600µV ( $V_{CM} = 12V, MAX$ )**  
**SGM8199A1: 350µV ( $V_{CM} = 12V, MAX$ )**  
**SGM8199A2: 250µV ( $V_{CM} = 12V, MAX$ )**  
**(Enable 10mV Full-Scale Shunt Drops)**
- **Gain Options:**  
**SGM8199A0 Gain: 20V/V**  
**SGM8199A1 Gain: 50V/V**  
**SGM8199A2 Gain: 100V/V**
- **Gain Error:**  
**SGM8199A0: ±0.7% (MAX)**  
**SGM8199A1: ±0.4% (MAX)**  
**SGM8199A2: ±0.4% (MAX)**
- **Low Quiescent Current: 85µA (TYP)**
- **-40°C to +125°C Operating Temperature Range**
- **Available in a Green SC70-6 Package**

### TYPICAL APPLICATION

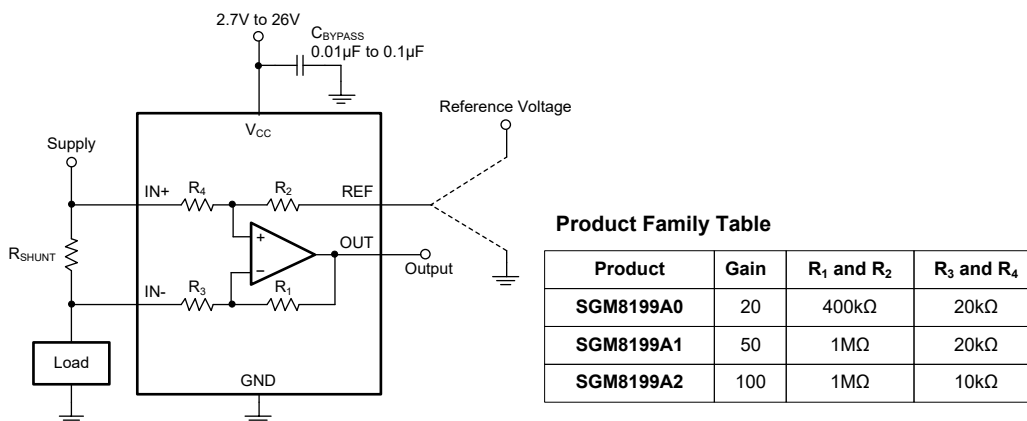


Figure 1. Recommended Application Circuit

# Voltage Output, High-side or Low-side Measurement, Bidirectional Current Shunt Monitor

## SGM8199

### PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	GAIN	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8199A0	SC70-6	20V/V	-40°C to +125°C	SGM8199A0XC6G/TR	M91XX	Tape and Reel, 3000
SGM8199A1	SC70-6	50V/V	-40°C to +125°C	SGM8199A1XC6G/TR	GS2XX	Tape and Reel, 3000
SGM8199A2	SC70-6	100V/V	-40°C to +125°C	SGM8199A2XC6G/TR	M93XX	Tape and Reel, 3000

### MARKING INFORMATION

NOTE: XX = Date Code.

**YYY X X**

\_\_\_\_\_ Date Code - Month  
 \_\_\_\_\_ Date Code - Year  
 \_\_\_\_\_ Serial Number

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.....	28V
V <sub>IN</sub> Differential.....	±28V
Input Common Mode Voltage Range.....	GND - 0.3V to 28V
Input Current into All Pins.....	5mA
Junction Temperature.....	+150°C
Storage Temperature Range.....	-65°C to +150°C
Lead Temperature (Soldering, 10s).....	+260°C
ESD Susceptibility	
HBM.....	3000V
MM.....	200V
CDM.....	2000V

### 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

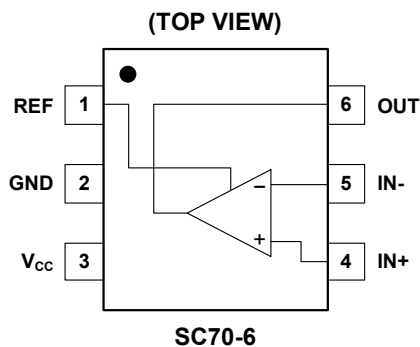
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all

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



# Voltage Output, High-side or Low-side Measurement, Bidirectional Current Shunt Monitor

## SGM8199

### ELECTRICAL CHARACTERISTICS

(At  $T_A = +25^\circ\text{C}$ , Full =  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ ,  $V_{CC} = 2.7\text{V}$  to  $26\text{V}$ ,  $V_{IN+} = 12\text{V}$ ,  $V_{SENSE} = V_{IN+} - V_{IN-}$ , and  $V_{REF} = V_{CC}/2$ , unless otherwise noted.)

PARAMETER	CONDITIONS		TEMP	MIN	TYP	MAX	UNITS
<b>Input Characteristics</b>							
Input Offset Voltage, RTI <sup>(1)</sup> ( $V_{OS}$ )	$V_{CM} = -0.1\text{V}$ to $2\text{V}$ , $V_{SENSE} = 0\text{mV}$	SGM8199A0	$+25^\circ\text{C}$		270	1420	$\mu\text{V}$
	$V_{CM} = 2\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$				260	600	
	$V_{CM} = -0.1\text{V}$ to $2\text{V}$ , $V_{SENSE} = 0\text{mV}$	SGM8199A1			150	720	
	$V_{CM} = 2\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$				150	350	
	$V_{CM} = -0.1\text{V}$ to $2\text{V}$ , $V_{SENSE} = 0\text{mV}$	SGM8199A2			80	750	
	$V_{CM} = 2\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$				80	250	
Input Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ )			Full		1		$\mu\text{V}/^\circ\text{C}$
Input Bias Current ( $I_b$ )	$V_{SENSE} = 0\text{mV}$	SGM8199A0	$+25^\circ\text{C}$		30		$\mu\text{A}$
		SGM8199A1/ SGM8199A2			16		
Input Offset Current ( $I_{OS}$ )	$V_{SENSE} = 0\text{mV}$	SGM8199A0	$+25^\circ\text{C}$		35		$\text{nA}$
		SGM8199A1/ SGM8199A2			25		
Input Common Mode Voltage Range ( $V_{CM}$ )			Full	-0.1		26	V
Common Mode Rejection Ratio (CMRR)	$V_{CM} = -0.1\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$	SGM8199A0	Full		85	97	dB
	$V_{CM} = 2\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$				81	93	
	$V_{CM} = -0.1\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$	SGM8199A1			85	104	
	$V_{CM} = 2\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$				87	100	
	$V_{CM} = -0.1\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$	SGM8199A2			90	108	
	$V_{CM} = 2\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$				91	106	
<b>Output Characteristics</b>							
Gain (G)			$+25^\circ\text{C}$		20		V/V
					50		
					100		
Gain Error	$V_{SENSE} = -5\text{mV}$ to $5\text{mV}$	SGM8199A0	Full		0.20	0.7	%
		SGM8199A1			0.02	0.4	
		SGM8199A2			0.05	0.4	
Gain Temperature Coefficient			Full		10		$\text{ppm}/^\circ\text{C}$
Nonlinearity Error	$V_{SENSE} = -5\text{mV}$ to $5\text{mV}$		$+25^\circ\text{C}$		0.01		%
Maximum Capacitive Load	No sustained oscillation		$+25^\circ\text{C}$		1		nF
Output Voltage Swing from Rail	$V_{OH}$	$V_{CC} = 26\text{V}$ , $R_L = 10\text{k}\Omega$ to $V_{CC}/2$	Full		140	380	mV
	$V_{OL}$				85	300	

NOTE: 1. RTI = Referred-to-input.

# Voltage Output, High-side or Low-side Measurement, SGM8199 Bidirectional Current Shunt Monitor

## ELECTRICAL CHARACTERISTICS (continued)

(At  $T_A = +25^\circ\text{C}$ , Full =  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ ,  $V_{CC} = 2.7\text{V}$  to  $26\text{V}$ ,  $V_{IN+} = 12\text{V}$ ,  $V_{SENSE} = V_{IN+} - V_{IN-}$ , and  $V_{REF} = V_{CC}/2$ , unless otherwise noted.)

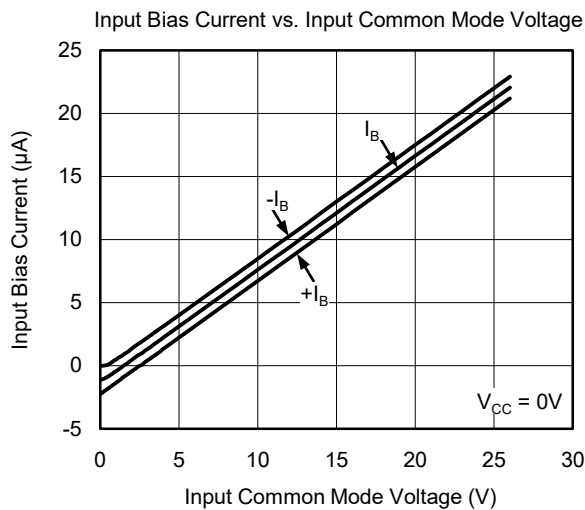
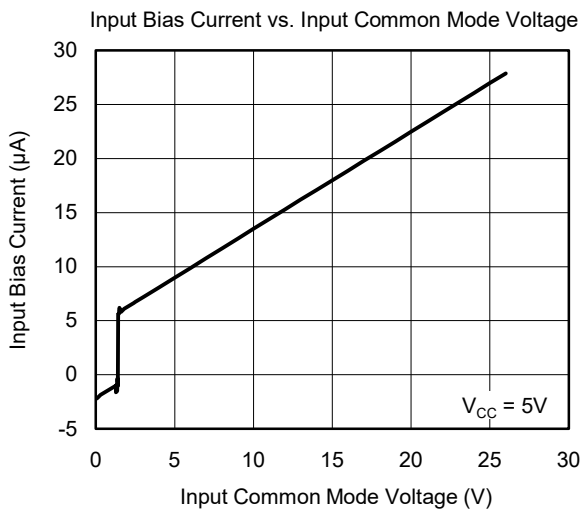
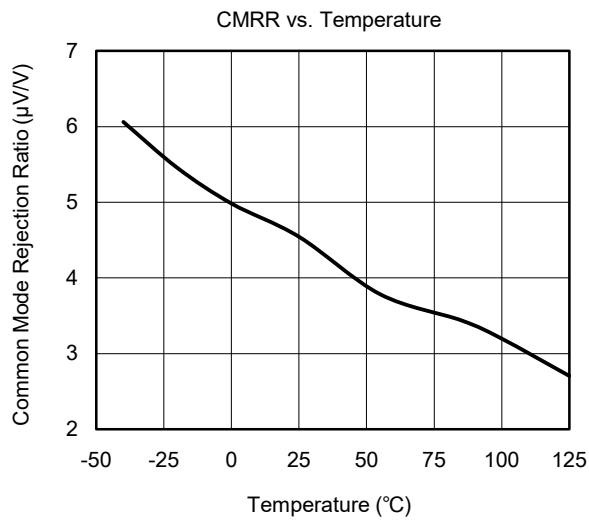
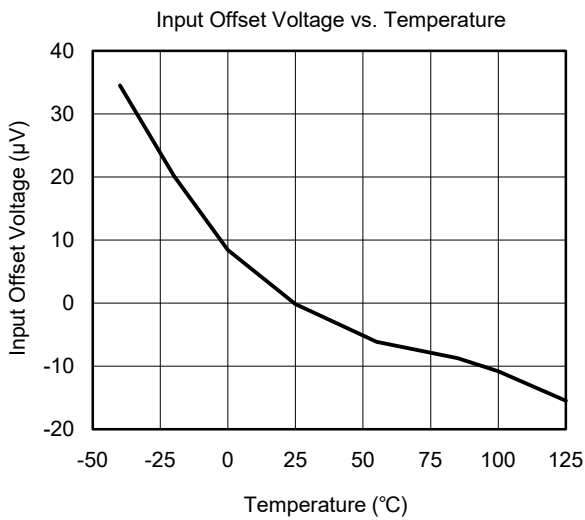
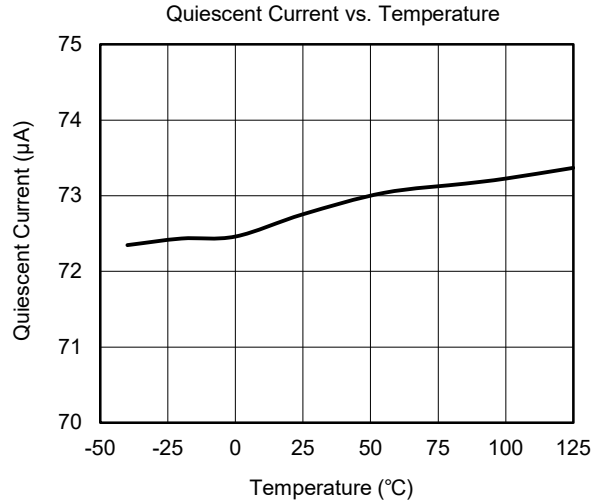
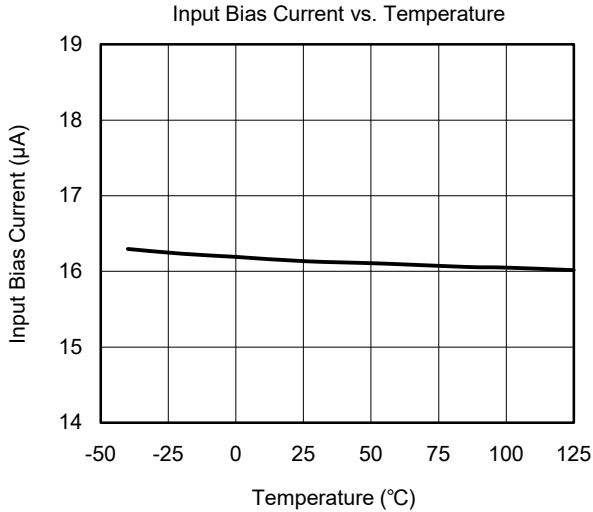
PARAMETER	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
<b>Dynamic Performance</b>						
-3dB Bandwidth	$V_{CC} = 5\text{V}$ , $R_L = 10\text{k}\Omega$ , $C_L = 10\text{pF}$	SGM8199A0	+25°C	74		kHz
		SGM8199A1		80		
		SGM8199A2		68		
Slew Rate (SR)	$f = 1\text{kHz}$ , $R_L = 10\text{k}\Omega$ , $V_{OUT} = 1V_{P-P}$	SGM8199A0	+25°C	0.42		V/ $\mu\text{s}$
	$f = 1\text{kHz}$ , $R_L = 10\text{k}\Omega$ , $V_{OUT} = 2V_{P-P}$	SGM8199A0		0.42		
	$f = 1\text{kHz}$ , $R_L = 10\text{k}\Omega$ , $V_{OUT} = 1V_{P-P}$	SGM8199A1		0.15		
	$f = 1\text{kHz}$ , $R_L = 10\text{k}\Omega$ , $V_{OUT} = 2V_{P-P}$	SGM8199A1		0.35		
	$f = 1\text{kHz}$ , $R_L = 10\text{k}\Omega$ , $V_{OUT} = 1V_{P-P}$	SGM8199A2		0.12		
	$f = 1\text{kHz}$ , $R_L = 10\text{k}\Omega$ , $V_{OUT} = 2V_{P-P}$	SGM8199A2		0.3		
<b>Noise, RTI <sup>(1)</sup></b>						
Voltage Noise Density ( $e_n$ )	$f = 1\text{kHz}$	SGM8199A0	+25°C	48		nV/ $\sqrt{\text{Hz}}$
		SGM8199A1		50		
		SGM8199A2		35		
<b>Power Supply</b>						
Operating Voltage Range ( $V_{CC}$ )		Full	2.7		26	V
Quiescent Current ( $I_Q$ )	$V_{CC} = 26\text{V}$ , $V_{SENSE} = 0\text{mV}$	+25°C		85	120	$\mu\text{A}$
		Full			130	
Power Supply Rejection Ratio (PSRR)	$V_{CC} = 2.7\text{V}$ to $26\text{V}$ , $V_{SENSE} = 0\text{mV}$	SGM8199A0	+25°C	100		dB
		SGM8199A1/		105		
		SGM8199A2				

NOTE: 1. RTI = Referred-to-input.

# SGM8199 Voltage Output, High-side or Low-side Measurement, Bidirectional Current Shunt Monitor

## TYPICAL PERFORMANCE CHARACTERISTICS

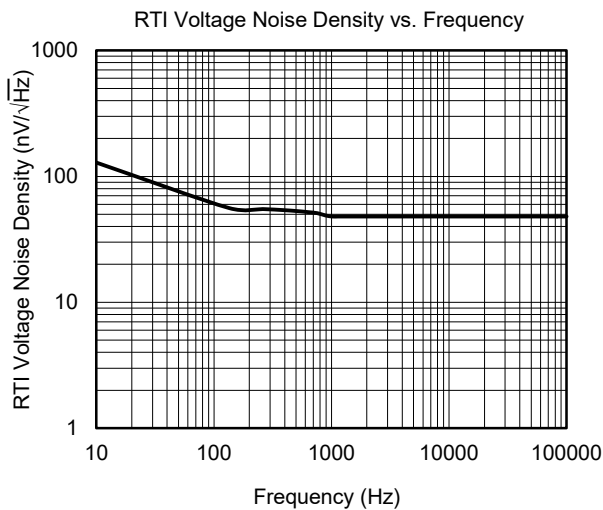
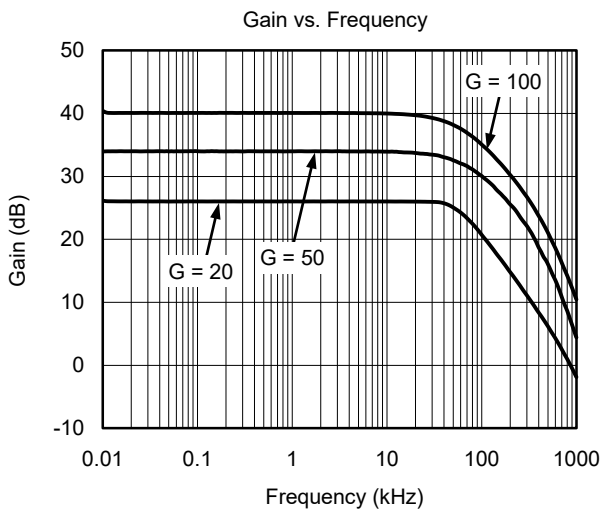
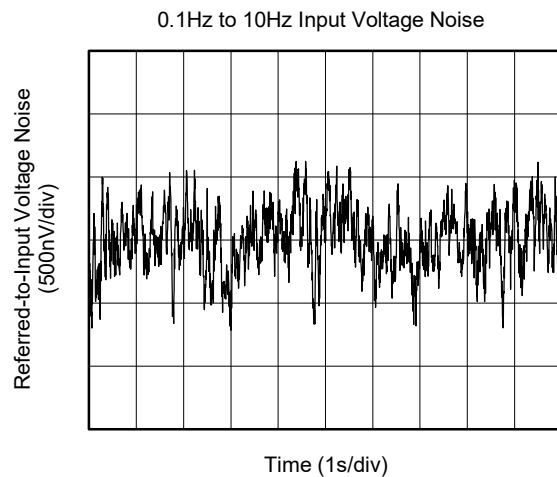
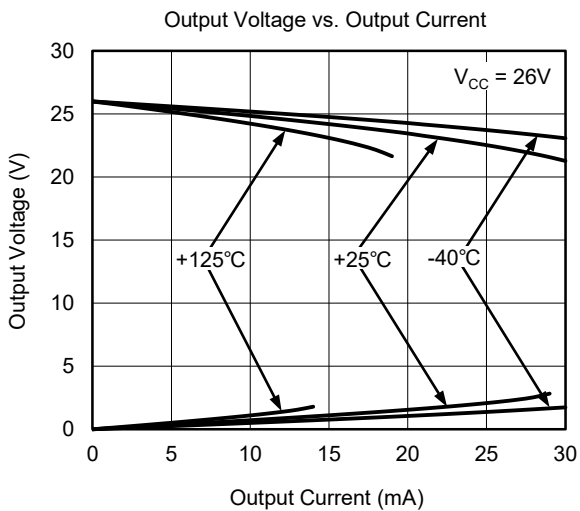
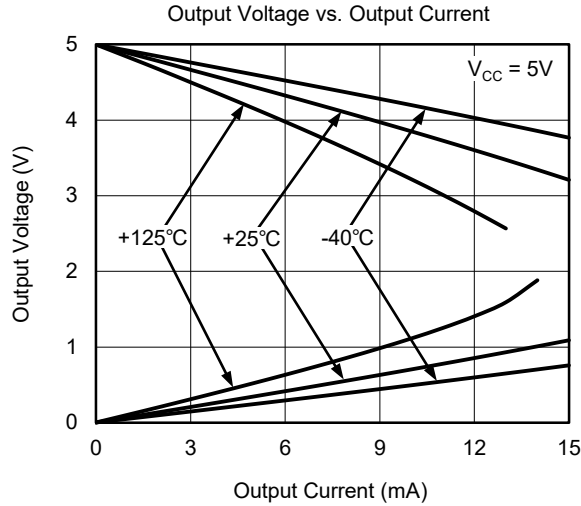
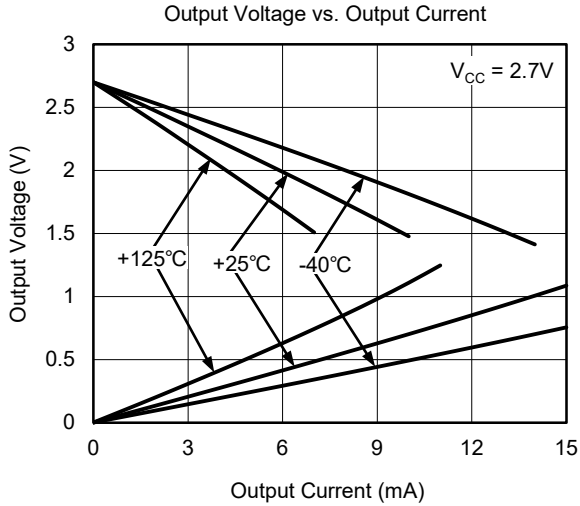
The following figures show the performance of SGM8199A1 at  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $\text{GND} = 0\text{V}$ ,  $V_{IN+} = 12\text{V}$ ,  $V_{SENSE} = V_{IN+} - V_{IN-}$  and  $V_{REF} = V_{CC}/2$ , unless otherwise noted.



# SGM8199 Voltage Output, High-side or Low-side Measurement, Bidirectional Current Shunt Monitor

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

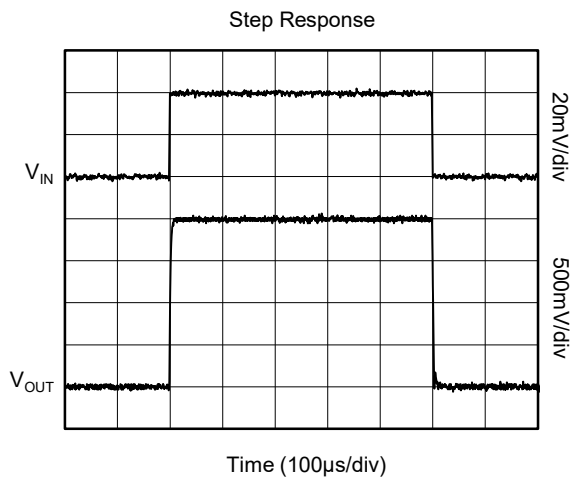
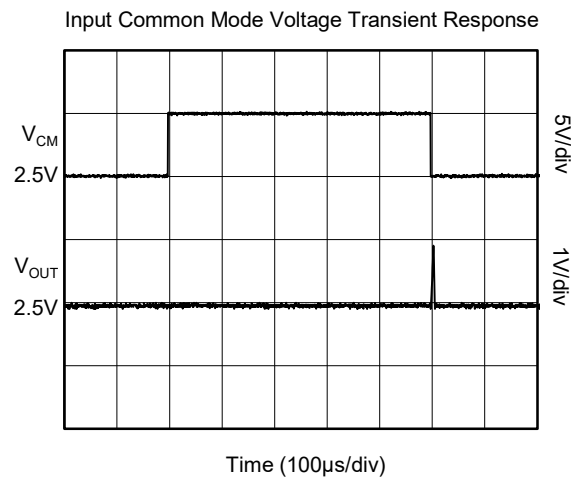
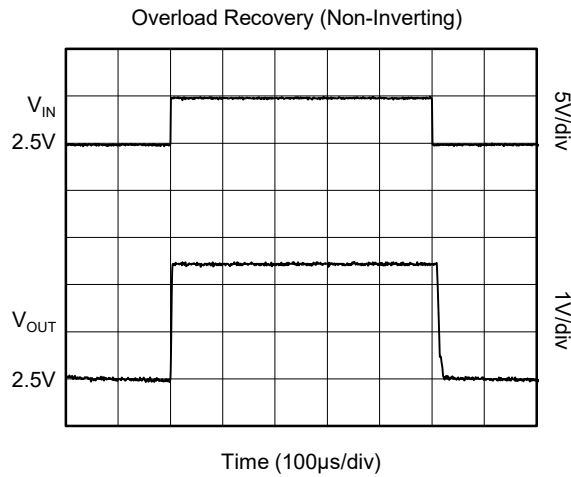
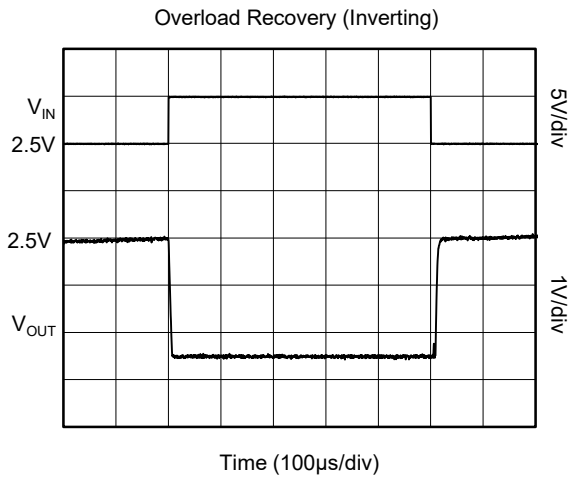
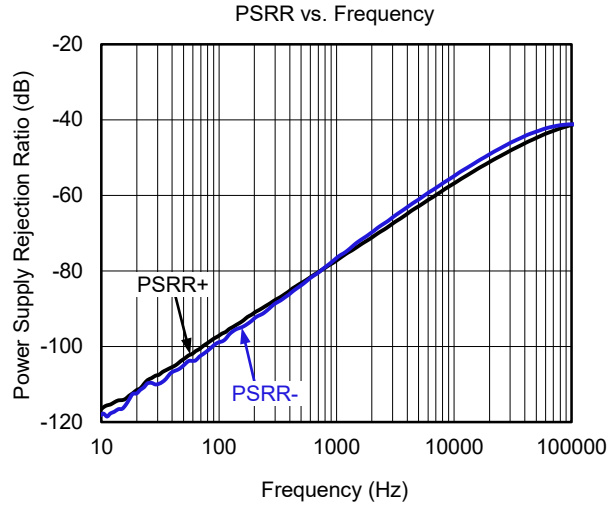
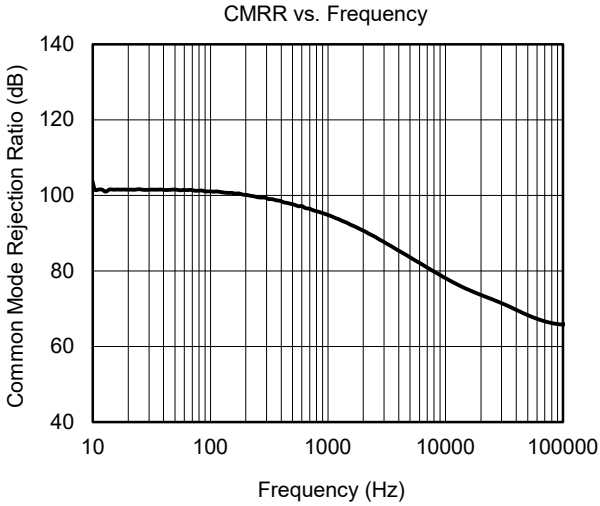
The following figures show the performance of SGM8199A1 at  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $\text{GND} = 0\text{V}$ ,  $V_{IN+} = 12\text{V}$ ,  $V_{SENSE} = V_{IN+} - V_{IN-}$  and  $V_{REF} = V_{CC}/2$ , unless otherwise noted.



# SGM8199 Voltage Output, High-side or Low-side Measurement, Bidirectional Current Shunt Monitor

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

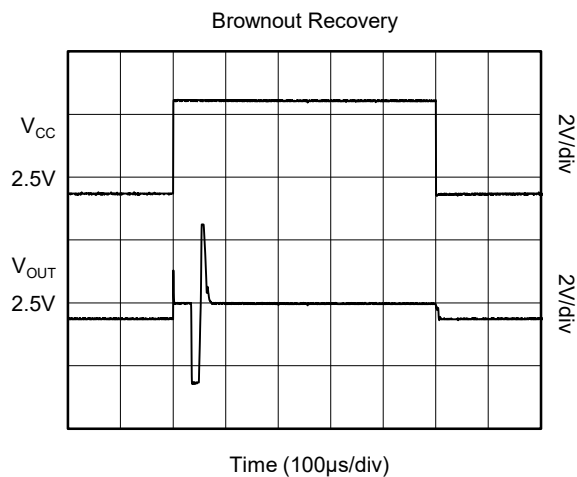
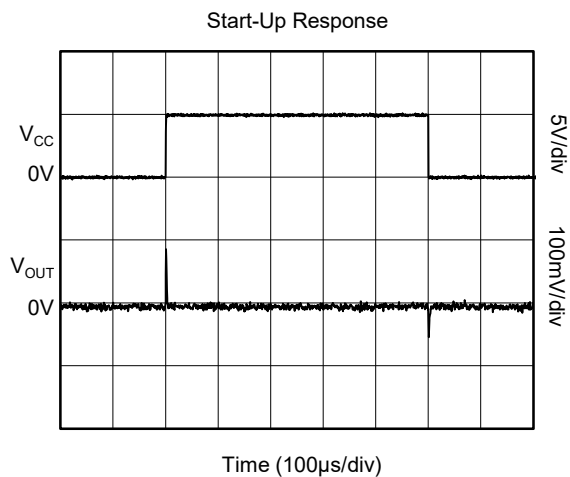
The following figures show the performance of SGM8199A1 at  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $\text{GND} = 0\text{V}$ ,  $V_{IN+} = 12\text{V}$ ,  $V_{SENSE} = V_{IN+} - V_{IN-}$  and  $V_{REF} = V_{CC}/2$ , unless otherwise noted.



# SGM8199 Voltage Output, High-side or Low-side Measurement, Bidirectional Current Shunt Monitor

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

The following figures show the performance of SGM8199A1 at  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $\text{GND} = 0\text{V}$ ,  $V_{IN+} = 12\text{V}$ ,  $V_{SENSE} = V_{IN+} - V_{IN-}$ , and  $V_{REF} = V_{CC}/2$ , unless otherwise noted.





## APPLICATION INFORMATION

### Recommended Connection

The recommended connection of SGM8199 is shown in Figure 1. Also, it is recommended that the shunt resistor should be placed as close as possible to the two input pins of the current shunt monitor, so the extra resistance which is series with the measured shunt resistor will be reduced.

The bypass capacitor is necessary for the current shunt monitor to improve its stability. In most applications, the power supply is noisy and it will affect the operation of SGM8199, so the bypass capacitor is needed in this case.

### Power Supply

The SGM8199 can accurately measure the current when the common mode voltage exceeds the power supply voltage presented at the  $V_{CC}$  pin. For example, the  $V_{CC}$  power supply can be 5V and the load or common mode power supply voltage is allowed to reach up to 26V. The output voltage range is limited by the level of the power supply.

### Selection of $R_{SHUNT}$

For the typical range of the differential input, the current shunt monitor of SGM8199 can work accurately with the order of 10mV. The application of SGM8199 series will determine the selection of the shunt resistor  $R_{SHUNT}$ . Also, the users should consider the trade-off between voltage loss and the accuracy of small input signals. The effect of offset can be minimized by using high values of  $R_{SHUNT}$ , while the voltage loss can be minimized by using low values of  $R_{SHUNT}$ . For most applications, a voltage drop of 60mV over  $R_{SHUNT}$  is the appropriate range for the selection of  $R_{SHUNT}$ , and the corresponding offset voltage is 350 $\mu$ V only.

### Unidirectional Application

In unidirectional operation, the current measuring direction of SGM8199 is fixed. Usually, the REF pin is connected directly to GND pin to ensure that the output is biased at 0V. Also, if the users desire to measure low input voltage with high accuracy, biasing REF pin to 300mV is a good method to set the current shunt monitor to its linear region.

For the least frequent case, REF pin can connect to the power supply pin directly to measure the negative current. In this case, the output voltage is equal to the

voltage of power supply when input voltage is equal to 0mV.

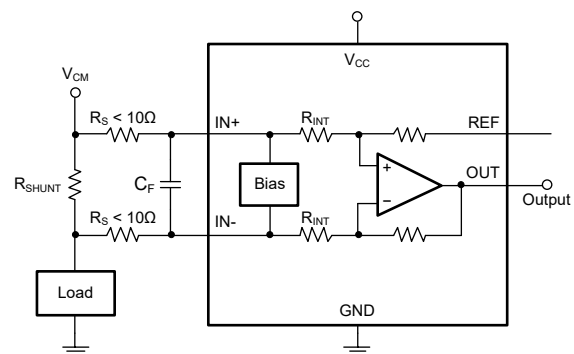
### Bidirectional Application

Bidirectional application indicates that the current shunt monitor of SGM8199 can measure the current for two different directions. For this special case, the REF pin can be set anywhere between 0V to  $V_{CC}$  for the bias of output voltage. For simplification, it is recommended that  $V_{REF} = V_{CC}/2$  is a typical voltage point. However, if the absolute values of positive and negative current are not equal, the voltage of REF pin should be set other than  $V_{CC}/2$ .

### Input Filtering

It is not recommended to add a filter at the output of SGM8199, as doing so increases impedance seen at the output of the internal buffer. Filtering at the input pins will be a good choice as long as the change of the input impedance is taken in account. Figure 2 indicates the application of input filtering.

For minimizing the error and enhancing the accuracy of the result, the resistance of the external resistor  $R_S$  should be less than 10 $\Omega$ . At the internal input structure of SGM8199, there is a bias network which causes mismatch in the bias current  $I_B$  of two input pins, and the external resistors result in the mismatch of voltage drops (because of the mismatch of  $I_B$ ) across  $R_S$  so that the differential error will be created. Also, this differential error will be reflected to the input pins of the current shunt monitor and result in the accuracy. However, the bias current difference can result in little effect on the operation of the current shunt monitor so the users do not need to care about that.



**Figure 2. Filtering at Input**

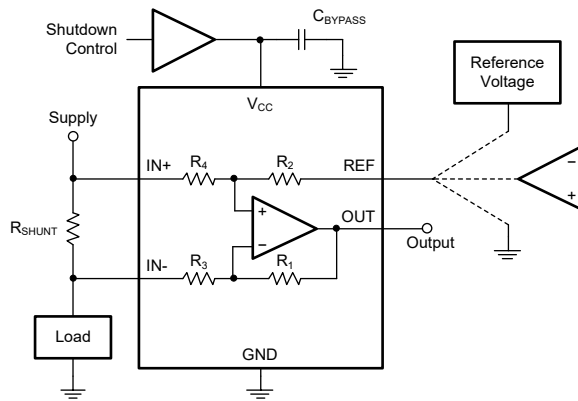
# SGM8199 Voltage Output, High-side or Low-side Measurement, Bidirectional Current Shunt Monitor

## APPLICATION INFORMATION (continued)

### Shutting Down SGM8199

There is no shutdown control at the internal of SGM8199, so the only way to shut down the quiescent current from the power supply is by using an external logic gate or transistor switch.

However, the users may concern about the amount of current through SGM8199 in shutdown mode. The schematic in Figure 3 can be used to evaluate the amount of current drain in shutdown mode.



Product Family Table

Product	Gain	R <sub>1</sub> and R <sub>2</sub>	R <sub>3</sub> and R <sub>4</sub>
SGM8199A0	20	400kΩ	20kΩ
SGM8199A1	50	1MΩ	20kΩ
SGM8199A2	100	1MΩ	10kΩ

NOTE: 400kΩ or 1MΩ path from shunt inputs to reference and SGM8199 output.

Figure 3. Shutting Down the Current Shunt Monitor with  $V_{REF} = 0$

### Input Impedance of REF Input

The common mode rejection ratio (CMRR) can be influenced by the input impedance of REF Pin, but the users do not need to concern about it if REF pin is driven by a power supply. However, if the REF pin is driven by resistive dividers, it should be buffered by an operational amplifier to provide low input impedance.

If the output can be measured differentially, for example, a differential analog-to-digital converter, the users do not need to care about the external impedance which is added at the REF pin and the effect can be removed. Figure 4 indicates an example about how to remove the effect of extra impedance at REF pin.

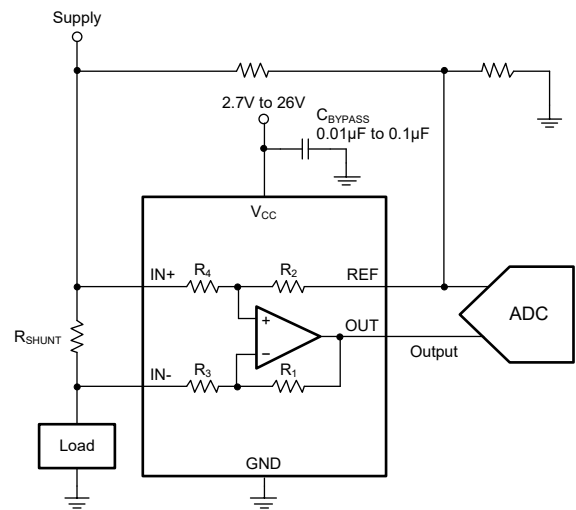


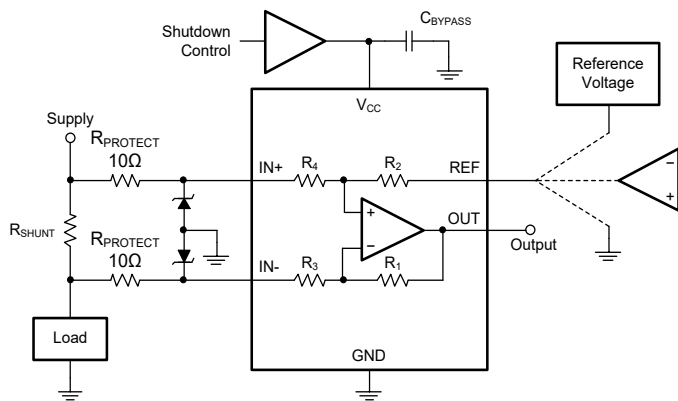
Figure 4. Cancelling the Input Impedance at REF Input

**APPLICATION INFORMATION (continued)**

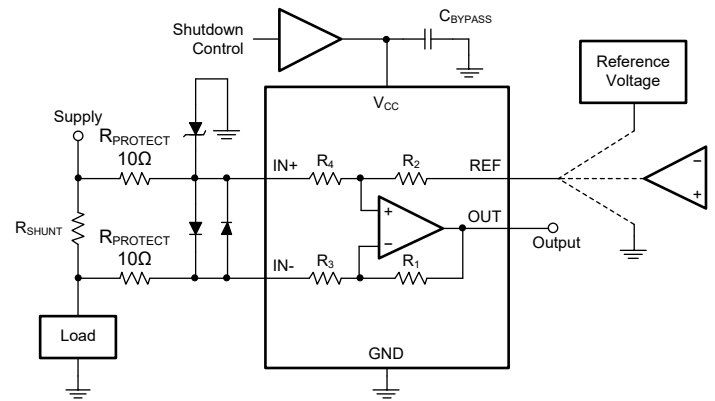
**The Performance of SGM8199 when Common Mode Transients above 26V**

The SGM8199 can be powered by the power supply whose power-on transient is higher than 26V, especially for the application of automotive industry. At this case, a Zener diode or Zener-type transient absorber (Transzorbs) can be used to prevent the current shunt monitor from over-voltage during the transient of power-on. It does not recommend the users to use the transient absorber other than Transzorbs because of the significant time delay. However, any Zener diode needs extra operational resistors to provide the operating current, so the 10Ω resistors are selected (any large external resistor will affect the gain). Also, 10Ω resistors and a Zener diode with lowest rating of power are enough for handling the short-term transient in most applications.

If the low power Zener diode cannot protect the current shunt monitor from supply transient, a Transzorb with high power must be taken into account in this case. In Figure 6, for saving the space of PCB board, a Transzorb and back-to-back diode can also be used to absorb the transient. For the applications of Figure 5 and Figure 6, the total area which is occupied by SGM8199 itself and its protective components is equivalent to the MSOP-8 package, and smaller than SOIC-8 package.



**Figure 5. Using Dual Diodes for Absorbing Supply Transient**



**Figure 6. Using Transzorb and Input Clamps for Absorbing Supply Transient**

# SGM8199 Voltage Output, High-side or Low-side Measurement, Bidirectional Current Shunt Monitor

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## REVISION HISTORY

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

OCTOBER 2020 – REV.A to REV.A.1	Page
Updated Typical Performance Characteristics section .....	7, 8

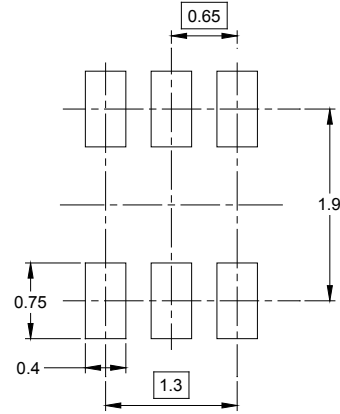
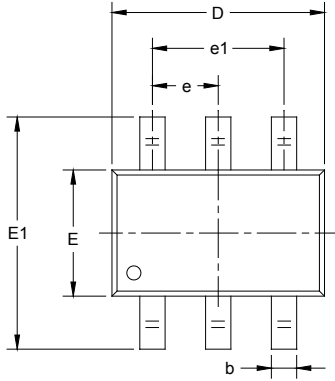
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Changes from Original (SEPTEMBER 2018) to REV.A	Page
Changed from product preview to production data.....	All

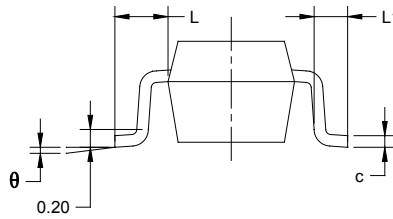
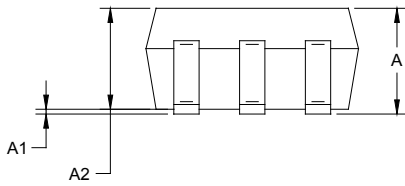
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PACKAGE OUTLINE DIMENSIONS

SC70-6



RECOMMENDED LAND PATTERN (Unit: mm)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026 TYP	
e1	1.300 BSC		0.051 BSC	
L	0.525 REF		0.021 REF	
L1	0.260	0.460	0.010	0.018
$\theta$	0°	8°	0°	8°

# 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
SC70-6	7"	9.5	2.40	2.50	1.20	4.0	4.0	2.0	8.0	Q3

000001

# 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
7" (Option)	368	227	224	8
7"	442	410	224	18

DD0002