SGM8199L
Voltage Output, High or Low Side Measurement, Bi-Directional Current Shunt Monitor

GENERAL DESCRIPTION

The SGM8199L is a voltage output current shunt monitor which can sense drop across shunt at common mode voltages from 0V to 26V, independent of the supply voltage. The gain of SGM8199L1 is 50V/V. The low offset enables current sensing with maximum drops across the shunt as low as 10mV full-scale.

This device operates from a single 2.7V to 26V power supply, drawing a typical 70μA of supply current.

The SGM8199L is available in Green SC70-6 package. It is specified over the extended -40℃ to +125℃ temperature range.

FEATURES

- **Wide Common Mode Range: 0V to 26V**
- **Offset Voltage: ±30μV (TYP)**
  (Enables shunt drops of 10mV full-scale)
- **Accuracy: ±0.02% Gain Error (TYP)**
- **SGM8199L1 Gain: 50V/V**
- **Quiescent Current: 70μA (TYP)**
- **Available in Green SC70-6 Package**

APPLICATIONS

Notebook Computers
Cell Phones
Telecom Equipment
Power Management
Battery Chargers
Welding Equipment

TYPICAL APPLICATION

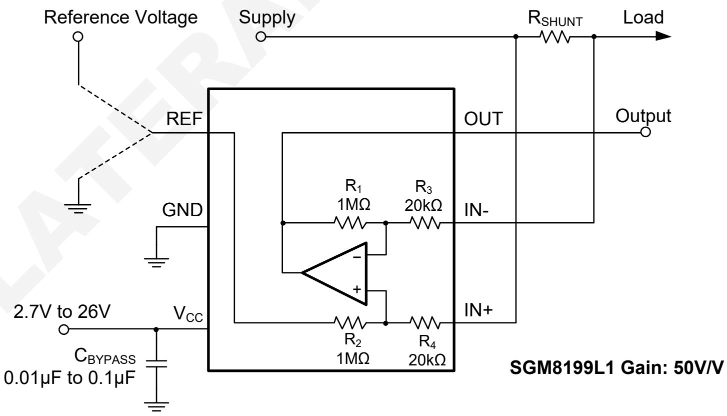


Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	GAIN	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8199L1	SC70-6	50V/V	-40℃ to +125℃	SGM8199L1XC6G/TR	MBCXX	Tape and Reel, 3000

NOTE: XX = Date Code.

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.

MARKING INFORMATION

MBC X X

- X (second): Date code - Month ("A" = Jan. "B" = Feb. ··· "L" = Dec.)
- X (first): Date code - Year ("A" = 2010, "B" = 2011 ···)
- MBC: Chip I.D.

For example: MBCIA (2018, January)

ABSOLUTE MAXIMUM RATINGS

Supply Voltage..28V
V_{IN} Differential...±28V
Input Common Mode Voltage Range..... GND - 0.3V to +28V
Input Current into All Pins 5mA
Junction Temperature ....+150℃
Storage Temperature Range........................-65℃ to +150℃
Lead Temperature (Soldering, 10s) ....+260℃

RECOMMENDED OPERATING CONDITIONS

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

OVERSTRESS CAUTION

Stresses beyond those listed may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational section of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

ESD SENSITIVITY CAUTION

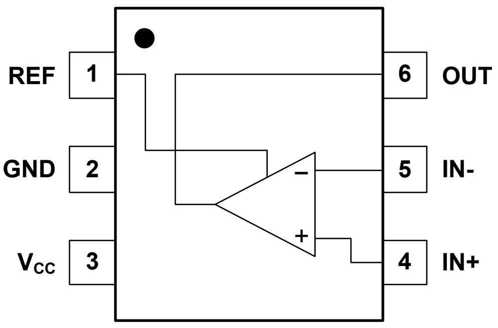
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time.

PIN CONFIGURATION

(TOP VIEW)



SC70-6

ELECTRICAL CHARACTERISTICS

(At T_A = +25℃, V_{CC} = +5V, GND = 0V, V_{IN+} = 12V, V_{SENSE} = V_{IN+} - V_{IN-} and V_{REF} = V_{CC}/2, unless otherwise noted.)

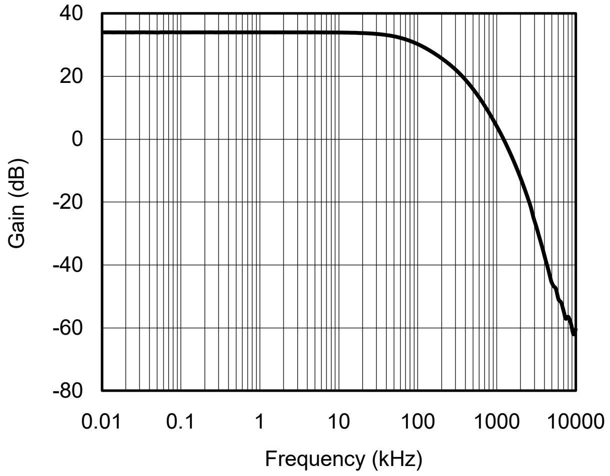
PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS						
Input Offset Voltage, RTI [1] (V_{OS})		V_{SENSE} = 0mV		±30		μV
Input Offset Voltage Drift				1		μV/℃
Input Bias Current (I_B)		V_{SENSE} = 0mV		16		μA
Input Offset Current (I_{OS})		V_{SENSE} = 0mV		±0.02		μA
Input Common Mode Voltage Range (V_{CM})			0		26	V
Common Mode Rejection Ratio (CMRR)		V_{IN+} = 0V to 26V, V_{SENSE} = 0mV		100		dB
OUTPUT CHARACTERISTICS						
Gain (G)		SGM8199L1		50		V/V
Gain Error		V_{SENSE} = -5mV to 5mV		±0.02		%
Gain Temperature Coefficient				8		ppm/℃
Nonlinearity Error		V_{SENSE} = -5mV to 5mV		±0.01		%
Maximum Capacitive Load		No sustained oscillation		1		nF
Output Voltage Swing from Rail	V_{OH}	R_L = 10kΩ to GND		50		mV
	V_{OL}	R_L = 10kΩ to GND		50		
DYNAMIC PERFORMANCE						
Gain-Bandwidth Product (GBP)		C_{LOAD} = 10pF, SGM8199L1		80		kHz
Slew Rate (SR)				0.4		V/μs
NOISE, RTI [1]						
Voltage Noise Density (e_n)		SGM8199L1, f = 1kHz		55		$nV/\sqrt{Hz}$
POWER SUPPLY						
Operating Voltage Range (V_{CC})			2.7		26	V
Quiescent Current (I_Q)		V_{SENSE} = 0mV		70		μA
Power Supply Rejection Ratio (PSRR)		V_{CC} = 2.7V to 26V, V_{IN+} = 12V, V_{SENSE} = 0mV		1		μV/V

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

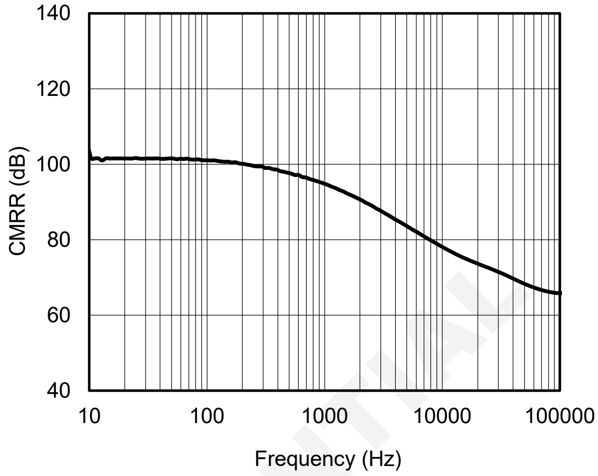
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_{CC} = +5V, GND = 0V, V_{IN+} = 12V, V_{SENSE} = V_{IN+} - V_{IN-} and V_{REF} = V_{CC}/2, unless otherwise noted.

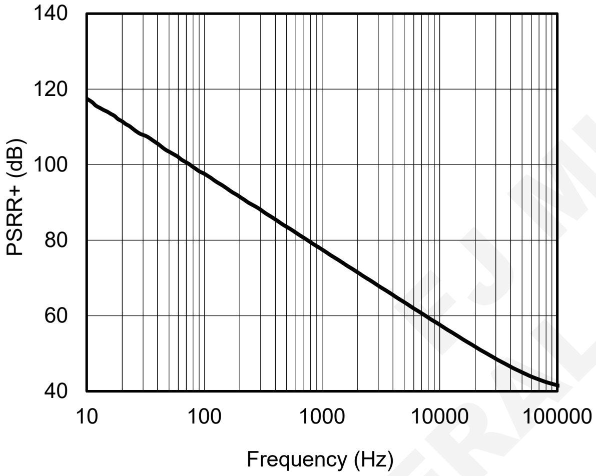
Gain vs. Frequency



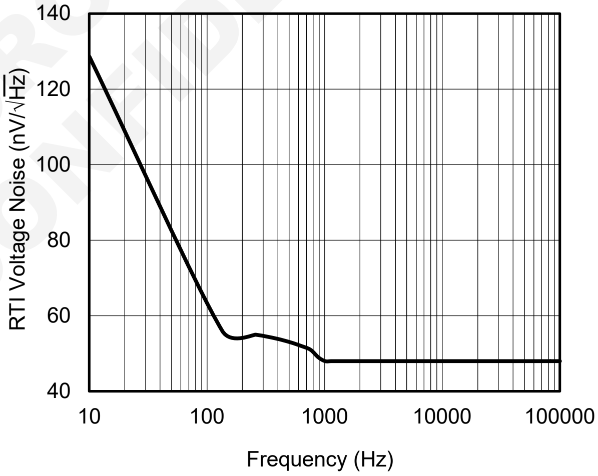
CMRR vs. Frequency



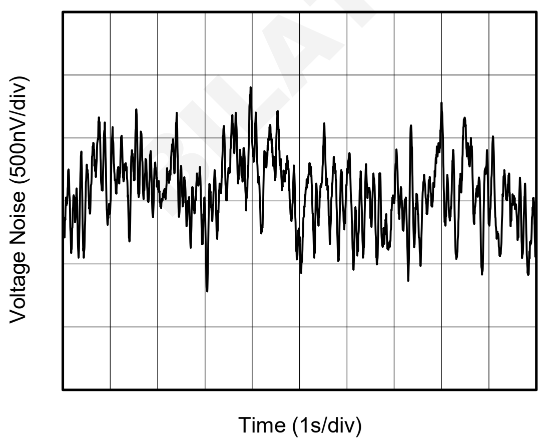
PSRR+ vs. Frequency



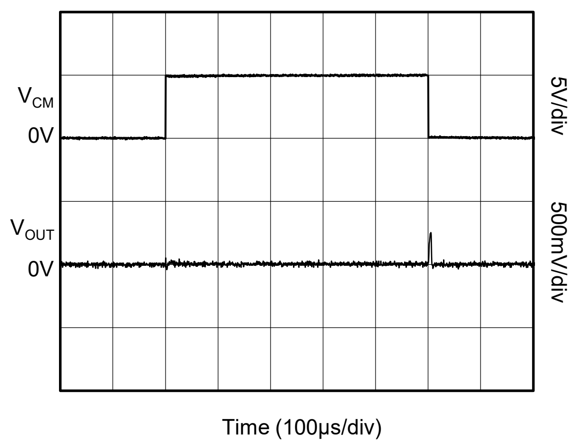
RTI Voltage Noise vs. Frequency



0.1Hz to 10Hz Voltage Noise



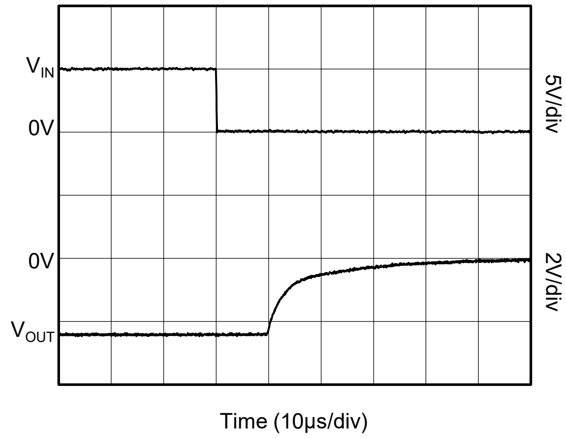
Common Mode Voltage Transient Response



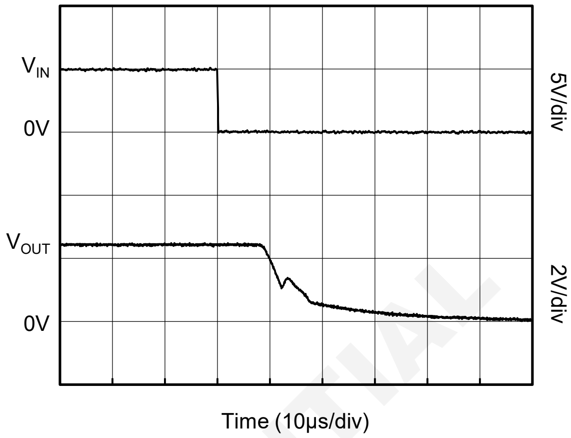
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_{CC} = +5V, GND = 0V, V_{IN+} = 12V, V_{SENSE} = V_{IN+} - V_{IN-} and V_{REF} = V_{CC}/2, unless otherwise noted.

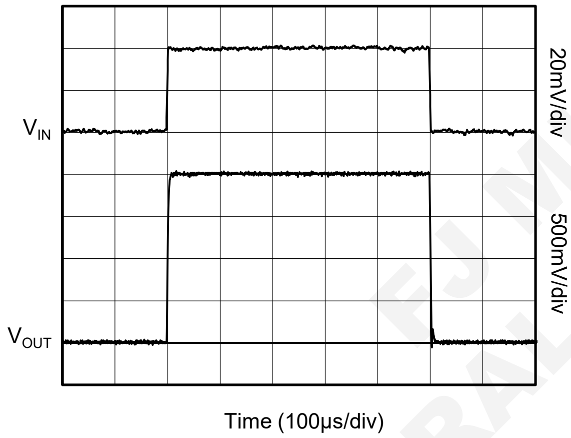
Overload Recovery (Inverting)



Overload Recovery (Non-Inverting)



Step Response



APPLICATION INFORMATION

Basic Connection

Figure 1 shows the basic connection for the SGM8199L. The input pins, IN+ and IN-, should be connected as closely as possible to the shunt resistor to minimize any resistance in series with the shunt resistance.

Power-supply bypass capacitors are required for stability. Applications with noisy or high-impedance power supplies may require additional decoupling capacitors to reject power-supply noise. Connect bypass capacitors close to the device pins.

Power Supply

The input circuitry of the SGM8199L can accurately measure beyond its power-supply voltage, V_{CC}. For example, the V_{CC} power supply can be 5V, whereas the load power-supply voltage can be as high as 26V. However, the output voltage range of the OUT terminal is limited by the voltages on the power-supply pin. Note also that the SGM8199L can withstand the full 0V to 26V range in the input pins, regardless of whether the device has power applied or not.

Selecting R_{SHUNT}

The SGM8199L of current-shunt monitor gives equivalent accuracy at a full-scale range on the order of 10mV. This accuracy reduces shunt dissipation by an order of magnitude with many additional benefits.

Alternatively, there are applications that must measure current over a wide dynamic range that can take advantage of the low offset on the low end of the measurement. Most often, these applications can use gain of 50 to accommodate larger shunt drops on the upper end of the scale. For instance, an SGM8199L1 operating on a 3.3V supply could easily handle a full-scale shunt drop of 60mV, with only 30μV of offset.

Unidirectional Operation

Unidirectional operation allows the SGM8199L to measure currents through a resistive shunt in one direction. The most frequent case of unidirectional operation sets the output at ground by connecting the REF pin to ground. In unidirectional applications where the highest possible accuracy is desirable at very low inputs, bias the REF pin to a convenient value above 50mV to get the device output swing into the linear range for zero inputs.

A less frequent case of unipolar output biasing is to bias the output by connecting the REF pin to the supply; in this case, the quiescent output for zero input is at quiescent supply. This configuration would only respond to negative currents (inverted voltage polarity at the device input).

Bi-Directional Operation

Bi-directional operation allows the SGM8199L to measure currents through a resistive shunt in two directions. In this case, the output can be set anywhere within the limits of what the reference inputs allow (that is, between 0V to V_{CC}). Typically, it is set at half-scale for equal range in both directions. In some cases, however, it is set at a voltage other than half-scale when the bi-directional current is nonsymmetrical.

The quiescent output voltage is set by applying voltage to the reference input. Under zero differential input conditions the output assumes the same voltage that is applied to the reference input.

Input Filtering

An obvious and straightforward filtering location is at the device output. However, this location negates the advantage of the low output impedance of the internal buffer. The only other filtering option is at the device input pins. Figure 2 shows a filter placed at the inputs pins.

APPLICATION INFORMATION (continued)

The addition of external series resistance, however, creates an additional error in the measurement so the value of these series resistors should be kept to 10Ω or less if possible to reduce impact to accuracy. The internal bias network shown in Figure 2 present at the input pins creates a mismatch in input bias currents when a differential voltage is applied between the input pins. If additional external series filter resistors are added to the circuit, the mismatch in bias currents results in a mismatch of voltage drops across the filter resistors. This mismatch creates a differential error voltage that subtracts from the voltage developed at the shunt resistor. This error results in a voltage at the device input pins that is different than the voltage developed across the shunt resistor. Without the additional series resistance, the mismatch in input bias currents has little effect on device operation.

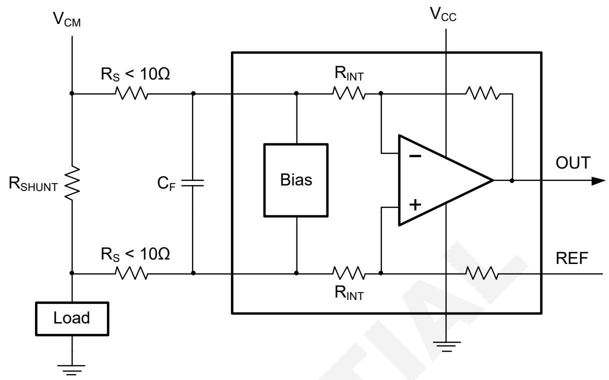
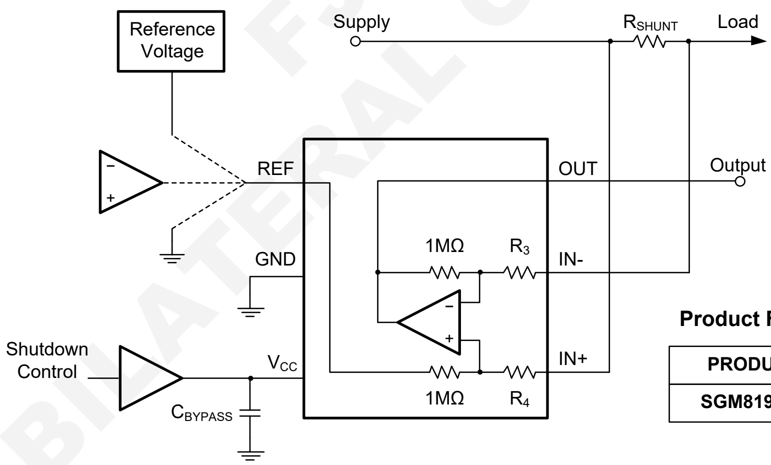


Figure 2. Filter at Input Pins

Shutting Down the SGM8199L

While the SGM8199L does not have a shutdown pin, the low power consumption allows powering from the output of a logic gate or transistor switch that can turn on and turn off the SGM8199L power-supply quiescent current.

However, in current shunt monitoring applications, there is also a concern for how much current is drained from the shunt circuit in shutdown conditions. Evaluating this current drain involves considering the simplified schematic of the SGM8199L in shutdown mode shown in Figure 3.



Product Family Table

PRODUCT	R_3 AND R_4
SGM8199L1	20kΩ

NOTE: 1MΩ pathes from shunt inputs to reference and SGM8199L outputs.

Figure 3. Basic Circuit for Shutting Down SGM8199L with Grounded Reference

APPLICATION INFORMATION (continued)

REF Input Impedance Effects

As with any difference amplifier, the SGM8199L common mode rejection ratio is affected by any impedance present at the REF input. This concern is not a problem when the REF pin is connected directly to most references or power supplies. When using resistive dividers from the power supply or a reference voltage, the REF pin should be buffered by an operational amplifier.

In systems where the SGM8199L output can be sensed differentially, such as by a differential input analog-to-digital converter (ADC) or by using two separate ADC inputs, the effects of external impedance on the REF input can be cancelled. Figure 4 depicts a method of taking the output from the SGM8199L by using the REF pin as a reference.

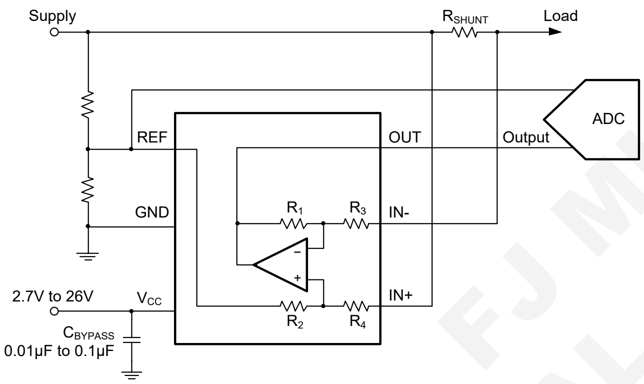


Figure 4. Sensing SGM8199L to Cancel Effects of Impedance on the REF Input

Using the SGM8199L with Common Mode Transients above 26V

With a small amount of additional circuitry, the SGM8199L can be used in circuits subject to transients higher than 26V, such as automotive applications. Use only Zener diode or Zener-type transient absorbers (sometimes referred to as Transzorbs); any other type of transient absorber has an unacceptable time delay. Start by adding a pair of resistors as shown in Figure 5 as working impedance for the Zener. It is desirable to keep these resistors as small as possible, most often around 10Ω. Larger values can be used with an effect on gain that is discussed in the section on input filtering. Because this circuit limits only short-term transients, many applications are satisfied with a 10Ω resistor along with conventional Zener diodes of the lowest power rating that can be found. This combination uses the least amount of board space.

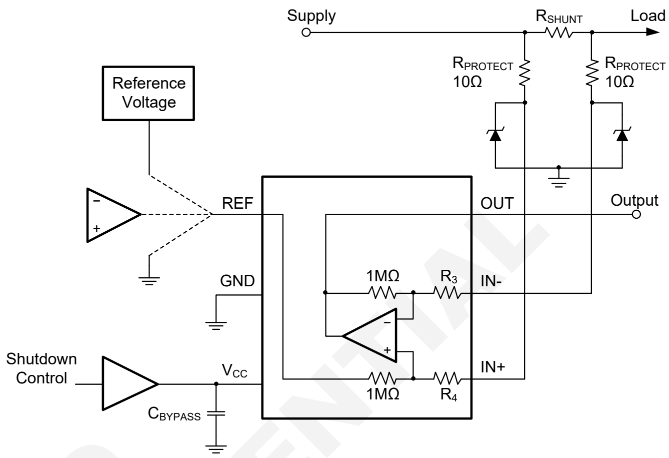


Figure 5. SGM8199L Transient Protection Using Dual Zener Diodes

In the event that low-power Zeners do not have sufficient transient absorption capability and a higher power Transzorb must be used, the most package -efficient solution then involves using a single Transzorb and back-to-back diodes between the device inputs. This method is shown in Figure 6. In both examples shown in Figure 5 and Figure 6, the total board area required by the SGM8199L with all protective components is less than that of an SOIC-8 package, and only slightly greater than that of an MSOP-8 package.

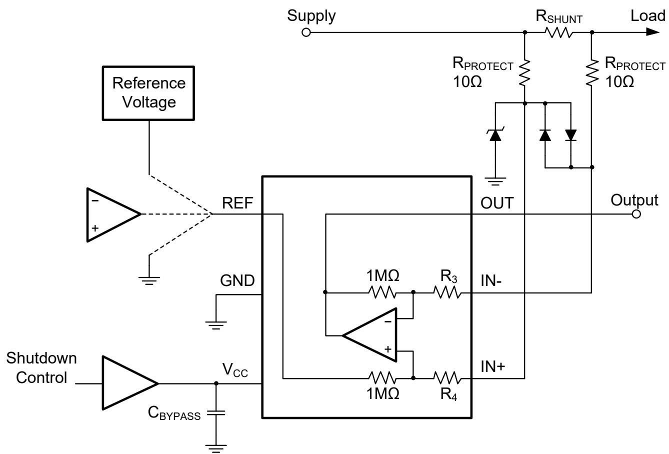
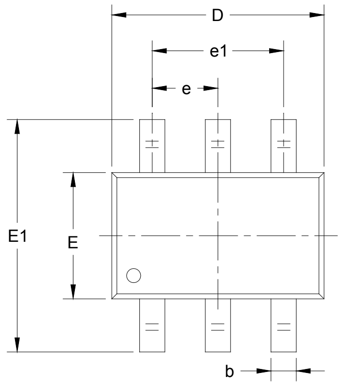
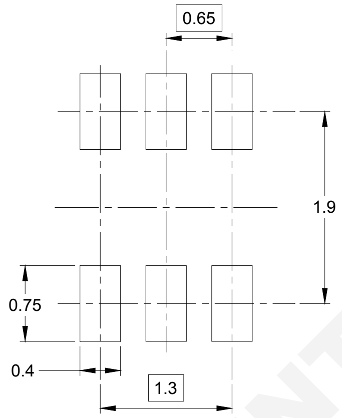


Figure 6. SGM8199L Transient Protection Using a Single Transzorb and Input Clamps

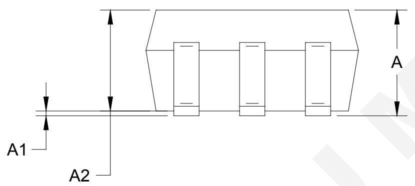
PACKAGE OUTLINE DIMENSIONS

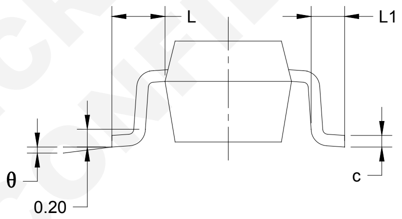
SC70-6





RECOMMENDED LAND PATTERN (Unit: mm)

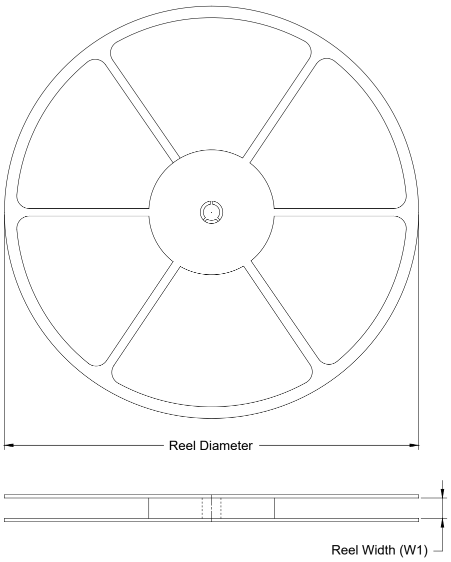




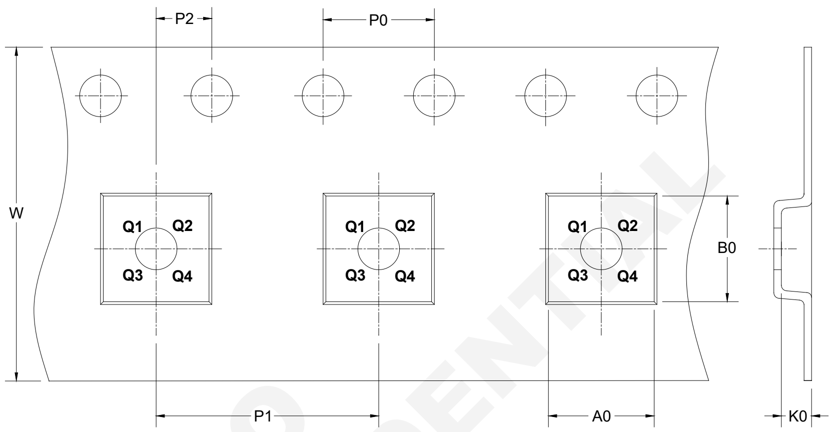
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026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

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

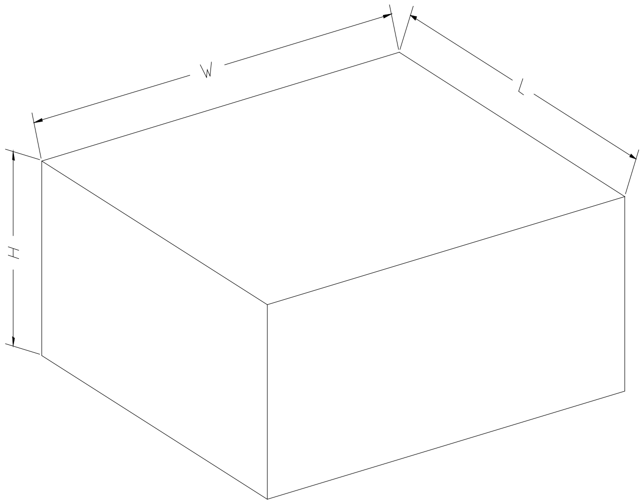
NOTE: The picture is only for reference. Please make the object as the standard.

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

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
7″ (Option)	368	227	224	8
7″	442	410	224	18

DD0002