SGM8181-1
Bidirectional, Low- and High-Side Voltage Output, Current-Sense Amplifier

GENERAL DESCRIPTION

The current-sense amplifier SGM8181-1 is designed for the applications which are sensitive for the cost. The bidirectional current-sense amplifier can sense the current that flowing through the sense resistor at the common mode range which from -0.2V to 30V. There are two gains for the customers to select, which are 20V/V and 50V/V. Moreover, the integrated resistive matching network can optimize the gain error and the temperature drift of the device.

The SGM8181-1 operates from a single 2.7V to 5.5V power supply. It draws a typical supply current of 220μA.

The SGM8181-1 is available in a Green SOT-23-6 package. It is specified over the extended operating temperature range of -40℃ to +125℃.

APPLICATIONS

Motor Control
Battery Monitors and Balancers
Power Management
Lighting Control
Solar Inverters

FEATURES

- **Power Supply Range: 2.7V to 5.5V**
- **Common Mode Range: -0.2V to 30V**
- **High Bandwidth:**
  - **SGM8181-1A1: 450kHz (TYP)**
  - **SGM8181-1A2: 290kHz (TYP)**
- **Output Slew Rate: 2V/μs (TYP)**
- **Gain Options:**
  - **SGM8181-1A1 Gain: 20V/V**
  - **SGM8181-1A2 Gain: 50V/V**
- **Gain Error:**
  - **SGM8181-1A1: ±0.03% (TYP)**
  - **SGM8181-1A2: ±0.01% (TYP)**
- **Input Offset Voltage:**
  - **SGM8181-1A1/A2: ±15μV (TYP) at V_{SENSE} = 0mV, V_{IN+} = 0V**
  - **SGM8181-1A1: ±110μV (TYP) at V_{SENSE} = 0mV, V_{IN+} = 12V**
  - **SGM8181-1A2: ±25μV (TYP) at V_{SENSE} = 0mV, V_{IN+} = 12V**
- **Input Offset Voltage Drift: 0.5μV/℃ (TYP)**
- **Quiescent Current: 220μA (TYP)**
- **Support Bidirectional Current Sense**
- **Available in a Green SOT-23-6 Package**

TYPICAL APPLICATION

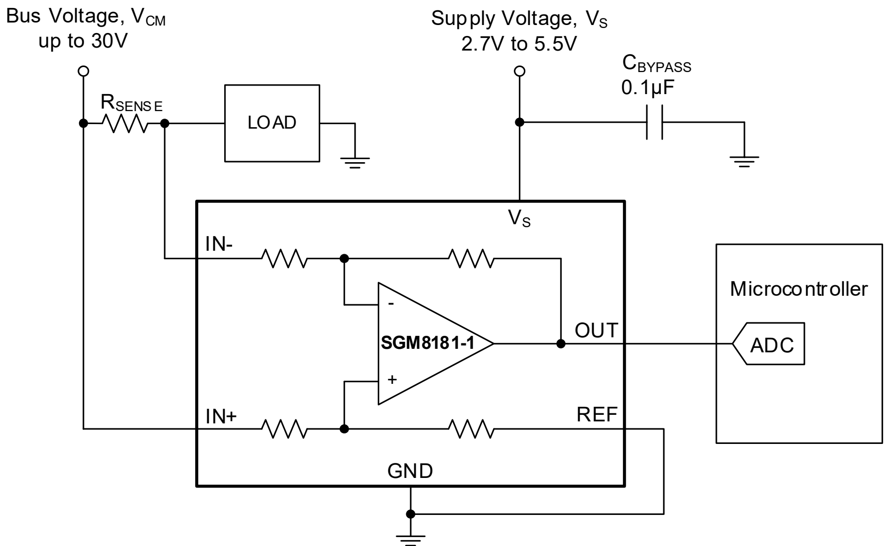


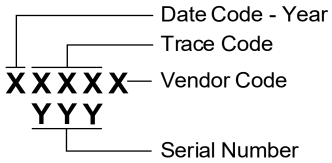
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8181-1A1 (Gain = 20V/V)	SOT-23-6	-40℃ to +125℃	SGM8181-1A1XN6G/TR	XXXXX 3CW	Tape and Reel, 3000
SGM8181-1A2 (Gain = 50V/V)	SOT-23-6	-40℃ to +125℃	SGM8181-1A2XN6G/TR	XXXXX 2FG	Tape and Reel, 3000

MARKING INFORMATION

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

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_S 6V
Analog Inputs, IN+, IN- (1)
Differential (V_{IN+}) - (V_{IN-}) .... -32V to 32V
Common Mode (2) .... GND - 0.3V to 32V
Input Voltage Range .... GND - 0.3V to V_S + 0.3V
Output Voltage .... GND - 0.3V to V_S + 0.3V
Maximum Output Current, I_{OUT} .... ±25mA
Package Thermal Resistance
SOT-23-6, θ_{JA} .... 176.3℃/W
SOT-23-6, θ_{JB} .... 66.1℃/W
SOT-23-6, θ_{JC} .... 121.4℃/W
Junction Temperature .... +150℃
Storage Temperature Range .... -65℃ to +150℃
Lead Temperature (Soldering, 10s) .... +260℃
ESD Susceptibility (3) (4)
HBM .... ±4000V
CDM .... ±1000V

NOTES:

1. V_{IN+} and V_{IN-} are the voltages at the pins IN+ and IN-.

2. The input voltage at any pin may exceed the indicated voltage if the current at that pin is limited to 5mA.

3. For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.

4. For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

RECOMMENDED OPERATING CONDITIONS

Operating Supply Voltage, V_S .... 2.7V to 5.5V
Input Common Mode Range, V_{CM} .... -0.2V to 30V
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.

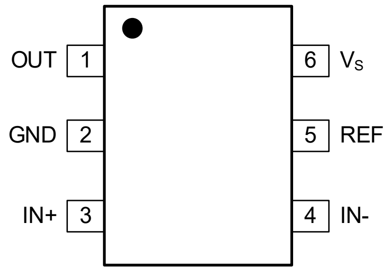
ESD SENSITIVITY CAUTION

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 CONFIGURATION



PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
1	OUT	O	Output Voltage.
2	GND	G	Ground.
3	IN+	I	Non-Inverting Input of Current-Sense Amplifier. For high-side applications, please put this pin at bus-voltage side of amplifier sense resistor. For low-side applications, please put this pin at load side of amplifier sense resistor.
4	IN-	I	Inverting Input of Current-Sense Amplifier. For high-side applications, please put this pin at load side of amplifier sense resistor. For low-side applications, please put this pin at ground side of amplifier sense resistor.
5	REF	I	Reference Input.
6	V_S	—	Power Supply.

NOTE: I = input, O = output, G = ground.

ELECTRICAL CHARACTERISTICS

(V_S = 5V, V_{REF} = V_S/2, V_{IN+} = 12V, and V_{SENSE} = V_{IN+} - V_{IN-}, Full = -40℃ to +125℃, typical values are measured at T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		TEMP	MIN	TYP	MAX	UNITS
Input Characteristics								
Input Offset Voltage	V_{OS}	V_{SENSE} = 0mV, V_{IN+} = 0V		+25℃		±15	±80	μV
		V_{SENSE} = 0mV	SGM8181-1A1	+25℃		±110	±280	
			SGM8181-1A2	+25℃		±25	±110	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	V_{SENSE} = 0mV		Full		0.5	1	μV/℃
Input Bias Current	I_B	V_{SENSE} = 0mV, V_{IN+} = 0V		+25℃		-5		μA
		V_{SENSE} = 0mV		+25℃		45		
Input Offset Current	I_{IO}	V_{SENSE} = 0mV		+25℃		±0.1		μA
Common Mode Rejection Ratio, RTI (1)	CMRR	V_{IN+} = 0V to 30V, V_{SENSE} = 0mV	SGM8181-1A1	Full	91	110		dB
			SGM8181-1A2	Full	94	115		
Output Characteristics								
Gain	G	SGM8181-1A1		+25℃		20		V/V
		SGM8181-1A2		+25℃		50		
Gain Error	GE	V_{OUT} = 0.5V to (V_S - 0.5V)	SGM8181-1A1	Full		±0.03	±0.2	%
			SGM8181-1A2	Full		±0.01	±0.2	
Gain Error Drift				Full		0.6	2	ppm/℃
Nonlinearity Error		V_{OUT} = 0.5V to (V_S - 0.5V)		+25℃		±0.01		%
Maximum Capacitive Load		No sustained oscillation		+25℃		1		nF
Reference Voltage Rejection Ratio, RTI (1)	RVRR	V_{REF} = 0.2V to (V_S - 0.2V)		+25℃		±2	±12	μV/V
Voltage Output								
Swing to V_S Power-Supply Rail (2)	V_{SP}	R_L = 10kΩ to GND		Full	V_S - 0.03	V_S - 0.015		V
Swing to GND (2)	V_{SN}	R_L = 10kΩ to GND		Full		V_{GND} + 0.001	V_{GND} + 0.005	V
Frequency Response								
Bandwidth	BW	C_{LOAD} = 10pF	SGM8181-1A1	+25℃		450		kHz
			SGM8181-1A2	+25℃		290		
Slew Rate	SR	SGM8181-1A1		+25℃		2		V/μs
		SGM8181-1A2		+25℃		2		
Noise, RTI (1)								
Voltage Noise Density		SGM8181-1A1		+25℃		50		nV/$\sqrt{Hz}$
		SGM8181-1A2		+25℃		40		
Power Supply								
Quiescent Current	I_Q	V_{SENSE} = 0mV		+25℃		220	300	μA
				Full			320	
Power Supply Rejection Ratio, RTI (1)	PSRR	V_S = 2.7V to 5.5V, V_{IN+} = 12V, V_{SENSE} = 0mV		+25℃		±3	±12	μV/V

NOTES:

1. RTI = referred-to-input.
2. Test swing specifications under overdriven input conditions.

FUNCTIONAL BLOCK DIAGRAM

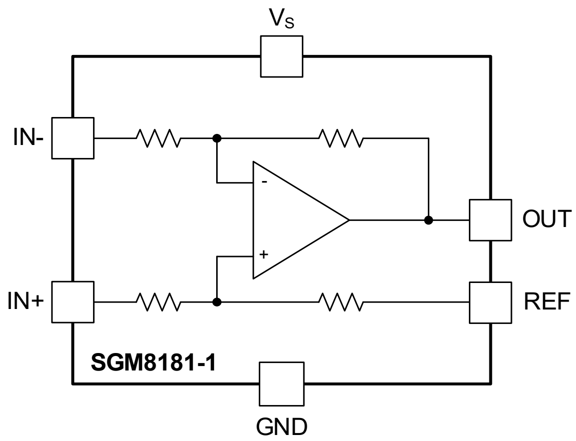
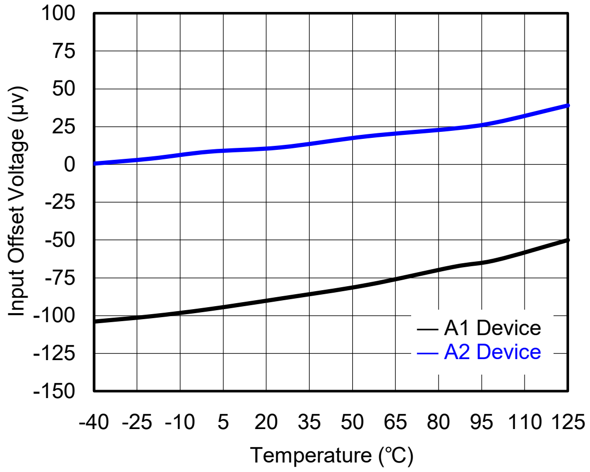


Figure 2. Block Diagram

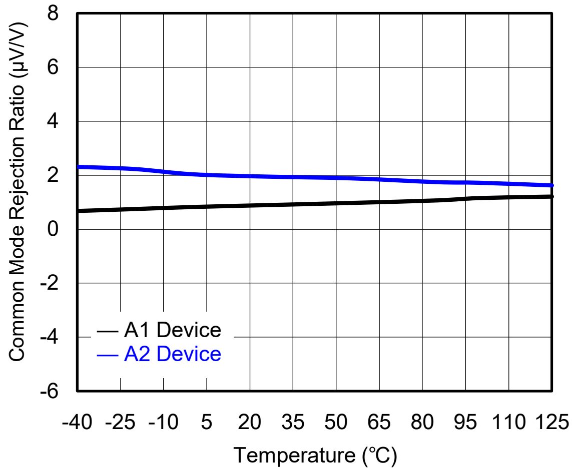
TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +25℃, V_S = 5V, V_{REF} = V_S/2, and V_{IN+} = 12V, unless otherwise noted.

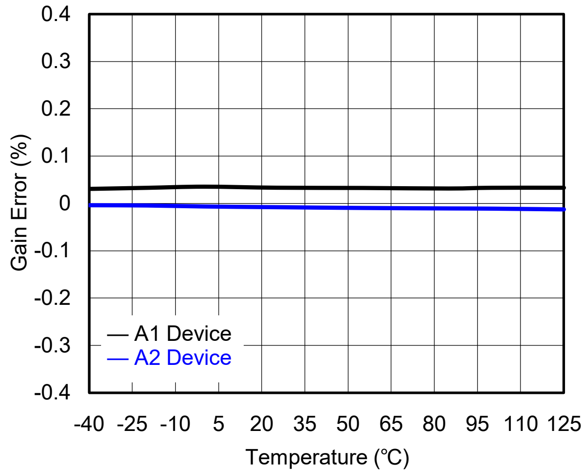
Input Offset Voltage vs. Temperature



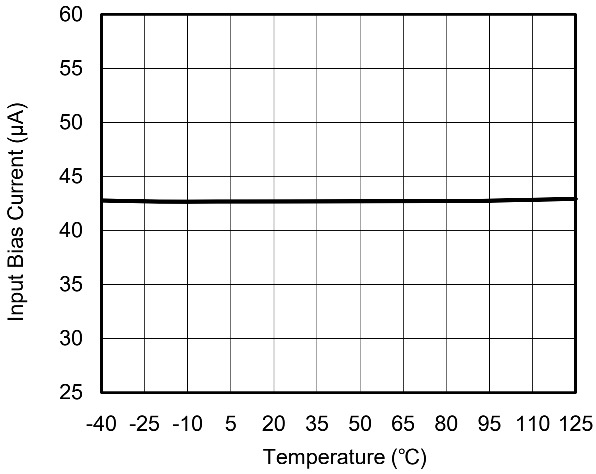
Common Mode Rejection Ratio vs. Temperature



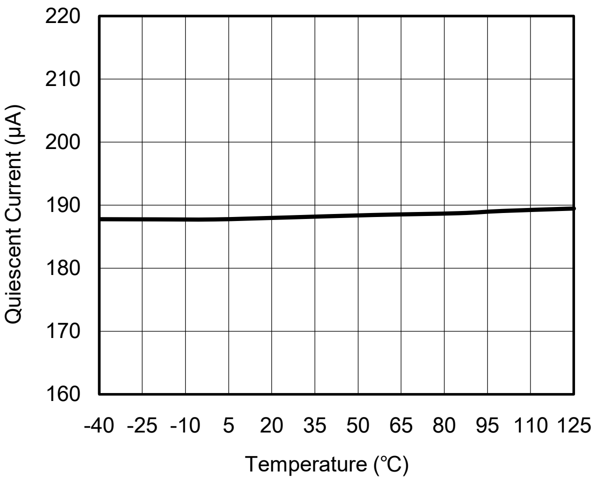
Gain Error vs. Temperature



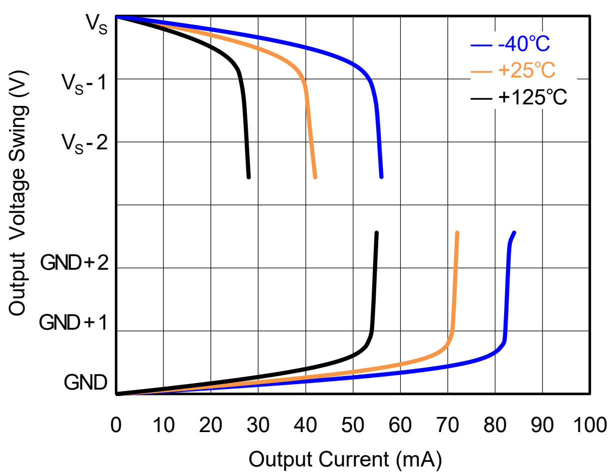
Input Bias Current vs. Temperature



Quiescent Current vs. Temperature

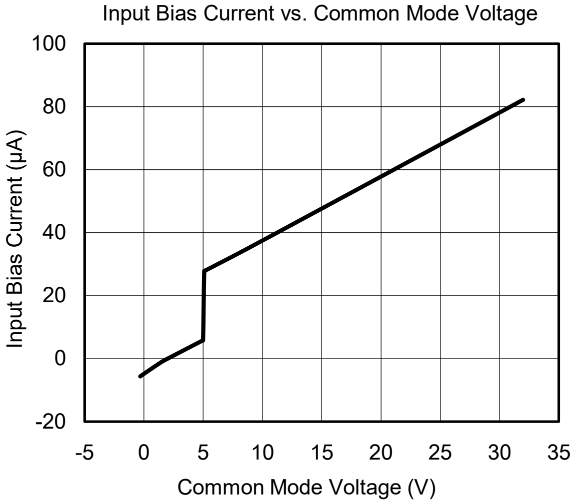


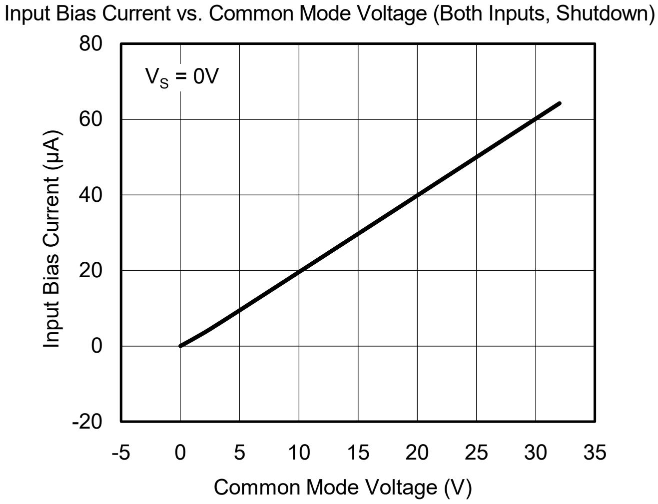
Output Voltage Swing vs. Output Current

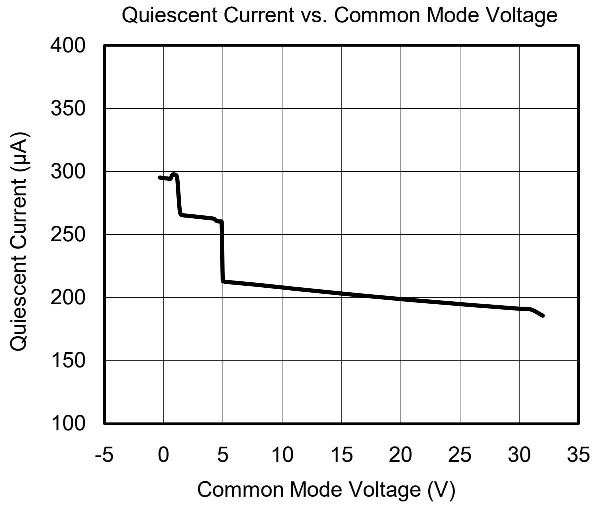


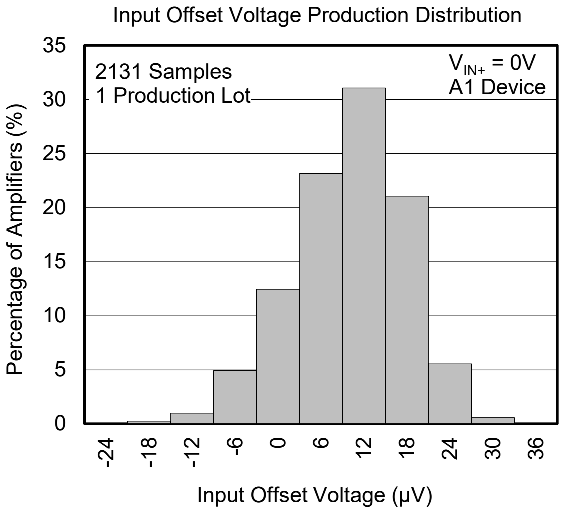
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

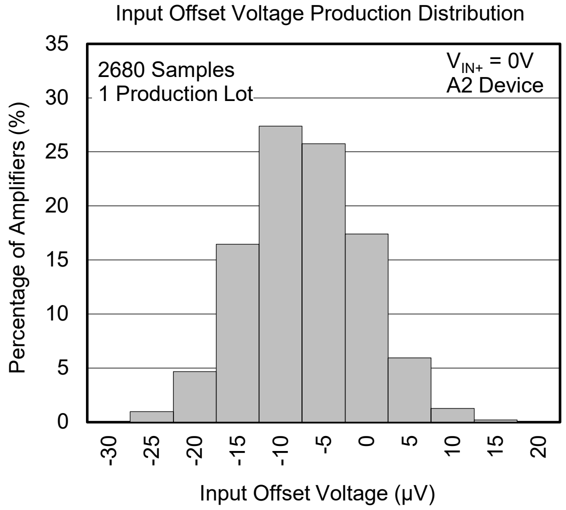
T_A = +25℃, V_S = 5V, V_{REF} = V_S/2, and V_{IN+} = 12V, unless otherwise noted.

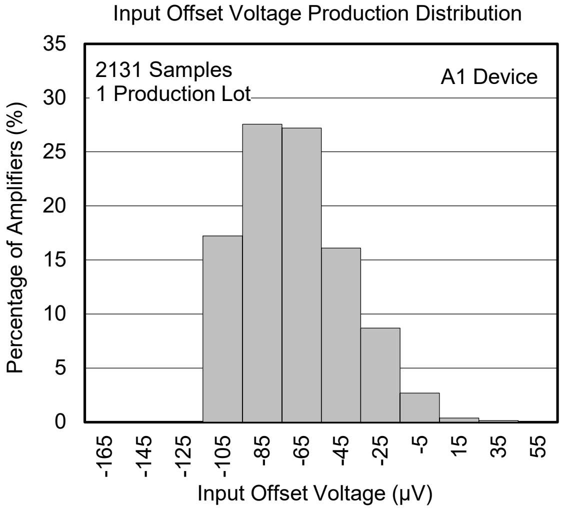






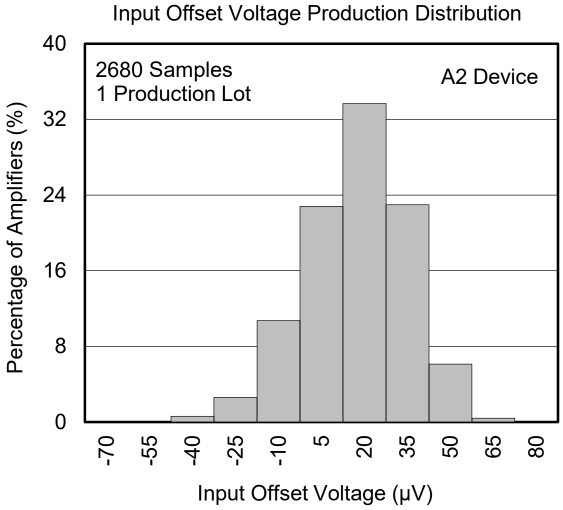


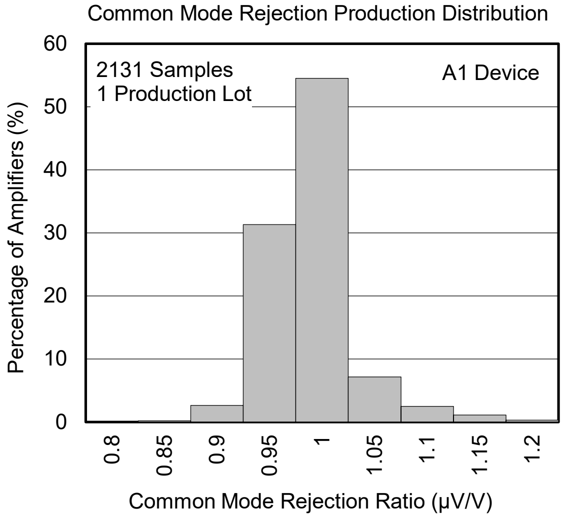


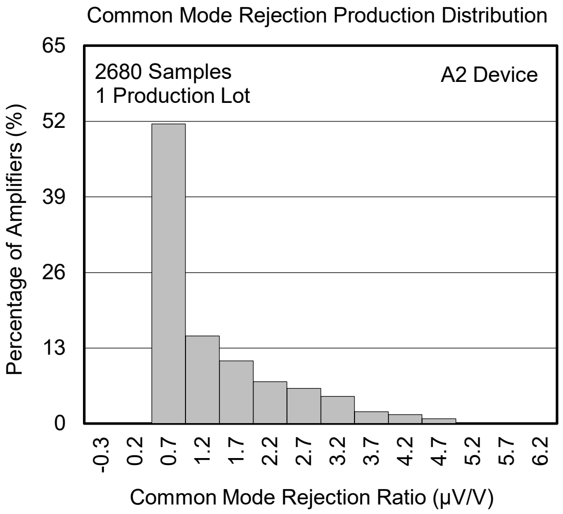


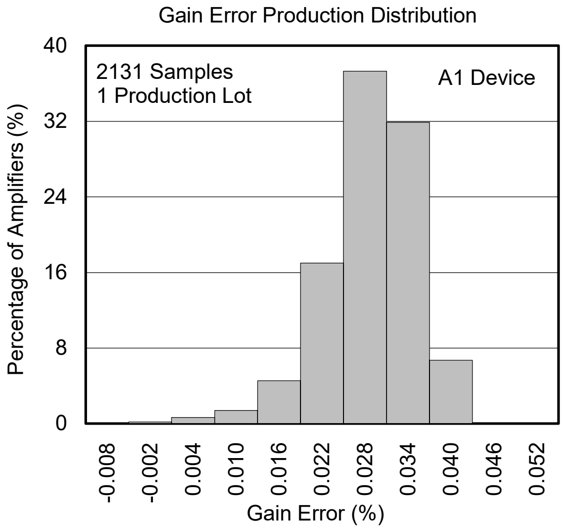
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

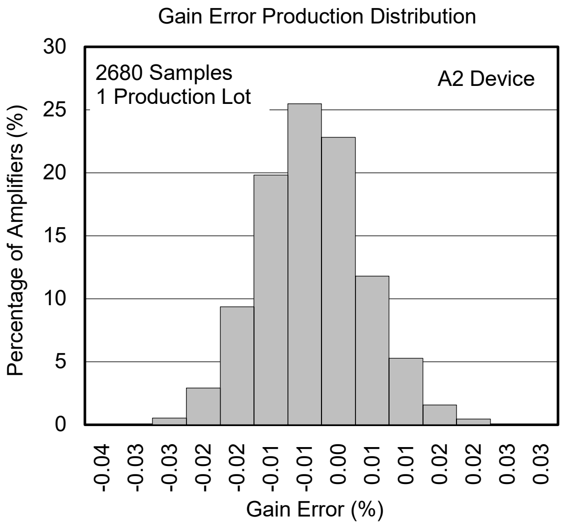
T_A = +25℃, V_S = 5V, V_{REF} = V_S/2, and V_{IN+} = 12V, unless otherwise noted.

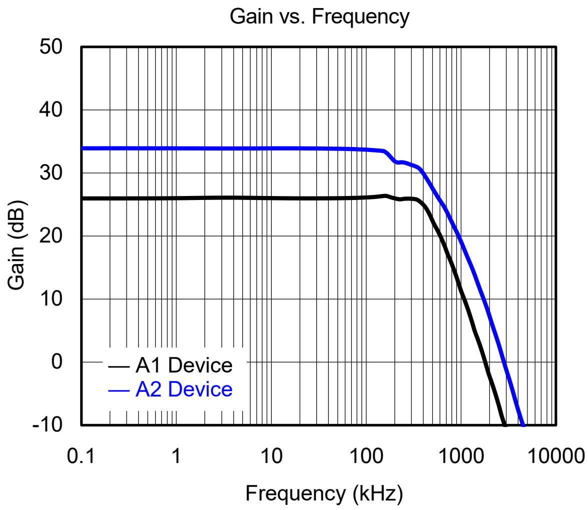








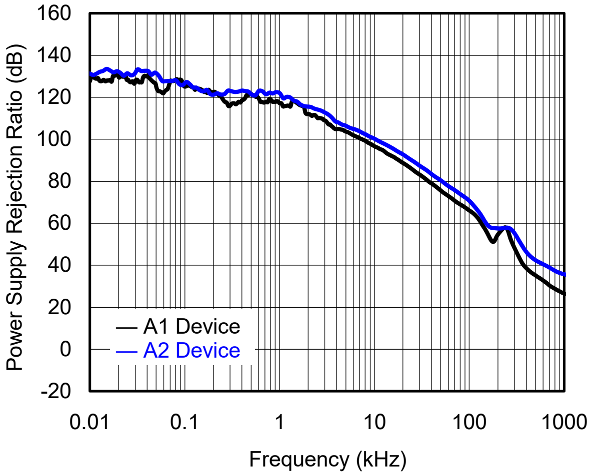




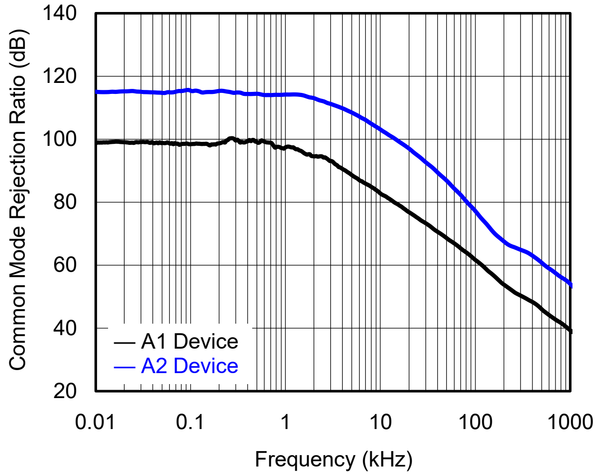
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, V_S = 5V, V_{REF} = V_S/2, and V_{IN+} = 12V, unless otherwise noted.

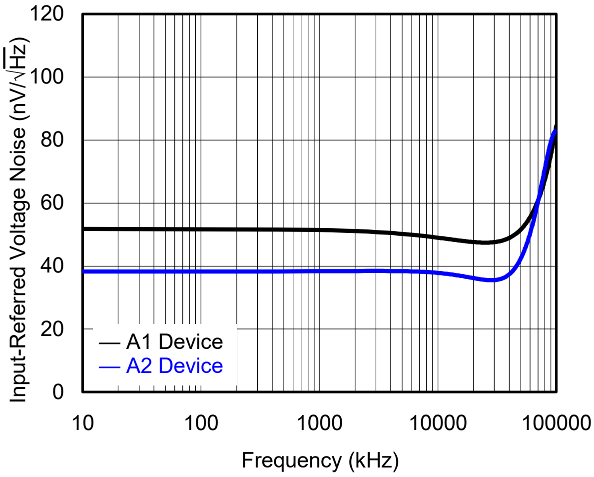
Power Supply Rejection Ratio vs. Frequency



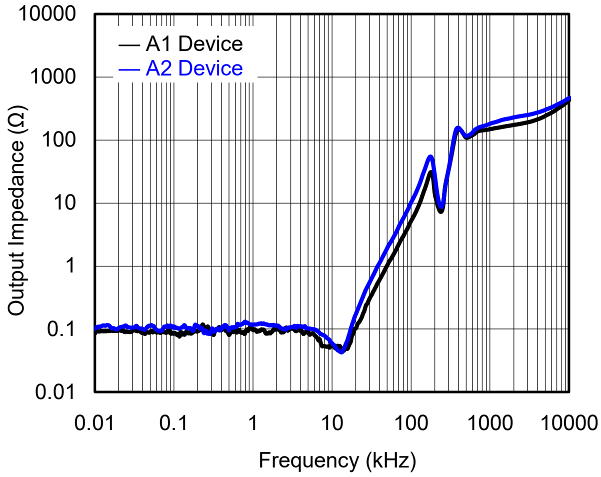
Common Mode Rejection Ratio vs. Frequency



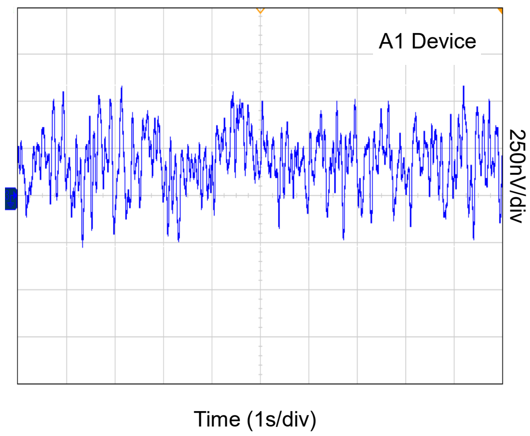
Input-Referred Voltage Noise vs. Frequency



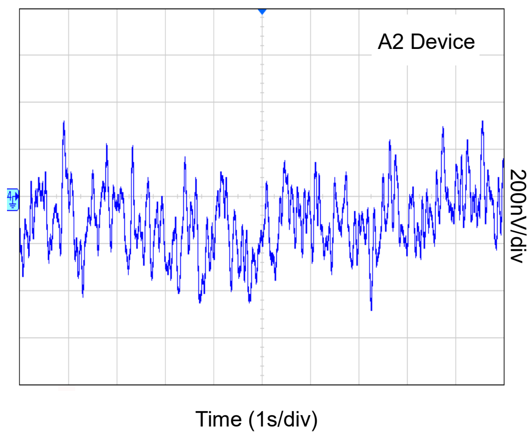
Output Impedance vs. Frequency



0.1Hz to 10Hz Voltage Noise (Referred-to-Input)



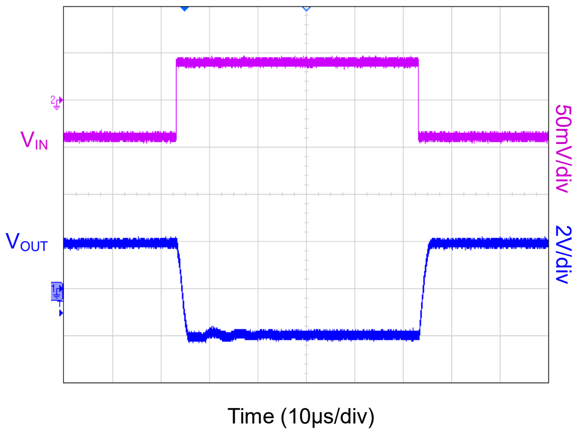
0.1Hz to 10Hz Voltage Noise (Referred-to-Input)



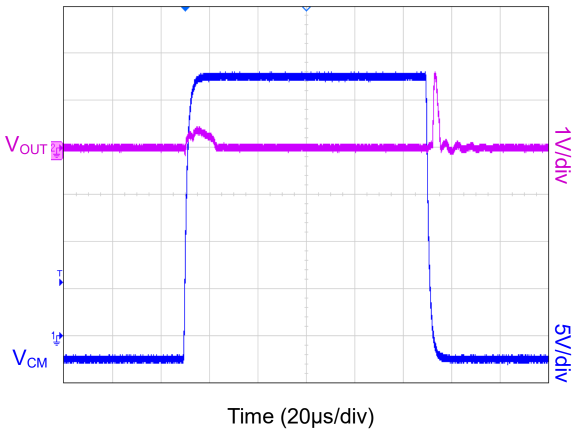
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, V_S = 5V, V_{REF} = V_S/2, and V_{IN+} = 12V, unless otherwise noted.

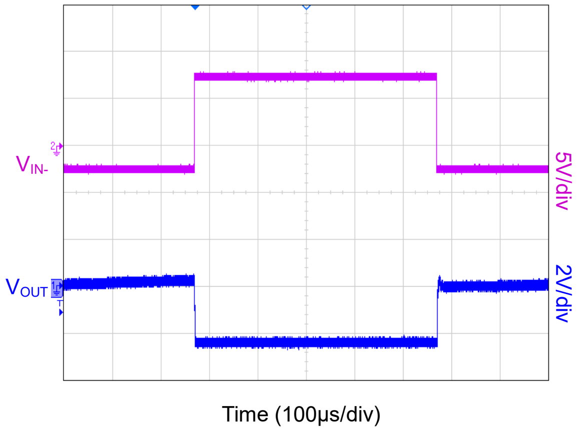
Step Response



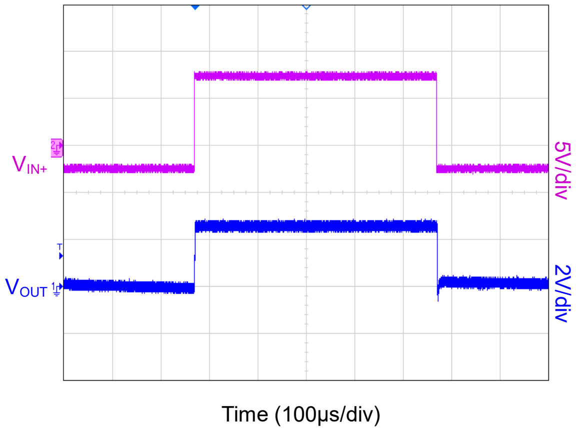
Common Mode Voltage Transient Response



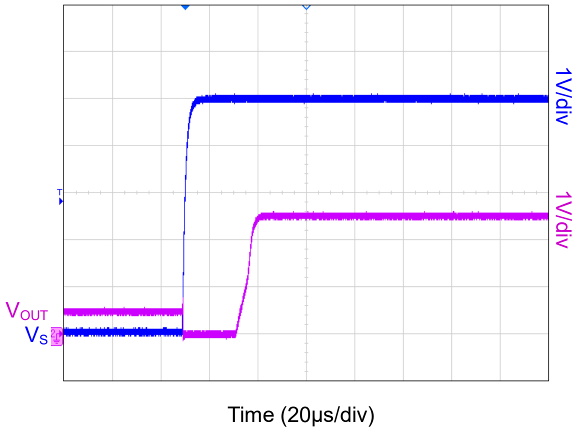
Inverting Differential Input Overload Recovery



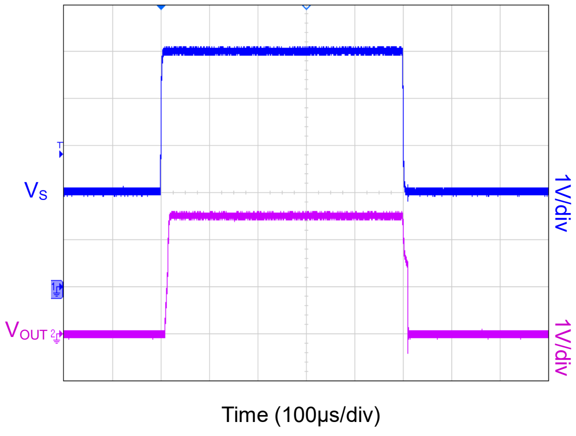
Non-Inverting Differential Input Overload Recovery



Start-Up Response



Brownout Recovery



DETAILED DESCRIPTION

Overview

The SGM8181-1 is a current-sensing amplifier that supports both low-side and high-side configurations. Designed for precision measurement, SGM8181-1 accurately resolves voltage differentials across current-sensing resistors even when the common mode voltage exceeds the device's supply voltage. Operating from a supply as low as 2.7V, the amplifier enables current monitoring on input rails up to 30V.

Feature Description

Bidirectional Current Monitoring

The SGM8181-1 can measure the current with positive and negative directions by applying REF pin. For instance, if the direction of current flowing is positive, the output voltage will be greater than V_{REF}, and vice versa. The following equation shows the relationship between I_{LOAD} and V_{REF}.

$$V_{OUT} = (I_{LOAD} \times R_{SENSE} \times GAIN) + V_{REF} \quad (1)$$

where:

I_{LOAD} is the measured current.
R_{SENSE} is the current-sense resistor.
GAIN is the selected gain of SGM8181-1.
V_{REF} is the voltage at the REF pin.

High Bandwidth and Slew Rate

The SGM8181-1 delivers a small-signal bandwidth up to 450kHz and a large-signal slew rate of 2V/μs. Combined with rapid output slew capability, this performance enables precise monitoring of fast current transients, positioning the SGM8181-1 as an optimal solution for dynamic current-response applications.

Wide Input Common Mode Voltage Range

The SGM8181-1 supports an input common mode voltage range of -0.2V to +30V, independent of its power-supply voltage (V_S = 2.7V to 5.5V). This architectural design decouples the common mode range from the supply voltage, enabling operation even when the input voltage exceeds or falls below V_S. As shown in Figure 3, this capability allows deployment in both high-side sensing and low-side sensing.

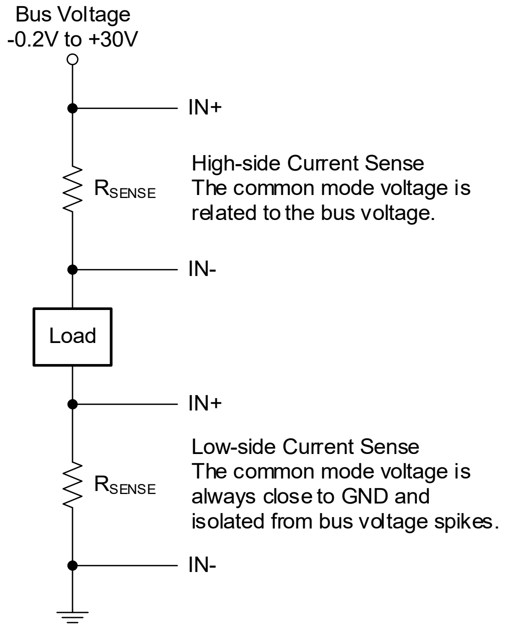


Figure 3. High-side and Low-side Sensing Connections

Precise Low-side Current Sensing

The SGM8181-1 maintains ±80μV input offset voltage in low-side current sensing. This low-offset characteristic enables two key advantages: precise current measurement across wide dynamic ranges (especially at low-current extremes) and accurate sensing of minimal voltage drops across sense resistors. Lower-value shunt resistors can thus be implemented, reducing power loss and improving end-application efficiency.

Rail-to-Rail Output Swing

The SGM8181-1 supports linear current sensing. Its output is proximity to both supply rail (15mV TYP swing) and GND (1mV TYP swing). For output swing comparison between the SGM8181-1 and standard operational amplifier (op amp), inputs are intentionally overdriven to emulate open-loop conditions in op amp datasheet specifications. The closed-loop architecture constrains the GND-side output swing by the product of input offset voltage and gain.

For devices with positive input offset voltages, the output swing to GND is constrained by the greater of two values: the product of input offset voltage and amplifier gain, or the GND swing limit specified in the ELECTRICAL CHARACTERISTICS table.

DETAILED DESCRIPTION (continued)

Functional Modes

Normal Operating Mode

The SGM8181-1 operates normally when the following criteria are satisfied:

- V_S (Power Supply): 2.7V to 5.5V
- V_{CM} (Common Mode Voltage): -0.2V to +30V
- Input Signal Constraints:

 - Maximum: Differential input × Gain + V_{REF} < (V_S - Output swing to V_S)

 - Minimum: Differential input × Gain + V_{REF} > Swing to GND (refer to Rail-to-Rail Output Swing section)

In normal operation, the output voltage linearly scales with the differential voltage between IN+ and IN-, amplified by the device's fixed gain.

Unidirectional Mode

The voltage level of V_{REF} depends on whether the device can work bidirectionally or unidirectionally only. For the most commonly used case, the REF pin is connected to GND directly to make sure that the output voltage is close to 0V if no current flowing, which is unidirectional mode. If the current starts flowing, the output voltage is increased accordingly.

The linear range of SGM8181-1 depends on how close the output voltage can make if there is no current flowing. For lots of unidirectional applications (V_{REF} = 0V), the output voltage is close to 0V if there is no current flowing. However, if the differential input voltage multiplies the gain of SGM8181-1, and the value is less than 0V, the V_{REF} should be biased accordingly to make the output voltage within the linear region of operation. Moreover, the REF pin should be buffered by an external amplifier to limit the errors caused by the common mode rejection.

In some applications, the REF pin is connected to the power supply pin (V_S), which means that the output voltage will be saturated when there is no differential input voltage (no current flowing). And the situation is the same for the REF pin that connected to GND. For the application where V_{REF} = V_S, the differential input should be negative, and the output level will decrease when the absolute value of negative input is increasing. However, the users need to make sure that the voltage applied to REF pin is less than or equal to the power supply voltages.

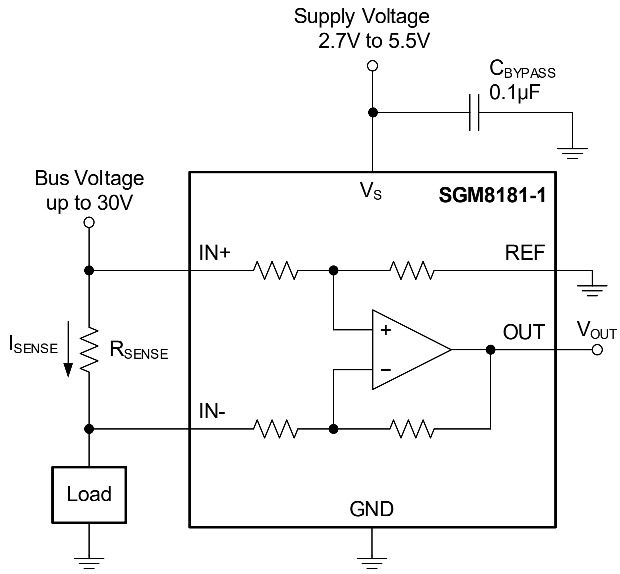


Figure 4. Typical Application of Unidirectional Mode

DETAILED DESCRIPTION (continued)

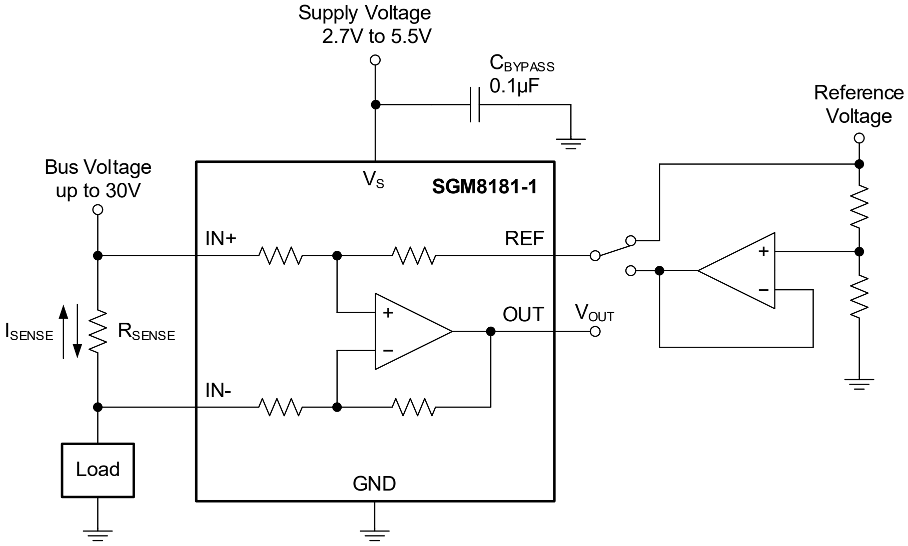


Figure 5. Application of Bidirectional Mode

Bidirectional Mode

Bidirectional application indicates that the current shunt monitor of SGM8181-1 can measure the current for two different directions. For this special case, the REF pin can be set anywhere between 0V and V_S for the bias of output voltage. For simplification, it is recommended that V_{REF} = V_S/2 should be 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_S/2.

Input Differential Overload

The users need to make sure that the differential input voltage multiplies gain is less than the maximum output swing of the amplifier. Otherwise, it does not guarantee the accuracy of the application. For normal operation, if the differential input signal is overloaded, then please reduce the resistance of the shunt resistor.

For the SGM8181-1, when the output saturates to either the supply rail or ground, the differential input voltage can be raised without component damage — this holds true only if all absolute maximum ratings are not exceeded. Operating the part under these rules ensures the output maintains correct signal polarity and eliminates any risk of phase reversal.

Shutdown

There is no shutdown control at the internal of the SGM8181-1, so the only way to shut down the quiescent current from the power supply is by using an external logic gate or transistor switch. For instance, when the REF pin is connected to ground, the current drawn from the shunt to ground via the 500kΩ impedance can be easily calculated. For SGM8181-1, if the reference voltage keeps operating after the chip switches to shutdown mode, input leakage current is decided by two factors: the internal 500kΩ impedance, and the voltage difference across the positive input and reference voltage node.

However, the users may concern about the amount of current through SGM8181-1 in shutdown mode. The schematic in Figure 6 can be used to evaluate the amount of current drain in shutdown mode.

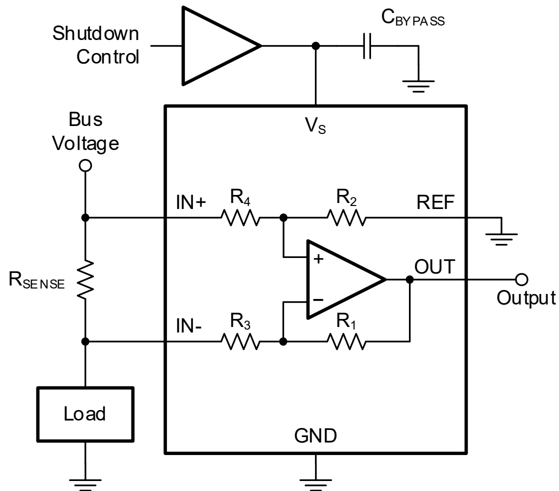
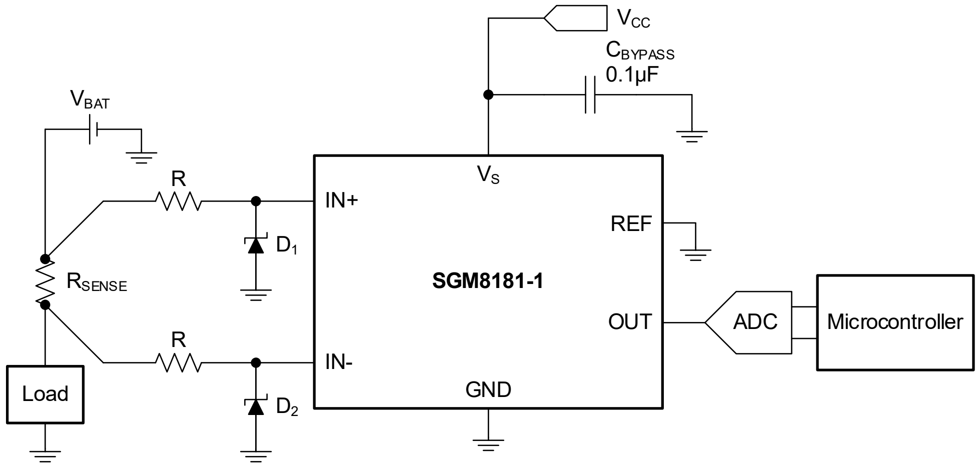


Figure 6. Shutting Down the Current Shunt Monitor

APPLICATION INFORMATION



NOTE: To optimize measurement accuracy Establish a direct path with minimal impedance between the SGM8181-1 GND pin and the ground reference of the analog-to-digital converter (ADC) or microcontroller.

Figure 7. Typical Application Circuit for Battery-Powered System

The current-sense amplifier can amplify the differential input voltage which is across R_{SENSE}. The accuracy of the measurement can be guaranteed over a wide range of common mode voltage because of the high common mode rejection.

Recommended Connection

The recommended connection of SGM8181-1 is shown in Figure 7. 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 the device, so the bypass capacitor is needed in this case.

Selection of R_{SENSE}

For the typical range of the differential input, the current shunt monitor of SGM8181-1 can work accurately with the order of 10mV. The application of SGM8181-1 will determine the selection of the shunt resistor R_{SENSE}. 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_{SENSE}, while the voltage loss can be minimized by using low values of R_{SENSE}.

$$R_{SENSE} < \frac{PD_{MAX}}{I_{MAX}^{\ 2}} \quad (2)$$

where:

PD_{MAX} is defined as the maximum allowable power dissipation across the sense resistor R_{SENSE}.

I_{MAX} is the maximum current that flowing through the R_{SENSE}.

Another constraint on the current-sense resistor value and amplifier gain arises from the supply voltage V_S and the device's output swing limitations relative to the supply rails. The upper and lower output swing thresholds require thorough assessment to fully deliver the sampled current signal to the output without distortion. Equation 3 specifies the upper limits of R_{SENSE} and GAIN, avoiding saturation at the positive supply rail on the output side.

$$I_{MAX} \times R_{SENSE} \times GAIN < V_{SP} - V_{REF} \quad (3)$$

where:

I_{MAX} is the maximum load current.
GAIN is the voltage gain of the SGM8181-1.
V_{REF} is the voltage that be applied at the REF pin.
V_{SP} is the maximum output swing.

APPLICATION INFORMATION (continued)

When choosing the value of R_{SENSE} to avoid positive output swing limitations, a trade-off always exists between the sense resistor value and the device gain. If the sense resistor sized for maximum power dissipation is too large, a lower-gain device variant can be chosen to prevent the output from hitting the positive swing limit.

The negative output swing constraint imposes a lower bound on the minimum usable sense resistor value in a given application, and Equation 4 defines this minimum limit for R_{SENSE}.

$$I_{MIN} \times R_{SENSE} \times GAIN > V_{SN} - V_{REF} \quad (4)$$

where:

I_{MIN} is the minimum load current.
GAIN is the voltage gain of the SGM8181-1.
V_{SN} is the minimum output swing.
V_{REF} is the voltage that be applied at the REF pin.

Other than offset and gain tuning, a mild increase in the bias voltage connected to the REF pin helps avoid the saturation restriction on the negative side of output swing.

Input Filtering

It is not recommended to add a filter at the output of SGM8181-1 if its output is connected to a low impedance input. Filtering at the input pins will be a good choice as long as the change of the input impedance is taken in account. Figure 8 indicates the application of input filtering.

For minimizing the error and enhancing the accuracy of the result, the resistance of the external resistor R_F should be less than 10Ω. At the internal input structure of SGM8181-1, there is a bias network which causes mismatch in the bias current of two input pins, and the external resistors result in the mismatch of voltage drops (because of the mismatch of I_B) across R_F 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.

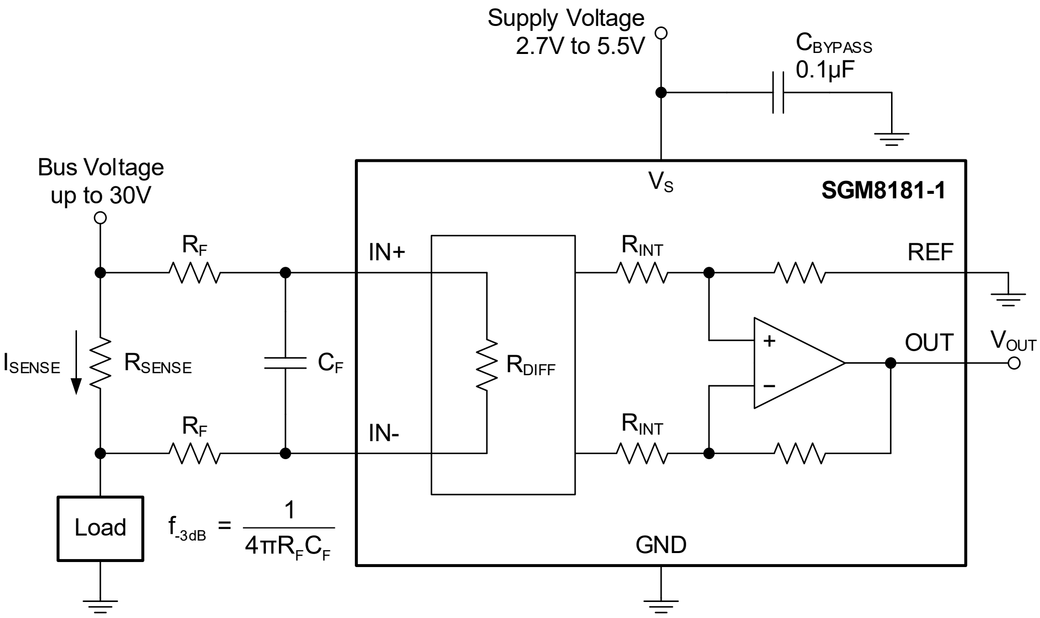


Figure 8. Filtering at Input

APPLICATION INFORMATION (continued)

$$\text{Gain Error Factor} = \frac{4000 \times R_{INT}}{(4000 \times R_F) + (4000 \times R_{INT}) + (R_F \times R_{INT})} \quad (5)$$

where:

For SGM8181-1, R_{INT} represents its on-chip input resistor, and R_F denotes the external resistor wired in series with the circuit.

Equation 5 yields a correction term that incorporates the device's internal input resistance. The value of this term changes with each gain variant, as tabulated in Table 1. The gain error factor for each individual device is provided in Table 2.

Table 1. Input Resistance

Product	Gain	R_{INT} (kΩ)
SGM8181-1A1	20	25
SGM8181-1A2	50	10

Table 2. Device Gain Error Factor

Product	Simplified Gain Error Factor
SGM8181-1A1	$\frac{25000}{(7.25 \times R_F) + 25000}$
SGM8181-1A2	$\frac{10000}{(3.5 \times R_F) + 10000}$

The resulting gain error introduced by the external series resistors can then be computed using Equation 6:

$$\text{Gain Error}(\%) = 100 - (100 \times \text{Gain Error Factor}) \quad (6)$$

For instance, taking the SGM8181-1A2 and its corresponding gain error formula from Table 2, a series resistance of 10Ω yields a gain error factor of 0.9965. Applying Equation 6 to compute the associated gain error results in an additional gain error of roughly 0.3488%, caused exclusively by the external 10Ω series resistors.

Typical Application

A key application of the SGM8181-1 is bidirectional current sensing, which is needed in systems that measure current flow in both directions—such as battery charging and discharging monitoring, as well as current detection in motor drive systems. Figure 9 shows the recommended circuit setup for this dual-direction current measurement. By applying a stable voltage to the REF pin near the midpoint of the device's supply voltage, the chip can accurately sense both positive and negative currents. For unidirectional current monitoring only, the SGM8181-1 can be simply configured by connecting the REF pin to ground.

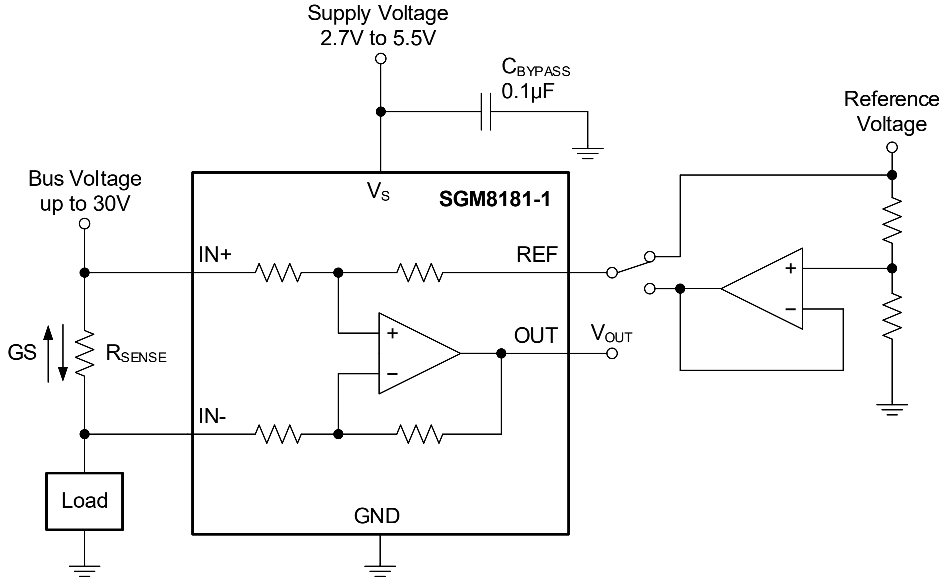


Figure 9. Application of Bidirectional Mode

APPLICATION INFORMATION (continued)

The Performance of SGM8181-1 when Common Mode Transients above 30V

The SGM8181-1 can be powered by the power supply whose power-on transient is higher than 30V, 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 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.

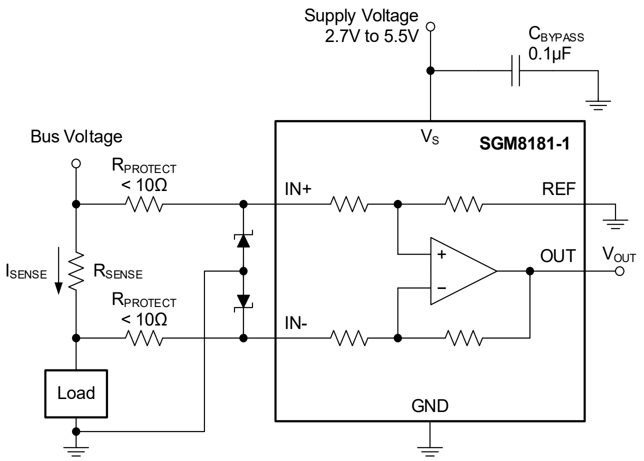


Figure 10. Using Dual Zener Diodes for Absorbing Supply Transient

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 11, 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 10 and Figure 11.

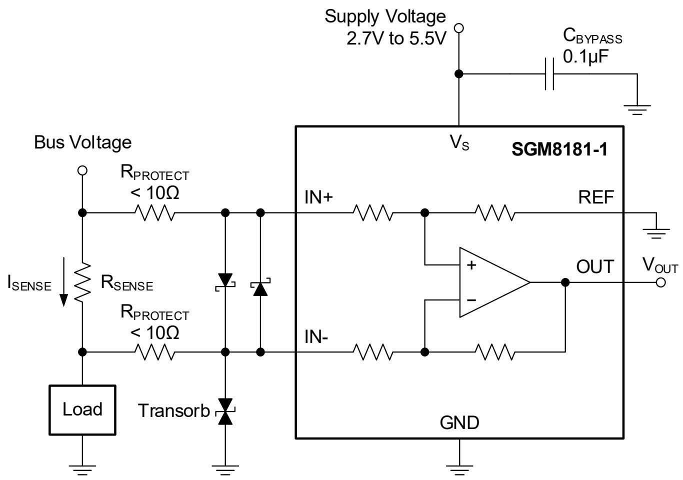


Figure 11. Using Transzorb and Input Clamps for Absorbing Supply Transient

Design Requirements

The requirement for low value current measurement is shown in the following table.

Table 3. Design Parameters

Design Parameter	Example Value
Power Supply Voltage, V_S	5V
Bus Supply Rail, V_{CM}	12V
R_{SENSE} Power Loss	< 450mW
Maximum Sense Current, I_{MAX}	±20A
Current Sensing Error	Less than 3.5% at maximum current, T_J = +25℃
Small-Signal Bandwidth	> 100kHz

APPLICATION INFORMATION (continued)

Detailed Design Procedure

The maximum allowable value for the current-sense resistor is determined by the maximum permissible power dissipation. Using Equation 2, this maximum value is calculated to be 1.125mΩ. Since this represents the upper limit for R_{SENSE}, a standard resistor value of 1mΩ is chosen, as it is the closest standard component satisfying the power constraint.

After that, engineers shall determine the best gain setting. R_{SENSE} can be scaled down when needed, preventing the output waveform from exceeding the rail voltage limits. Considering the bidirectional current measurement requirement of this scheme, users must feed a voltage between ground and V_S into the REF pin. With symmetric bidirectional currents of ±20A, the ideal reference voltage is V_S/2, or 2.5V. Setting V_{REF} to a lower level can also help maximize output swing when positive current exceeds negative current within the expected operating range. Using Equation 3 with I_{MAX} = 20A, R_{SENSE} = 1mΩ, and V_{REF} = 2.5V, the maximum current-sense gain to avoid positive output clipping is calculated as 123.5. Similarly, Equation 4 yields a maximum gain of 124.75 to prevent negative output saturation.

Power Supply Recommendations

The SGM8181-1 can accurately measure the current when the common mode voltage exceeds the power supply voltage presented at the V_S pin. For example, the V_S power supply can be 5V and the load or common mode power supply voltage is allowed to reach up to 30V. The output voltage range is limited by the level of the power supply.

Layout

Layout Guidelines

- The Kelvin or 4-wire connection should be taken into account between the shunt resistor and the input pins of the current-sense amplifier. The advantage of this kind of connection is to ensure that the measured resistance between IN+ and IN- is the shunt resistor only. The additional resistance would be detected if the poor routing is used. If the significant low resistance is taken into account as the shunt resistor, the output voltage will be significant high once the additional peak current takes place.

- The bypass capacitor should be close to the V_S pin and GND, and 0.1μF bypass capacitor is recommended. For the noisy or high-impedance power supply, additional decoupling capacitor can also be taken into account.

- Moreover, the trace between the shunt resistor and the input pins of SGM8181 should be short. Also, if the input filter is considered, please place it as close as possible to the IN+ and IN- pins of SGM8181-1.

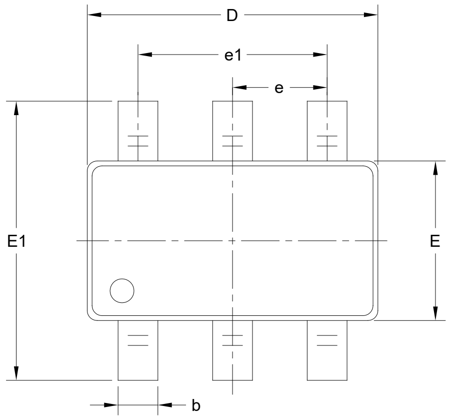
REVISION HISTORY

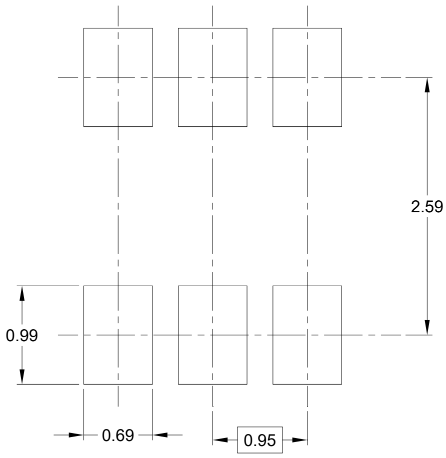
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (JULY 2026) to REV.A	Page
Changed from product preview to production data	All

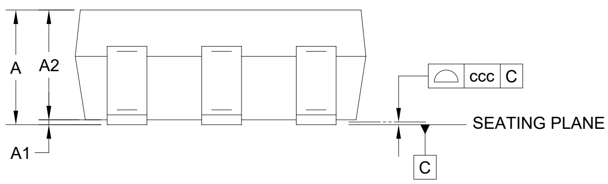
PACKAGE OUTLINE DIMENSIONS

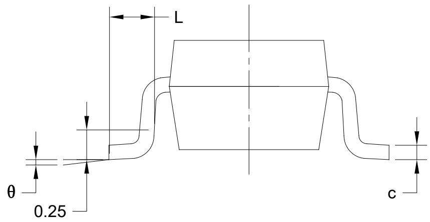
SOT-23-6





RECOMMENDED LAND PATTERN (Unit: mm)



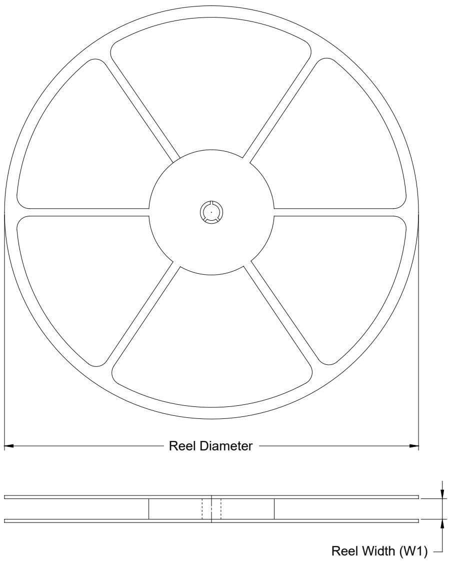


Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	-	-	1.450
A1	0.000	-	0.150
A2	0.900	-	1.300
b	0.300	-	0.500
c	0.080	-	0.220
D	2.750	-	3.050
E	1.450	-	1.750
E1	2.600	-	3.000
e	0.950 BSC		
e1	1.900 BSC		
L	0.300	-	0.600
θ	0°	-	8°
ccc	0.100		

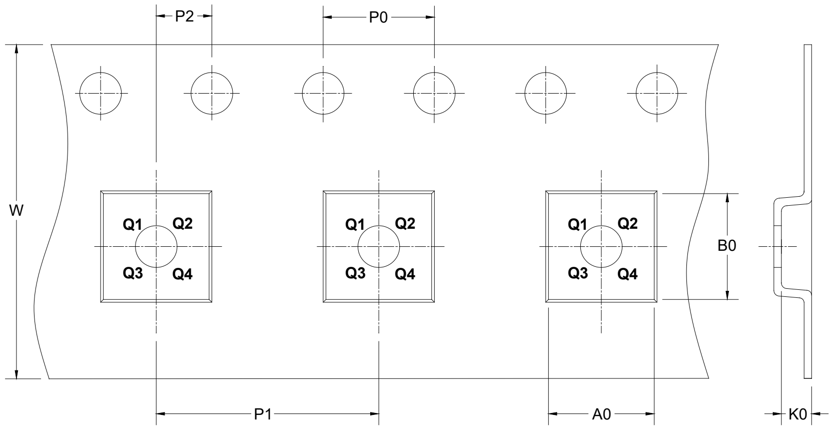
NOTES:
1. This drawing is subject to change without notice.
2. The dimensions do not include mold flashes, protrusions or gate burrs.
3. Reference JEDEC MO-178.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

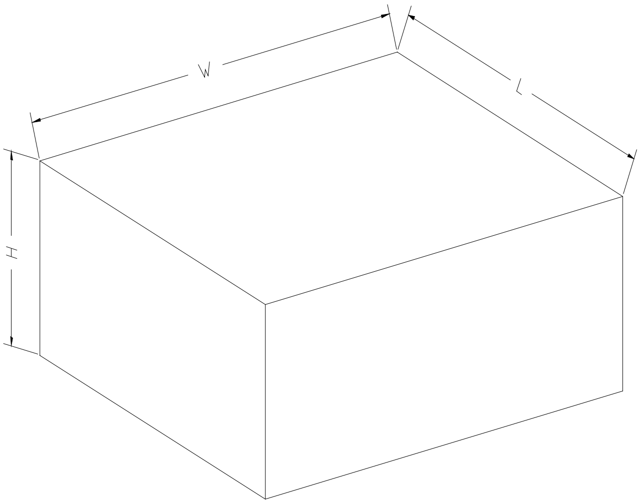
NOTE: The picture is only for reference. Please make the object as the standard.

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
SOT-23-6	7"	9.5	3.23	3.17	1.37	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