



SGM8477-1/SGM8477-3 1.8V to 5.5V, Low Noise, Zero-Drift Difference Amplifiers

GENERAL DESCRIPTION

The SGM8477-1/3 are low noise, high precision CMOS difference amplifiers, which are designed to support precision differential signal processing. These devices can operate from 1.8V to 5.5V single supply or $\pm 0.9V$ to $\pm 2.75V$ dual power supplies, and consume only 380 μA quiescent current. The supply current of SGM8477-3 is less than 0.5 μA in shutdown mode, when external MCU controls EN pin to logic "low".

The SGM8477-1/3 feature low noise, a 10 μV maximum input offset voltage and zero-drift over time and temperature. These devices are suitable in low voltage and low power systems. They support rail-to-rail input and output operation. Meanwhile, the SGM8477-1/3 fit in tiny packages. They are designed to provide high performance for sensing high-side and low-side current accurately, such as single battery voltage.

The SGM8477-1/3 save external components by integrated matched resistors in differential applications. They have different versions for gains of 50 and 300.

The SGM8477-1 is available in Green SC70-6 and UTQFN-1.8 \times 1.4-10L packages. The SGM8477-3 is available in a Green UTQFN-1.8 \times 1.4-10L package. They are all specified over $-40^{\circ}C$ to $+125^{\circ}C$ temperature range.

FEATURES

- **Low Input Offset Voltage: 10 μV (MAX)**
- **Low Drift: 0.02 $\mu V/^{\circ}C$ (TYP)**
- **Low 0.1Hz to 10Hz Noise: 250nV_{p-p}**
- **Low Noise: 10nV/ \sqrt{Hz} at 1kHz**
- **Integrated RFI Filter**
- **Rail-to-Rail Input and Output**
- **Single-Supply Operation**
- **Supply Voltage Range: 1.8V to 5.5V**
- **Quiescent Current: 380 μA (TYP)**
- **Shutdown Status Current: < 0.5 μA**
- **$-40^{\circ}C$ to $+125^{\circ}C$ Operating Temperature Range**
- **Small Packaging:**
 - **SGM8477-1 is Available in Green SC70-6 and UTQFN-1.8 \times 1.4-10L Packages**
 - **SGM8477-3 is Available in a Green UTQFN-1.8 \times 1.4-10L Package**

APPLICATIONS

Industrial Equipment
Battery-Powered Equipment
Sensor Signal Conditioning

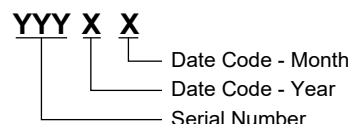
PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8477-1B (Gain = 50)	SC70-6	-40°C to +125°C	SGM8477-1BXC6G/TR	G10XX	Tape and Reel, 3000
	UTQFN-1.8×1.4-10L	-40°C to +125°C	SGM8477-1BXUWQ10G/TR	I6XX	Tape and Reel, 3000
SGM8477-1G (Gain = 300)	SC70-6	-40°C to +125°C	SGM8477-1GXC6G/TR	GHFXX	Tape and Reel, 3000
	UTQFN-1.8×1.4-10L	-40°C to +125°C	SGM8477-1GXUWQ10G/TR	I4XX	Tape and Reel, 3000
SGM8477-3B (Gain = 50)	UTQFN-1.8×1.4-10L	-40°C to +125°C	SGM8477-3BXUWQ10G/TR	I7XX	Tape and Reel, 3000
SGM8477-3G (Gain = 300)	UTQFN-1.8×1.4-10L	-40°C to +125°C	SGM8477-3GXUWQ10G/TR	I5XX	Tape and Reel, 3000

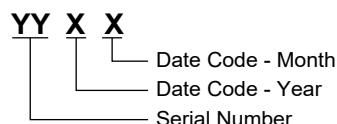
MARKING INFORMATION

NOTE: XX = Date Code.

SC70-6



UTQFN-1.8×1.4-10L



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.....	6V
Input Common Mode Voltage Range	
.....	(-V _S) - 0.3V to (+V _S) + 0.3V
Junction Temperature.....	+150°C
Storage Temperature Range.....	-65°C to +150°C
Lead Temperature (Soldering 10sec).....	+260°C
ESD Susceptibility	
HBM.....	4000V
MM.....	400V
CDM.....	1000V

RECOMMENDED OPERATING CONDITIONS

Specified Voltage Range.....	1.8V to 5.5V
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.

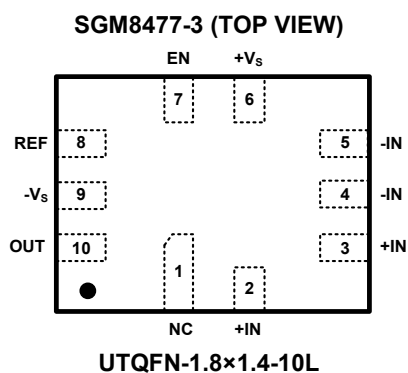
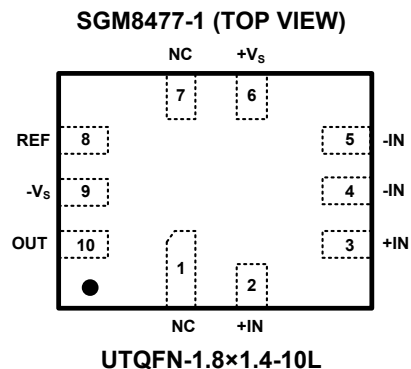
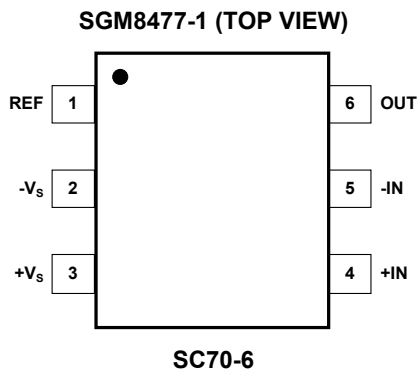
ESD SENSITIVITY CAUTION

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 CONFIGURATIONS



ELECTRICAL CHARACTERISTICS

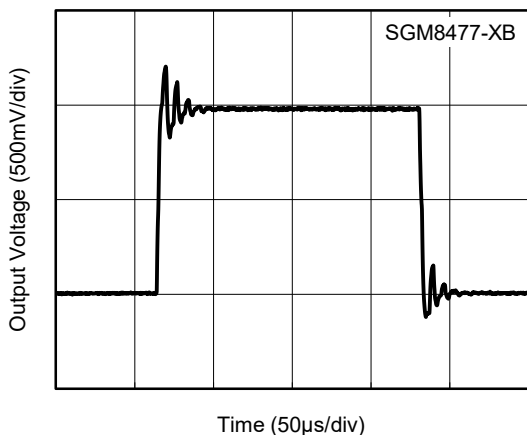
(At $T_A = +25^\circ\text{C}$, $+V_S = 1.8\text{V}$ to 5.5V , $-V_S = 0\text{V}$, $V_{CM} = +V_S/2$, $V_{REF} = +V_S/2$ and $R_L = 10\text{k}\Omega$, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics					
Input Offset Voltage (V_{OS})	$+V_S = 5\text{V}$		3	10	μV
	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$			12	
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta T$)	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		0.02		$\mu\text{V}/^\circ\text{C}$
Input Common Mode Voltage Range (V_{CM})		$-V_S$		$+V_S$	V
Common Mode Rejection Ratio (CMRR)	$(-V_S) < V_{CM} < (+V_S)$	89	108		dB
	$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	84			
	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	58			
Output Characteristics					
Output Voltage Swing from Rail	$R_L = 10\text{k}\Omega$		6	21	mV
	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$			23	
Short-Circuit Current (I_{SC})	$+V_S = 1.8\text{V}$		12		mA
	$+V_S = 5\text{V}$		50		
Power Supply					
Specified Voltage Range (V_S)		1.8		5.5	V
Power Supply Rejection Ratio (PSRR)	$+V_S = 1.8\text{V}$ to 5.5V		1	4	$\mu\text{V}/\text{V}$
	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$			6	
Quiescent Current (I_Q)	$I_{OUT} = 0\text{mA}$, EN = 1.8V (active), $+V_S = 5\text{V}$		380	530	μA
	$I_{OUT} = 0\text{mA}$, EN = 0V (shutdown), $+V_S = 5\text{V}$, SGM8477-3 only		0.2	0.5	
Turn-On Time	$+V_S = 5\text{V}$		100		μs
Dynamic Performance					
-3dB Bandwidth (BW_{-3})	$C_L = 50\text{pF}$, Gain = +50		150		kHz
	$C_L = 50\text{pF}$, Gain = +300		32		
Slew Rate (SR)	$+V_S = 5\text{V}$, Gain = +50		0.4		V/ μs
	$+V_S = 5\text{V}$, Gain = +300		0.15		
Noise					
Input Voltage Noise	$f = 0.1\text{Hz}$ to 10Hz		250		nV_{P-P}
Input Voltage Noise Density (e_n)	$f = 1\text{kHz}$		10		$\text{nV}/\sqrt{\text{Hz}}$
Enable Control (SGM8477-3 Only)					
Input Logic High Voltage (V_{IH})		$(-V_S) + 1.8$			V
Input Logic Low Voltage (V_{IL})				$(-V_S) + 0.4$	V
EN Input Bias Current	$V_{EN} = +V_S$ or $V_{EN} = -V_S$	-0.4		0.4	μA
Gain					
Gain Error	$(-V_S) + 0.1\text{V} \leq V_{OUT} \leq (+V_S) - 0.1\text{V}$, Gain = +50		0.01	0.2	%
	$(-V_S) + 0.1\text{V} \leq V_{OUT} \leq (+V_S) - 0.1\text{V}$, Gain = +300		0.01	0.3	
Gain Temperature Coefficient	$(-V_S) + 0.1\text{V} \leq V_{OUT} \leq (+V_S) - 0.1\text{V}$, Gain = +50		2		ppm/ $^\circ\text{C}$
	$(-V_S) + 0.1\text{V} \leq V_{OUT} \leq (+V_S) - 0.1\text{V}$, Gain = +300		7		

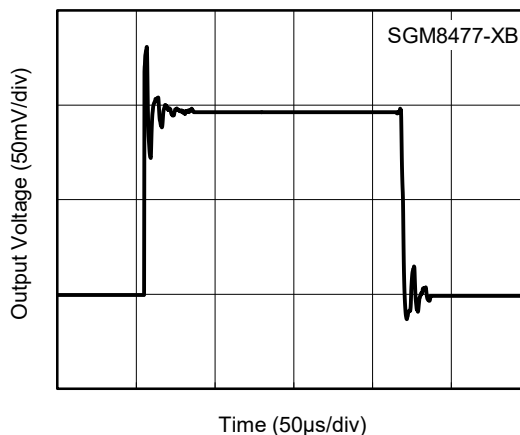
TYPICAL PERFORMANCE CHARACTERISTICS

+V_S = 5V, T_A = +25°C, unless otherwise noted.

Large-Signal Step Response



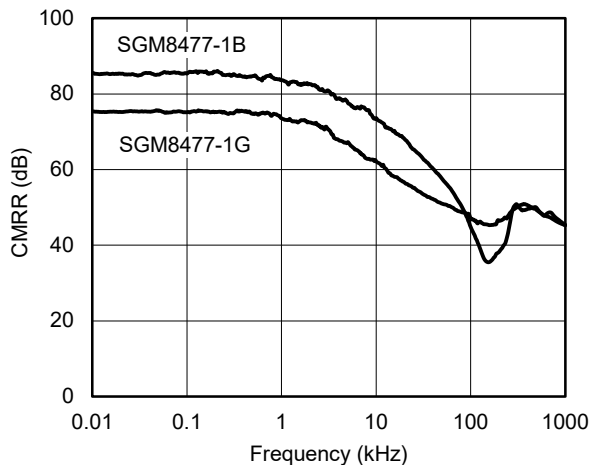
Small-Signal Step Response



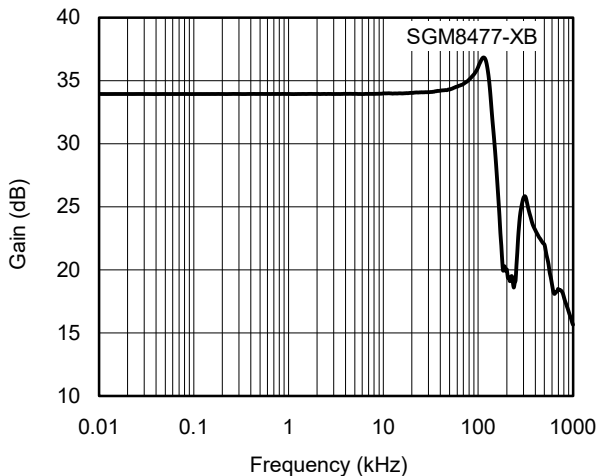
Large-Signal Step Response



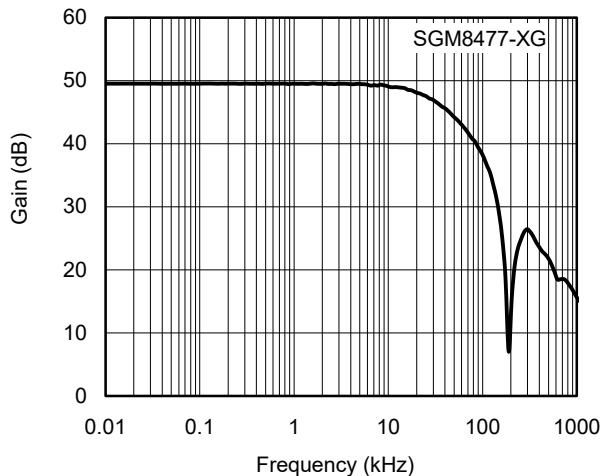
Common Mode Rejection Ratio vs. Frequency



Small-Signal Gain vs. Frequency

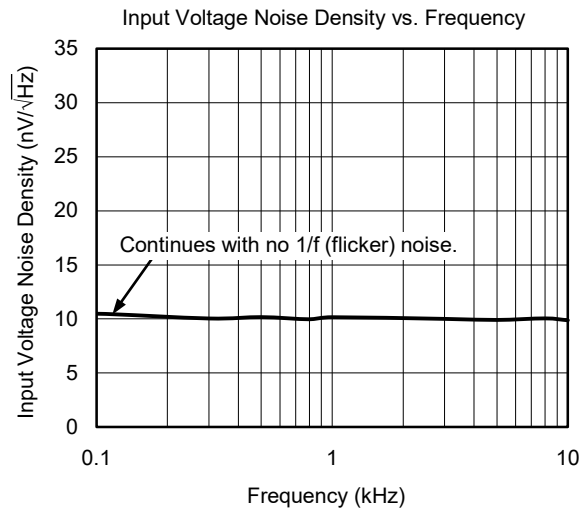
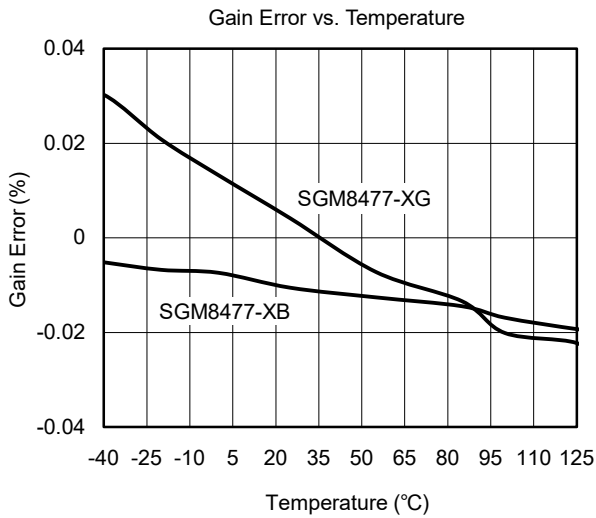
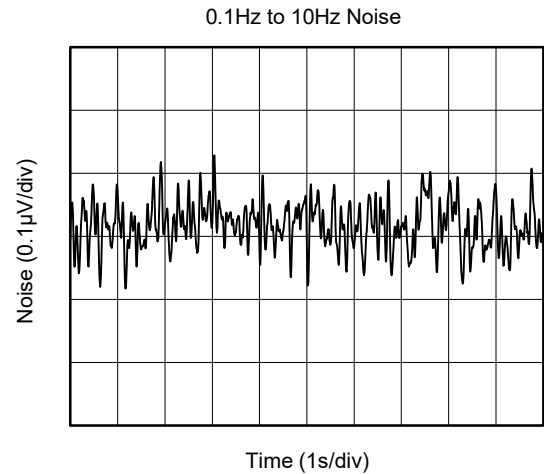
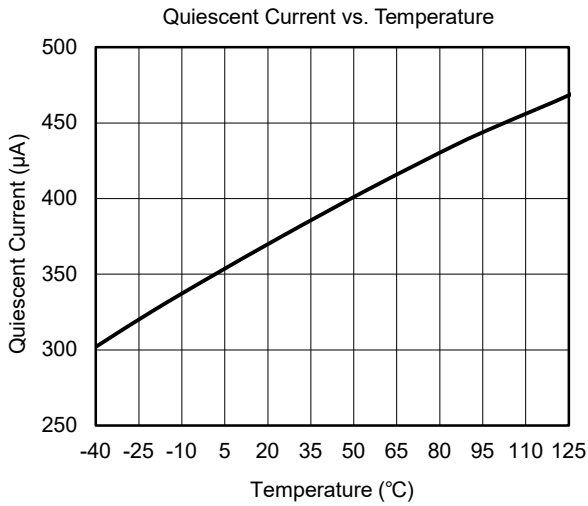
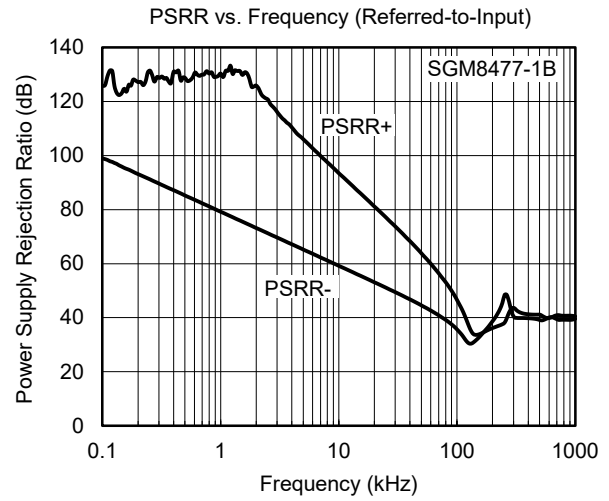
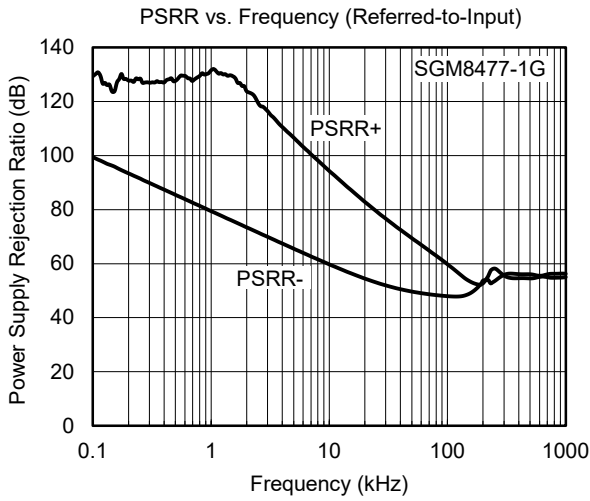


Small-Signal Gain vs. Frequency



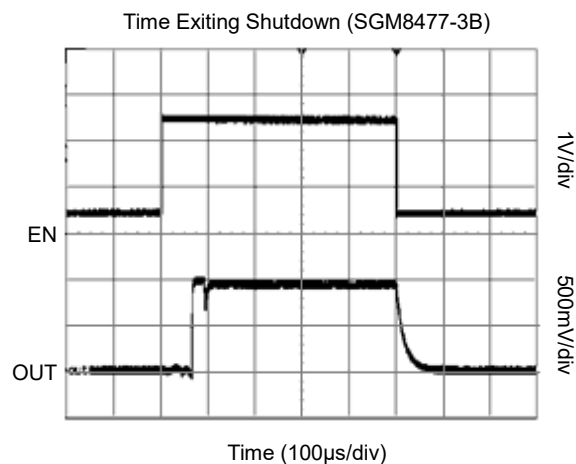
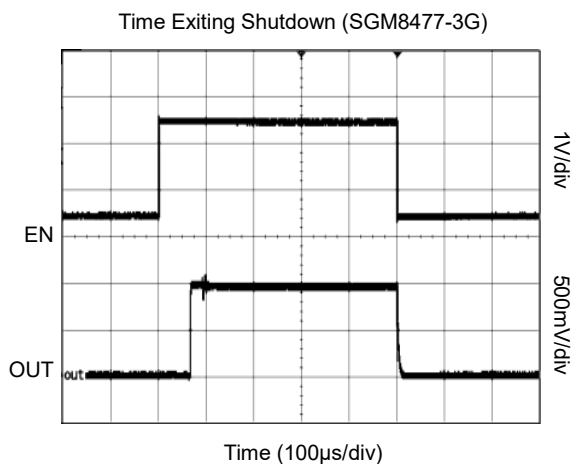
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

+V_S = 5V, T_A = +25°C, unless otherwise noted.

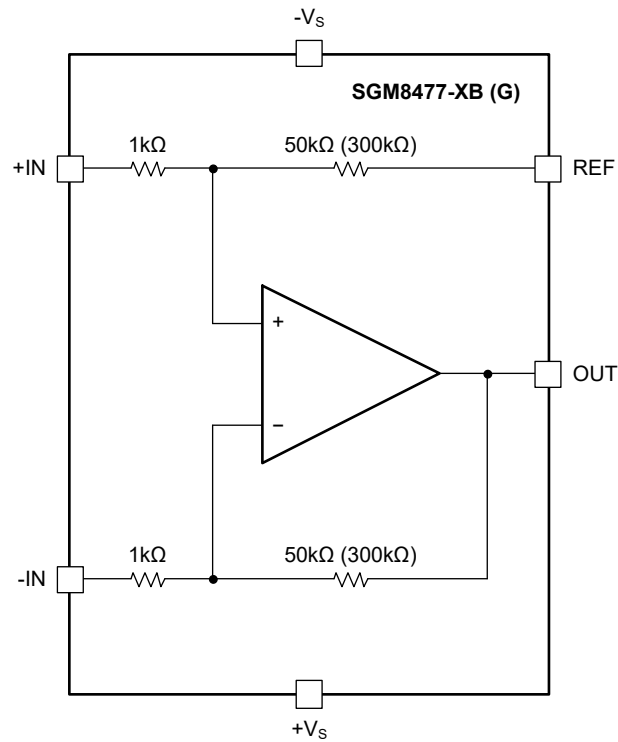


TYPICAL PERFORMANCE CHARACTERISTICS (continued)

+V_S = 5V, T_A = +25°C, unless otherwise noted.



FUNCTIONAL BLOCK DIAGRAM



"(") are for SGM8477-XG only.

APPLICATION INFORMATION

The offset voltage and the output voltage drift of the SGM8477-1/3 is significant low. To achieve a better performance of low offset voltage and precision measurement, the layout and the mechanical condition should be taken into account at first. The operator should be careful when they use the thermocouple junctions formed from connecting the dissimilar conductors as it can produce the thermoelectric (Seebeck) effects. The potentials of thermal generation can be decreased by guaranteeing that the mechanical conditions of both input terminals are equal. The following conditions should be always taken into account:

- To avoid the condition of dissimilar metals, the SGM8477-1/3 should be used in the situation where the thermoelectric-coefficient is low.
- The external mechanical components should be taken into account to isolate any thermal conditions from power supply or other components.
- The difference amplifier and input circuitry should be shielded from any currents of air, for instance, the cooling fans.

The above guidelines can significantly reduce the possibility that the junctions are operated at the different temperatures, which may cause $0.02\mu\text{V}/^\circ\text{C}$ or higher voltage level of thermoelectric.

Operating Voltage

The supported power supply of SGM8477-1/3 is from 1.8V to 5.5V for single supply or $\pm 0.9\text{V}$ to $\pm 2.75\text{V}$ for dual power supplies. If the supply voltage is higher than 6V (absolute maximum voltage), the device can permanently be damaged.

Enable Control

For SGM8477-3, if EN pin is floating or logic "high", SGM8477-3 is in active status; when EN pin is logic "low", SGM8477-3 will enter into shutdown status.

General Layout Guidelines

A good layout for SGM8477-1/3 is required. For the PCB layout, the trace of the board should be short, the GND plane should be taken into account, and the surface-mount devices should be placed close to the pins of SGM8477-1/3. The $0.1\mu\text{F}$ capacitor should be placed as close as possible to the supply pin. The above recommendations should be taken into account to reduce the effect of EMI (electromagnetic interference). The susceptibility of the difference amplifier can be varied by the RFI (radio frequency interference). RFI can be defined as the shift of the DC voltage level or offset voltage of the device by varying the interfering RF signal. For SGM8477-1/3, the susceptibility and the sensitivity of the RF signal is extreme low. However, if the level of the radio frequency signal is strong, the offset voltage of the SGM8477-1/3 will be varied. The application in Figure 1 illustrates the condition of thermocouple signal.

The application of measuring current for low common mode voltage side is illustrated in Figure 2. For achieving the maximum accuracy of the 16-bit ADC, a precision voltage reference is significant. Figure 3~4 illustrate the applications of the thermistor measurement and the precision instrumentation amplifier.

APPLICATION INFORMATION (continued)

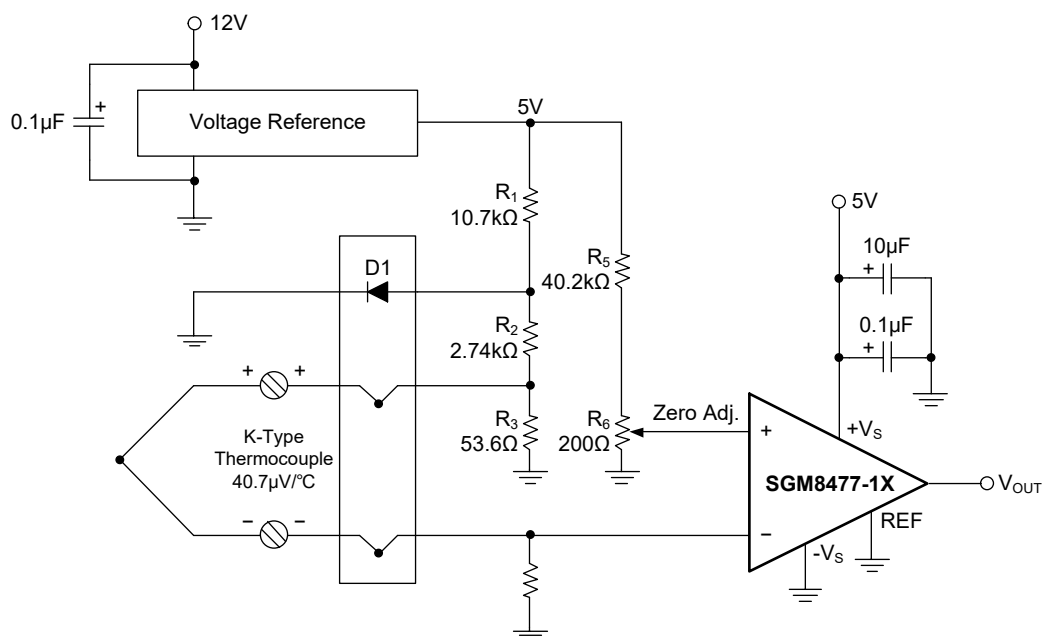


Figure 1. Thermocouple Temperature Measuring Circuit

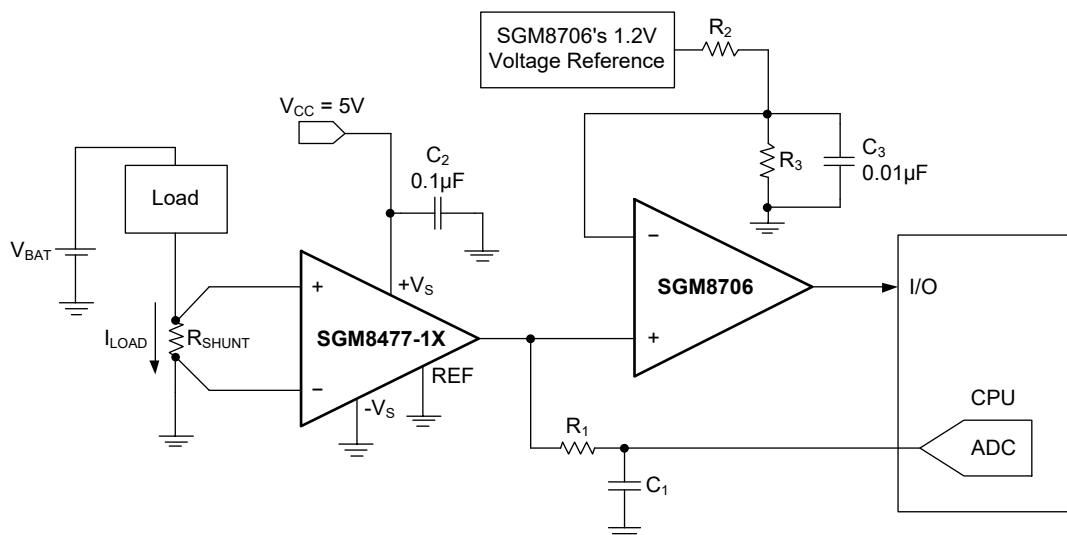


Figure 2. Accurate Low-side Current Sensing

APPLICATION INFORMATION (continued)

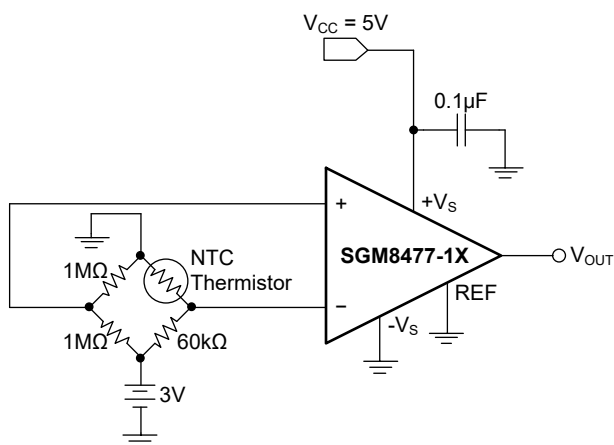


Figure 3. Thermistor Measurement

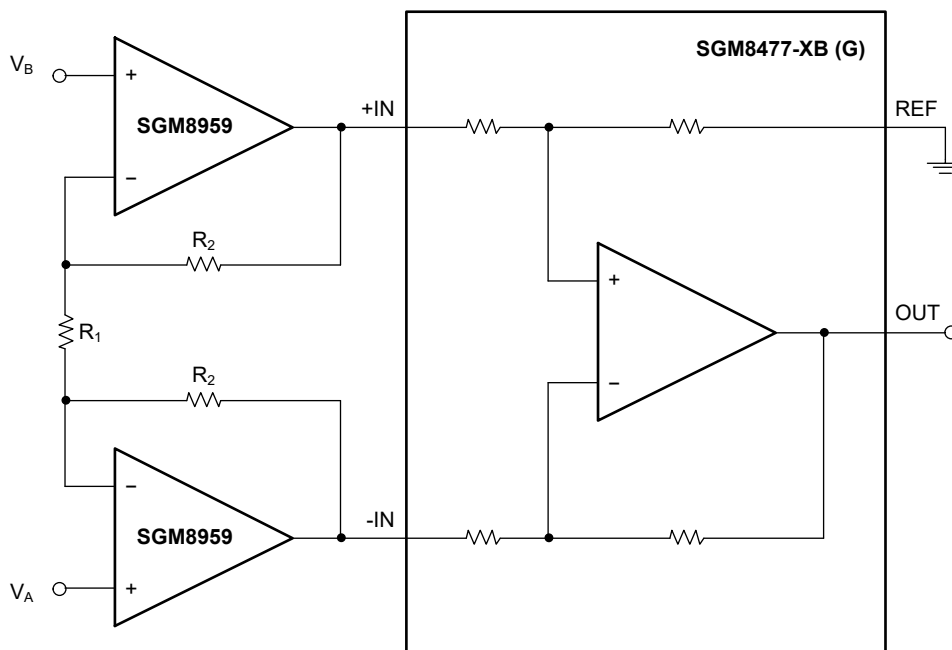


Figure 4. Precision Instrumentation Amplifier

REVISION HISTORY

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

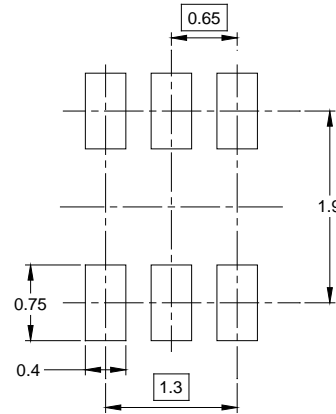
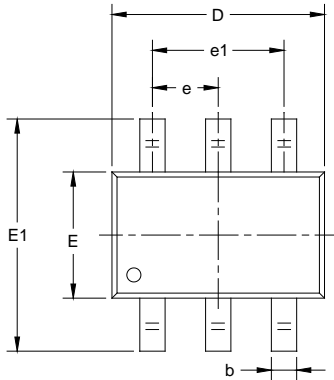
JULY 2023 – REV.A.1 to REV.A.2	Page
Updated Package Outline Dimensions section	13

JULY 2022 – REV.A to REV.A.1	Page
Updated Typical Performance Characteristics section	6

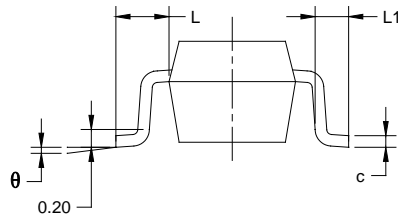
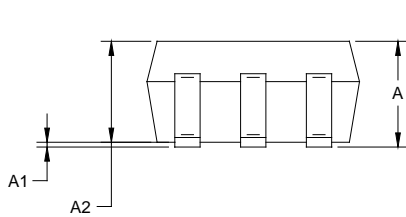
Changes from Original (MAY 2017) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

SC70-6



RECOMMENDED LAND PATTERN (Unit: mm)

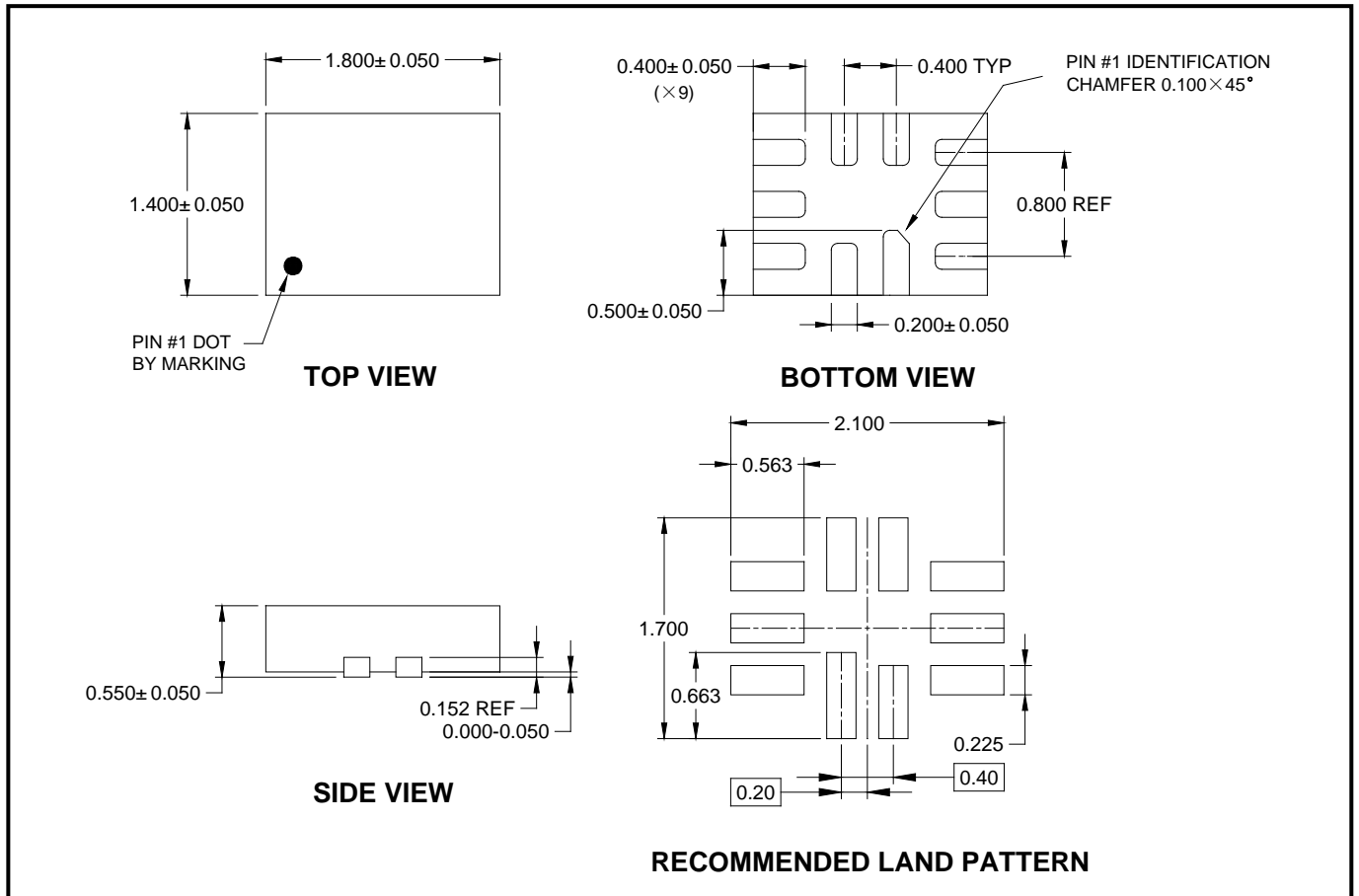


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.220	0.003	0.009
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026 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°

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

PACKAGE OUTLINE DIMENSIONS

UTQFN-1.8x1.4-10L



NOTES:

1. All linear dimensions are in millimeters.
2. This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



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

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SC70-6	7"	9.5	2.40	2.50	1.20	4.0	4.0	2.0	8.0	Q3
UTQFN-1.8×1.4-10L	7"	9.0	1.75	2.10	0.70	4.0	4.0	2.0	8.0	Q1

DD0001

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