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

GENERAL DESCRIPTION

The SGM8477-1/3 CMOS difference amplifiers provide very low offset voltage, low noise and zero-drift over time and temperature for precision differential signal processing.

The miniature, high-precision, low quiescent current amplifiers offer rail-to-rail input and output. Single or dual supplies as low as +1.8V (±0.9V) and up to +5.5V (±2.75V) may be used. It is optimized for low voltage operation.

SGM8477-1/3 are high performance amplifiers for accurate high-side and low-side current sensing, such as single battery voltage. SGM8477-3 can enter into shutdown status (I_Q < 0.5μA) when EN pin is logical "low", controlled by the external MCU.

Integrated matched resistors for differential application save external components. The SGM8477-1/3 have different versions for gains of 50 and 300.

The SGM8477-1 is available in Green SC70-6 and UTQFN-1.8×1.4-10L packages. The SGM8477-3 is available in Green UTQFN-1.8×1.4-10L package. They are all specified over -40℃ to +125℃ temperature range.

FEATURES

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

APPLICATIONS

Transducer Applications
Temperature Measurements
Electronic Scales
Medical Instrumentation
Battery-Powered Instrument
Handheld Test Equipment

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8477-1B (Gain = 50)	SC70-6	-40℃ to +125℃	SGM8477-1BXC6G/TR	GI0XX	Tape and Reel, 3000
	UTQFN-1.8×1.4-10L	-40℃ to +125℃	SGM8477-1BXUWQ10G/TR	I6XX	Tape and Reel, 3000
SGM8477-1G (Gain = 300)	SC70-6	-40℃ to +125℃	SGM8477-1GXC6G/TR	GHFXX	Tape and Reel, 3000
	UTQFN-1.8×1.4-10L	-40℃ to +125℃	SGM8477-1GXUWQ10G/TR	I4XX	Tape and Reel, 3000
SGM8477-3B (Gain = 50)	UTQFN-1.8×1.4-10L	-40℃ to +125℃	SGM8477-3BXUWQ10G/TR	I7XX	Tape and Reel, 3000
SGM8477-3G (Gain = 300)	UTQFN-1.8×1.4-10L	-40℃ to +125℃	SGM8477-3GXUWQ10G/TR	I5XX	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.

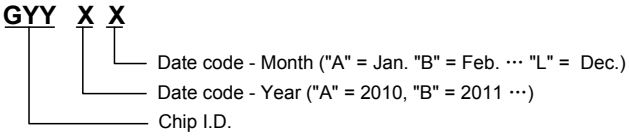
ABSOLUTE MAXIMUM RATINGS

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

RECOMMENDED OPERATING CONDITIONS

Specified Voltage Range ..... 1.8V to 5.5V
Operating Temperature Range ..... -40℃ to +125℃

MARKING INFORMATION



For example: GI0FA (2015, January)

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

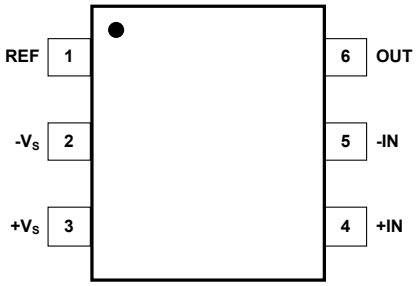
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

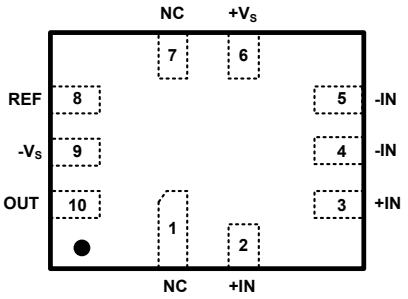
PIN CONFIGURATIONS

SGM8477-1 (TOP VIEW)



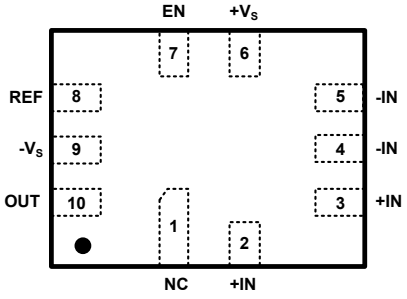
SC70-6

SGM8477-1 (TOP VIEW)



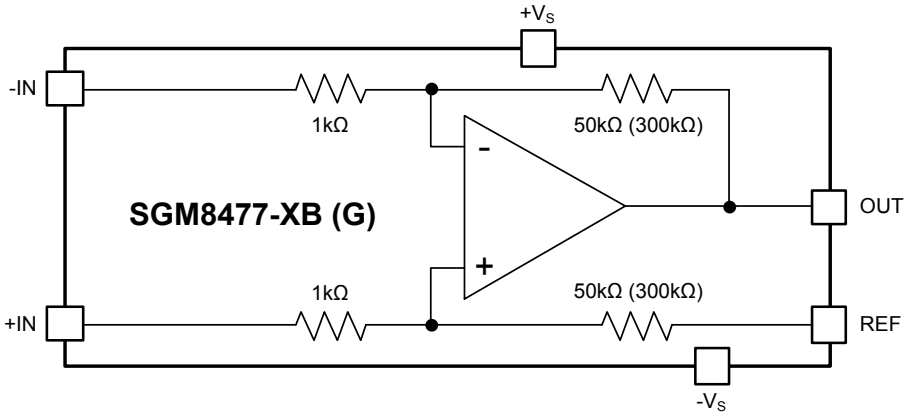
UTQFN-1.8×1.4-10L

SGM8477-3 (TOP VIEW)



UTQFN-1.8×1.4-10L

FUNCTIONAL BLOCK DIAGRAM



"( )" ARE FOR SGM8477-XG ONLY.

ELECTRICAL CHARACTERISTICS

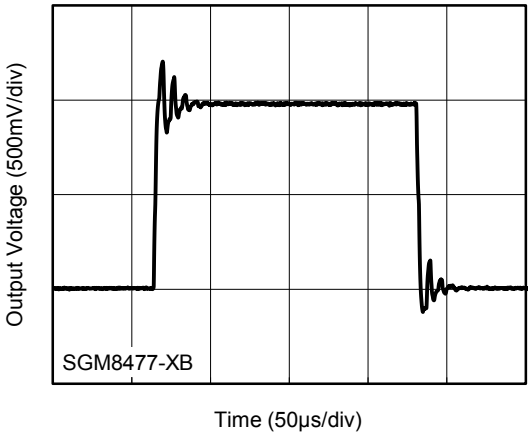
(At T_A = +25℃, $+V_S$ = 1.8V to 5.5V, $-V_S$ = 0V, V_{CM} = $+V_S$/2, V_{REF} = $+V_S$/2 and R_L = 10kΩ, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS					
Input Offset Voltage (V_{OS})	$+V_S$ = 5V		3	10	μV
	-40℃ ≤ T_A ≤ +125℃			12	
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta T$)	-40℃ ≤ T_A ≤ +125℃		0.02		μV/℃
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℃ ≤ T_A ≤ +85℃	84			
	-40℃ ≤ T_A ≤ +125℃	58			
OUTPUT CHARACTERISTICS					
Output Voltage Swing from Rail	R_L = 10kΩ		6	21	mV
	-40℃ ≤ T_A ≤ +125℃			23	
Short-Circuit Current (I_{SC})	$+V_S$ = 1.8V		12		mA
	$+V_S$ = 5V		50		
POWER SUPPLY					
Specified Voltage Range (V_S)		1.8		5.5	V
Power Supply Rejection Ratio (PSRR)	$+V_S$ = 1.8V to 5.5V		1	4	μV/V
	-40℃ ≤ T_A ≤ +125℃			6	
Quiescent Current (I_Q)	I_O = 0, EN = 1.8V (active), $+V_S$ = 5V		380	530	μA
	I_O = 0, EN = 0V (shutdown), $+V_S$ = 5V, SGM8477-3 only		0.2	0.5	
Turn-On Time	$+V_S$ = 5V		100		μs
DYNAMIC PERFORMANCE					
-3dB Bandwidth (BW_{-3})	C_L = 50pF, Gain = +50		150		kHz
	C_L = 50pF, Gain = +300		32		kHz
Slew Rate (SR)	$+V_S$ = 5V, Gain = +50		0.4		V/μs
	$+V_S$ = 5V, Gain = +300		0.15		
NOISE					
Input Voltage Noise	f = 0.1Hz to 10Hz		250		nV_{P-P}
Input Voltage Noise Density (e_n)	f = 1kHz		10		$nV/\sqrt{Hz}$
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	($-V_S$) + 0.1V ≤ V_{OUT} ≤ ($+V_S$) - 0.1V, Gain = +50		0.01	0.2	%
	($-V_S$) + 0.1V ≤ V_{OUT} ≤ ($+V_S$) - 0.1V, Gain = +300		0.01	0.3	%
Gain Temperature Coefficient	($-V_S$) + 0.1V ≤ V_{OUT} ≤ ($+V_S$) - 0.1V, Gain = +50		2		ppm/℃
	($-V_S$) + 0.1V ≤ V_{OUT} ≤ ($+V_S$) - 0.1V, Gain = +300		7		ppm/℃

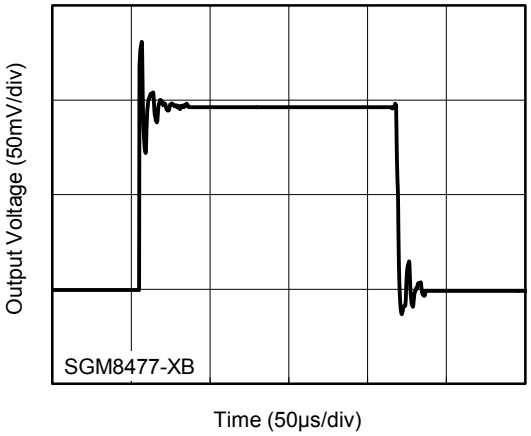
TYPICAL PERFORMANCE CHARACTERISTICS

$+V_S$ = 5V, T_A = +25℃, unless otherwise noted.

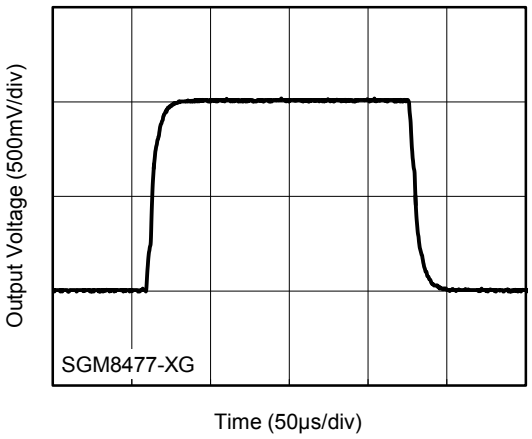
Large-Signal Step Response



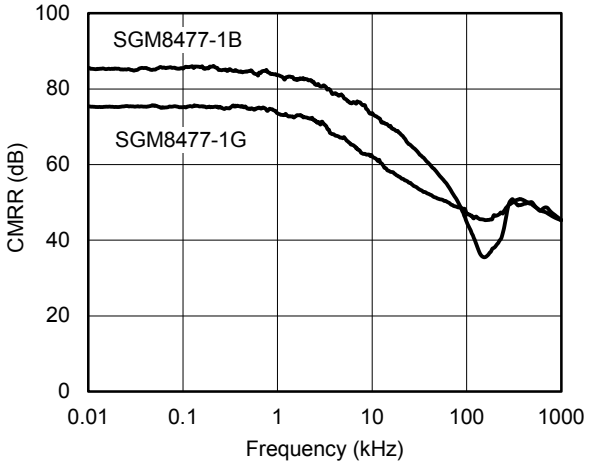
Small-Signal Step Response



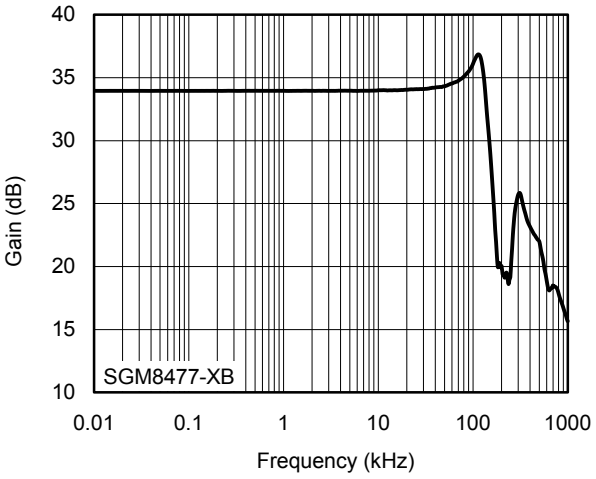
Large-Signal Step Response



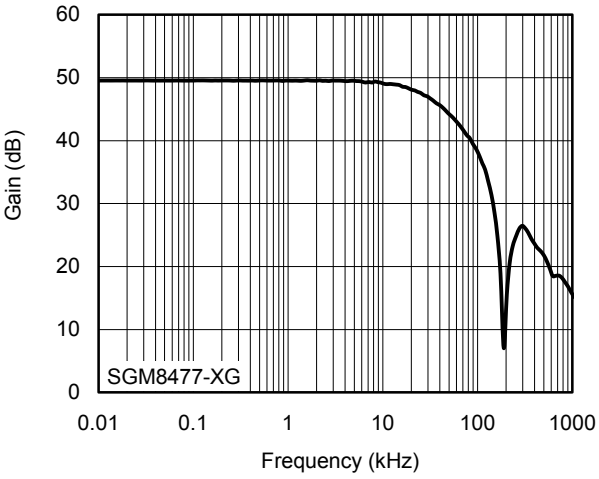
Common Mode Rejection Ratio vs. Frequency



Small-Signal Gain vs. Frequency



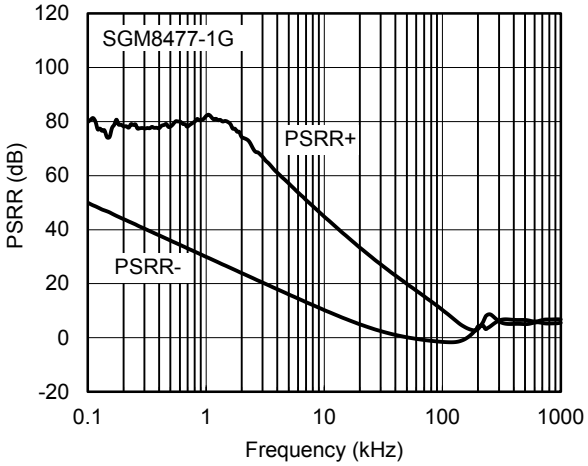
Small-Signal Gain vs. Frequency



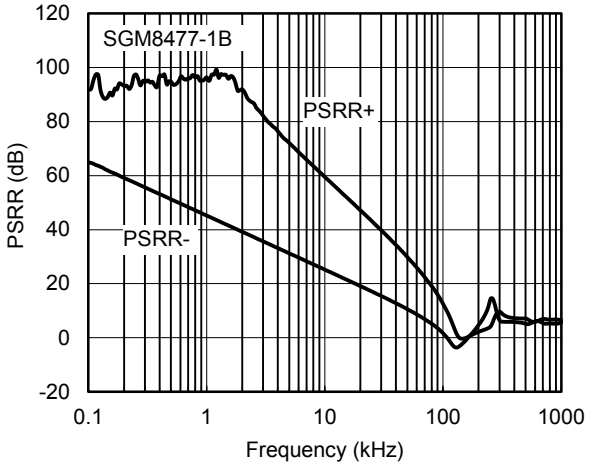
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

$+V_S$ = 5V, T_A = +25℃, unless otherwise noted.

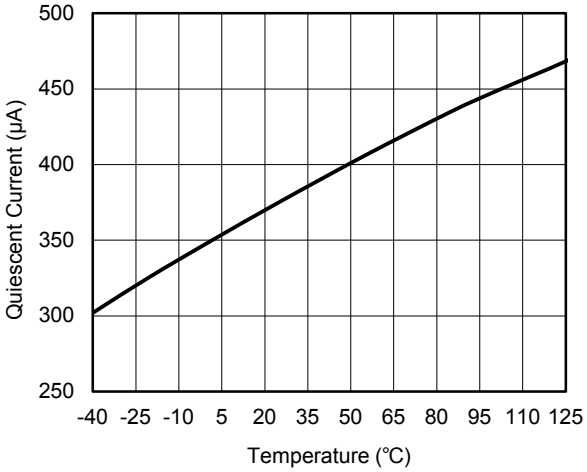
Power Supply Rejection Ratio vs. Frequency



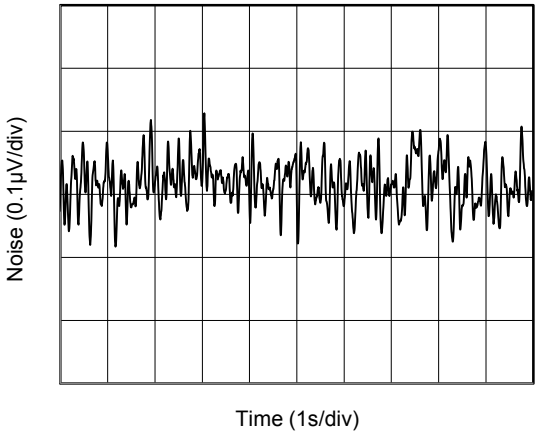
Power Supply Rejection Ratio vs. Frequency



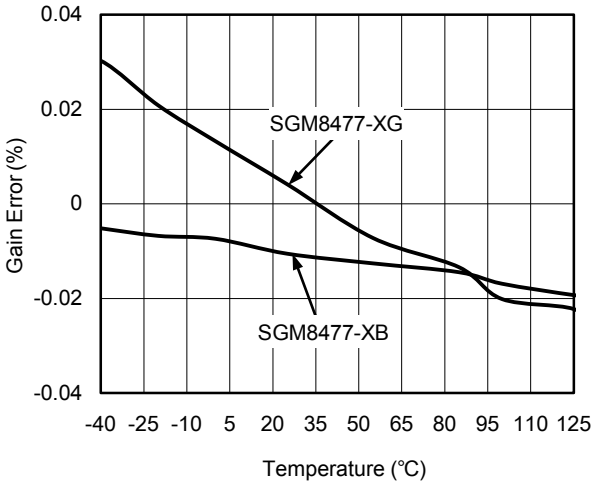
Quiescent Current vs. Temperature



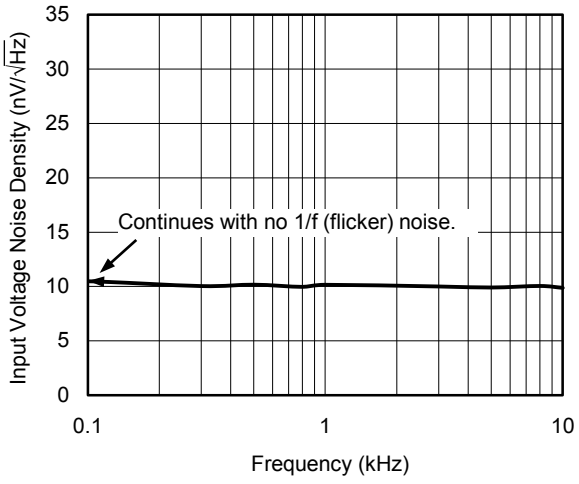
0.1Hz to 10Hz Noise



Gain Error vs. Temperature



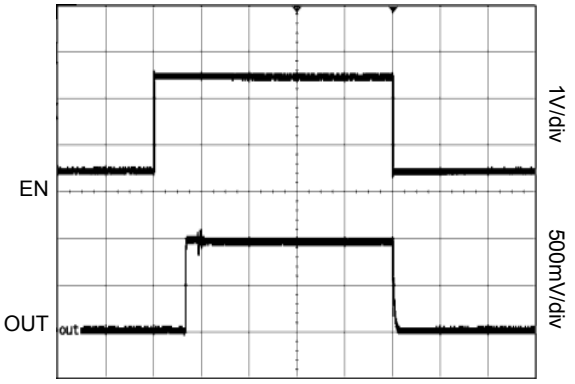
Input Voltage Noise Density vs. Frequency



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

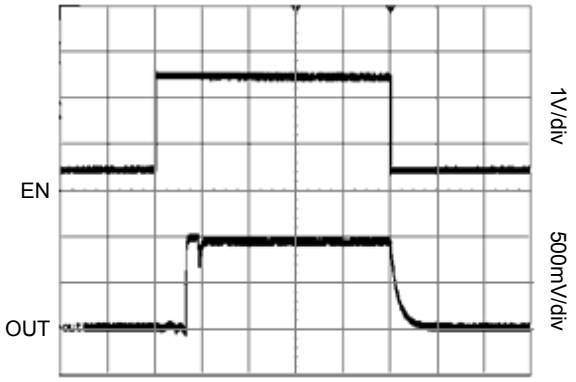
$+V_S$ = 5V, T_A = +25℃, unless otherwise noted.

Time Exiting Shutdown (SGM8477-3G)



Time (100μs/div)

Time Exiting Shutdown (SGM8477-3B)



Time (100μs/div)

APPLICATION INFORMATION

The SGM8477-1/3 provide low offset voltage and very low drift over time and temperature. For lowest offset voltage and precision performance, circuit layout and mechanical conditions should be optimized. Avoid temperature gradients that create thermoelectric (Seebeck) effects in the thermocouple junctions formed from connecting dissimilar conductors. These thermally-generated potentials can be made to cancel by assuring they are equal on both input terminals. Other layout and design considerations include:

• Use low thermoelectric-coefficient conditions (avoid dissimilar metals).
• Thermally isolate components from power supplies or other heat sources.
• Shield difference amplifier and input circuitry from air currents, such as cooling fans.

Following these guidelines will reduce the likelihood of junctions being at different temperatures, which can cause thermoelectric voltages of 0.02μV/℃ or higher, depending on materials used.

Operating Voltage

The SGM8477-1/3 difference amplifiers operate over a power supply range of +1.8V to +5.5V (or ±0.9V to ±2.75V). Supply voltages higher than +6V (absolute maximum) can permanently damage the device.

Enable Control

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

General Layout Guidelines

Attention to good layout practices is always recommended. Keep traces short and, when possible, use a printed circuit board (PCB) ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1μF capacitor closely across the supply pins. These guidelines should be applied throughout the analog circuit to improve performance and provide benefits such as reducing the EMI (electromagnetic-interference) susceptibility. Difference amplifiers vary in their susceptibility to radio frequency interference (RFI). RFI can generally be identified as a variation in offset voltage or DC signal levels with changes in the interfering RF signal. The SGM8477-1/3 have been specifically designed to minimize susceptibility to RFI and demonstrate remarkably low sensitivity. Strong RF fields may still cause varying offset levels. The circuit in Figure 1 is for thermocouple signal condition.

A low-side current shunt monitor is shown in Figure 2. R_N are operational resistors used to isolate the ADC from the noise of the digital I^2C bus. Since the ADC is a 16-bit converter, a precision reference is essential for maximum accuracy. Related application circuits are shown in Figures 3 ~ 4.

APPLICATION INFORMATION (continued)

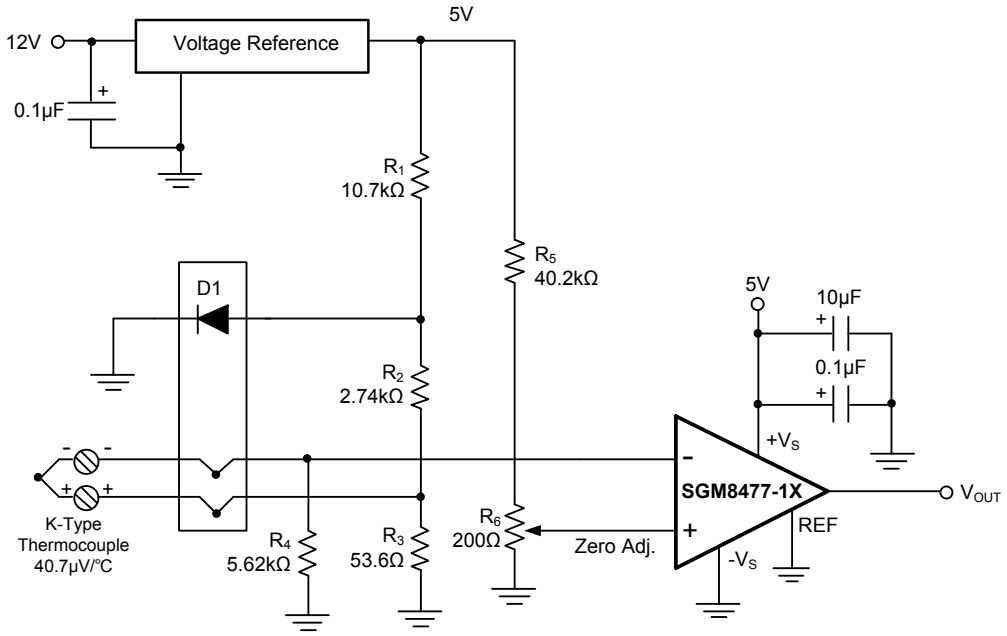


Figure 1. Thermocouple Temperature Measuring Circuit

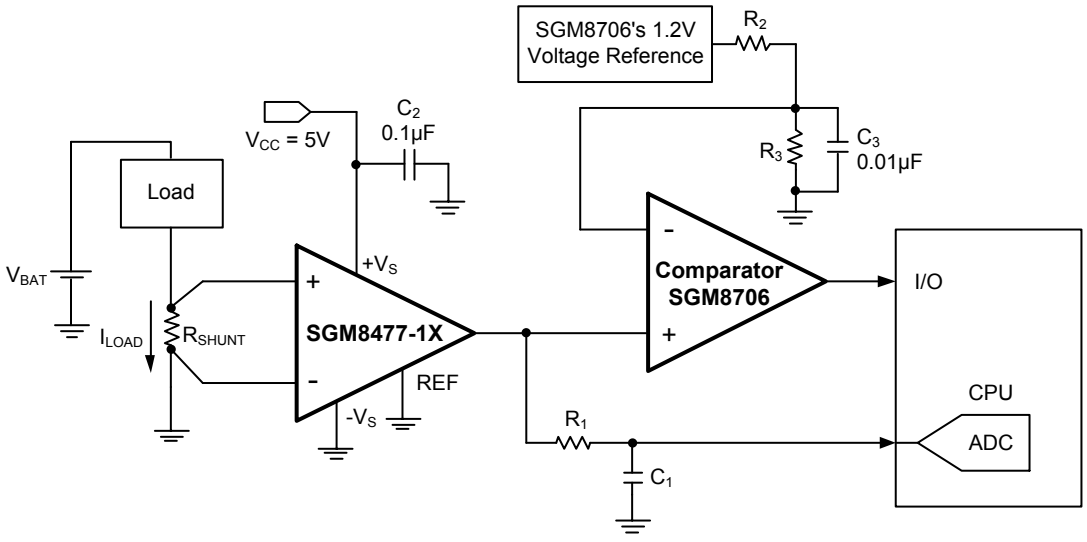


Figure 2. Accurate Low-side Current Sensing

APPLICATION INFORMATION (continued)

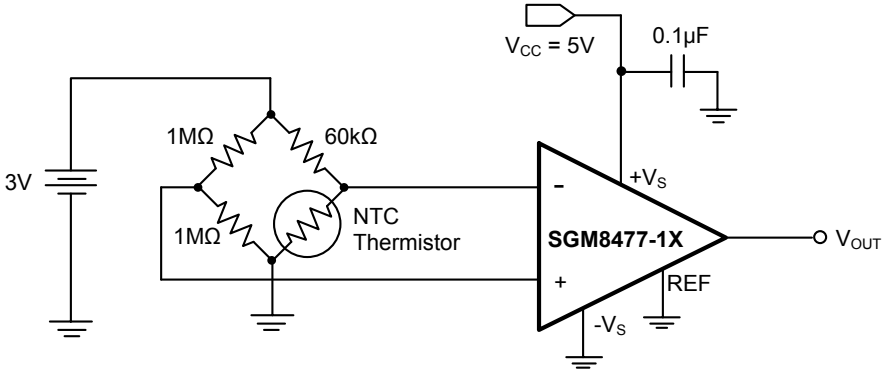


Figure 3. Thermistor Measurement

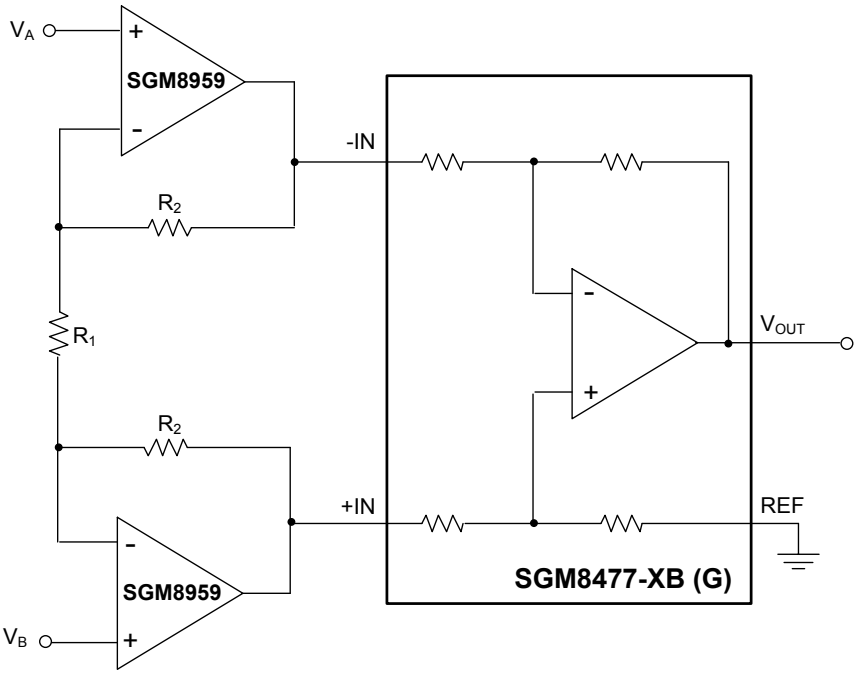


Figure 4. Precision Instrumentation Amplifier

REVISION HISTORY

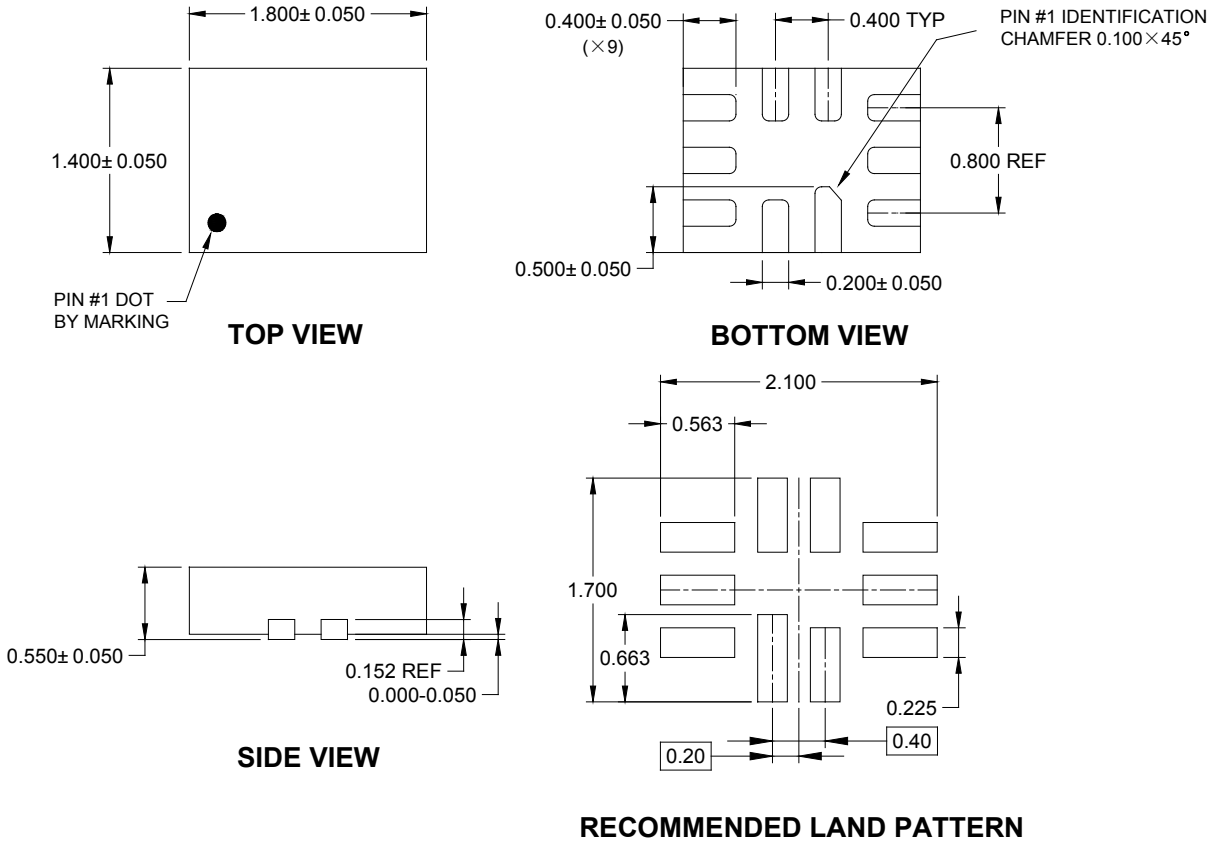
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (MAY 2017) to REV.A

Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

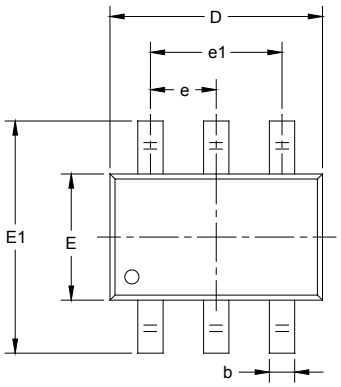
UTQFN-1.8×1.4-10L

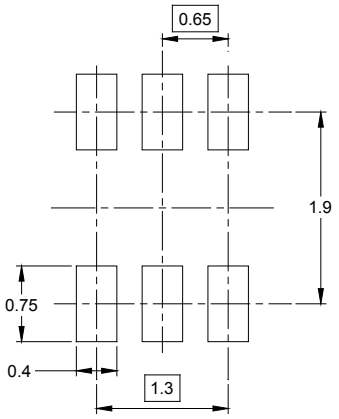


NOTE: All linear dimensions are in millimeters.

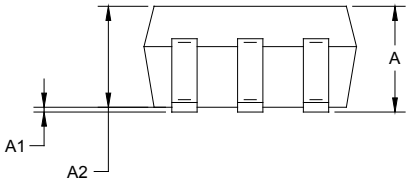
PACKAGE OUTLINE DIMENSIONS

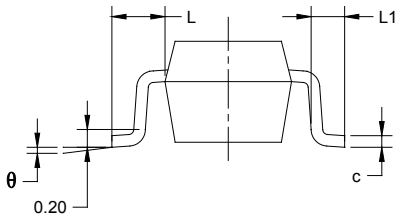
SC70-6





RECOMMENDED LAND PATTERN (Unit: mm)

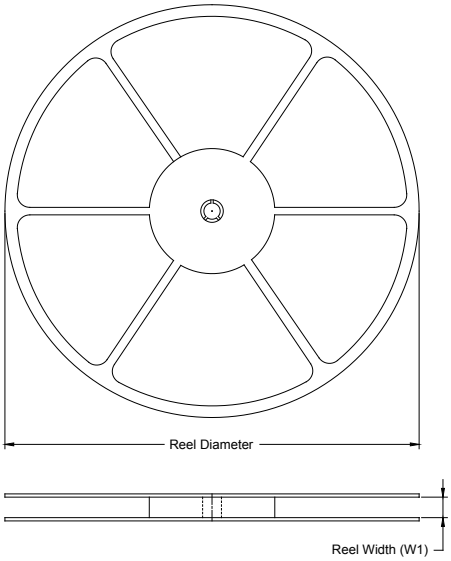




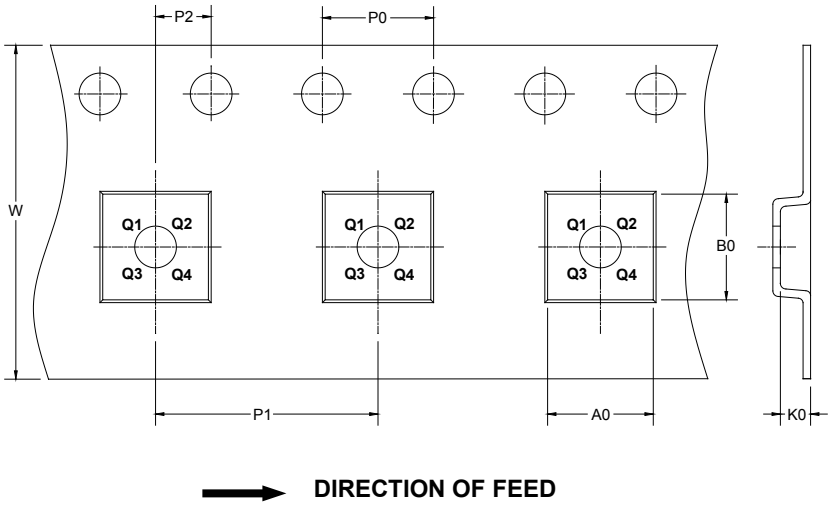
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026 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

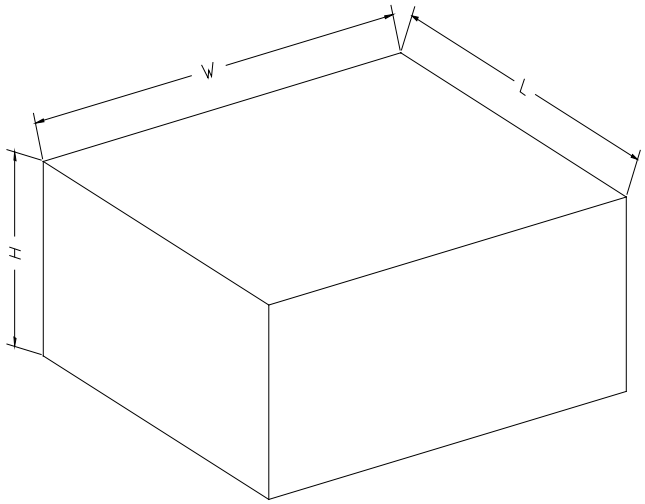
NOTE: The picture is only for reference. Please make the object as the standard.

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
UTQFN-1.8×1.4-10L	7″	9.0	1.75	2.10	0.70	4.0	4.0	2.0	8.0	Q1
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