GENERAL DESCRIPTION

The SGM450 is a precision integrated-circuit linear analog temperature sensor with an output voltage proportional to temperature, which can be used in multiple analog temperature-sensing or temperature compensation applications. Featuring typical accuracy of ±0.5℃ from 0℃ to +85℃ temperature range, the SGM450 is more accurate than similar pin-compatible devices on the market. The SGM450 provides a positive slope output of 10mV/℃ over a wide temperature range of -40℃ to +150℃ and it operates from a single 2.3V to 5.5V power supply.

The SGM450 features a low 7.5µA typical quiescent current and a 420µs typical power-on time, and this low power consumption feature enables SGM450 suitable for battery-powered applications. A Class-AB structure output driver provides a strong 500µA maximum output current capability for driving heavy load up to 1000pF, making it well suited to source the input of a sample-and-hold analog-to-digital converter (ADC). With excellent accuracy and a strong linear output driver, the SGM450 analog output temperature sensor is a cost-effective alternative to passive thermistors.

The SGM450 is available in Green SC70-5 and SOT-23 packages. It is specified over the extended industrial temperature range from -40℃ to +150℃.
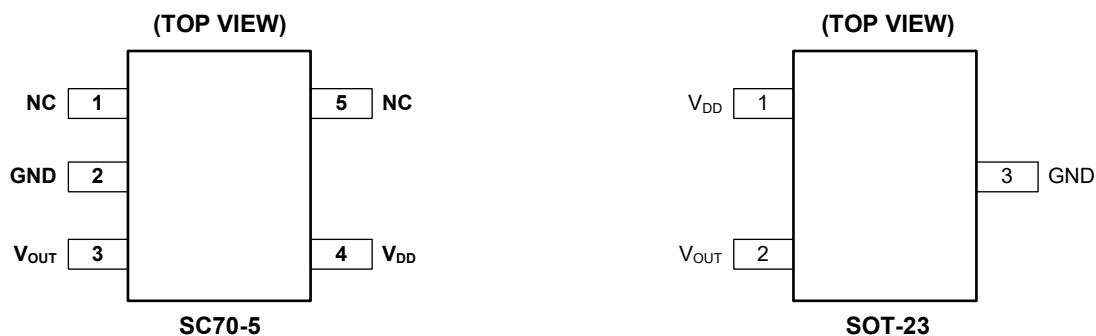
FEATURES

- **Wide Temperature Measurement Range:**
  -40℃ to +150℃
- **Temperature Accuracy:**
  ±2°C (MAX): -40℃ to +150℃
- **Positive Slope Sensor Gain: 10mV/°C (TYP)**
- **Output Voltage Offset: 500mV at 0℃ (TYP)**
- **Wide Power Supply Range: 2.3V to 5.5V**
- **Short-Circuit Protected Output**
- **Low Quiescent Current: 7.5µA (TYP)**
- **Class-AB Structure Output**
- **Able to Drive Capacitive Load up to 1000pF**
- **Available in Green SC70-5 and SOT-23 Packages**

APPLICATIONS

Wireless and Telecom Infrastructure
Automotive Infotainment
Factory Automation and Control
Test and Measurement

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM450	SC70-5	-40℃ to +150℃	SGM450A2XC5G/TR	QAXX	Tape and Reel, 3000
	SOT-23	-40℃ to +150℃	SGM450A2XN3LG/TR	Q9XX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XX = Date Code.

<u>YY</u> <u>X</u> <u>X</u>

├─── Date Code - Week
├─── Date Code - Year
└─── Serial Number

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{DD}..6V
Output Voltage Range, V_{OUT}....................-0.3V to V_{DD} + 0.3V
Output Current Range ....-30mA to 30mA
Latch-Up Current Range, Each Pin ....-200mA to 200mA
Package Thermal Resistance
SC70-5, θ_{JA}.. 218℃/W
SOT-23, θ_{JA} .... 260℃/W
Junction Temperature...+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)...........................+260℃
ESD Susceptibility
HBM...4000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range, V_{DD} ....2.3V to 5.5V
Operating Ambient Temperature Range......-40℃ to +150℃

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

(TOP VIEW)

NC $\boxed{1}$ $\boxed{5}$ NC

GND $\boxed{2}$

V_{OUT} $\boxed{3}$ $\boxed{4}$ V_{DD}

SC70-5

(TOP VIEW)

V_{DD} $\boxed{1}$

V_{OUT} $\boxed{2}$ $\boxed{3}$ GND

SOT-23

PIN DESCRIPTION

PIN		NAME	TYPE	FUNCTION
SC70-5	SOT-23			
1, 5	—	NC	—	No Internal Connection. This pin may be left floating or connected to GND in application.
2	3	GND	G	Ground Pin.
3	2	V_{OUT}	O	Temperature Sensor Output. Output voltage is proportional to the temperature.
4	1	V_{DD}	I	Positive Power Supply Pin.

ELECTRICAL CHARACTERISTICS

(V_{DD} = 2.3V to 5.5V, T_A = -40℃ to +150℃, GND = Ground and no load, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Power Supply						
Operating Current	I_{DD}	T_A = +25℃, V_{DD} = 2.3V		7.5	10	μA
		T_A = +150℃		11	16	
Line Regulation	Δ℃/ΔV_{DD}		-0.2	0.04	0.2	℃/V
Sensor Accuracy						
Temperature Accuracy [1]	T_{ACC}	T_A = +25℃		±0.5		℃
		T_A = 0℃ to +85℃	-1.5	±0.5	1.5	
		T_A = -40℃ to +150℃	-2.0	±0.5	2.0	
Sensor Output						
Offset Output Voltage	V_{OFFS}	T_A = 0℃		500		mV
Temperature Coefficient (Sensor Gain)	T_C			10		mV/℃
Output Nonlinearity [1]	V_{ONL}	T_A = 0℃ to +85℃, no load		±0.5		℃
Output Current	I_{OUT}				500	μA
Output Impedance	Z_{OUT}	I_{OUT} = 100μA, f = 100Hz		3		Ω
		I_{OUT} = 100μA, f = 500Hz		4		
Output Load Regulation		T_A = 0℃ to +85℃, I_{OUT} = 100μA, ΔV_{OUT}/ΔI_{OUT}		0.1	0.6	Ω
Power-On Time	t_{ON}	Time to reach accuracy within ±0.5℃		420	1300	μs
Typical Load Capacitance	C_{LOAD}				1000	pF

NOTE:

1. Accuracy is defined as the error between the measured and reference output voltages, tabulated in the Table 2 at the specified conditions of supply voltage and temperature (expressed in ℃). Accuracy limits include line regulation within the specified conditions. Accuracy limits do not include load regulation; they assume no DC load.
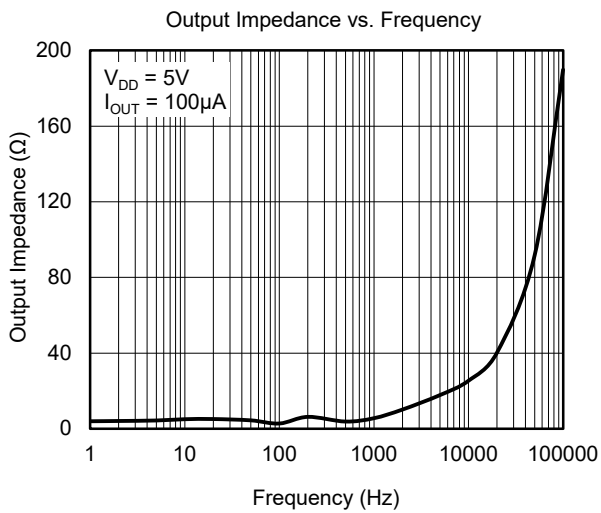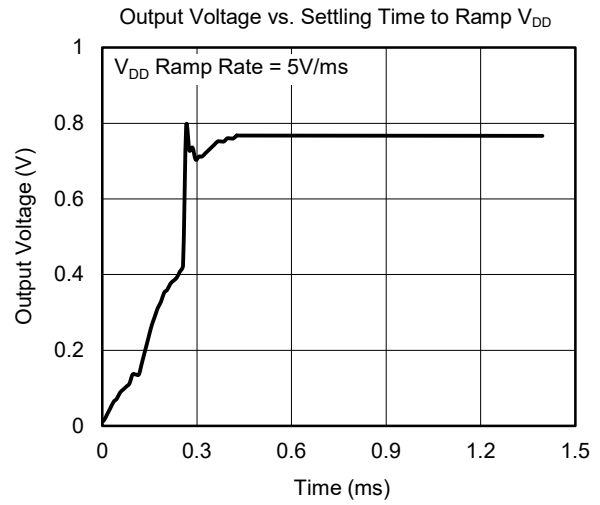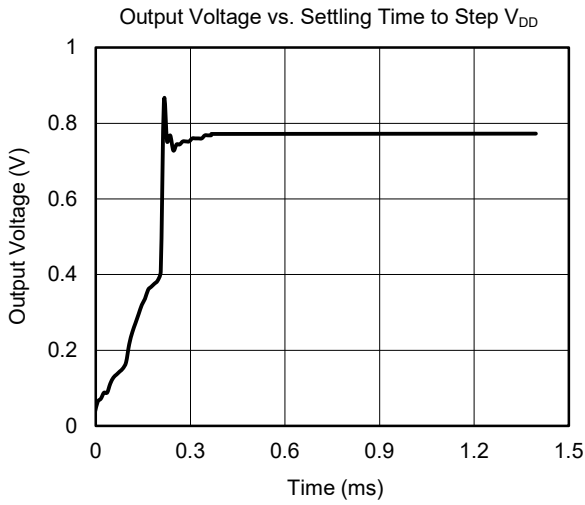
TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +25℃, unless otherwise noted.

Accuracy vs. Temperature

V_{DD} = 2.3V to 5.5V,
I_{OUT} = 0µA,
C_{LOAD} = 1000pF

— Average, — Average ± 3σ, — Limits

Supply Current vs. Temperature

V_{DD} = 2.3V,
I_{OUT} = 0µA,
C_{LOAD} = 1000pF

Load Regulation vs. Temperature

V_{DD} = 2.3V,
I_{OUT} = 3mA,
C_{LOAD} = 1000pF

Line Regulation vs. Temperature

V_{DD} = 2.3V to 5.5V,
I_{OUT} = 0µA,
C_{LOAD} = 1000pF

Output Voltage vs. Temperature

I_{OUT} = 0µA,
C_{LOAD} = 1000pF

Output Voltage vs. Power Supply
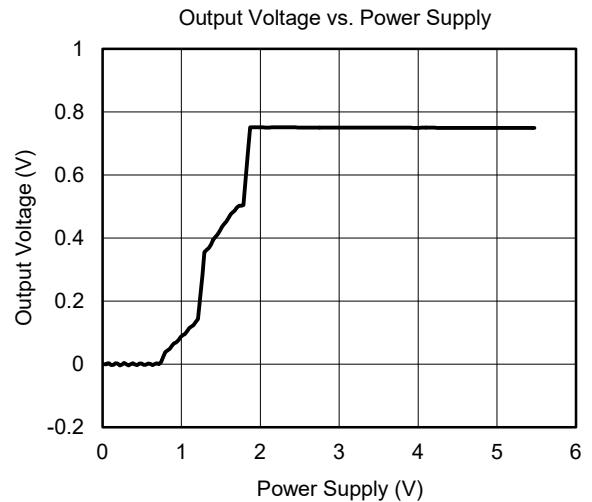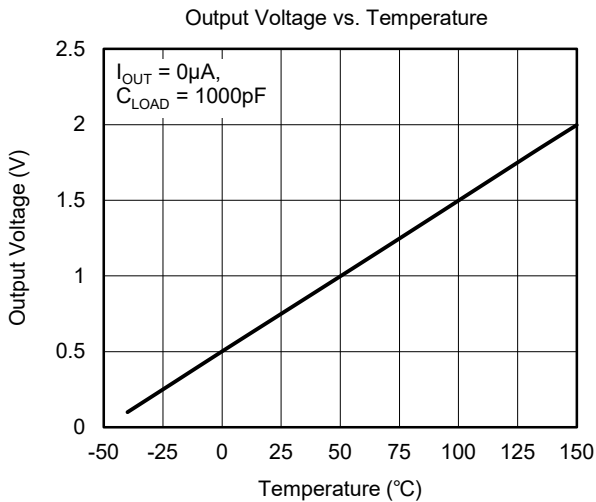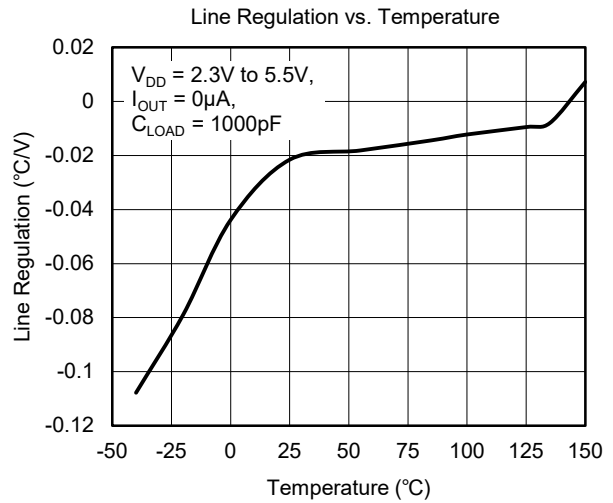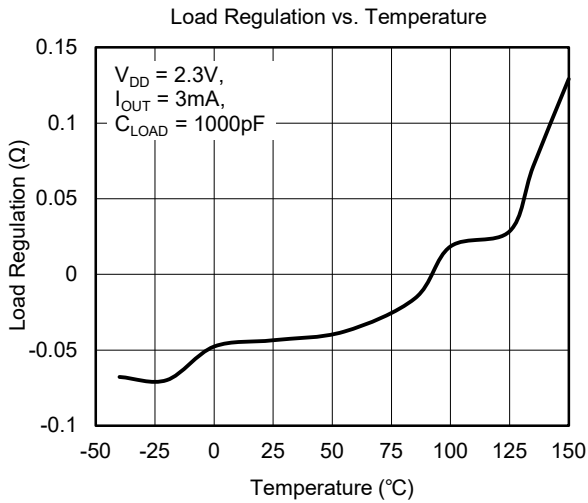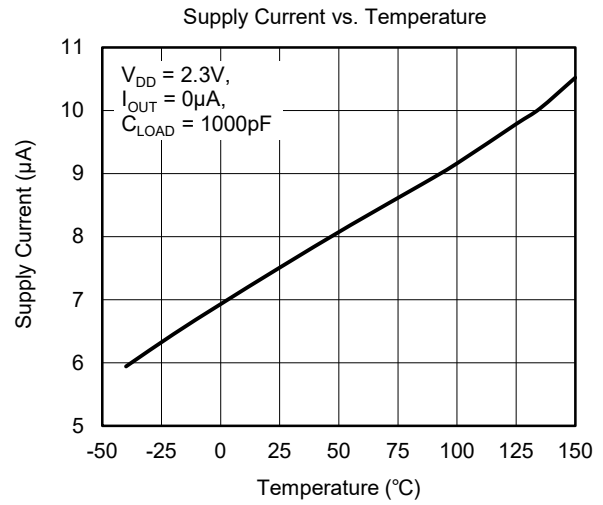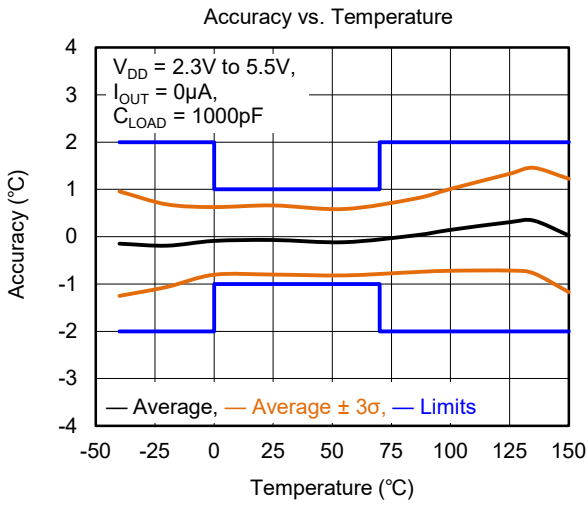
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, unless otherwise noted.

Output Voltage vs. Settling Time to Step V_{DD}

Output Voltage vs. Settling Time to Ramp V_{DD}

Output Impedance vs. Frequency

FUNCTIONAL BLOCK DIAGRAM
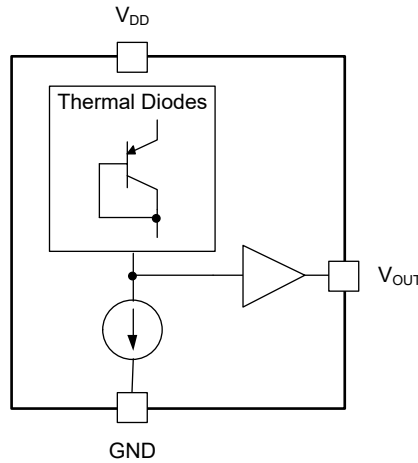
Figure 1. Block Diagram

DETAILED DESCRIPTION

The SGM450 is a linear analog temperature sensor with an output voltage proportional to temperature. Typical accuracy of temperature from 0℃ to +85℃ is ±0.5℃. The SGM450 provides a positive slope output of 10mV/℃ over the full temperature range of -40℃ to +150℃ and a single power supply range from 2.3V to 5.5V. A Class-AB structure output driver provides a maximum output current of 500μA to drive capacitive load up to 1000pF.

Feature Description

As shown in Figure 3, the SGM450 is linear; however, a small V_{OUT} gain shift is present at temperatures above +100℃. When small shifts are expected, a piecewise linear function provides the best accuracy and is used for the device accuracy specifications.

The piecewise linear function uses three temperature ranges listed in Table 1. In equation form, the temperature-to-voltage V_{OUT} of the SGM450 is calculated by Equation 1:

$$V_{OUT} = (T_A - T_{INFL}) \times T_C + V_{OFFS} \qquad (1)$$

where:
• V_{OUT} is the SGM450 temperature-to-voltage output for a given temperature.
• T_A is the ambient temperature in ℃.
• T_{INFL} is the temperature inflection point for a piecewise segment in ℃.
• T_C is the SGM450 temperature coefficient or gain.
• V_{OFFS} is the SGM450 voltage offset.

Therefore, the T_A temperature for a given V_{OUT} temperature-to-voltage output within a piecewise voltage range (V_{RANGE}) is calculated using Equation 2. For applications where the accuracy enhancement above +100℃ is not required, use the first row of Table 1 for all voltages.

$$T_A = (V_{OUT} - V_{OFFS})/T_C + T_{INFL} \qquad (2)$$

Table 1. Piecewise Linear Function Summary

T_A Range (℃)	V_{RANGE} (mV)	T_{INFL} (℃)	T_C (mV/℃)	V_{OFFS} (mV)
-40 to +100	< 1500	0	10	500
+100 to +125	1500 to 1751.3	100	10.05	1500
+125 to +150	> 1751.3	125	9.876	1751.3

Typical temperature-to-voltage V_{OUT} of the SGM450 across the full operating temperature range is listed in Table 2. The ideal linear columns represent the ideal linear V_{OUT} output response with respect to temperature while the piecewise linear columns indicate the small voltage shift at elevated temperatures.

Device Functional Mode

The singular functional mode of the SGM450 is an analog output directly proportional to temperature.

DETAILED DESCRIPTION (continued)

Table 2. Transfer Table

Temperature (℃)	V$_{OUT}$ (mV) Ideal Linear Values	V$_{OUT}$ (mV) Piecewise Linear Values	Temperature (℃)	V$_{OUT}$ (mV) Ideal Linear Values	V$_{OUT}$ (mV) Piecewise Linear Values	Temperature (℃)	V$_{OUT}$ (mV) Ideal Linear Values	V$_{OUT}$ (mV) Piecewise Linear Values
-40	100	100	25	750	750	90	1400	1400
-35	150	150	30	800	800	95	1450	1450
-30	200	200	35	850	850	100	1500	1500
-25	250	250	40	900	900	105	1550	1550.3
-20	300	300	45	950	950	110	1600	1600.5
-15	350	350	50	1000	1000	115	1650	1650.8
-10	400	400	55	1050	1050	120	1700	1701
-5	450	450	60	1100	1100	125	1750	1751.3
0	500	500	65	1150	1150	130	1800	1800.7
5	550	550	70	1200	1200	135	1850	1850.1
10	600	600	75	1250	1250	140	1900	1899.4
15	650	650	80	1300	1300	145	1950	1948.8
20	700	700	85	1350	1350	150	2000	1998.2

APPLICATION INFORMATION

The features of the SGM450 make the device designed for various general temperature-sensing applications. The SGM450 can operate down to a 2.3V power supply with 7.5μA quiescent current consumption, respectively. As a result, the device is designed for battery-powered applications. The SGM450 is mounted in surface mount technology packages (SC70-5 and SOT-23).

Connection with ADC
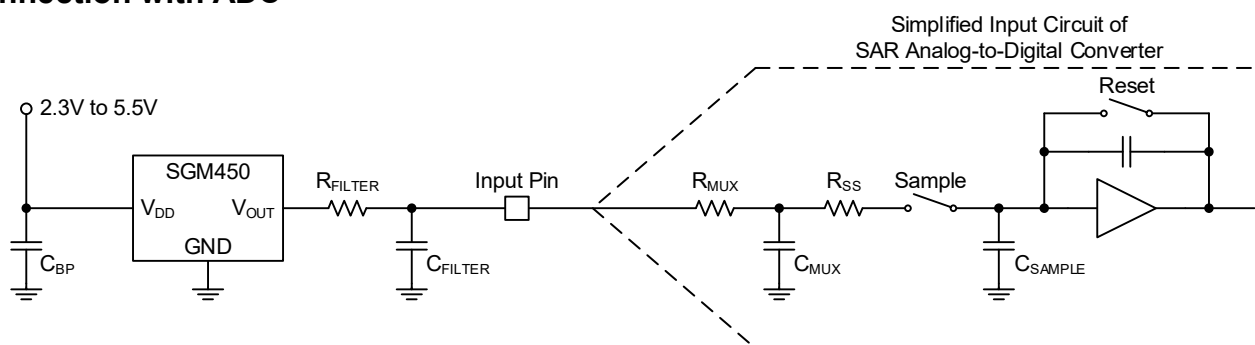
Figure 2. Suggested Connections to an ADC Input Stage

Design Requirements

See Figure 2 for suggested connections to an ADC input stage. Most CMOS-based ADCs have a sampling capacitor input structure. When the ADC charges the sampling capacitor (C_{SAMPLE}), the capacitor requires instantaneous charge from the output of the analog source temperature sensor. Therefore, the output impedance of the temperature sensor can affect ADC performance. In most cases, adding an external capacitor (C_{FILTER}) mitigates design challenges. The SGM450 is specified and characterized with a 1000pF maximum capacitive load (C_{LOAD}). Figure 2 shows C_{LOAD} as the sum of C_{FILTER} + C_{MUX} + C_{SAMPLE}. It is recommended to maximize the C_{FILTER} value while allowing for the maximum specified ADC input capacitance (C_{MUX} + C_{SAMPLE}) to limit the total C_{LOAD} at 1000pF. In most cases, a 680pF C_{FILTER} provides a reasonable allowance for ADC input capacitance to minimize ADC sampling error and reduce noise coupling. An optional series resistor (R_{FILTER}) and C_{FILTER} provide additional low-pass filtering to reject system level noise. It is recommended to place R_{FILTER} and C_{FILTER} as close as possible to the ADC input for optimal performance.

Detailed Design Procedure

Depending on the input characteristics of the ADC, an external C_{FILTER} may be required. The value of C_{FILTER} depends on the size of the sampling capacitor (C_{SAMPLE}) and the sampling frequency while observing a maximum C_{LOAD} of 1000pF. The capacitor requirements can vary because the input stages of all ADCs are not identical. Figure 2 shows a general ADC application as an example only.

Application Curve

The analog output voltage of SGM450 is proportional to temperature and it provides a positive slope output of 10mV/°C over the full -40°C to +150°C temperature range.
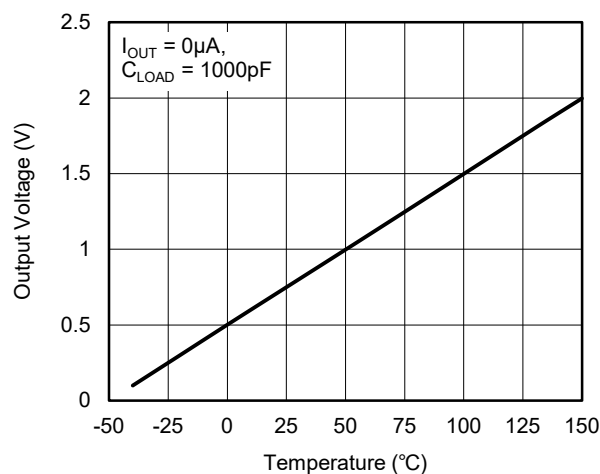

Figure 3. Output Voltage vs. Temperature

APPLICATION INFORMATION (continued)

Power Supply Recommendations

The low supply current and wide supply range of SGM450 allow the device to be easily powered from many sources.

Power supply bypassing is very important to reduce the noise of the power supply. In noisy environments, it is recommended to add a 0.1μF capacitor from V_{DD} to GND to bypass the power supply voltage. Larger capacitances may be required and are dependent on the noise of the power supply.

Layout

The layout of the SGM450 is simple. A power supply bypass capacitor is used to reduce noise, and the capacitor must be connected as close to V_{DD} pin as possible.
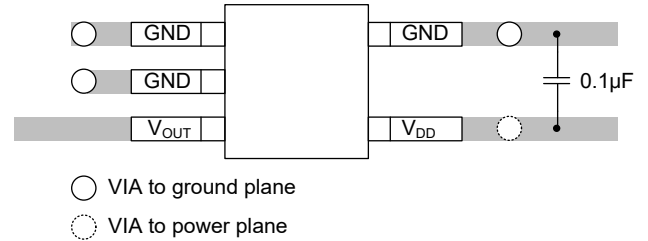
Figure 4. Recommended Layout: SC70-5 Package

REVISION HISTORY

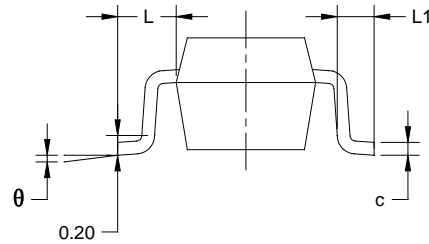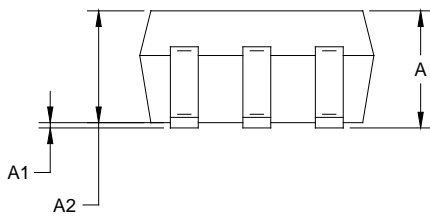NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (JUNE 2021) to REV.A   **Page**

Changed from product preview to production data ....All

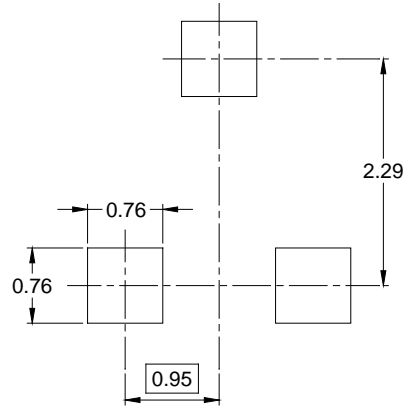## PACKAGE OUTLINE DIMENSIONS

SC70-5
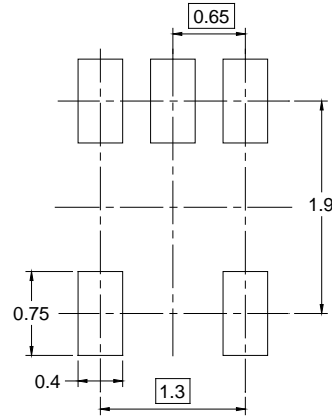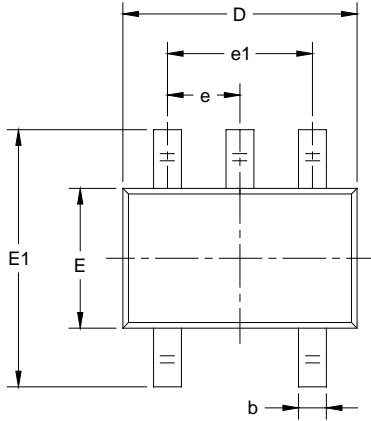
RECOMMENDED LAND PATTERN (Unit: mm)

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°

PACKAGE OUTLINE DIMENSIONS

SOT-23
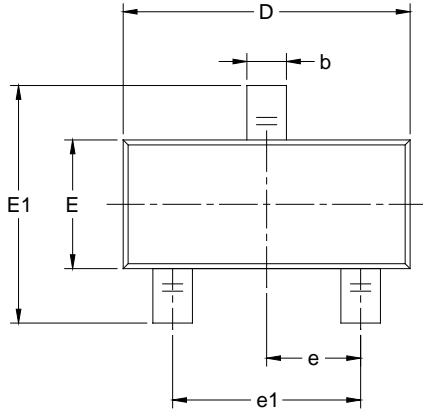
RECOMMENDED LAND PATTERN (Unit: mm)
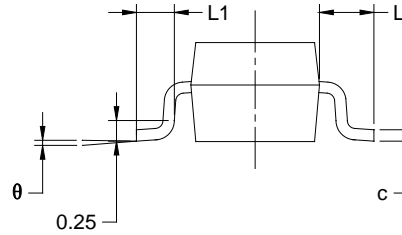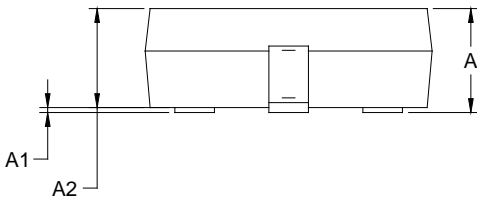
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A	0.89	1.12	0.035	0.044
A1	0.01	0.10	0.000	0.004
A2	0.88	1.02	0.035	0.040
b	0.30	0.50	0.012	0.020
c	0.08	0.20	0.003	0.008
D	2.80	3.04	0.110	0.120
E	1.20	1.40	0.047	0.055
E1	2.10	2.64	0.083	0.104
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.54 REF		0.021 REF	
L1	0.40	0.60	0.016	0.024
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS

Reel Diameter

Reel Width (W1)

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
SC70-5	7"	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3
SOT-23	7"	9.5	3.15	2.77	1.22	4.0	4.0	2.0	8.0	Q3

DD0001
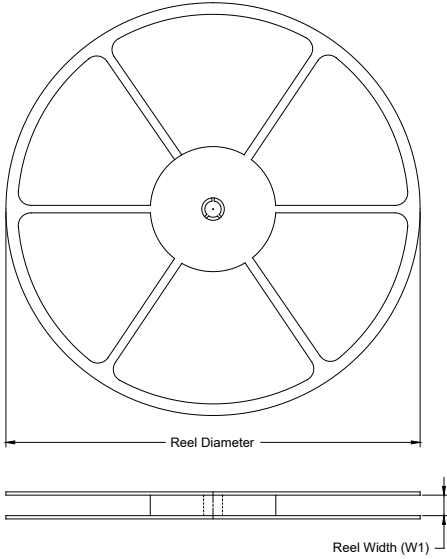
CARTON BOX DIMENSIONS

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