General Description

The MAX6613 is a low-power precision analog output temperature sensor in a tiny 5-pin SC70 package. The MAX6613 operates over a 1.8V to 5.5V supply voltage range, with a typical current consumption of only 7.5µA. It is particularly well suited for portable applications where minimizing battery cost and maximizing useful battery life are crucial.

The MAX6613 provides an analog voltage output proportional to temperature. Accuracy is ±4.0°C (max) over a range of T_A = 0°C to +50°C and ±4.4°C (max) from T_A = -20°C to +80°C. Self-heating effects are negligible due to the low current consumption of the part.
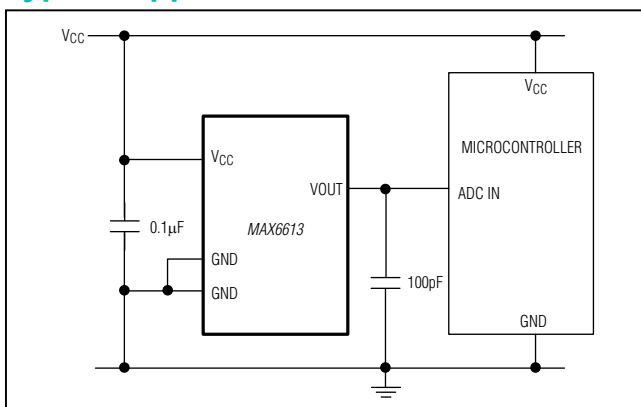
Unlike many analog temperature sensors, the MAX6613 is stable with any capacitive load from 0pF to 1000pF, providing broad flexibility in board-level design.

The operating temperature range varies with the voltage supply. The MAX6613 can be used over a -55°C to +130°C range with a 2.5V to 5.5V supply voltage. For applications with a supply voltage of 1.8V, the MAX6613 can be used over a +25°C to +130°C temperature range.

Applications

- Cellular Phones
- GPS Equipment
- Medical Instruments
- Battery Management
- Appliances
- Disk Drives
- Printers
- Fax Machines
- HVAC

Benefits and Features

- Minimizes Power Consumption with Ultra-Low 7.5µA (typ) Supply Current
- Minimizes Board Space with Tiny SC70 Package
- Extends Performance Range with Wide 1.8V to 5.5V Operating Range
- Ideal for Broad Range of Thermal Management Applications
  - -55°C to +130°C Measurement Range
  - 4.0°C Accuracy
- Pin Compatible with LM20

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX6613MXK+T	-55°C to +130°C	5 SC70	ADJ
MAX6613MXK/V+T	-55°C to +130°C	5 SC70	ADJ

+Denotes a lead(Pb)-free/RoHS-compliant package.
/V denotes an automotive qualified part.

Typical Application Circuit

Pin Configuration

maxim integrated™
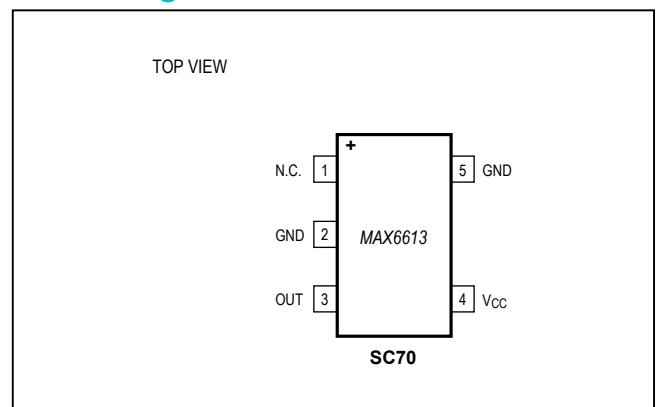
Absolute Maximum Ratings

(All voltages referenced to GND, unless otherwise noted.)

V_{CC} to GND ....-0.3V to +6V
All Other Pins to GND .... -0.3V to (V_{CC} + 0.3V)
OUT Short to GND ....Continuous
Output Current....................................... -1mA to +50mA
ESD Protection (Human Body Model).............................2000V

Continuous Power Dissipation (T_A = +70°C)
   5-Pin SC70 (derate 3.1mW/°C above +70°C)..........246.9mW
Operating Temperature Range........................ -55°C to +130°C
Junction Temperature..+150°C
Storage Temperature Range........................... -65°C to +150°C
Lead Temperature (soldering 10s) ....+300°C
Soldering Temperature (reflow)......................................+260°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
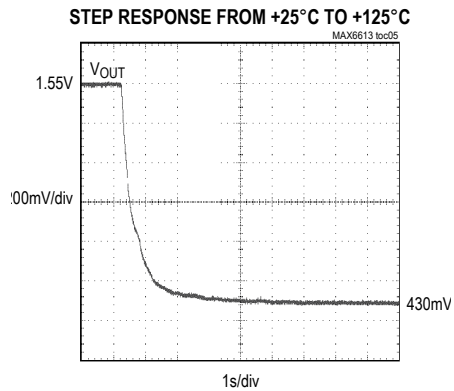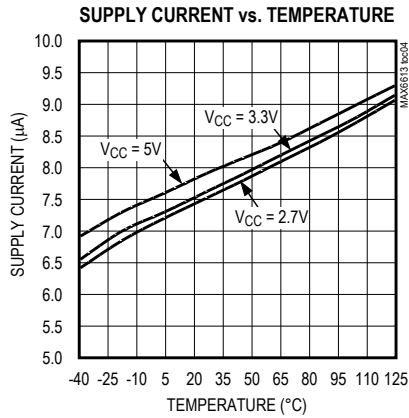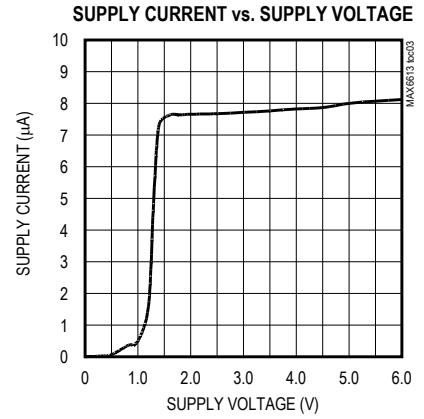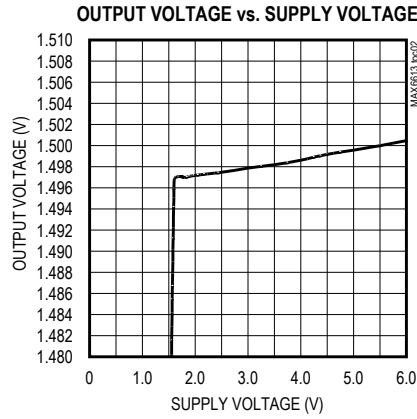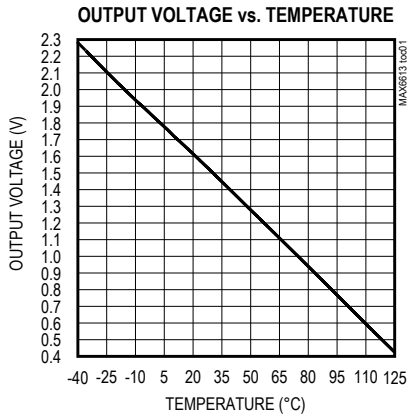
DC Electrical Characteristics

(V_{CC} = 1.8V to 5.5V, T_A = -55°C to +130°C. Typical values are at T_A = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Temperature-to-Voltage Error (Notes 2, 3)		V_{CC} = 2.7V, T_A = 0°C to +50°C	-4		+4	°C
		V_{CC} = 2.7V, T_A = -20°C to +85°C	-4.4		+4.4	
		V_{CC} = 2.7V, T_A = -55°C to +100°C	-4.5		+4.5	
		V_{CC} = 2.7V, T_A = +100°C to +125°C	-4.7		+4.7	
		V_{CC} = 2.7V, T_A = +125°C to +130°C	-5		+5	
Output Voltage		T_A = 0°C		1.8455		V
Nonlinearity		T_A = -55°C to +100°C		±0.4		%
Sensor Gain (Temperature Sensitivity or Average Slope)		T_A = -20°C to +100°C (Note 3)	-10.98	-11.23	-11.47	mV/°C
Maximum Output Impedance		0 < I_L < 16µA, T_A = -55°C to +125°C			160	Ω
		0 < I_L < 16µA, T_A = +125°C to +130°C			300	
Load Regulation		0 < I_L < 16µA, T_A = -55°C to +125°C			-2.5	mV
		0 < I_L < 16µA, T_A = 125°C to 130°C			-4.8	
Supply Sensitivity (Note 3)		T_A = -20°C to +130°C, V_{CC} ≤ 5.5V		1	3.3	mV/V
		T_A = -55°C to -20°C, V_{CC} ≤ 4.5V		1	4.7	
		T_A = -55°C to -20°C, V_{CC} ≤ 5.5V		1		
Quiescent Current	I_Q	No load		7.5	13	µA
Capacitive Load		No sustained oscillations for capacitive loads in this range (Note 4)	0		1000	pF
Long-Term Stability		T_A = room temperature for 1000hr (Note 4)		0.1		°C
Temperature Coefficient of Supply Current				15		nA/°C
Power-Down Supply Current		V_{CC} < 0.8V		0.1		µA

Typical Operating Characteristics

(R_L = ∞Ω, T_A = +30°C, unless otherwise noted.)

OUTPUT VOLTAGE vs. TEMPERATURE

OUTPUT VOLTAGE vs. SUPPLY VOLTAGE

SUPPLY CURRENT vs. SUPPLY VOLTAGE

SUPPLY CURRENT vs. TEMPERATURE

STEP RESPONSE FROM +25°C TO +125°C

Pin Description

PIN	NAME	FUNCTION
1	N.C.	No Connection. Must be connected to ground or left unconnected.
2	GND	Ground. Should be connected to pin 5. Can be left unconnected, if desired.
3	OUT	Voltage Output
4	V_{CC}	Supply Voltage. Bypass to GND with a 0.1µF capacitor.
5	GND	Ground

Table 1. Linear and Quadratic Output Equation

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Temperature Error Based on: OUT = 1.8639 - 0.0115 x Temp (Note 4)		V_{CC} = 2.7V, T_A = -55°C	0.6		7.9	°C
		V_{CC} = 2.7V, T_A = -20°C	-0.4		+5.8	
		V_{CC} = 2.7V, T_A = 0°C	-0.9		+4.5	
		V_{CC} = 2.7V, T_A = +50°C	-2.6		+3.0	
		V_{CC} = 2.7V, T_A = +85°C	-3.6		+3.5	
		V_{CC} = 2.7V, T_A = +100°C	-4.0		+3.7	
		V_{CC} = 2.7V, T_A = +125°C	-4.8		+4.2	
		V_{CC} = 2.7V, T_A = +130°C	-5.1		+4.2	
Temperature Error Based on: OUT = 1.8639 - 0.0115 x Temp - 0.00000388 x $Temp^2$ (Note 4)		V_{CC} = 2.7V, T_A = -55°C	-0.4		+6.9	°C
		V_{CC} = 2.7V, T_A = -20°C	-0.6		+5.7	
		V_{CC} = 2.7V, T_A = 0°C	-0.9		+4.5	
		V_{CC} = 2.7V, T_A = +50°C	-3.5		+2.1	
		V_{CC} = 2.7V, T_A = +85°C	-6.1		+1.0	
		V_{CC} = 2.7V, T_A = +100°C	-7.4		+0.4	
		V_{CC} = 2.7V, T_A = +125°C	-10.1		-1.0	
		V_{CC} = 2.7V, T_A = +130°C	-10.8		-1.5	

Detailed Description

The MAX6613 analog output temperature sensor's output voltage is a discrete function of its die temperature. The maximum supply current is 13µA, and the supply voltage range is from 2.5V to 5.5V for the -55°C to +130°C temperature range, or 1.8V to 5.5V for the +25°C to +130°C temperature range.

Transfer Function

The temperature-to-voltage transfer function is approximately linear and can be described by the quadratic equation:

$$V_{OUT} = -0.0000022\ 5\ T^2 - 0.01105 \times T + 1.8455V$$

In many cases, a linear approximation can be applied:

$$V_{OUT} = -0.01123 \times T + 1.8455V$$

where T is the die temperature of the MAX6613 in °C. Therefore:

$$T = (1.8455 - V_{OUT})/0.01123V$$

Compatibility with Other Temperature Sensors

The MAX6613 can be used to replace temperature sensors using other output algorithms. Table 1 provides information for a linear and quadratic output equation. Contact the factory for performance information about another equation.

Applications Information

Sensing Circuit Board and Ambient Temperature

A temperature sensor IC like the MAX6613 that senses its own die temperature must be mounted on, or close to, the object whose temperature it is intended to measure. Because there is a good thermal path between the package's metal lead and the IC die, the MAX6613 can accurately measure the temperature of the circuit board to which it is soldered. If the sensor is intended to measure the temperature of a heat-generating component on the circuit board, it should be mounted as close as possible to that component and should share supply and ground traces (if they are not noisy) with that component where possible. This optimizes the thermal connection from the component to the sensor.

The thermal path between the plastic package and the die is not as good as the path through the lead, so the MAX6613, like all temperature sensors in plastic packages, is less sensitive to the temperature of the surrounding air than to the temperature of its leads. It can be successfully used to sense ambient temperature if the circuit board is designed to track the ambient temperature.

As with any IC, the wiring and circuits must be kept insulated and dry to avoid leakage and corrosion, especially if the part is operated at cold temperatures where condensation can occur.

The change in die temperature introduced by the part due to self-heating is negligible.

Chip Information

PROCESS: BiCMOS

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maximintegrated.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
5 SC70	X5+1	21-0076	90-0188

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	5/02	Initial release	—
1	11/03	Corrected error in equation	4
2	1/06	Updated spec in table	2
3	12/10	Added lead-free and automotive part, style edits	1, 2, 3, 5, 6
4	5/15	Revised *Benefits and Features* section	1