THERMAL MANAGEMENT

Design Guide

1st Edition August 2009

Maxim has the industry's broadest thermal-mangement portfolio

Temp sensors, fan controllers, and temp switches for all your thermal needs

What's inside?

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MAXIM

Using multichannel temperature sensors to save space and cost

When a circuit board includes multiple hot spots, standard practice is to monitor the temperatures of those locations to avoid performance degradation and even catastrophic failure.

A conventional approach is shown in **Figure 1**, where a sensor is placed near each hot spot. Monitoring board hot spots can be done with standard local sensors (TS5–TS8). If a thermally sensitive component has a temperature-sensing transistor (also called a "thermal diode") integrated on the die of a high-temperature IC, a remote-temperature sensor can use the IC's thermal diode to accurately measure its die temperature (TS1–TS4).

Figure 2 shows the same board, but in this case a single multichannel sensor IC monitors all of the hot spots. The circuit uses the MAX6581* (also see **Figure 3**), which can measure up to seven external temperatures as well as its own temperature. The device can monitor temperatures on ASICs, CPUs, and FPGAs using thermal diodes, or it can measure board hot spots using discrete diode-connected transistors and the internal local sensor.

Using a single IC to monitor several locations reduces sensor cost. It also simplifies the design by allowing several channels of temperature data to be read from a single I^2C slave address.

Useful features in multichannel temperature sensors

- **Overtemperature alarm outputs.** These outputs are useful if you need a signal to indicate that one of the thermal channels has exceeded its temperature limit.
- **Bus timeout.** Useful on I^2C and SMBus™ sensors, this timeout resets the bus if the IC holds the data line low for more than a preset limit (usually around 35ms), thus preventing the IC from locking up the bus.
- **Resistance cancellation.** Excess resistance (more than a few ohms) in the remote-diode path will cause measurement errors. These errors are predictable if you know the resistance value. If you do not, resistance cancellation is helpful to eliminate series-resistance errors.
- **Beta compensation.** Measurement errors can result when a target IC's thermal diode has very low beta (e.g., less than one). If your thermal diode's beta is very low, a sensor with beta compensation will improve accuracy.
- **Thermistor inputs.** A thermistor can be useful for measuring temperature. For example, you can use a thermistor with long leads to monitor air temperature above the surface of a board. The MAX6698 (page 4) has inputs for three external thermal diodes and three thermistors.

Maintaining good measurement accuracy

- If discrete diode-connected transistors are used, either PNPs or NPNs will work. Use small-signal transistors with consistent beta greater than 50.
- Separate the thermal diode's signal traces from high-speed and high-current traces to avoid noise pickup.
- Use a filter capacitor at the thermal-diode inputs (DXP and DXN). See the sensor data sheet for the optimum value.
- Most multichannel sensors bias the thermal diode's cathode about 0.6V. If you want to measure the temperature of an IC with the thermal diode's cathode grounded, use one of Maxim's many multichannel sensors that specifies accuracy with a grounded cathode.

SMBus is a trademark of Intel Corp.
*Future product—contact the factory for availability.

Using multichannel temperature sensors (*continued*)

Conventional approach using multiple sensors

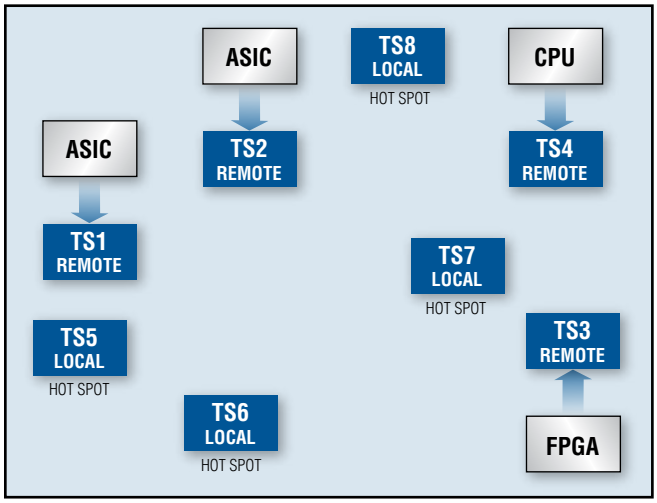


Figure 1. The conventional way to monitor multiple hot spots is to mount one temperature sensor at each location.

Improved approach using one multichannel sensor

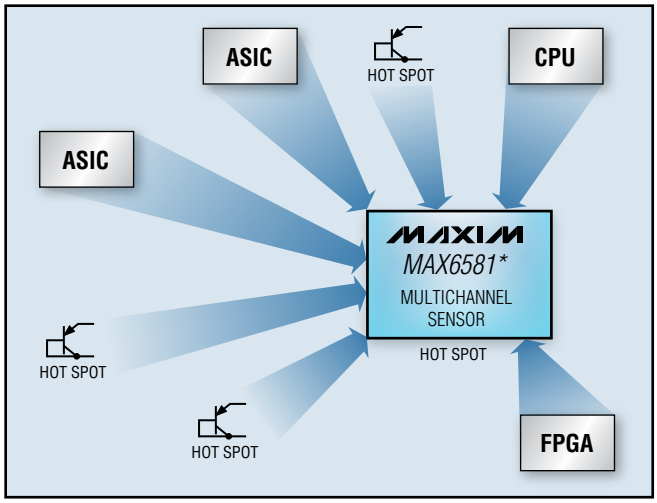


Figure 2. The MAX6581 can monitor up to seven external temperatures as well as its own die temperature. This approach saves space and cost by eliminating multiple discrete sensors.*

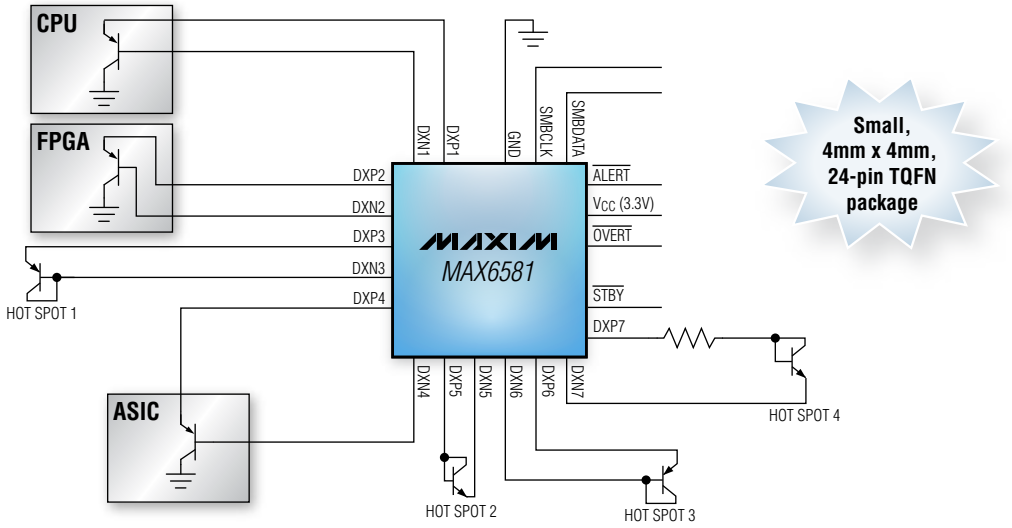


Figure 3. The MAX6581 monitors a total of eight temperature locations with ±1°C accuracy.

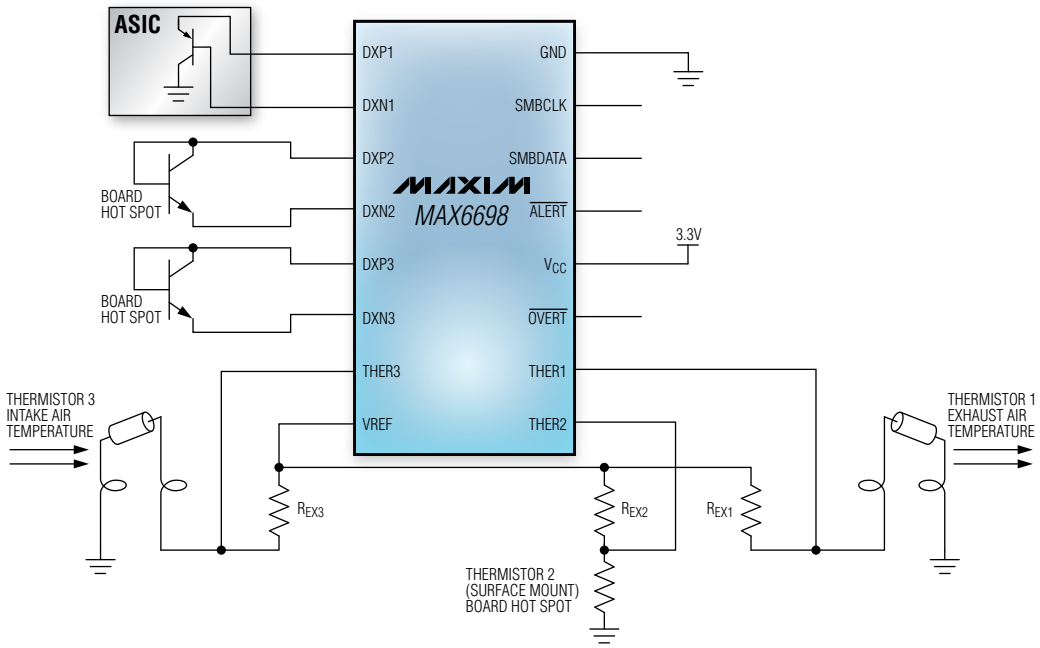
MAX6581 key features

- **Seven remote-sensing channels monitor ASICs, FPGAs, CPUs, and board hot spots**
- **One local temperature sensor**
- **±1°C remote-temperature accuracy (+60°C to +100°C)**
- **All remote channels have series-resistance cancellation**
- **All remote channels can accurately monitor low-beta sense transistors**

*Future product—contact the factory for availability.

Industry's *only* multichannel temp sensor that monitors three thermistor inputs

Also monitors three remote diodes and its internal temperature



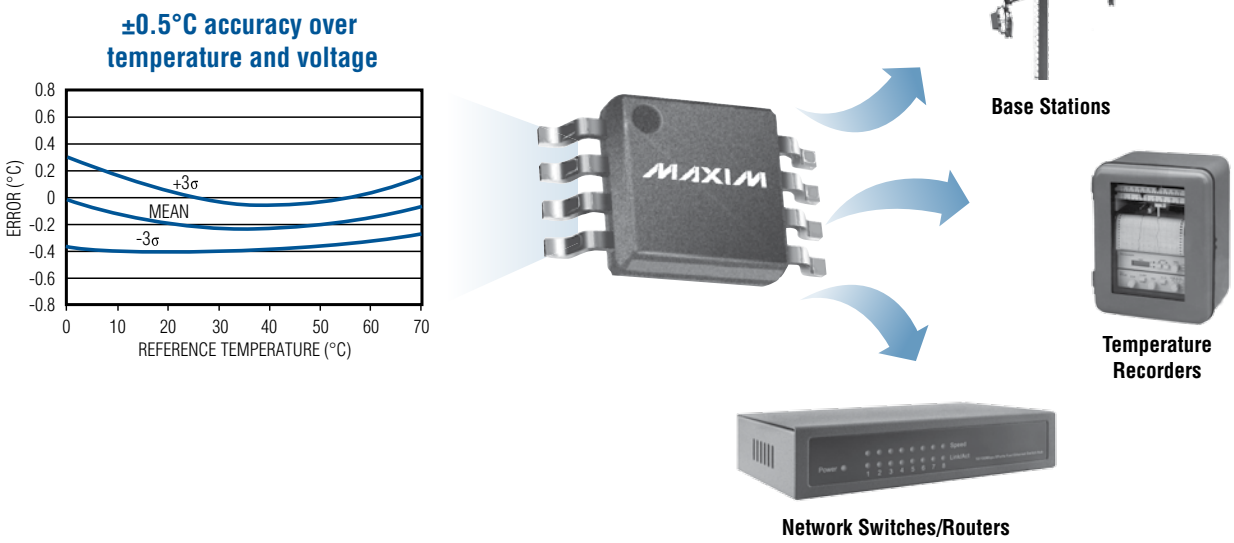
- Three thermistor inputs
  - Monitor air temperatures with leaded thermistors
  - Monitor board hot spots with board-mounted thermistors
- Three thermal-diode inputs
  - Monitor ICs with on-die sense transistors (thermal diodes)
  - Monitor board hot spots with discrete PNP or NPN diode-connected transistors
- Local temperature sensor
  - Monitors board hot spot
- ±1°C remote-temperature accuracy (+60°C to +100°C)

Part	Remote-Diode Channels	Thermistor Channels	Remote-Temperature Accuracy (°C)	Internal Sensor	Standby Pin	Package (mm x mm)
MAX6581*	7	—	±1	✓	✓	24-TQFN (4 x 4)
MAX6689	6					20-QSOP (6 x 8.7), 20-TSSOP (6.4 x 6.5)
MAX6602	4					16-TSSOP (6.4 x 5)
MAX6697	6					20-QSOP (6 x 8.7), 20-TSSOP (6.4 x 6.5)
MAX6699	4					16-QSOP (6 x 5), 16-TSSOP (6.4 x 5)
MAX6698	3	3				16-QSOP (6 x 5), 16-TSSOP (6.4 x 5)

*Future product—contact the factory for availability.

Industry's highest accuracy temp sensors

We offer a broad range of temperature devices with an accuracy of ±0.5°C (max) over wide temperature and voltage ranges. Several popular digital-communication interfaces, including analog output, support a wide range of applications.



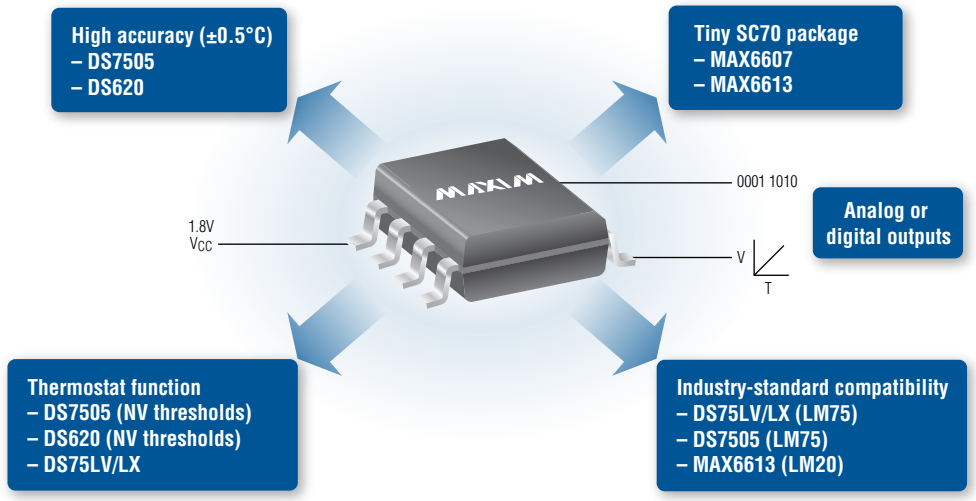
- **±0.5°C accuracy over a wide temperature range**
- **1-Wire®, 2-wire, 3-wire, and analog output options**
- **-55°C to +125°C operating range**
- **2.7V to 5.5V or 1.7V to 3.7V (DS620) supply range**
- **User-selectable 9- to 12-bit resolution**
- **No external components required to measure temperature**
- **Thermostat/alarm functionality with user-defined nonvolatile thresholds**
- **Stand-alone thermostat capability (DS620, DS1631A, and DS1626)**
- **Multiple packaging options**

Highest accuracy temperature sensors

Part	Interface	Accuracy (°C)	Package
DS18B20	1-Wire	±0.5 (-10 to +85)	3-TO-92, 8-µSOP (µMAX®), 8-SO
DS1631/DS1631A	2-wire	±0.5 (0 to +70)	8-µSOP (µMAX), 8-SO
DS1626	3-wire	±0.5 (0 to +70)	8-µSOP (µMAX), 8-SO
DS620	2-wire	±0.5 (0 to +70)	8-µSOP (µMAX), exposed pad
DS600	Analog	±0.5 (-20 to +100)	8-µSOP (µMAX), exposed pad

Most complete portfolio of low-voltage temp sensor ICs

Maxim offers a wide variety of temperature devices with supply voltages as low as 1.7V. Our portfolio includes both digital and analog sensors with several accuracy grades to choose among. The low operating voltages simplify design in systems operating from popular low-voltage rails, as well as power-sensitive systems.



- **Low supply voltage**
  - **1.7V for digital temperature sensors**
  - **1.8V for analog temperature sensors**
- **2-wire and analog output options**
- **-55°C to +125°C operating range (up to +130°C for the MAX6613)**
- **No external components required to measure temperature**
- **User-selectable 9- to 12-bit resolution**
- **Multiple packaging options**

Low-voltage temperature sensors

Part	Interface	Supply Voltage (V)	Accuracy (°C)	Package
DS7505	2-wire	1.7 to 3.7	±0.5 (0 to +70)	8-µSOP (µMAX), 8-SO
DS620	2-wire	1.7 to 3.5	±0.5 (0 to +70)	8-µSOP (µMAX) with exposed pad
DS75LV	2-wire	1.7 to 3.7	±2.0 (-25 to +100)	8-µSOP (µMAX), 8-SO
DS75LX	2-wire	1.7 to 3.7	±2.0 (-25 to +100)	8-µSOP (µMAX), 8-SO
MAX6607	Analog	1.8 to 3.6	±3.5 (0 to +70)	5-SC70
MAX6608	Analog	1.8 to 3.6	±3.5 (0 to +70)	5-SOT23
MAX6613	Analog	1.8 to 5.5	±4.0 (0 to +50)	5-SC70

Choosing the right fan controller

Maxim offers over 20 products with fan-control functions. This design note describes how to narrow the choice in two simple steps.

Step 1: Start with the fan

What type are you using? Fans are usually described by the number of wires, as shown in **Figure 1**. A 2-wire fan has just two power-supply leads. A 3-wire fan adds an output, usually a "tachometer" output that produces a square wave consisting of a fixed number of pulses per fan revolution. The tachometer signal can be used to monitor fan speed and can serve as a feedback signal when closed-loop control of speed is necessary. A 4-wire fan also includes a speed-control input that accepts a PWM signal (usually in the 20kHz to 40kHz range) whose duty cycle controls the fan's speed.

Step 2: Pick the speed-adjustment method

Typically, fan control is used to reduce the audibility of fan noise, so the preferred approach is to gradually adjust fan speed in response to temperature changes.

If a 4-wire fan is used, it is easy to adjust the fan's speed: just drive the speed-control input with a PWM signal in the 20kHz to 40kHz range as shown in **Figure 2**. In the figure, the MAX6639 fan controller regulates the speed of two fans by adjusting the PWM waveforms' duty cycles to produce the desired speed as indicated by the fans' tachometer outputs.

In contrast, 2- and 3-wire fans require a more complex control scheme. PWM drive works, but instead of driving the fan's speed-control input, the PWM signal drives a power-supply pass transistor. (An example can be found in the MAX6639's data sheet.) The optimum frequency is in the 30Hz range. Note that this approach can be noisy—each edge of the PWM waveform can cause an audible transient due to motion of the fan motor assembly. Also, some fan manufacturers recommend against PWM on the fan's power supply due to reliability concerns. Be sure to check with your fan vendor before proceeding with this approach.

Another way to control the speed of a 2- or 3-wire fan is to linearly vary the fan's power-supply voltage. You lose a bit of efficiency, but the approach is both quiet and reliable. A few fan controllers, such as the MAX6620 (**Figure 4**), can produce a variable fan supply voltage controlled over a bus such as I^2C. You can also generate an adjustable linear fan supply by using a PWM-output fan controller and adding a lowpass filter and power amplifier, as shown in Maxim application notes 3149 and 3530.

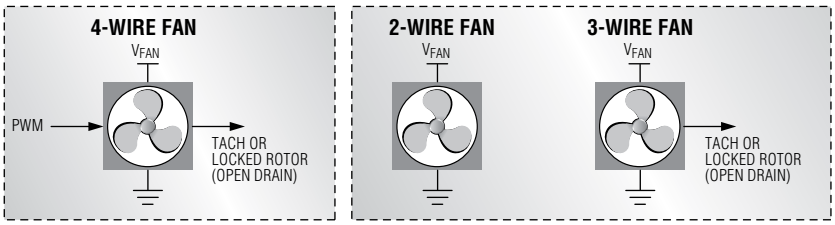
If the fan will be used infrequently or if it will be located far from users, the acoustic noise may not be important. In this case, you can implement very simple, low-cost fan control using a temperature switch to turn a fan on and off. In the **Figure 3** example, the temperature switch's output directly drives the control input of a 4-wire fan. For 2- or 3-wire fans, the temperature switch in **Figure 5** drives the gate of a power transistor that enables or disables the fan's power supply. Note that switching the fan on and off suddenly is very audible and, therefore, is rarely appropriate for consumer or office equipment that will be located close to users.

	2-Wire and 3-Wire Fans		4-Wire Fans	
	Control Method	*Maxim Solution**	Control Method	*Maxim Solution**
Linear Control	Linear fan controller	MAX6620 (Figure 4)	N/A	
	PWM fan controller + LP filter + pass device	MAX6639, MAX6615, MAX6641 (refer to application notes 3149 and 3530)		
PWM Control	Low-frequency PWM controller + pass device	MAX6639, MAX6615	High-frequency PWM controller	MAX6639 (Figure 2), MAX6615
On/Off (Noise and Power-Supply Stress Are Not Concerns)	Temperature switch + pass device	MAX6510 (Figure 5)	Temperature switch	MAX6510 (Figure 3)

*See page 15 for a full list of Maxim's fan controllers.

Choosing the right fan controller (*continued*)

What kind of fan will you use?



Variable linear drive for minimal audible noise (see page 9)

Figure 1. Three common fan types.

Variable speed control for minimal audible noise

Simple on/off control when acoustic noise is not a concern (see page 9)

Simple on/off control when acoustic noise is not a concern

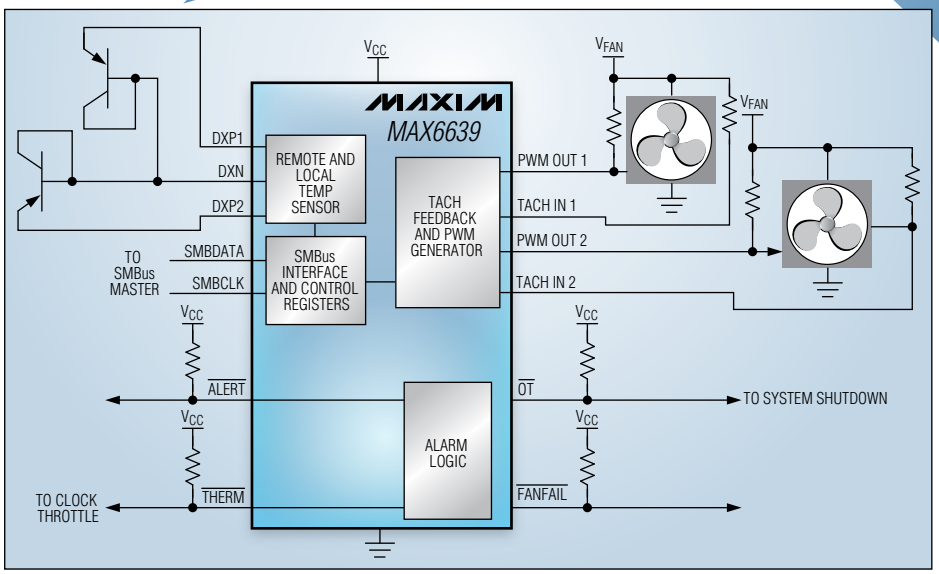


Figure 2. PWM control of 4-wire fans.

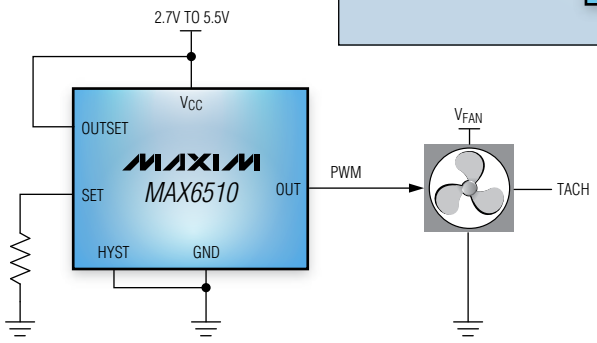


Figure 3. On/off control of a 4-wire fan with a temperature switch.

Choosing the right fan controller (*continued*)

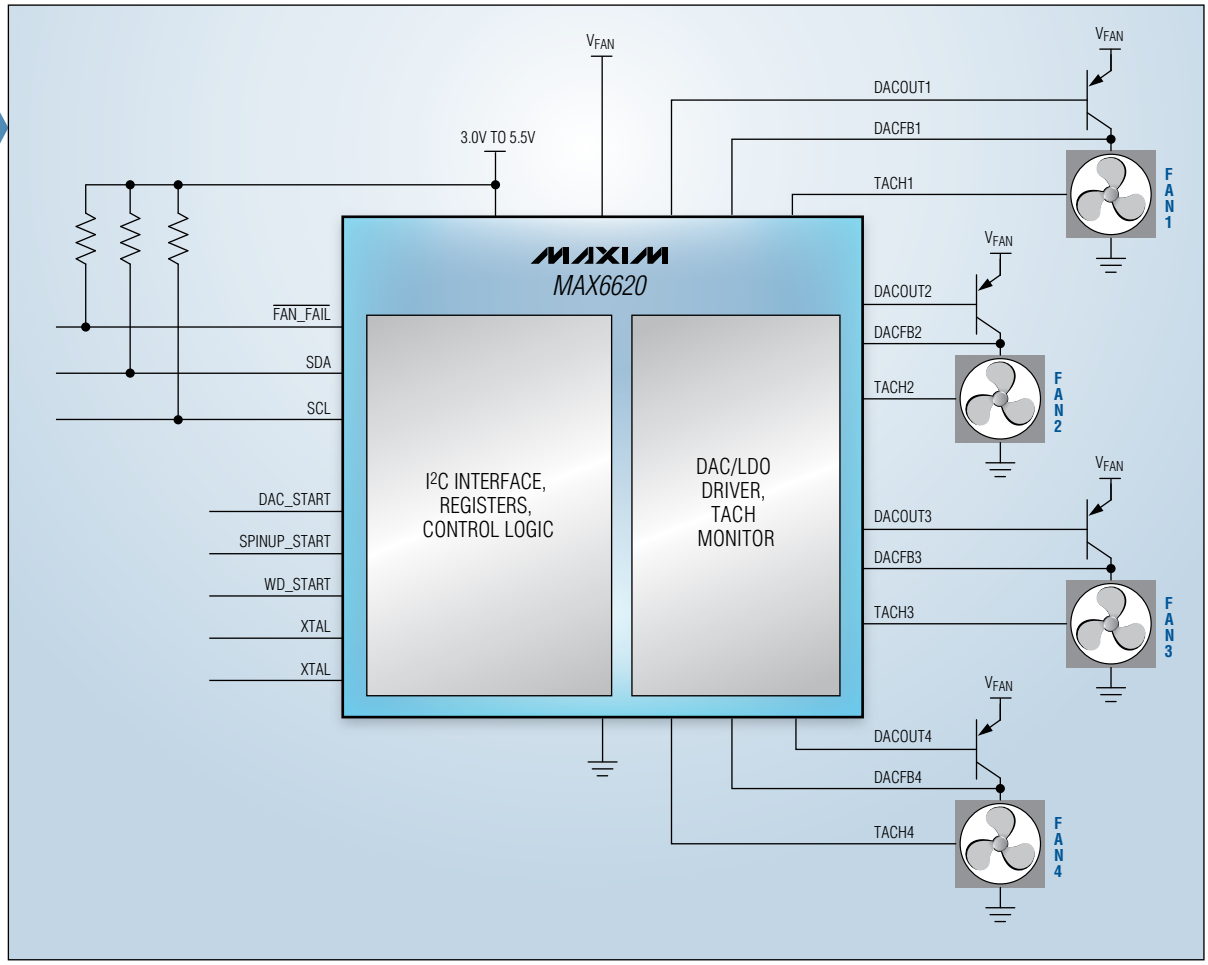


Figure 4. Fan-speed control of a 2- or 3-wire fan by varying the fan's power-supply voltages.

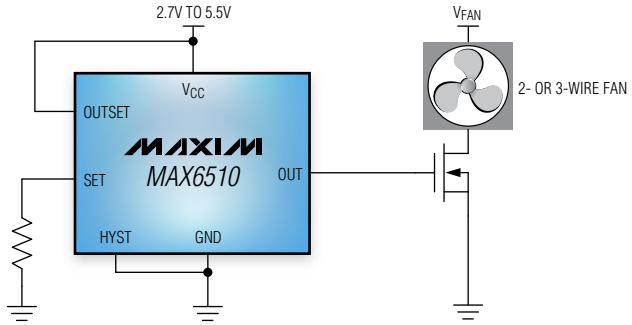


Figure 5. On/off control of a 2- or 3-wire fan using a temperature switch and pass transistor.

LM75-compatible temp sensors—from industry standard to best in the industry

Maxim offers more than a dozen "LM75-compatible" temperature sensors that give you options ranging from industry-standard configurations to sensors with dramatically improved performance. Whether you need an alternate source for the standard LM75 or a temperature sensor that offers best-in-class performance, you will find what you are looking for at Maxim.

±0.5°C accuracy and NV memory

If you need better accuracy than the LM75 can achieve, select the DS7505, a pin- and register-compatible upgrade with superior accuracy. The DS7505 features a maximum temperature-measurement error of ±0.5°C from 0°C to +70°C across its full power-supply range. The device operates from a 1.7V to 3.6V supply-voltage range, making it ideal for low-voltage systems.

The DS7505's conversion resolution is programmable from 0.5°C to 0.0625°C (9 to 12 bits). For systems that require the OS trip threshold to be the correct value at power-up, the DS7505's threshold is stored in nonvolatile memory. This is an especially powerful feature when using OS for system protection—for example, to disable the system's power supply when the measured temperature is too high.

Other improvements

Maxim offers other LM75-compatible digital temperature sensors with a variety of improved features. Because temperature accuracy is guaranteed across the full supply-voltage range instead of just at 3.3V or 5.0V, all of these products have better accuracy than the LM75 in real systems.

An example is the DS75LX, which operates from power-supply voltages as low as 1.7V. This device is ideal for designs that require more than eight sensors on a single bus; its three address-selection inputs use three-state logic, resulting in 27 available slave addresses.

Products such as the MAX7501–MAX7504 offer another useful feature: an input that resets the I²C interface. Pulling this input low returns the internal registers to their default values and resets the I²C inteface, thus allowing the I²C master to reset any slaves on the board when a communications fault is detected.

Lastly, if you need a smaller footprint, choose the MAX6625, MAX6626, or DS1775. These devices are all register compatible with the LM75 and are available in space-saving, 3mm x 3mm SOT23 or TDFN packages.

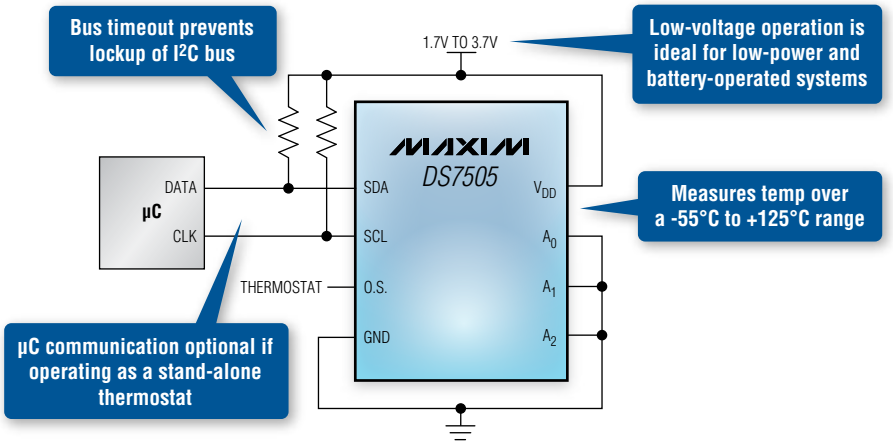
Maxim's industry-standard, LM75-compatible temp sensors

Maxim Sensor	Features	Benefits
LM75	Fully compatible	Ideal for designs requiring multisourced temp sensors
DS7505	±0.5°C accuracy, NV memory, 1.7V to 3.6V supply range	Better accuracy, fail-safe overtemperature detection
DS75LV	1.7V to 3.6V supply range	Compatible with low-voltage, low-power designs
DS75LX	1.7V to 3.6V supply range, 27 I²C addresses	Up to 27 sensors can be on a single bus
DS75	Fully compatible	Accuracy guaranteed across full supply voltage
MAX7500	Fully compatible	Accuracy guaranteed across full supply voltage
MAX7501–MAX7504	I²C reset input	Allows controller to reset I²C interface
MAX6625/MAX6626	3mm x 3mm, 6-pin TDFN package	Ideal for space-limited designs
DS1775	3mm x 3mm, 5-pin SOT23 package	Ideal for space-limited designs

www.maxim-ic.com/TempSensors

Highly accurate LM75-compatible sensor offers custom thermostat trip points

The DS7505 is ±0.5°C (max) accurate over a wide 0°C to +70°C temperature range. It has nonvolatile thermostat thresholds that allow customized trip points at power-up, an *industry first* for an LM75-compatible device. Also unique, its nonvolatile configuration registers enable it to power up and operate in any user-defined mode.

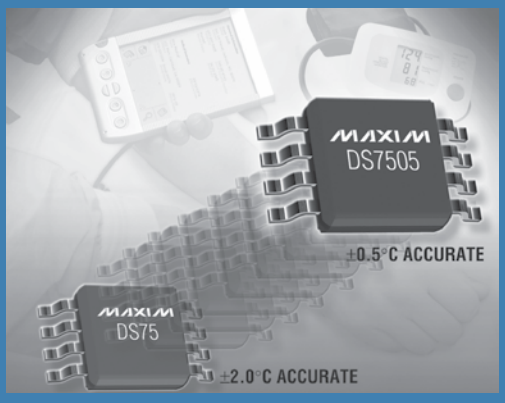


- **±0.5°C accuracy over a 0°C to +70°C range**
- **1.7V to 3.7V operating range**
- **Optional bus timeout feature prevents lockup problems on 2-wire interface**
- **User-definable, nonvolatile thermostatic settings**
- **Thermometer resolution is configurable from 9 to 12 bits (0.5°C to 0.0625°C resolution)**
- **Available in 8-pin SO and µMAX packages**

Migrate to a lower-voltage or higher-precision design

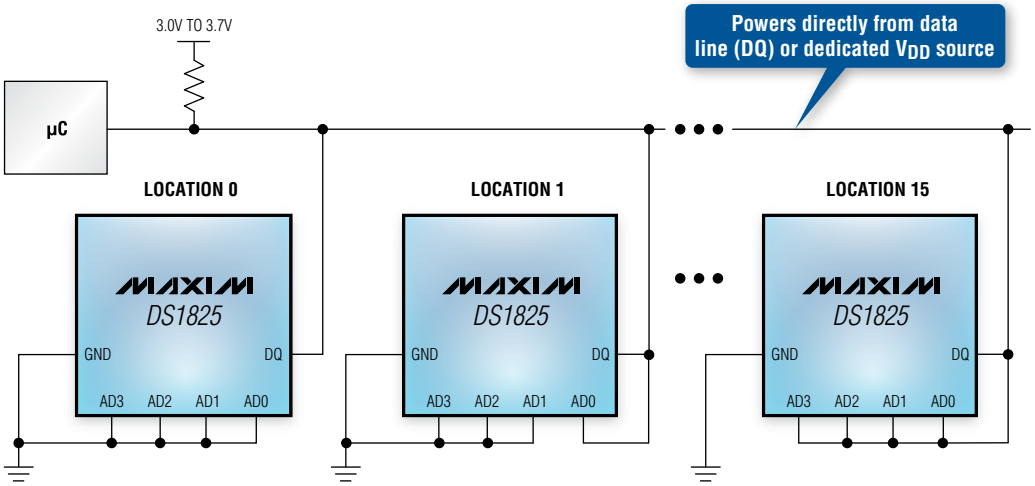
The DS7505 operates from a low, 1.7V to 3.7V supply voltage and can, therefore, be connected directly to low-voltage rails. Because the DS7505 is function, pin, and software compatible with the popular LM75 and DS75, it allows you to seamlessly migrate to a lower-voltage or higher-precision design.

Learn more at: www.maxim-ic.com/DS7505



Addressable 1-Wire temp sensor simplifies multisensor applications

The DS1825 greatly reduces the complexity of applications that require multipoint temperature sensing. It features four dedicated address pins, each of which can be set to GND or DQ to determine the DS1825's location. Just a simple read of the configuration register easily pinpoints the location of each DS1825.



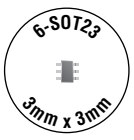
- **±0.5°C accuracy over -10°C to +85°C temperature range**
- **User-selectable 9- to 12-bit resolution**
- **Thermal alarm function with EEPROM**
- **User-programmable trip points**
- **Tiny 8-pin µSOP package**

Tiny temp sensors use only one µP pin

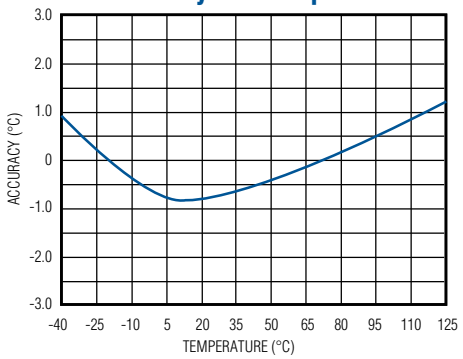
Simple, direct digital interface with period, frequency, or timed outputs

The MAX6575/MAX6576/MAX6577 family of temperature sensors communicates the temperature to a µP through a single control line. These devices feature ±0.8°C accuracy (±3°C max) at room temperature (+25°C). They operate from a 2.7V to 5.5V supply and are available in tiny 6-SOT23 packages.

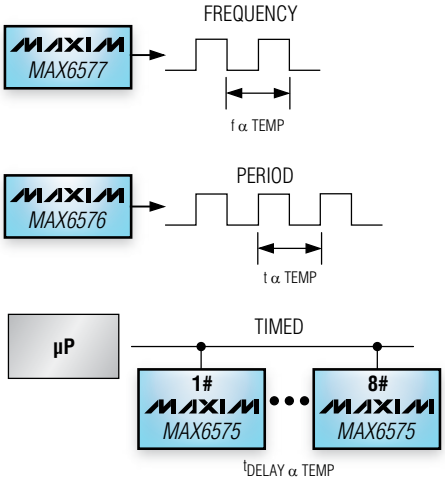
- **Multidrop capability (MAX6575L/H)**
- **±0.8°C (typ) accuracy**
- **User-selectable period/ frequency options**
- **Small SOT23 package**



Accuracy vs. temperature



Three flexible output functions

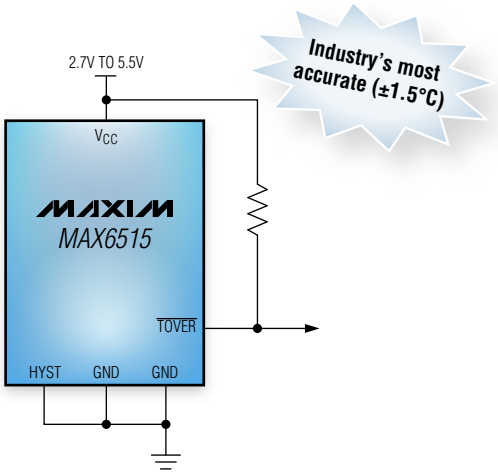


Industry's most comprehensive portfolio of temp switches

Temperature switches provide simple protection from potentially damaging thermal conditions by generating an over- or undertemperature signal when the temperature is outside the safe operating range. Whatever kind of temperature switch you need—factory preset, resistor adjustable, pin strapped, or remote-diode sensing—Maxim has you covered. Are you looking for the industry's most accurate temperature switches? We have those too!

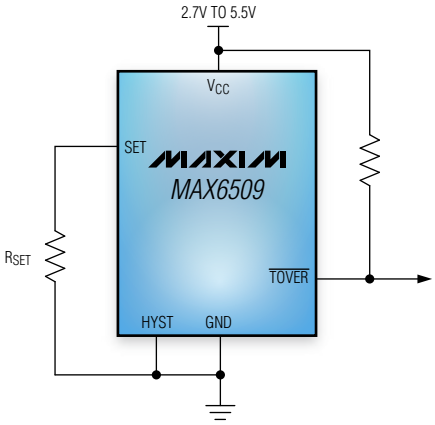
Factory-preset trip thresholds

MAX6501–MAX6508
MAX6514–MAX6519



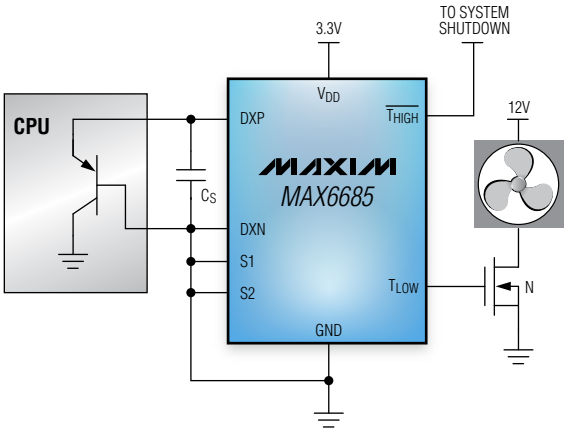
Resistor-adjustable trip thresholds

MAX6509/MAX6510



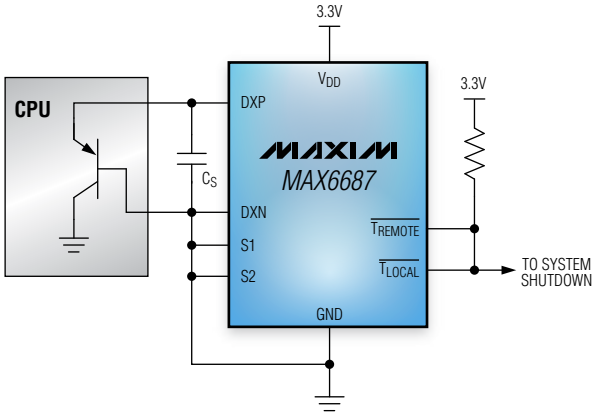
Remote with preset or pin-strapped thresholds

MAX6511–MAX6513 (Preset)
MAX6685/MAX6686 (Pin strapped)



Local/remote with pin-strapped local threshold

MAX6687/MAX6688



Remote Digital Temperature Sensors

www.maxim-ic.com

Part	Description	Interface	Remote Sensors	Local Sensor	Accuracy (°C)	Accuracy Range (°C)	Operating Temp Range (°C)	V_{CC} Supply Range (V)	I_{DD} (µA, max)	Package	Footprint (mm^2)	Price† ($)	EV Kit
MAX6627/28	Remote temp sensors with SPI™ interface	3-wire	1	—	±1	0 to +125	-55 to +125	3.0 to 5.5	400/50	8-TDFN, 8-SOT23	9	1.78	—
MAX6674/75	K-thermocouple-to-digital converters (0°C to +128°C and 0°C to +1024°C)	3-wire	1	✓	±2	0 to +125	-20 to +85	3.0 to 5.5	1500	8-SO	30	3.82	—
MAX6682	Thermistor-to-digital converter	3-wire	1	—	±3 LSB	—	-55 to +125	3.0 to 5.5	300	8-µMAX	15	1.89	—
MAX6581*	8-channel, ±1°C accurate temp monitor	I²C/SMBus	7	✓	±1	+60 to +100	-40 to +125	3.0 to 5.5	1000	24-TSSOP	16	—	—
MAX6602	5-channel temp monitor (4 remote, 1 local) with standby	I²C/SMBus	4	✓	±1	+60 to +100	-40 to +125	3.0 to 5.5	1000	16-TSSOP	30	3.82	—
MAX6638	Remote/local temp monitor with 2 independent SMBus interfaces	I²C/SMBus	1	✓	±2	+25 to +100	-40 to +125	3.0 to 5.5	950	16-TQFN	16	—	✓
MAX6642	Remote/local temp sensor with overtemp alarm	I²C/SMBus	1	✓	±1	+60 to +100	-40 to +125	3.0 to 5.5	1000	6-TDFN	9	1.15	✓
MAX6646/47/49	Remote/local temp sensors with overtemp alarms	I²C/SMBus	1	✓	±1	+60 to +145	-55 to +125	3.0 to 5.5	400	8-µMAX	15	1.96	—
MAX6648/92	Remote/local temp sensors with overtemp alarms	I²C/SMBus	1	✓	±0.8	+25 to +125	-55 to +125	3.0 to 5.5	400	8-µMAX, 8-SO	15	1.96	—/✓
MAX6654	Remote/local temp sensor with resistance cancellation and overtemp alarm	I²C/SMBus	1	✓	±2	+70 to +100	-55 to +125	3.0 to 5.5	1000	16-QSOP	30	2.37	✓
MAX6655/56	2-channel remote/local temp sensors and 4-channel voltage monitors	I²C/SMBus	2	✓	±1.5	+60 to +100	-55 to +125	3.0 to 5.5	1000	16-QSOP	30	2.81	✓/—
MAX6657/58/59	Remote/local temp sensors with overtemp alarms	I²C/SMBus	1	✓	±1	+60 to +100	-55 to +125	3.0 to 5.5	1000	8-SO, 16-QSOP	30	2.02	—
MAX6680/81	Fail-safe remote/local temp sensors with overtemp alarms	I²C/SMBus	1	✓	±1	+60 to +100	-55 to +125	3.0 to 5.5	1000	16-QSOP	30	2.42	—/✓
MAX6689	7-channel temp monitor (6 remote, 1 local) with standby	I²C/SMBus	6	✓	±1	+60 to +100	-40 to +125	3.0 to 5.5	1000	20-TSSOP, 20-QSOP	30	3.82	—
MAX6690	Remote/local temp sensor with resistance cancellation and overtemp alarm	I²C/SMBus	1	✓	±2	+70 to +100	-55 to +125	3.0 to 5.5	70	16-QSOP	30	—	—
MAX6695/96	Dual remote/local temp sensors with fixed or pin-selectable SMBus address	I²C/SMBus	2	✓	±1.5	+60 to +100	-40 to +125	3.0 to 5.5	1000	10-µMAX	15	2.42	✓/—
MAX6697	7-channel temp monitor (6 remote, 1 local)	I²C/SMBus	6	✓	±1	+60 to +100	-40 to +125	3.0 to 5.5	1000	20-TSSOP, 20-QSOP	30	3.82	—
MAX6698	7-channel temp monitor (3 remote, 1 local, 3 thermistor)	I²C/SMBus	6	✓	±1	+60 to +100	-40 to +125	3.0 to 5.5	1000	20-TSSOP, 20-QSOP	30	3.82	✓
MAX6699	5-channel temp monitor (4 remote, 1 local)	I²C/SMBus	4	✓	±1	+60 to +100	-40 to +125	3.0 to 5.5	1000	16-TSSOP, 16-QSOP	30	3.82	—

Local Digital Temperature Sensors

Part	Description	Interface	Accuracy (°C)	Accuracy Range (°C)	Operating Temp Range (°C)	V_{CC} Supply Range (V)	I_{DD} (µA, max)	Package	Footprint (mm^2)	Price† ($)	EV Kit
DS1821	Programmable digital thermostat and thermometer	1-Wire	±1	0 to +85	-55 to +125	2.7 to 5.5	1000	8-SO, PR35	30	2.01	✓
DS1822	Econo 1-Wire digital thermometer	1-Wire	±2	-10 to +85	-55 to +125	3.0 to 5.5	1500	8-SO, TO-92	30	1.61	✓
DS1825	Precision 1-Wire digital thermometer with 4-bit ID	1-Wire	±0.5	-10 to +85	-55 to +125	3.0 to 3.7	1500	8-µMAX	15	1.70	✓
DS18B20	Precision digital thermometer	1-Wire	±0.5	-10 to +85	-55 to +125	3.0 to 5.5	1500	8-µSOP, 8-SO, TO-92	15	1.76	✓
DS18S20	Precision digital thermometer	1-Wire	±0.5	-10 to +85	-55 to +125	3.0 to 5.5	1500	8-SO, TO92	30	2.09	✓
DS28EA00	Precision digital thermometer with sequence detect and GPIO	1-Wire	±0.5	-10 to +85	-40 to +85	3.0 to 5.5	1500	8-µSOP	15	2.25	✓
MAX6575	Temp sensor with single-wire time-delay interface	Single wire	±4.5	+85	-55 to +125	2.7 to 5.5	250	6-SOT23	9	0.79	—
MAX6576/77	Temp sensors with single-wire period output/frequency output	Single wire	±4.5/±3.5	+85	-55 to +125	2.7 to 5.5	250	6-SOT23	9	0.79	—
DS1620	Precision digital thermometer and thermostat	3-wire	±0.5	0 to +70	-55 to +125	2.7 to 5.5	1000	8-SO, 8-DIP	30	2.89	✓
DS1624	Precision digital thermometer and memory	3-wire	±0.5	0 to +70	-55 to +125	2.7 to 5.5	1000	8-SO, 8-DIP	30	3.75	✓
DS1626	Precision digital thermometer and thermostat	3-wire	±0.5	0 to +70	-55 to +125	2.7 to 5.5	1000	8-µMAX	15	1.66	✓
DS1720	Econo digital thermometer and thermostat	3-wire	±2.5	-55 to +125	-55 to +125	2.7 to 5.5	1000	8-SO	30	2.26	✓
DS1722	Digital thermometer	3-wire	±2	-40 to +85	-55 to +125	2.65 to 5.5	500	8-µMAX, 8-SO	15	1.10	✓
DS1726	Digital thermometer and thermostat	3-wire	±1	-10 to +85	-55 to +125	2.7 to 5.5	400	8-µMAX	15	1.61	—
MAX6629–32	Digital temp sensors with SPI interface	3-wire	±1	0 to +70	-55 to +150	3.0 to 5.5	400/50	6-TDFN, 6-SOT23	9	1.39	✓/—
MAX6662	12-bit + sign SPI temp sensor	3-wire	±1.6	0 to +70	-55 to +150	3.0 to 5.5	600	8-SO	30	1.44	—
DS1629	Digital thermometer and RTC (real-time clock)	I²C/SMBus	±2	-10 to +85	-55 to +125	2.2 to 5.5	1000	8-SO	30	3.22	✓
DS1631	Precision digital thermometer and thermostat	I²C/SMBus	±0.5	0 to +70	-55 to +125	2.2 to 5.5	1000	8-µMAX, 8-SO	30	1.66	✓
DS1721	Digital thermometer and thermostat	I²C/SMBus	±1	-10 to +85	-55 to +125	2.7 to 5.5	1000	8-µMAX, 8-SO	30	1.61	✓
DS1731	Digital thermometer and thermostat	I²C/SMBus	±1	-10 to +85	-55 to +125	2.2 to 5.5	1000	8-µMAX	15	1.61	✓
DS1775	Digital thermometer and thermostat	I²C/SMBus	±2	-10 to +85	-55 to +125	2.7 to 5.5	1000	5-SOT23	9	0.88	✓
DS620	Low-voltage, precision digital thermometer and thermostat	I²C/SMBus	±0.5	0 to +70	-55 to +125	1.7 to 3.5	800	8-µMAX	15	1.66	✓
DS75	Digital thermometer and thermostat	I²C/SMBus	±2	-25 to +100	-55 to +125	2.7 to 5.5	1000	8-µMAX, 8-SO	15	0.90	✓
DS75LV	Low-voltage digital thermometer and thermostat	I²C/SMBus	±2	-25 to +100	-55 to +125	1.7 to 3.7	1000	8-µMAX, 8-SO	15	0.90	✓
DS75LX	Digital thermometer and thermostat with extended addressing	I²C/SMBus	±2	-25 to +100	-55 to +125	1.7 to 3.7	1000	8-µMAX, 8-SO	15	0.75	✓
LM75	Digital temp sensor and thermal watchdog (LM75 second source)	I²C/SMBus	±2	-25 to +100	-55 to +125	3.0 to 5.5	500	8-µMAX, 8-SO	15	0.65	—
MAX6604	Temp monitor for DDR memory modules	I²C/SMBus	±2	+40 to +125	-20 to +125	2.7 to 3.6	500	8-TDFN, 8-TSSOP	6	0.95	—
MAX6625/26	Digital temp sensors with overtemp alarm	I²C/SMBus	±2	0 to +70	-55 to +125	3.0 to 5.5	1000	6-TDFN, 6-SOT23	9	0.90	—
MAX6633/34/35	Digital temp sensors with overtemp alarms and 4/3/2 address pins	I²C/SMBus	±1.5	-20 to +125	-55 to +150	3.0 to 5.5	350	8-SO	30	1.28	—
MAX6652/83	Digital temp sensors and 4-channel voltage monitor	I²C/SMBus	±3	-20 to +80	-40 to +125	2.7 to 5.5	500	10-µMAX	15	1.84	—
MAX7500–04	Digital temp sensors with overtemp alarm (LM75 compatible)	I²C/SMBus	±2	-25 to +100	-55 to +125	3.0 to 5.5	500	8-µMAX, 8-SO	15	0.72	—

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*Future product—contact the factory for availability.

†1000-up recommended resale. Prices provided are for design guidance and are FOB USA. International prices will differ due to local duties, taxes, and exchange rates. Not all packages are offered in 1k increments, and some may require minimum order quantities.

Analog Temperature Sensors

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Part	Description	Accuracy (°C)	Accuracy Range (°C)	Operating Temp Range (°C)	V_{CC} Supply Range (V)	I_{DD} (µA, max)	Package	Footprint (mm^2)	Price† ($)	EV Kit
DS600	Precision analog temp sensor with temp switch	±0.5	-20 to +100	-40 to +125	2.7 to 5.5	140	8-µMAX	15	1.80	✓
MAX6605	Analog temp sensor in SC70	±3.8	-20 to +85	-55 to +125	2.7 to 5.5	10	5-SC70	4	0.40	—
MAX6607/08	1.8V analog temp sensors in SC70/SOT23	±5	-10 to +85	-20 to +85	1.8 to 3.6	15	5-SC70, 5-SOT23	4/9	0.59	—
MAX6610/11	Temp sensors with voltage reference in SOT23	±3.7	-20 to +85	-40 to +125	3.0 to 5.5	250	6-SOT23	9	0.80	—
MAX6612	High-slope analog temp sensor	±4.3	+60 to +100	-55 to +150	2.4 to 5.5	35	5-SC70	4	0.59	—
MAX6613	1.8V to 5.5V analog temp sensor	±4.4	-20 to +85	-55 to +130	1.8 to 5.5	13	5-SC70	4	0.35	—

Temperature Switches

Part	Description	Remote Sensors	Local Sensor	Accuracy (°C)	Accuracy Range (°C)	Operating Temp Range (°C)	V_{CC} Supply Range (V)	I_{DD} (µA, max)	Package	Footprint (mm^2)	Price† ($)	EV Kit
MAX6501–04	Temp switches with factory-set thresholds (in 10°C increments)	0	✓	±6	+75 to +125	-55 to +125	2.7 to 5.5	85	5-SOT23, 7-TO-220	9	0.67	—
MAX6505–08	Dual-output temp switches, factory-set thresholds (in 5°C increments)	0	✓	±3.5	0 to +95	-55 to +125	2.5 to 5.5	1	6-SOT23	9	0.79	—
MAX6509/10	Resistor-programmable temp switches	0	✓	±4.7	0 to +125	-55 to +125	2.5 to 5.5	0	5-SOT23, 6-SOT23	9	0.70	—
MAX6511/12/13	Remote temp switches with factory-set thresholds (in 10°C increments)	1		±5	-40 to +85	-40 to +85	3.0 to 5.5	600	6-TDFN, 6-SOT23	9	0.85	—
MAX6514/15	Temp switches with factory-set thresholds (in 10°C increments)	0	✓	±2.5	+75 to +115	-55 to +125	2.7 to 5.5	40	5-SOT23	9	0.75	—
MAX6516–19	Temp switches with analog outputs, factory-set thresholds (in 10°C increments)	0	✓	±2.5	+75 to +115	-55 to +125	2.7 to 5.5	40	5-SOT23	9	0.75	—
MAX6685/86	Dual-output remote-junction temp switches	1		±1.5	0 to +125	-40 to +125	3.0 to 5.5	800	8-µMAX	15	3.31	—
MAX6687	Dual-output remote-junction temp switch	1	✓	±3	0 to +85	-40 to +125	3.0 to 5.5	800	8-µMAX	15	3.31	—

Fan Controllers

Part	Description	Interface	Remote Sensors	Local Sensor	Fan Outputs	Tach Inputs	Operating Temp Range (°C)	V_{CC} Supply Range (V)	I_{DD} (µA, max)	Package	Footprint (mm^2)	Price† ($)	EV Kit
MAX6665	Temp switch with factory-programmed threshold and fan on/off driver	Analog	0	✓	1	—	-40 to +125	2.7 to 5.5	200	8-SO	30	1.32	—
DS1780	2-channel hardware monitor with DAC output	I^2C/SMBus	0	✓	1	—	-40 to +125	2.8 to 5.75	1000	24-TSSOP	52	2.21	✓
MAX6615/16	2-channel thermistor inputs, 1 local sensor, 2 PWM fan controllers	I^2C/SMBus	2	✓	2	2	-40 to +125	3.0 to 5.5	—	16-QSOP/24-QSOP	30	1.95	—/✓
MAX6620	Quad linear fan controller with RPM control	I^2C/SMBus	0		4	4	-40 to +125	3.0 to 5.5	500	28-TQFN	25	2.50	✓
MAX6639	2-channel temp monitor with dual PWM fan-speed control	I^2C/SMBus	1	✓	2	2	-40 to +125	3.0 to 3.6	1000	16-TQFN, 16-QSOP	25	1.22	—/✓
MAX6650/51	Fan-speed regulators and monitors (single/quad)	I^2C/SMBus	0		1	1/4	-40 to +85	3.0 to 5.5	10,000	10-µMAX	15	2.10	—/✓
MAX6653/63/64	Local/remote temp monitors and PWM fan controllers	I^2C/SMBus	1	✓	1	1	-40 to +125	3.0 to 5.5	—	16-QSOP	30	2.02	✓/—
MAX6660	Remote temp monitor and fan-speed controller	I^2C/SMBus	1		1	1	-40 to +125	3.0 to 5.5	500	16-QSOP	30	3.26	✓
MAX6661	Remote-junction, temp-controlled fan-speed regulator	I^2C/SMBus	1		1	1	-40 to +125	3.0 to 5.5	700	16-QSOP	30	3.46	—
MAX6678	2-channel temp monitor with dual PWM fan controller and 5 GPIOs	I^2C/SMBus	2	✓	2	—	-40 to +125	3.0 to 5.5	1000	20-TQFN, 20-QSOP	25	1.82	—
MAX6684	Fan-failure detector and power switch for 2-wire fans	Logic	0		1	—	-40 to +85	3.0 to 5.5	3400	8-SO	30	1.06	—

Other Thermal Products

Part	Description	Interface	Operating Temp Range (°C)	V_{CC} Supply Range (V)	I_{DD} (µA, max)	Package	Footprint (mm^2)	Price† ($)	EV Kit
DS1682	Total-elapsed-time recorder with alarm	I^2C/SMBus	-40 to +85	2.5 to 5.5	300	8-SO	30	1.73	—
DS2422	1-Wire temp/data logger with 8KB data-log memory	1-Wire	-40 to +85	2.8 to 3.6	350	24-SO	166	27.25	—
MAX6603	2-channel platinum RTD-to-voltage signal conditioner	Analog	-40 to +125	3.0 to 5.5	5500	10-TDFN	9	1.50	✓
MAX6618	PECI-to-I^2C translator	I^2C/SMBus	-20 to +120	3.0 to 3.6	7000	10-µMAX	15	—	—
MAX6674/75	K-thermocouple-to-digital converters (0°C to +128°C and 0°C to +1024°C)	3-wire	-20 to +85	3.0 to 5.5	1500	8-SO	30	3.82	✓
MAX6684	Fan-failure detector and power switch for 2-wire fans	Logic	-40 to +85	3.0 to 5.5	3400	8-SO	30	1.06	—

†1000-up recommended resale. Prices provided are for design guidance and are FOB USA. International prices will differ due to local duties, taxes, and exchange rates. Not all packages are offered in 1k increments, and some may require minimum order quantities.

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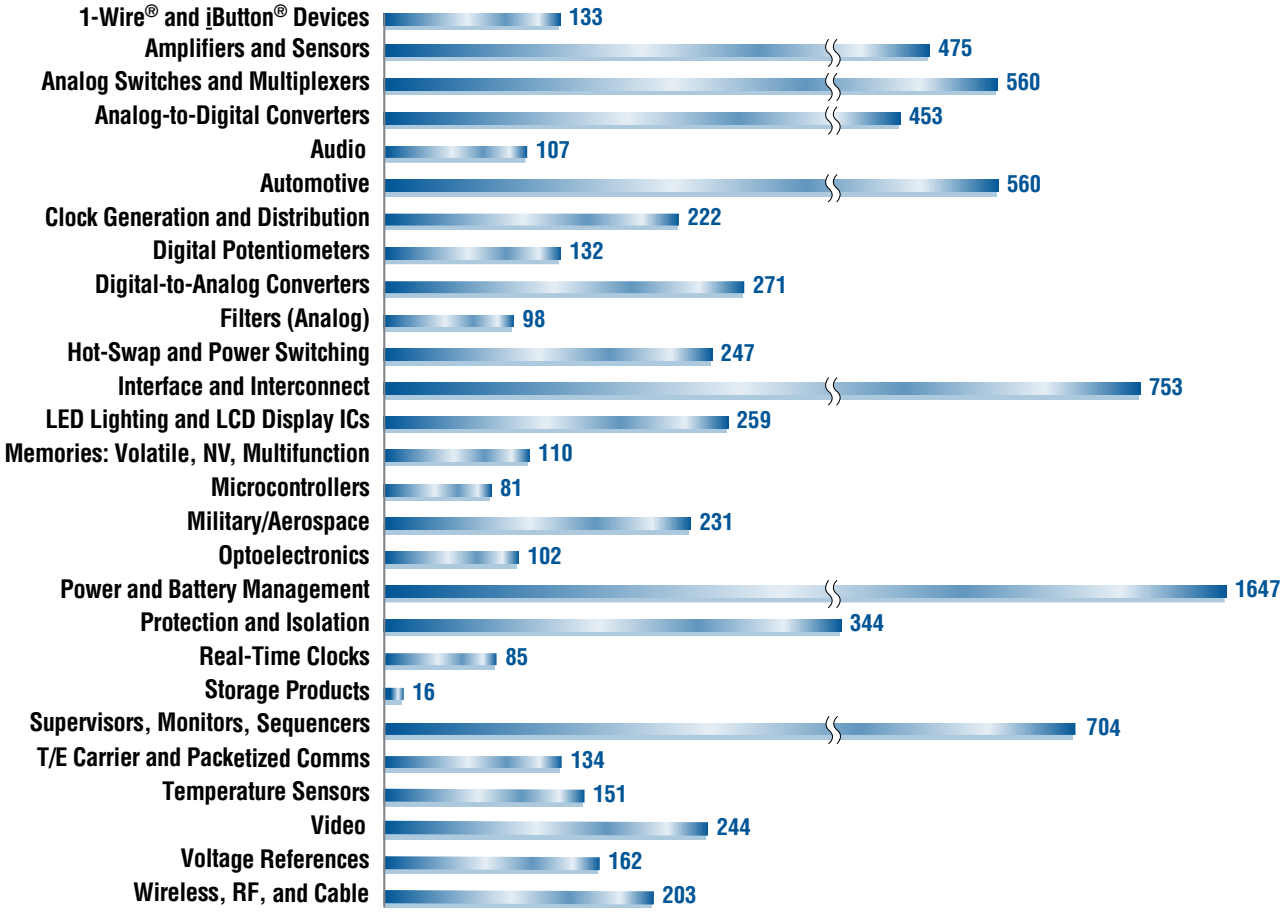

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