MAXIM

Local/Remote Temperature Switches in a µMAX Package

MAX6687/MAX6688

General Description

The MAX6687/MAX6688 comprise a remote-junction temperature switch and a local temperature switch in a single package. The remote-junction switch uses an external P-N junction (typically a diode-connected transistor on the die of an external CPU, ASIC, or FPGA) as a sensing element to measure the remote temperature. The remote-junction temperature switch has a factory-programmed trip temperature threshold of either +120°C or +125°C. The local temperature switch has a pin-programmable temperature threshold that is set by connecting pins S1 and S2 to ground, to V_{DD}, or leaving them floating. Hysteresis for both local and remote thresholds is 5°C. The MAX6687/MAX6688 do not assert on transient (single-sample) faults or when power is first applied.

The MAX6687 has two open-drain active-low outputs while the MAX6688 has two push-pull active-high outputs. T_{REMOTE} asserts a logic signal when the remote temperature exceeds the factory-programmed +120°C or +125°C trip threshold. T_{LOCAL} is asserted when the die temperature exceeds the pin-programmed threshold, which is controlled by pins S1 and S2. The local thresholds are available in two ranges in 5°C increments. The two ranges are +40°C to +80°C and +75°C to +115°C.

The MAX6687/MAX6688 operate from a 3.0V to 5.5V power supply and are available in a space-saving 8-pin µMAX package.

Applications

CPU Temperature Protection

FPGA Temperature Protection
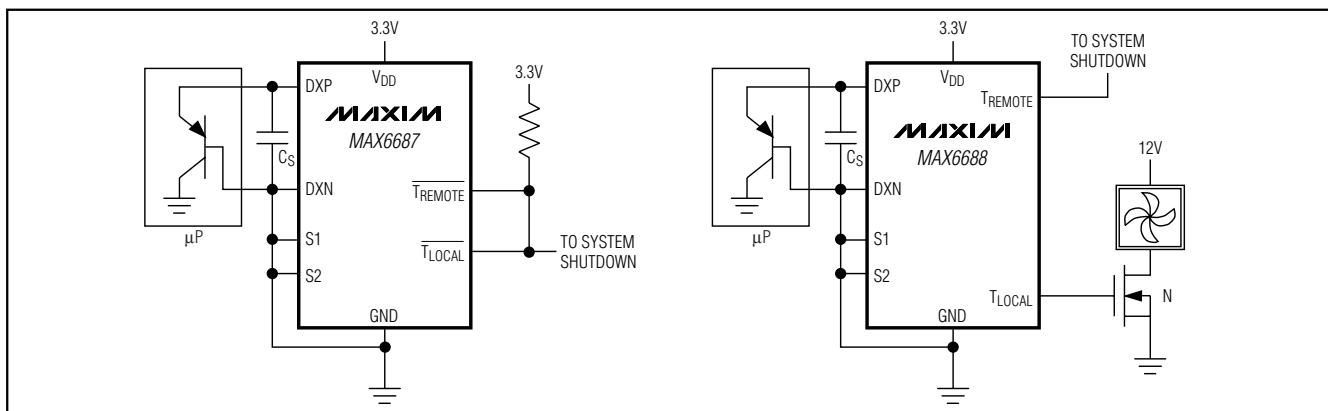
Fan Control

Temperature Alarms

Features

♦ **Pin-Programmable Local Temperature Threshold in 5°C Increments in Two Distinct Ranges: +40°C to +80°C and +75°C to +115°C**

♦ **Factory-Programmed Remote Threshold: +120°C (L Suffix) or +125°C (H Suffix)**

♦ **Open-Drain Active-Low Outputs (MAX6687)**

♦ **CMOS Push-Pull, Active-High Outputs (MAX6688)**

♦ **±1.5°C Accuracy**

♦ **2Hz Temperature Sampling Rate**

♦ **215µA Average Supply Current**

♦ **3.0V to 5.5V Power-Supply Voltage**

♦ **8-Pin µMAX Package**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX6687AU40L	-40°C to +125°C	8 µMAX
MAX6687AU40H	-40°C to +125°C	8 µMAX
MAX6687AU75L	-40°C to +125°C	8 µMAX
MAX6687AU75H	-40°C to +125°C	8 µMAX
MAX6688AU40L	-40°C to +125°C	8 µMAX
MAX6688AU40H	-40°C to +125°C	8 µMAX
MAX6688AU75L	-40°C to +125°C	8 µMAX
MAX6688AU75H	-40°C to +125°C	8 µMAX

Pin Configurations/Functional Diagrams/Selector Guide appear at end of data sheet.

Typical Operating Circuit

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Local/Remote Temperature Switches in a µMAX Package

ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to GND
V_{DD}, T_{LOCAL}, T_{REMOTE} ....-0.3V to +6V
DXN ....-0.3V to +0.8V
All Other Pins...-0.3V to (V_{DD} + 0.3V)
Input Current..5mA
Output Current 20mA

Continuous Power Dissipation (T_A = +70°C)
  8-Pin µMAX (derate 4.1mW/°C above +70°C) 330mW
Operating Temperature Range ....-40°C to +125°C
Junction Temperature..+150°C
Storage Temperature Range ....-65°C to +165°C
Lead Temperature (soldering, 10s) ....+300°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.

ELECTRICAL CHARACTERISTICS

(V_{DD} = 3V to 5.5V, T_A = -40°C to +125°C, unless otherwise noted. Typical values are at V_{DD} = 3.3V and T_A = +25°C.) (Note 1)

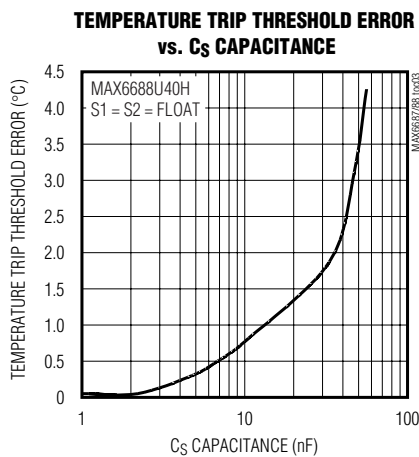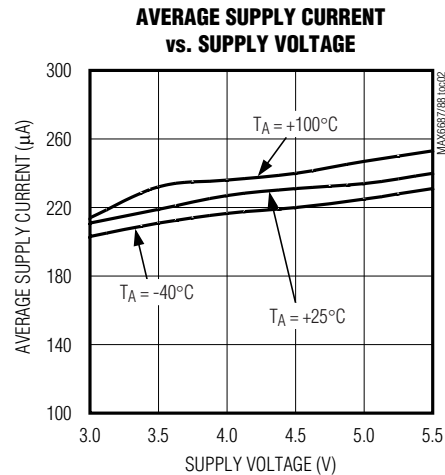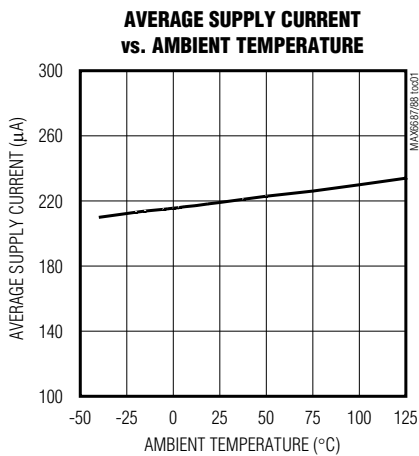| PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS
Power-Supply Range	V_{DD}		3		5.5	V
Average Supply Current	I_{DD}			215	500	µA
Supply Current During Conversion				400	800	µA
Power-On Reset (POR) Threshold	POR	V_{DD} falling edge	1	1.5	2.0	V
POR Threshold Hysteresis				50		mV
Remote-Diode Temperature Threshold Accuracy, Rising Temperature	ΔT_{TH}	T_A = +25°C, V_{DD} = 3.3V	-1.5		+1.5	°C
		T_A = 0°C to +85°C, V_{DD} = 3.3V	-3.0		+3.0	
		T_A = -40°C to +125°C, V_{DD} = 3.3V	-5.0		+5.0	
Internal Temperature Threshold Accuracy, Rising Temperature	ΔT_{TH}	Temperature trip thresholds from +40°C to +105°C, V_{DD} = 3.3V	-3.0		+3.0	°C
		Temperature trip thresholds +110°C and +115°C, V_{DD} = 3.3V	-3.5		+3.5	
Temperature Threshold Hysteresis	T_{HYST}			5.0		°C
Temperature Threshold Supply Sensitivity					0.6	°C/V
Output Voltage High	V_{OH}	I_{SOURCE} = 1mA, MAX6688	V_{DD} - 0.2			V
Output Voltage Low	V_{OL}	I_{SINK} = 1mA			0.2	V
Logic Input Low Voltage (S1, S2)	V_{IL}				0.4	V
Logic Input High Voltage (S1, S2)	V_{IH}		1.8			V
Input Current (S1, S2)					10	µA
Open-Drain Output Leakage Current		V_{OUT} = 5.5V, MAX6687			1	µA

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MAX6687/MAX6688

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = 3V to 5.5V, T_A = -40°C to +125°C, unless otherwise noted. Typical values are at V_{DD} = 3.3V and T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS
Temperature Conversion Time			0.2	0.25	0.3	s
Temperature Sample Period			0.4	0.5	0.6	s
Current Sourcing for External Diode		High level	80	100	120	µA
		Low level	8	10	12	

Note 1: All parameters are tested at +25°C. Temperature specifications over a range of -40°C to +125°C are guaranteed by design.

Typical Operating Characteristics

(V_{DD} = 3.3V, C_S = 2200pF, T_A = +25°C, unless otherwise noted.)

AVERAGE SUPPLY CURRENT vs. AMBIENT TEMPERATURE

AVERAGE SUPPLY CURRENT vs. SUPPLY VOLTAGE

TEMPERATURE TRIP THRESHOLD ERROR vs. C_S CAPACITANCE

REMOTE TEMPERATURE TRIP THRESHOLD ERROR vs. AMBIENT TEMPERATURE

MAX6687/MAX6688

PIN		NAME	FUNCTION
MAX6687	**MAX6688**		
1	1	V_{DD}	Power-Supply Input. Bypass to GND with a 0.1µF capacitor.
2	2	GND	Ground
3	3	DXP	This pin connects to the positive (anode) terminal of the external P-N sense junction. It sources current into the external junction. A 2200pF capacitor should be connected across DXP and DXN.
4	4	DXN	This pin connects to the negative (cathode) terminal of the external P-N sense junction. It sinks current from the external junction. A 2200pF capacitor should be connected across DXP and DXN. DXN must be connected to the GND pin at the pin.
5	—	$\overline{T_{REMOTE}}$	Open-Drain Active-Low Output. $\overline{T_{REMOTE}}$ goes low when the temperature exceeds the factory-programmed temperature threshold, either +120°C or +125°C. Connect a pullup resistor (typically 10kΩ) between $\overline{T_{REMOTE}}$ and a positive power supply up to 5.5V.
—	5	T_{REMOTE}	CMOS Push-Pull, Active-High Output. T_{REMOTE} goes high when the temperature exceeds the factory-programmed temperature threshold, either +120°C or +125°C.
6	—	$\overline{T_{LOCAL}}$	Open-Drain Active-Low Output. $\overline{T_{LOCAL}}$ goes low when the temperature exceeds the pin-programmable temperature threshold set by S1 and S2. Connect a pullup resistor (typically 10kΩ) between $\overline{T_{LOCAL}}$ and a positive power supply up to 5.5V.
—	6	T_{LOCAL}	CMOS Push-Pull, Active-High Output. T_{LOCAL} goes high when the temperature exceeds the pin-programmable temperature threshold set by S1 and S2.
7	7	S1	Threshold Select Input. Used in conjunction with S2 to set the local threshold temperature (Table 1). It can be connected to V_{DD}, GND, or left floating.
8	8	S2	Threshold Select Input. Used in conjunction with S1 to set the local threshold temperature (Table 1). It can be connected to V_{DD}, GND, or left floating.

Detailed Description

The MAX6687/MAX6688 sense the temperatures of both a remote P-N junction and their own die. The external P-N junction is typically a base-emitter junction of a substrate PNP on a microprocessor, FPGA, or ASIC die (see the _Typical Operating Circuit_).

The remote temperature switch has a factory-programmed trip temperature of either +120°C or +125°C and is intended to be used for system shutdown when the die temperature of a remote IC, such as a microprocessor, FPGA, or ASIC exceeds the factory-programmed thresholds.

The local temperature switch has a pin-programmable threshold temperature (Table 1). This temperature switch may be used for such functions as system shutdown or for turning on a cooling fan when board temperature exceeds the temperature limit. Two temperature ranges are available for the local trip

threshold: +40°C to +80°C and +75°C to +115°C. S1 and S2 pins must be set to the desired trip temperature before power is applied to the V_{DD} pin. If S1 and S2 settings are changed after the power is turned on, the local trip threshold remains set to the point where S1 and S2 were when power was applied.

Since the MAX6687/MAX6688 are often used for system shutdown, they are designed so that the outputs do not change on transient faults or when power is first applied. This eliminates the possibility that the IC could erroneously shut a system down.

The MAX6687/MAX6688 provide noise immunity by integration and oversampling of the diode voltage, but good design practice includes routing the DXP and DXN lines away from noise sources, such as high-speed digital lines, switching regulators, inductors, and transformers. The DXP and DXN traces should be paired together and surrounded by a ground plane whenever possible.

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Table 1. Local Temperature Trip Threshold Selection

S1	S2	MAX6687AUA40L/MAX6687AUA40H/ MAX6688AUA40L/MAX6688AUA40H	MAX6687AUA75L/MAX6687AUA75H/ MAX6688AUA75L/MAX6688AUA75H
		LOCALTEMPERATURE TRIP THRESHOLD (°C)	LOCAL TEMPERATURE TRIP THRESHOLD (°C)
GND	GND	+40	+75
GND	FLOAT	+45	+80
GND	V_{DD}	+50	+85
FLOAT	GND	+55	+90
FLOAT	FLOAT	+60	+95
FLOAT	V_{DD}	+65	+100
V_{DD}	GND	+70	+105
V_{DD}	FLOAT	+75	+110
V_{DD}	V_{DD}	+80	+115

Applications Information

Remote-Diode selection

The MAX6687/MAX6688 are optimized to measure the die temperature of CPUs and other ICs that have on-chip temperature-sensing diodes. These on-chip diodes are substrate PNPs with their collectors grounded. Connect the base of the PNP to DXN and the emitter to DXP. When using a discrete, diode-connected NPN or PNP as a sensing diode, use a good-quality small-signal device. Examples are listed in Table 2. Tight specifications for forward current gain indicate the manufacturer has good process controls and that the devices have consistent V_{BE} characteristics. Always use a transistor for the sensing junction; diodes do not work.

The MAX6687/MAX6688 are optimized for use with thermal-sensing transistors with an ideality factor of 1.008. Different ideality factors cause predictable, usually small deviations in trip temperature thresholds.

Table 2. Sensor Transistor Manufacturers

MANUFACTURER	MODEL NO.
Central Semiconductor (USA)	CMPT3904
Rohm Semiconductor (Japan)	SST3904
Samsung (Korea)	KST3904-TF
Siemens (Germany)	SMBT3904

Noise-Filtering Capacitors

A quality ceramic capacitor must be connected across the DXP/DXN inputs to maintain temperature threshold accuracy by filtering out noise. The capacitor should be located physically close to the DXP/DXN pins and should typically have a value of 2200pF. Larger capacitor values can cause temperature measurement errors. A 50% increase from the recommended capacitor value can cause up to ±1°C error.

Sensing Circuit Board and Ambient Temperature

Temperature switches like the MAX6687/MAX6688 that sense their own die (local) temperatures must be mounted on or close to the object whose temperature they are intended to measure. The MAX6687/MAX6688 can accurately measure the temperature of a circuit board to which they are soldered because the package leads provide a good thermal path between the circuit board and their own die. If the MAX6687/MAX6688 are intended to be triggered by the temperature of a heat-generating component on the circuit board, they 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. The thermal path between the plastic package and the die is not as good as the path through the package leads, so the MAX6687/MAX6688 are less sensitive to the surrounding air temperature than they are to the temperature of their package leads, but they can be successfully used to respond to the ambient temperature if the circuit board is designed to track the ambient temperature.
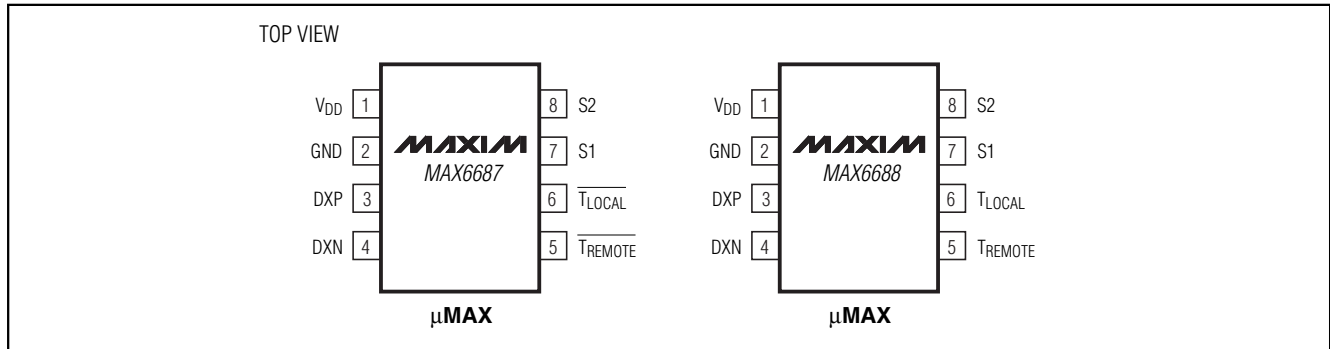
Chip Information

TRANSISTOR COUNT: 7765
PROCESS: BiCMOS

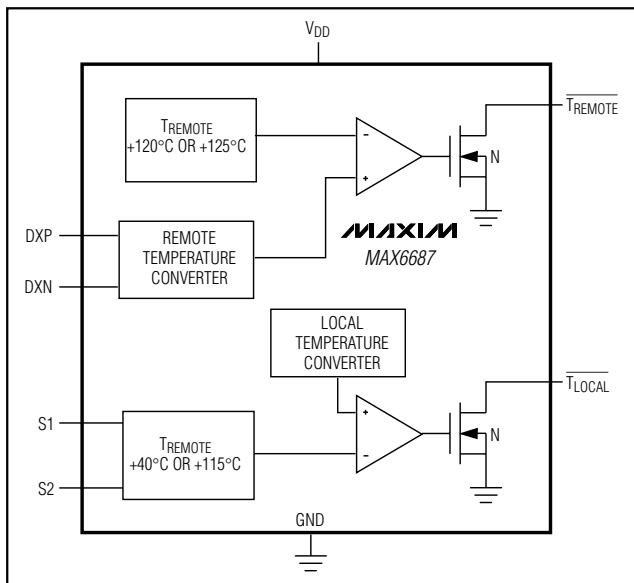# Local/Remote Temperature Switches in a µMAX Package

Pin Configurations

TOP VIEW

```
        MAX6687
VDD   1          8   S2
GND   2          7   S1
DXP   3          6   T̄LOCAL
DXN   4          5   T̄REMOTE
          µMAX
```

```
        MAX6688
VDD   1          8   S2
GND   2          7   S1
DXP   3          6   TLOCAL
DXN   4          5   TREMOTE
          µMAX
```

Functional Block Diagrams

Figure 1a. MAX6687 Functional Block Diagram
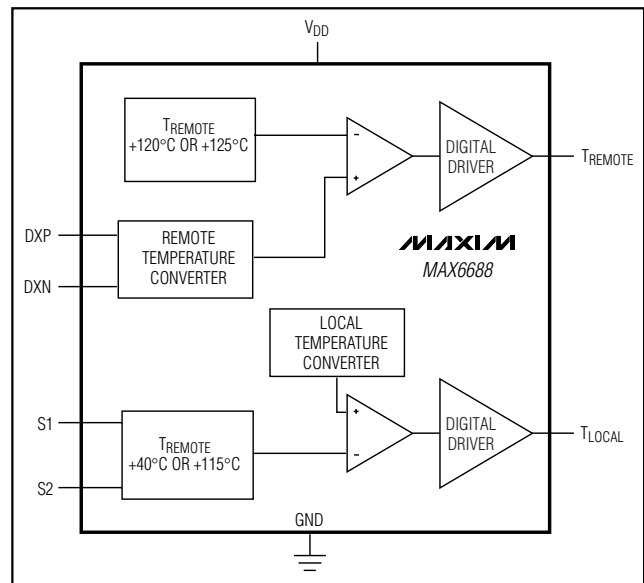
Figure 1b. MAX6688 Functional Block Diagram

Selector Guide

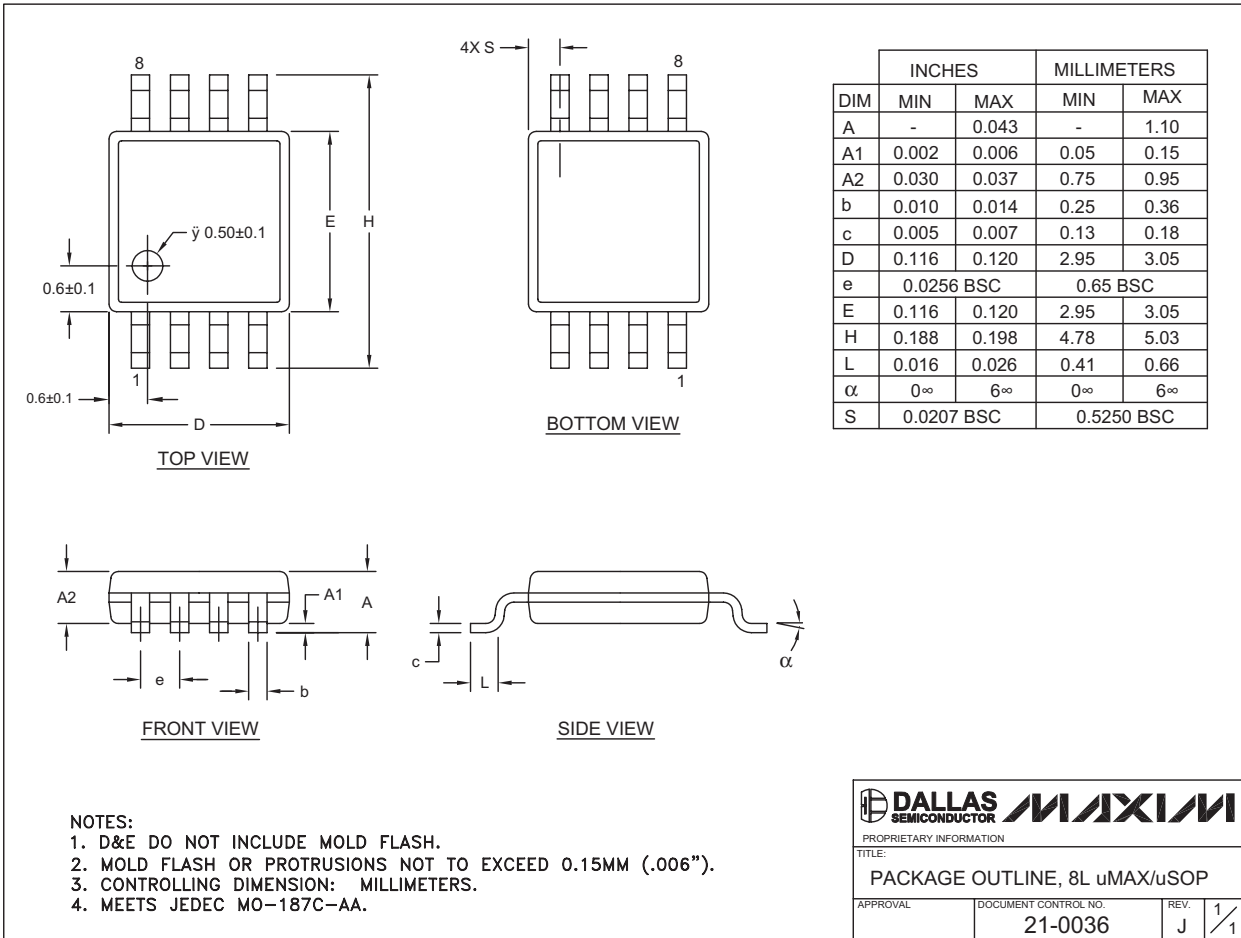| PART	OUTPUTS	REMOTE TRIP THRESHOLD (°C)	LOCAL TRIP THRESHOLD RANGE (°C)
MAX6687AU40L	Open drain, active low	+120	+40 to +80
MAX6687AU40H	Open drain, active low	+125	+40 to +80
MAX6687AU75L	Open drain, active low	+120	+75 to +115
MAX6687AU75H	Open drain, active low	+125	+75 to +115
MAX6688AU40L	Push pull, active high	+120	+40 to +80
MAX6688AU40H	Push pull, active high	+125	+40 to +80
MAX6688AU75L	Push pull, active high	+120	+75 to +115
MAX6688AU75H	Push pull, active high	+125	+75 to +115

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Local/Remote Temperature Switches in a µMAX Package

_____Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

8LUMAXD.EPS

TOP VIEW

BOTTOM VIEW

FRONT VIEW

SIDE VIEW

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	-	0.043	-	1.10
A1	0.002	0.006	0.05	0.15
A2	0.030	0.037	0.75	0.95
b	0.010	0.014	0.25	0.36
c	0.005	0.007	0.13	0.18
D	0.116	0.120	2.95	3.05
e	0.0256 BSC		0.65 BSC	
E	0.116	0.120	2.95	3.05
H	0.188	0.198	4.78	5.03
L	0.016	0.026	0.41	0.66
α	0∞	6∞	0∞	6∞
S	0.0207 BSC		0.5250 BSC	

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO–187C–AA.

DALLAS SEMICONDUCTOR **MAXIM**

PROPRIETARY INFORMATION

TITLE:
PACKAGE OUTLINE, 8L uMAX/uSOP

APPROVAL	DOCUMENT CONTROL NO.	REV.	1/1
	21-0036	J	

Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600 _____ **7**

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
MAX6687

Part Number Table

Notes:

1. See the MAX6687 QuickView Data Sheet for further information on this product family or download the MAX6687 full data sheet (PDF, 144kB).
2. Other options and links for purchasing parts are listed at: http://www.maxim-ic.com/sales.
3. Didn't Find What You Need? Ask our applications engineers. Expert assistance in finding parts, usually within one business day.
4. Part number suffixes: T or T&R = tape and reel; + = RoHS/lead-free; # = RoHS/lead-exempt. More: See full data sheet or Part Naming Conventions.
5. * Some packages have variations, listed on the drawing. "PkgCode/Variation" tells which variation the product uses.

Part Number	Free Sample	Buy Direct	Package: TYPE PINS SIZE DRAWING CODE/VAR *	Temp	RoHS/Lead-Free? Materials Analysis
MAX6687AU40H+				-40C to +125C	RoHS/Lead-Free: Yes
MAX6687AU75L+				-40C to +125C	RoHS/Lead-Free: Yes
MAX6687AU75H+				-40C to +125C	RoHS/Lead-Free: Yes
MAX6687AU40L+				-40C to +125C	RoHS/Lead-Free: Yes
MAX6687AU75H+T				-40C to +125C	RoHS/Lead-Free: Yes
MAX6687AU40L+T				-40C to +125C	RoHS/Lead-Free: Yes
MAX6687AU40H+T				-40C to +125C	RoHS/Lead-Free: Yes

MAX6687AU40H			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8-1*	-40C to +125C	RoHS/Lead-Free: No Materials Analysis
MAX6687AU75L-T			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8-1*	-40C to +125C	RoHS/Lead-Free: No Materials Analysis
MAX6687AU75L			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8-1*	-40C to +125C	RoHS/Lead-Free: No Materials Analysis
MAX6687AU75H-T				-40C to +125C	RoHS/Lead-Free: No
MAX6687AU75H			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8-1*	-40C to +125C	RoHS/Lead-Free: No Materials Analysis
MAX6687AU40L-T				-40C to +125C	RoHS/Lead-Free: No
MAX6687AU40L			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8-1*	-40C to +125C	RoHS/Lead-Free: No Materials Analysis
MAX6687AU40H-T				-40C to +125C	RoHS/Lead-Free: No
MAX6687AU75L+T				-40C to +125C	RoHS/Lead-Free: Yes

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