19-1712; Rev 1; 4/00

MAXIM

Dual Trip SOT Temperature Switches

General Description

The MAX6505–MAX6508 temperature switches have dual logic outputs that assert when the die temperature crosses their trip thresholds. Trip thresholds are factory programmed to convenient temperatures in 5°C increments.

The MAX6505/MAX6506 have an ALARM output that asserts when the temperature is above the factory-programmed thresholds (available from -40°C to +125°C). They also have a WARN output that asserts when the temperature is several degrees below the ALARM threshold. The difference between the ALARM and WARN thresholds (ΔT_{AW}) is pin selectable to +5°C, +10°C, +20°C, or +30°C. The MAX6505's logic outputs are open drain, while the MAX6506's logic outputs are push-pull.

The MAX6507 has open-drain outputs ($\overline{OVER}$, $\overline{OK}$), and the MAX6508 has push-pull outputs (OVER, $\overline{OK}$), each with two factory-programmed threshold temperatures (TOVER and TUNDER) in the wide range of -40°C to +125°C. The overtemperature output asserts when the temperature is above TOVER. When the temperature is in the desired window (less than TOVER and greater than TUNDER), OK ($\overline{OK}$) asserts.

The MAX6505–MAX6508 are accurate to ±0.5°C (typ), ±5.5°C (max). Operating from a +2.5V to +5.5V supply, these low-cost devices typically consume 30µA supply current and require no external components for setting trip points. The MAX6505–MAX6508 are available in a 6-pin SOT23 package.

Applications

µP Temperature Monitoring in High-Speed Computers

Temperature Control

Temperature Alarms

Fan Control

Features

- ♦ **±0.5°C (typ) Threshold Accuracy Over Full Temperature Range**
- ♦ **No External Components Required**
- ♦ **Low Cost**
- ♦ **30µA (typ) Supply Current**
- ♦ **Factory-Programmed Thresholds from -40°C to +125°C in 5°C Increments**
- ♦ **Open-Drain Outputs (MAX6505/MAX6507), Push-Pull Outputs (MAX6506/MAX6508)**
- ♦ **Pin Selectable +2°C, +10°C Hysteresis (MAX6507/MAX6508)**
- ♦ **Pin Selectable +5°C, +10°C, +20°C, +30°C T_{ALARM} - T_{WARN} (MAX6505/MAX6506)**
- ♦ **SOT23-6 Package**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX6505UT_ _ _ _-T*	-40°C to +125°C	6 SOT23-6
MAX6506UT_ _ _ _-T*	-40°C to +125°C	6 SOT23-6
MAX6507UT_ _ _ _-T**	-40°C to +125°C	6 SOT23-6
MAX6508UT_ _ _ _-T**	-40°C to +125°C	6 SOT23-6

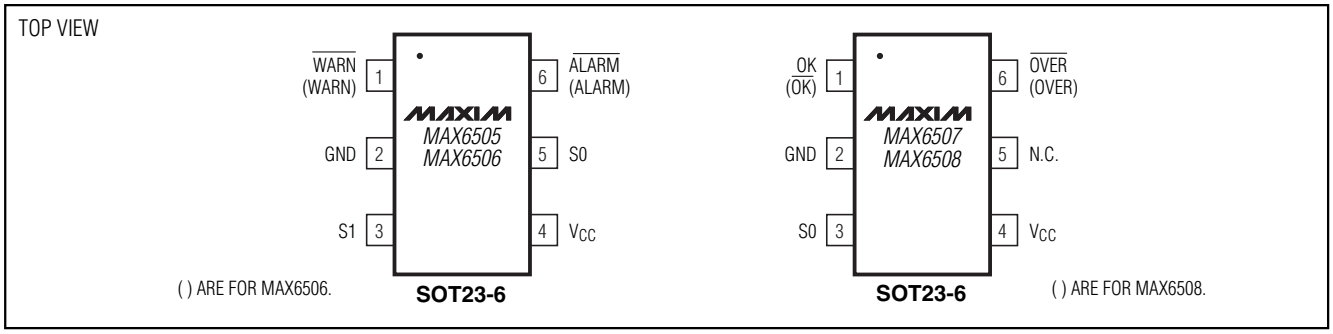
**To complete the suffix information for the MAX6505/MAX6506, add P or N for positive or negative trip temperature, and select an available trip point in degrees centigrade. For example, the MAX6505UTP055-T describes a MAX6505 in a SOT23-6 package with a +55°C threshold (Table 3). Contact the factory for pricing and availability of temperature versions (minimum order 10,000 pieces).*

***To complete the suffix information for MAX6507/MAX6508, see Table 4.*

Selector Guide appears at end of data sheet.

Typical Operating Circuits appear at end of data sheet.

Pin Configurations



Dual Trip SOT Temperature Switches

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC} to GND) .....-0.3V to +6V
S1, S0 to GND .....-0.3V to (V_{CC} + 0.3V)
All Other Pins to GND.....-0.3V to (V_{CC} + 0.3V)
Input/Output Current, All Pins.....±20mA
Continuous Power Dissipation (T_A = +70°C)
6-Pin SOT23 (derate 7.1mW/°C above +70°C).....571mW

Operating Temperature Range
(T_{MIN} to T_{MAX}) .....-40°C to +125°C
Thermal Resistance (Θ_{JA}).....115°C/W
Storage Temperature Range .....-65°C to +150°C
Maximum Die Temperature.....+150°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_{CC} = +2.5V to +5.5V, R_{PULLUP} = 100kΩ (MAX6505/MAX6507 only), T_A = -40°C to +125°C, unless otherwise noted. Typical values are at T_A = +25°C and V_{CC} = +5V, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{CC}			2.5		5.5	V
Supply Current	I_{CC}	S0 = S1 = GND	MAX6505/ MAX6506		40	80	µA
		S0 = GND	MAX6507/ MAX6508		30	60	
Temperature Threshold Accuracy (Note 2)	ΔT_{TH}	-40°C to 0°C		-5.5	±0.5	5.5	°C
		0°C to +95°C		-3.5	±0.5	3.5	
		+95°C to +125°C		-4	±0.5	4	
Delta Temperature (T_{ALARM} -$T_{WARNING}$) MAX6505/MAX6506	ΔT_{AW}	S1 = GND, S0 = GND			5		°C
		S1 = GND, S0 = V_{CC}			10		
		S1 = V_{CC}, S0 = GND			20		
		S1 = V_{CC}, S0 = V_{CC}			30		
Temperature Threshold Hysteresis (Note 3)	T_{HYST}	ALARM (MAX6505/MAX6506)			2		°C
		WARN (MAX6505/MAX6506)	ΔT_{AW} = 5°C or 10°C		5		
			ΔT_{AW} = 20°C or 30°C		10		
		OK, OVER (MAX6507/MAX6508)	S0 = GND		2		
			S0 = V_{CC}		10		
Logic Input Levels (S1, S0)	V_{IH}			0.8 x V_{CC}			V
	V_{IL}					0.8	
Output Voltage High (MAX6506/MAX6508)	V_{OH}	I_{SOURCE} = 500µA, V_{CC} > 2.5V		0.8 x V_{CC}			V
		I_{SOURCE} = 800µA,V_{CC} > 4.5V		V_{CC} -1.5			
Output Voltage Low	V_{OL}	I_{SINK} = 3.2mA, V_{CC} > 2.5V				0.5	V
		I_{SINK} = 5mA, V_{CC} > 4.5V				0.5	

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +2.5V to +5.5V, R_{PULLUP} = 100kΩ (MAX6505/MAX6507 only), T_A = -40°C to +125°C, unless otherwise noted. Typical values are at T_A = +25°C and V_{CC} = +5V, unless otherwise noted.) (Note 1)

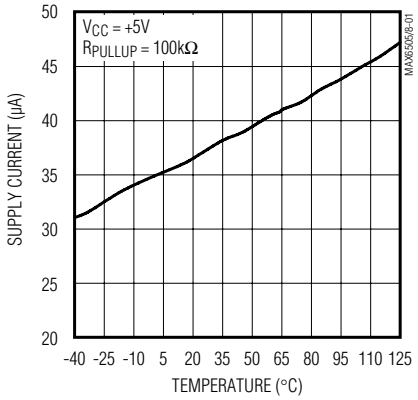
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Open-Drain Output Leakage Current		V_{CC} = 5.5V, V_{ALARM} = 5.5V, V_{WARN} = 5.5V (MAX6505)			1	µA
		V_{CC} = 5.5V, V_{OK} = 5.5V, V_{OVER} = 5.5V (MAX6507)			1	

Note 1: 100% production tested at T_A = +25°C. Specifications over temperature limits are guaranteed by design.
Note 2: T_{ALARM}, T_{UNDER}, and T_{OVER} are factory-programmed temperature trip thresholds from -40°C to +125°C in 5°C increments.
Note 3: Temperature threshold hysteresis is defined as the difference from positive-going temperature thresholds minus the negative-going temperature thresholds.

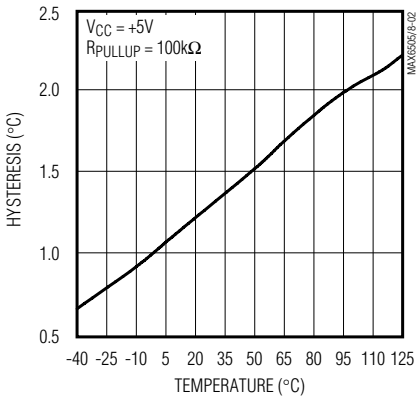
Typical Operating Characteristics

(V_{CC} = +5V, unless otherwise noted.)

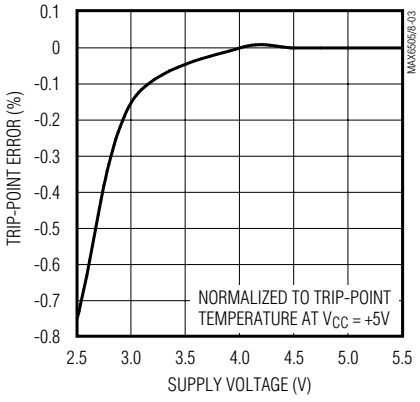
SUPPLY CURRENT vs. TEMPERATURE



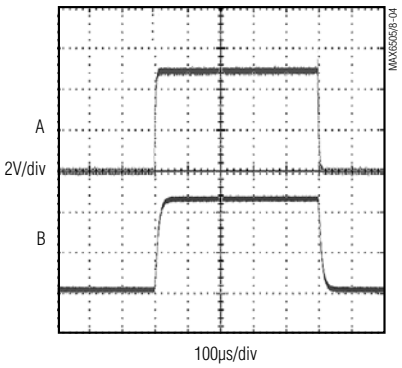
HYSTERESIS vs. TRIP TEMPERATURE



TRIP-POINT ERROR (%) vs. SUPPLY VOLTAGE

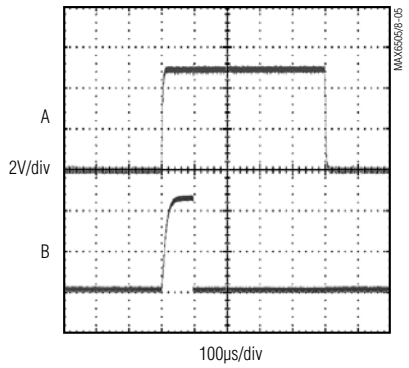


MAX6505 STARTUP AND POWER-DOWN ($T < T_{TH}$)



A: V_{CC} PULSE
B: ALARM VOLTAGE, R_{PULLUP} = 100kΩ

MAX6505 STARTUP DELAY ($T > T_{TH}$)



A: V_{CC} PULSE
B: ALARM VOLTAGE, R_{PULLUP} = 100kΩ

Dual Trip SOT Temperature Switches

Pin Description

PIN				NAME	FUNCTION
MAX6505	MAX6506	MAX6507	MAX6508		
1		—	—	$\overline{WARN}$	Open-Drain Active-Low Warning Output. $\overline{WARN}$ goes low when the die temperature exceeds $T_{WARN} = T_{ALARM} - \Delta T_{AW}$.
—	1	—	—	WARN	Push-Pull Active-High Warning Output. WARN goes high when the die temperature exceeds $T_{WARN} = T_{ALARM} - \Delta T_{AW}$.
2	2	2	2	GND	Ground
3, 5	3, 5	—	—	S1, S0	Delta Temperature Select Input. Connect to V_{CC} or GND to select the difference between T_{ALARM} and T_{WARN} (Table 1 or see *Electrical Characteristics*).
—	—	3	3	S0	Hysteresis Select Input. Connect to V_{CC} for 10°C hysteresis. Connect to GND for 2°C hysteresis.
4	4	4	4	V_{CC}	Supply Voltage Input. Bypass V_{CC} to GND with a 0.1µF ceramic capacitor.
—	—	5	5	N.C.	No Connection. Not internally connected.
—	—	6	—	$\overline{OVER}$	Open-Drain Active-Low Overtemperature Output. $\overline{OVER}$ goes low when the die temperature exceeds the factory-set value of T_{OVER}.
—	—	_	6	OVER	Push-Pull Active-High Overtemperature Output. OVER goes high when the die temperature exceeds the factory-set value of T_{OVER}.
—	—	1	—	OK	Open-Drain Active-High Temperature Sensor Output. OK goes high impedance when the die temperature is between the factory-set values of T_{OVER} and T_{UNDER}. When the die temperature is above T_{OVER} or below T_{UNDER}, OK goes low.
—	—	—	1	$\overline{OK}$	Push-Pull Active-Low Temperature Sensor Output. $\overline{OK}$ goes low when the die temperature is between the factory-set values of T_{OVER} and T_{UNDER}. When the die temperature is above T_{OVER} or below T_{UNDER}, $\overline{OK}$ goes high.
6	—	—	—	$\overline{ALARM}$	Open-Drain Active-Low Alarm Output. $\overline{ALARM}$ goes low when the die temperature exceeds the factory-set value of T_{ALARM}.
—	6	—	—	ALARM	Push-Pull Active-High Alarm Output. ALARM goes high when the die temperature exceeds the factory-set value of T_{ALARM}.

Detailed Description

The MAX6505–MAX6508 fully integrated temperature switches incorporate two temperature-dependent references and a comparator. One reference exhibits a positive temperature coefficient and the other a negative temperature coefficient. The temperature at which the two reference voltages are equal determines the temperature trip point. There are two versions, each of which has two logic outputs.

The MAX6505/MAX6506 have a main trip point (T_{ALARM}) and a lower, "warning" trip point (T_{WARN}). When the die temperature rises above these trip points, the ALARM and WARN outputs are asserted (Figure 1). The difference between the two trip points (ΔT_{AW}) is pin selectable to +5°C, +10°C, +20°C, or +30°C by connecting the two control pins (S0 and S1) high or low (Table 1). MAX6505 has open-drain active-low outputs; MAX6506 has push-pull active-high outputs.

The MAX6507/MAX6508 have two factory-programmed threshold temperatures (T_{OVER} and T_{UNDER}) and two outputs (OK and OVER). One output (OK) asserts when the temperature is between T_{OVER} and T_{UNDER}. The other output (OVER) asserts when the temperature is above T_{OVER}. Table 4 shows the hex codes to determine the part numbers associated with specific values of T_{OVER} and T_{UNDER}. The first hex code indicates the lower trip point (T_{UNDER}) and the second indicates the higher trip point (T_{OVER}). For example, a part with T_{UNDER} = -10°C and T_{OVER} = +75°C will have the part number MAX6508UTA04B (Table 4 and Figure 2). MAX6507 has open-drain outputs; MAX6508 has push-pull outputs.

Hysteresis Selection

The temperature threshold hysteresis for the ALARM output of the MAX6505/MAX6506 is 2°C. The hysteresis for the WARN output depends on the value of ΔT_{AW}. If ΔT_{AW} is 5°C or 10°C (set by S0 and S1), WARN hysteresis is 5°C. If ΔT_{AW} is 20°C or 30°C, WARN hysteresis is 10°C. MAX6507 and MAX6508 have pin-selectable hysteresis of 2°C or 10°C for both OVER and OK outputs (Table 2).

Applications Information

Thermal Considerations

The MAX6505–MAX6508 supply current is typically 30µA. When used to drive high-impedance loads, the devices dissipate negligible power. Therefore, the die temperature is essentially the same as the package temperature. The key to accurate temperature monitoring is good thermal contact between the MAX6505–MAX6508 package and the device being monitored. In some applications, the SOT23-6 packages may be small enough to fit underneath a socketed microprocessor (µP), allowing the device to monitor the µP's temperature directly. Use the monitor's output to reset the µP, assert an interrupt, or trigger an external alarm. Accurate temperature monitoring depends on the thermal resistance between the device being monitored and the MAX6505–MAX6508 die.

The rise in die temperature due to self-heating is given by the following formula:

$$\Delta T_J = P_{DISSIPATION} \times \theta_{JA}$$

where $P_{DISSIPATION}$ is the power dissipated by the MAX6505–MAX6508, and θ_{JA} is the package's thermal resistance. The typical thermal resistance is +115°C/W for the SOT23-6 package. To limit the effects of self-heating, minimize the output currents. For example, if the MAX6505 sinks 5mA, the output voltage is guaranteed to be less than 0.5V. Therefore, an additional 2.5mW of

Table 1. MAX6505/MAX6506 ΔT_{AW} Selection Table

CONTROL PINS		DESCRIPTION
S0	S1	$\Delta T_{AW} = T_{ALARM} - T_{WARN}$ (°C)
GND	GND	5
GND	V_{CC}	10
V_{CC}	GND	20
V_{CC}	V_{CC}	30

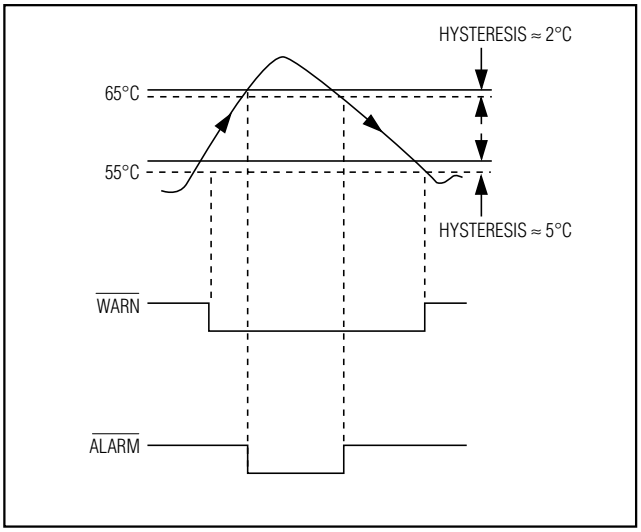


Figure 1. Temperature Response—MAX6505UTP065 Outputs, ΔT_{AW} = 10°C, and WARN Hysteresis ≈ 5°C

Table 2. Hysteresis Selection

PART	TYPICAL THRESHOLD HYSTERESIS					
	ALARM	CONDITIONS	WARN	CONDITIONS	OK, OVER	
MAX6505 MAX6506	2°C	—	5°C	ΔT_{WA} = 5°C or 10°C	—	
	—	—	10°C	ΔT_{WA} = 20°C or 30°C		
MAX6507 MAX6508	—	—	—	—	2°C	S0 = GND
	—	—	—	—	10°C	S0 = V_{CC}

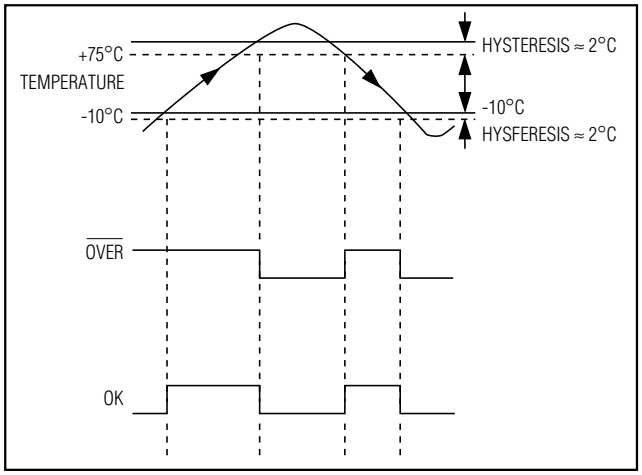


Figure 2. Temperature Response—MAX6507A04B Outputs with 2°C Hysteresis

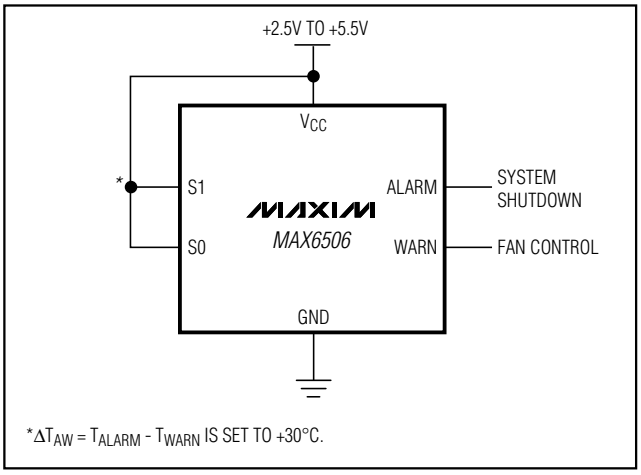


Figure 3. Low-Power, High-Reliability, Fail-Safe Temperature Monitor

power is dissipated within the IC. This corresponds to a +0.288°C shift in the die temperature in the SOT23-6.

Power Supply and Bypassing

The MAX6505 and MAX6508 operate from a single-supply voltage in the +2.5V to +5.5V range. Connect a 0.1µF capacitor on the supply voltage line close to the V_{CC} pin for bypassing.

Low-Cost, Fail-Safe Temperature Monitor

The MAX6505/MAX6506 provide two outputs that can be used for fail-safe temperature applications (Figure 3). For example, the first output can activate a fan when the die temperature exceeds a certain preset temperature. The second output asserts at a higher temperature that could be caused by a wide variety of destructive fault conditions, including latchup, short circuit, and cooling system failure. This output can be used to initiate such actions as shutdown of the entire system (see *Typical Operating Circuits*).

The high-level integration, low cost, and small size of the MAX6505–MAX6508 facilitate the use of multiple temperature monitors to increase system reliability.

Table 3. MAX6505/MAX6506 Suffix and Top Mark Codes

PART	SUFFIX	TRIP POINT (°C)	TOP MARK
MAX6505	UTN035	-35	AAKK
MAX6505	UTN030	-30	AAKL
MAX6505	UTN025	-25	AAKM
MAX6505	UTN020	-20	AAKN
MAX6505	UTN015	-15	AAKO
MAX6505	UTN010	-10	AAKP
MAX6505	UTN005	-5	AAKQ
MAX6505	UTP000	0	AAKR
MAX6505	UTP005	5	AAKS
MAX6505	UTP010	10	AAKT
MAX6505	UTP015	15	AAKU
MAX6505	UTP020	20	AAKV
MAX6505	UTP025	25	AAKW
MAX6505	UTP030	30	AAKX
MAX6505	UTP035	35	AAKY
MAX6505	UTP040	40	AAKZ
MAX6505	UTP045	45	AALA
MAX6505	UTP050	50	AALB
MAX6505	UTP055	55	AALC
MAX6505	UTP060	60	AALD
MAX6505	UTP065	65	AALE
MAX6505	UTP070	70	AALF
MAX6505	UTP075	75	AALG
MAX6505	UTP080	80	AALH
MAX6505	UTP085	85	AALI
MAX6505	UTP090	90	AALJ
MAX6505	UTP095	95	AALK
MAX6505	UTP100	100	AALL
MAX6505	UTP105	105	AALM
MAX6505	UTP110	110	AALN
MAX6505	UTP115	115	AALO
MAX6505	UTP120	120	AALP
MAX6505	UTP125	125	AALQ

PART	SUFFIX	TRIP POINT (°C)	TOP MARK
MAX6506	UTN035	-35	AALR
MAX6506	UTN030	-30	AALS
MAX6506	UTN025	-25	AALT
MAX6506	UTN020	-20	AALU
MAX6506	UTN015	-15	AALV
MAX6506	UTN010	-10	AALW
MAX6506	UTN005	-5	AALX
MAX6506	UTP000	0	AALY
MAX6506	UTP005	5	AALZ
MAX6506	UTP010	10	AAMA
MAX6506	UTP015	15	AAMB
MAX6506	UTP020	20	AAMC
MAX6506	UTP025	25	AAMD
MAX6506	UTP030	30	AAME
MAX6506	UTP035	35	AAMF
MAX6506	UTP040	40	AAMG
MAX6506	UTP045	45	AAMH
MAX6506	UTP050	50	AAMI
MAX6506	UTP055	55	AAMJ
MAX6506	UTP060	60	AAMK
MAX6506	UTP065	65	AAML
MAX6506	UTP070	70	AAMM
MAX6506	UTP075	75	AAMN
MAX6506	UTP080	80	AAMO
MAX6506	UTP085	85	AAMP
MAX6506	UTP090	90	AAMQ
MAX6506	UTP095	95	AAMR
MAX6506	UTP100	100	AAMS
MAX6506	UTP105	105	AAMT
MAX6506	UTP110	110	AAMU
MAX6506	UTP115	115	AAMV
MAX6506	UTP120	120	AAMW
MAX6506	UTP125	125	AAMX

Table 4. MAX6507/MAX6508 Trip Temperature Code

TRIP TEMPERATURE (°C)	HEX CODE*
-40	82
-35	87
-30	8C
-25	91
-20	96
-15	9B
-10	A0
-5	A5
0	00
5	05
10	0A
15	0F
20	14
25	19
30	1E
35	23
40	28
45	2D
50	32
55	37
60	3C
65	41
70	46
75	4B
80	50
85	55
90	5A
95	5F
100	64
105	69
110	6E
115	73
120	78
125	7D

**Two hex codes are used in the suffix. The first indicates the the low trip temperature and the second indicates the high trip temperature. For example, the MAX6507UT8255-T has a lower trip point of -40°C and an upper trip point of +85°C.*

Temperature-Window Alarm

The MAX6507 and MAX6508 have an output (OK, $\overline{OK}$) that indicates the die temperature is within the selected temperature window. This output is asserted when within the window, and deasserted when outside the window. Additionally, a second digital output indicates when the die temperature is above the upper set point. This is useful in systems where operation is optimized over a predetermined temperature range. The thermal overrange signal can be used to assert a thermal shutdown, power-up, recalibration, or other temperature-dependent function (Figure 4 and *Typical Operating Circuits*).

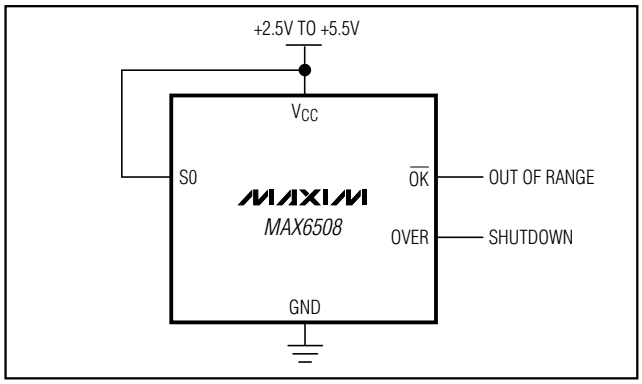


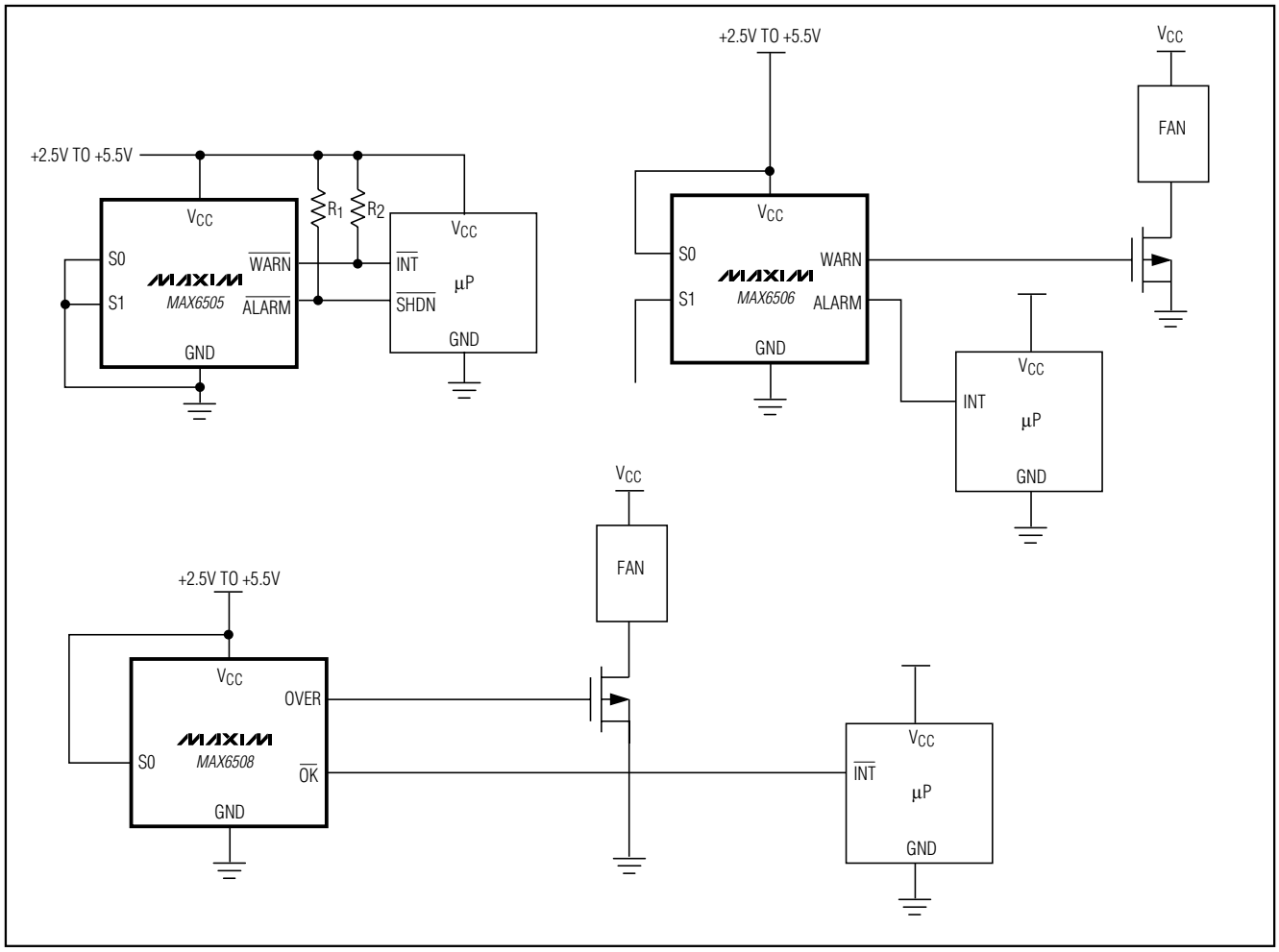
Figure 4. Temperature-Window Alarms

Chip Information

TRANSISTOR COUNT: 796

PROCESS: BiCMOS

Typical Operating Circuits



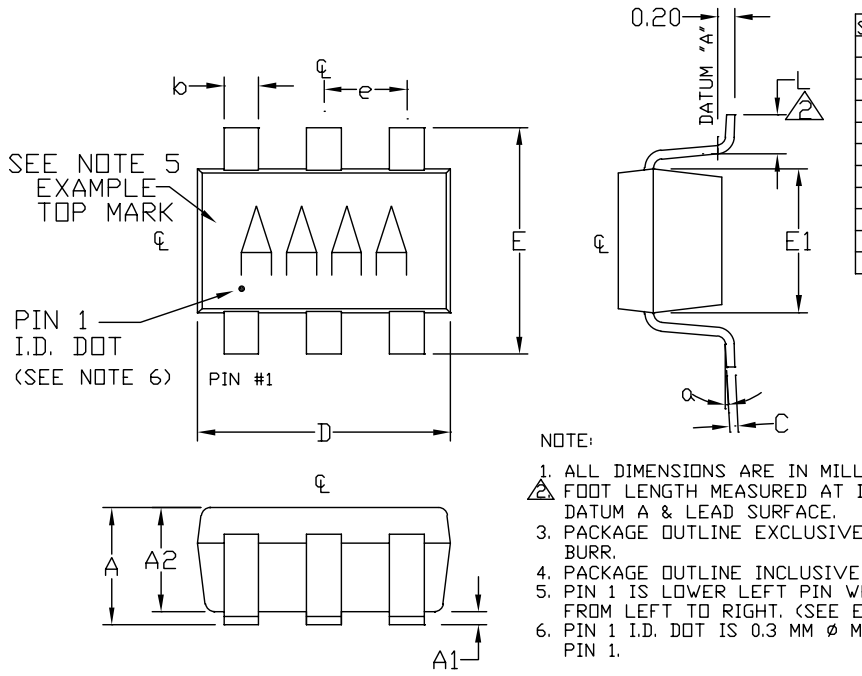
Selector Guide

PART	OUTPUT LOGIC	OUTPUT STAGE	TEMPERATURE THRESHOLD RANGE
MAX6505	$\overline{\text{ALARM}}$, $\overline{\text{WARN}}$	Open Drain	-40°C to +125°C
MAX6506	ALARM, WARN	Push-Pull	-40°C to +125°C
MAX6507	$\overline{\text{OVER}}$, OK	Open Drain	-40°C to +125°C
MAX6508	OVER, $\overline{\text{OK}}$	Push-Pull	-40°C to +125°C

Dual Trip SOT Temperature Switches

Package Information

6LSOT.EPS



SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.35	0.50
C	0.08	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.55
e	0.95 REF	
α	0°	10°

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM A & LEAD SURFACE.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. PIN 1 IS LOWER LEFT PIN WHEN READING TOP MARK FROM LEFT TO RIGHT. (SEE EXAMPLE TOP MARK)
6. PIN 1 I.D. DOT IS 0.3 MM ø MIN. LOCATED ABOVE PIN 1.

MAXIM

PROPRIETARY INFORMATION

TITLE:

PACKAGE OUTLINE, SOT23, 6L

APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0058	D	1/1

NOTES

NOTES