General Description

The MAX6575L/H is a low-cost, low-current temperature sensor with a single-wire digital interface. It features accuracy of ±3°C at +25°C, ±4.5°C at +85°C, and ±5°C at +125°C. The MAX6575L/H is a monostable, externally triggered temperature sensor that allows a microprocessor (μP) to interface with up to eight temperature sensors using a single control line. Temperatures are sensed by measuring the time delay between the falling edge of the external triggering pulse and the falling edge of the subsequent pulse delays reported from the devices. Different sensors on the same I/O line use different timeout multipliers to avoid overlapping signals.

The MAX6575L/H features eight different timeout multipliers; these are selectable by using the two time-select pins on each device and choosing the “L” or “H” version. The “L” version provides four delay ranges less than 50ms. The “H” version provides four delay ranges greater than 50ms. The MAX6575L/H is available in a space-saving 6-pin SOT23 package.

Applications

- Critical μP and μC Temperature Monitoring
- Portable Battery-Powered Equipment
- Cell Phones
- Battery Packs
- Hard Drives/Tape Drives
- Networking and Telecom Equipment
- Medical Equipment

Features

- Simple Single-Wire Interface to μP or μC
- Multidrop up to Eight Sensors on One Wire
- ±0.8°C Accuracy at +25°C (±3°C max)
- Operates from +2.7V to +5.5V Supply Voltage
- Low 150μA (typ) Supply Current
- Standard Operating Temperature Range -40°C to +125°C
- Small 6-Pin SOT23 Package

Ordering Information

<table>
<thead>
<tr>
<th>PART</th>
<th>TEMP.RANGE</th>
<th>PIN-PACKAGE</th>
<th>SOT</th>
<th>TOP MARK</th>
</tr>
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<tbody>
<tr>
<td>MAX6575LZUT</td>
<td>-40°C to +125°C</td>
<td>6 SOT23</td>
<td>AABG</td>
<td></td>
</tr>
<tr>
<td>MAX6575HZUT</td>
<td>-40°C to +125°C</td>
<td>6 SOT23</td>
<td>AABH</td>
<td></td>
</tr>
</tbody>
</table>

Selector Guide

<table>
<thead>
<tr>
<th>PART</th>
<th>TIMEOUT MULTIPLIERS (μs/°K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX6575L</td>
<td>5, 20, 40, 80</td>
</tr>
<tr>
<td>MAX6575H</td>
<td>160, 320, 480, 640</td>
</tr>
</tbody>
</table>

Pin Configuration appears at end of data sheet.
**Absolute Maximum Ratings**

Terminal Voltage (with respect to GND)

- VDD: -0.3V to +6V
- TS1, TS0: -0.3V to (VDD + 0.3V)
- I/O: -0.3V to +6V

Input/Output Current, All Pins: ±20mA

Continuous Power Dissipation (T_A = +70°C)

- 6-Pin SOT23: 571mW

Operating Temperature Range: -40°C to +125°C

Storage Temperature Range: -65°C to +150°C

Lead Temperature (soldering, 10s): +300°C

(VDD = +2.7V to +5.5V, T_A = -40°C to +125°C, unless otherwise noted. Typical values are specified at T_A = +25°C and VDD = +5V, unless otherwise noted.)

---

**Electrical Characteristics**

- Supply Current: I_DD
  - VDD = 5.5V
    - T_A = -40°C to +85°C: 150 ≤ I_DD ≤ 250 µA
    - T_A = -40°C to +125°C: 400 µA

- Temperature Sensor Error (Note 1)
  - T_A = -20°C: ±7.5°C
  - T_A = 0°C: ±0.9°C
  - T_A = +25°C: ±0.8°C
  - T_A = +85°C: ±0.5°C
  - T_A = +125°C: ±0.5°C

- Output Pulse Delay
  - MAX6575L, T (temp) in °K, Figure 1
    - tD1: VTS1 = GND, VTS0 = GND
      - VTS1 = GND, VTS0 = VDD
      - 5T
    - tD2: VTS1 = GND, VTS0 = VDD
      - 20T
    - tD3: VTS1 = VDD, VTS0 = GND
      - 40T
    - tD4: VTS1 = VDD, VTS0 = VDD
      - 80T
    - tD5: MAX6575H, T (temp) in °K, Figure 1
      - VTS1 = GND, VTS0 = GND
      - 160T
    - tD6: VTS1 = GND, VTS0 = VDD
      - 320T
    - tD7: VTS1 = VDD, VTS0 = GND
      - 480T
    - tD8: VTS1 = VDD, VTS0 = VDD
      - 640T

- Output Pulse Low Time
  - iT1-8: Figure 1
    - 5T

- Reset Pulse Width (Note 2)
  - tRESET
    - 4.6 ms
    - 16.0 ms

- Setup Time
  - tSETUP
    - 10 µs

- Start Pulse (Note 3)
  - tSTART
    - 2.5 µs

- Delay Time from Trigger to Ready (Note 4)
  - tREADY
    - 520 ms

- Glitch Immunity on I/O Input
  - 500 ns

- Time-Select Pin Logic Levels
  - VIL
    - 0.8 V
  - VIH
    - 2.3 V

- I/O Output Voltage Low
  - VSL
    - VDD > 4.5V, ISINK = 3.2mA
    - 0.4 V
    - VDD > 2.7V, ISINK = 1.2mA
    - 0.3 V

- I/O Input Voltage Low
  - VIL
    - 0.8 V

- I/O Input Voltage High
  - VIH
    - 2.3 V

---

**Notes:**

- Note 1: See Temperature Accuracy histograms in Typical Operating Characteristics.
- Note 2: Guaranteed by design. Not production tested.
- Note 3: Limit maximum start pulse at 1ms to avoid timing overlap.
- Note 4: If no reset pulse is applied.
典型运作特性

(V_{DD} = +5V, T_A = +25°C, unless otherwise noted.)

### Pin Configuration

<table>
<thead>
<tr>
<th>PIN</th>
<th>NAME</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(V_{DD})</td>
<td>Positive Supply Voltage</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>N.C.</td>
<td>No Connect. Connect pin to GND or leave open.</td>
</tr>
<tr>
<td>4, 5</td>
<td>TS0, TS1</td>
<td>Time-Select Pins. Set the time delay factor by connecting TS1 and TS0 to either (V_{DD}) or GND. See Table 1.</td>
</tr>
<tr>
<td>6</td>
<td>I/O</td>
<td>Bidirectional Interface Pin. A time delay between when the part is initiated externally by pulling I/O low and when the part subsequently pulls I/O low, is proportional to absolute temperature (°K).</td>
</tr>
</tbody>
</table>
Detailed Description
The MAX6575L/H low-cost, low-current (150μA typ) temperature sensor is ideal for interfacing with microcontrollers or microprocessors. The MAX6575L/H is a monostable, externally triggered temperature sensor that uses a Temp→Delay conversion to communicate with a μP over a single I/O line. Time-select pins (TS1, TS0) permit the internal temperature-controlled oscillator (TCO) to be scaled by four preset timeout multipliers, allowing eight separate temperature sensors to share one I/O line. Different sensors on the same I/O line will use different timeout multipliers to avoid overlapping signals.

Operating the MAX6575L/H
Figure 1 illustrates the timing for the MAX6575L/H. When the device is powered up, it assumes a ready state where it awaits an external trigger at the I/O pin. The I/O pin of the MAX6575L/H has an open-drain output structure that requires a pullup resistor to maintain the proper logic levels. Once the I/O pin is pulled low and then released, control of the I/O pin is transferred to the MAX6575L/H. The temperature conversion begins on the falling edge of the externally triggered pulse. The I/O line is pulled low at a later time. That time is determined by the device temperature and the Time Select pins (TS1, TS0). The I/O line remains low for 5Tμs, where T is the temperature in degrees Kelvin. The temperature of the device is represented by the edge-to-edge delay of the externally triggered pulse and the falling edge of the subsequent pulse originating from the device. The device can be manually reset by pulling the I/O line low for more than tRESET (16ms max). The device will automatically reset after a maximum delay of 520ms, at which point it will again be in a ready state awaiting a start pulse.

Definition of Terms:
tRESET: Time I/O must be externally pulled low to guarantee the MAX6575L/H is in a ready state awaiting external trigger. (Part will assume a ready state after 520ms without a reset pulse.)
tSETUP: Time I/O must be high prior to a start pulse.
tSTART: Trigger pulse which starts the on-chip timing sequence on its falling edge.
tDx: Timing delay between the falling edge of the start pulse and the falling edge initiated by CHIP#x.
tLx: I/O pulse low time (5Tμs).
tREADY: Time after falling edge of start pulse when the MAX6575L/H will reset itself and await the next external trigger.

The temperature, in degrees Celsius, may be calculated as follows:

\[ T(\degree C) = \left\lfloor \frac{t_{Dx}(\mu s)}{\text{timeout multiplier}(\mu s/\degree K)} \right\rfloor - 273.15\degree K \]

Table 1. Time-Select Pin Configuration

<table>
<thead>
<tr>
<th>TIME-SELECT PINS</th>
<th>TIMEOUT MULTIPLIERS (μs/°K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS1, TS0</td>
<td>MAX6575L</td>
</tr>
<tr>
<td>GND, GND</td>
<td>5</td>
</tr>
<tr>
<td>GND, VDD</td>
<td>20</td>
</tr>
<tr>
<td>VDD, GND</td>
<td>40</td>
</tr>
<tr>
<td>VDD, VDD</td>
<td>80</td>
</tr>
</tbody>
</table>

Figure 1. Timing Diagram
Time-Select Pins (TS1, TS0)
Table 1 shows the configuration of the Time-select pins for the MAX6575L/H. Each device allows four selectable timeout multipliers intended to prevent overlapping when multiple devices are used on the same I/O line. Tie TS1 and TS0 to either GND or VDD to select the desired temperature multiplier.

To monitor several chips on the same I/O line, different timeout multipliers should be selected using the TS1 and TS0 pins. The timeout periods are then scaled so that the response times will not overlap (see Timeout Selection).

Applications Information
Timeout Selection
Under extreme temperature conditions, it is possible for an overlap to occur between the timeout delays of different sensors in a multidrop configuration. This overlap can occur only if the temperature differential recorded between two devices is very large. Timeout overlaps can be avoided in multidrop configurations by selecting the appropriate timeout multipliers. Table 2 illustrates the allowable temperature differential between devices when the maximum error is present on each device. Allowable temperature differentials greater than 165°C indicate no overlap.

For example, if the maximum temperature differential in a system is 80°C, the only combinations of timeout multipliers that could result in timeout overlap would be a 320:480μs/°K (70.2°C) or a 480:640μs/°K (37.9°C) combination. As long as these combinations of timeout multipliers are not used in the same multidrop configuration, no overlap can occur. Thus, seven MAX6575L/H parts can be used in the same multidrop configuration if the maximum temperature differential between parts is 80°C. A similar analysis shows that four MAX6575L/H parts can be used when the maximum temperature differential extends over the entire 165°C range of the part.

Noise Considerations
The accuracy of the MAX6575L/H timeout delay is susceptible to noise generated both internally and externally. The effects of external noise can be minimized by placing a 0.1μF ceramic bypass capacitor close to the device’s supply pin. Internal noise is inherent in the operation of the device and is detailed in Table 3. Internal averaging minimizes the effect of this noise when using longer timeout multipliers. The effects of this noise are included in the overall accuracy of the device as specified in the Electrical Characteristics table.

Table 2. Allowable Temperature Differential (°C)

<table>
<thead>
<tr>
<th>TIMEOUT MULTIPLIER</th>
<th>MAX6575L</th>
<th>MAX6575H</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>&gt;165</td>
<td>&gt;165</td>
</tr>
<tr>
<td>20</td>
<td>95.5</td>
<td>&gt;165</td>
</tr>
<tr>
<td>40</td>
<td>132.0</td>
<td>&gt;165</td>
</tr>
<tr>
<td>80</td>
<td>153.5</td>
<td>&gt;165</td>
</tr>
<tr>
<td>160</td>
<td></td>
<td>&gt;165</td>
</tr>
<tr>
<td>320</td>
<td></td>
<td>70.2</td>
</tr>
<tr>
<td>480</td>
<td></td>
<td>37.9</td>
</tr>
<tr>
<td>640</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Typical Peak Noise Amplitude

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MAX6575L</th>
<th>MAX6575H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeout Multiplier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>±0.33</td>
<td>±0.091</td>
</tr>
<tr>
<td>20</td>
<td>±0.15</td>
<td>±0.063</td>
</tr>
<tr>
<td>40</td>
<td>±0.15</td>
<td>±0.043</td>
</tr>
<tr>
<td>80</td>
<td>±0.098</td>
<td>±0.037</td>
</tr>
<tr>
<td>160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>320</td>
<td></td>
<td></td>
</tr>
<tr>
<td>480</td>
<td></td>
<td></td>
</tr>
<tr>
<td>640</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Interfacing Multiple Devices with a Microcontroller

Figure 2 shows how to interface multiple MAX6575L/H devices with an 8051 microcontroller. The first device, T1, is configured for a timeout multiplier of 40μs/°K, while the second device, T2, is configured for a timeout multiplier of 80μs/°K to avoid overlap. The microcontroller takes in temperature values from both sensors, T1 and T2, on a single port pin, P3.7. The microcontroller displays five times the temperature in degrees Celsius in binary on Port 1. A switch connected to a pull-up resistor at Port 3.5 selects which temperature is displayed: open = T1, closed = T2. Code is provided for this application as Listing 1.
Listing 1. 8051 Code Example

`; Demonstration and test code for MAX6575 Temp to Delay
; Takes in temperature values from 2 sensors on single
; port pin, P3.7 and displays temp as 5 times C in binary on
; port 1. port 3.5 selects which temp displayed- H=1, L=2.
; example: room temp= 21 C, display 105 or 01101001 on P1
;******************************************************************************

;EQUATRS
TEMP1H EQU 10H ;TEMPERATURE 1
TEMP1L EQU 11H
TEMP2H EQU 12H ;TEMPERATURE 2
TEMP2L EQU 13H

D1 EQU 30H ;delay scratch registers
D2 EQU 31H
D3 EQU 32H

;PINS
IOPIN BIT P3.7 ;single pin interface
SLCT BIT P3.5 ;select display 1/2= H/L

;MAIN
ORG 0 ;note one isr's used- timer overflow
AJMP BEGIN ;jump over isr's

ORG 0BH ;timer 0 overflow error
CLR T0 ;clear timer overflow
POP ACC ;unstack return address
POP ACC ;unstack return address
PUSH LOW(DOTMP) ;return to top on error
PUSH HIGH(DOTMP) ;return to top on error
CLR TR0 ;clear timer run
RETI ;error

org 30h
BEGIN: MOV SP,#70h ;set sp at 70H
;setup timer0 to do timing
MOV TMOD,#01H ;t0 timer 16 bit
MOV IE,#82H ;enable tf0 irq- error

; inits done- measure 2 temps
DOTMP: MOV TH0,#0 ;zero counter
 MOV TL0,#0 ;zero counter
SFTB TR0 ;start timer
CLR IOPIN ;write pin low- start
CALL DLYP1 ;100 us min low
SFTB IOPIN ;bring high

;do temp 1
MOV R0,#TEMP1H ;point at temp1- high byte
CALL GTTP ;get temp1

;do temp 2
MOV R0,#TEMP2H ;point at temp2- high byte
CALL GTTP ;get temp2
CLR TR0 ;stop timer- acquisition done`
Listing 1. 8051 Code Example (continued)

; 2 temps are stored- display bin value of selected on P1
; temps are 40T,80T- times are in us

    MOV R0,#TEMP1L           ; get temp1 low byte (40T)
    MOV R4,#3                ; shift right 3x for 5x temp, div 8
    CALL TMTOC               ; convert delay to degrees C x 5
    JNB P3.5,DSP2            ; if select low, display temp2
    MOV A,TEMP1L             ; get temperature
    CPL A                    ; invert it for active low led's
    MOV P1,A                 ; display this temp

DSP2:    MOV R0,#TEMP2L           ; get temp2 low byte (80T)
    MOV R4,#4                ; shift right 4x for 5x temp, div 16
    CALL TMTOC               ; convert delay to degrees C x 5
    JB P3.5,DSP1             ; if select high, display temp1 above
    MOV A,TEMP2L             ; get temperature
    CPL A                    ; invert it for active low led's
    MOV P1,A                 ; display this temp

; done

; wait for 600 ms and do it again
DSP1:    MOV D3,#60
DLL1:     MOV D2,#100
DLL2:     MOV D1,#50          ; inner loop
DLLLP:    DJNZ D1,DLLLP       ; loop 100 us
DJNZ D2,DLL2; loop 10 ms
DJNZ D3,DLL1; loop 600 ms
JMP DOTMP; loop forever

;****************************************************************************
; subroutines
;****************************************************************************
; GET TEMP- main, capture timer0 to @r0 after pin low edge
GETTP:    JB IOPIN,GTTP       ; wait for low- irq gets hangs
    MOV A,TH0                ; get high- quick
    MOV B,TL0                ; get low- quick
    CJNE A,TH0,ROLL          ; check rollover msb
    JMP NOROL                ; no
ROLL:     MOV A,TH0            ; get high again
    MOV B,TL0                ; get low again
NOROL:    MOV @R0,A           ; stash msb
    INC R0                  ; point next
    MOV @R0,B                ; stash lsb
WAITH:     JNB IOPIN,WAITH   ; wait for low- irq gets hangs
    RET

; sub; converts us to degrees c x 5, R4 is # of right shifts
TMTOC:    CALL SHR0            ; shift right
    DJNZ R4,TMTOC            ; loop till shifted= 5x
    MOV A,@R0                ; get x5 lab
    CLR C                    ; ready for subb
    SUBB A,#055H             ; low byte of 273 x 5- offset
    MOV @R0,A                ; stash back
    DEC R0                   ; point hi
    MOV A,@R0                ; get hi- prop carry
Listing 1. 8051 Code Example (continued)

```asm
SUBB A,#05H ; sub high of 273 x 5 - offset
MOV @R0,A ; stash back- degrees c x 5 in temp
RET ; done

; shift right routine- "divide by 2" - point low on enter/exit
SHR0: DBC R0 ; point high
MOV A,@R0 ; get high
CLR C ; roll 0 into mabit
RRC A ; shift right
MOV @R0,A ; stash back
INC R0 ; point low
MOV A,@R0 ; get low- prop carry
RRC A ; shift right
MOV @R0,A ; stash back
RET ; pointing at lsb on exit

; short delay- 100 uS
DLYP1: MOV D1,#50 ; ~100 uS
DJNZ D1,D1LP ; delay- also entry
RET ; return after .1 ms

END
```

## Pin Configuration

![TOP VIEW OF MAX6575L/H SOT23-6 PACKAGE](image)

## Package Information

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://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.

<table>
<thead>
<tr>
<th>PACKAGE TYPE</th>
<th>PACKAGE CODE</th>
<th>OUTLINE NO.</th>
<th>LAND PATTERN NO.</th>
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<tbody>
<tr>
<td>6 SOT23</td>
<td>U6-4</td>
<td>21-0058</td>
<td>90-0175</td>
</tr>
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</table>

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## MAX6575L/H

SOT Temperature Sensor with Multidrop Single-Wire Digital Interface

### Revision History

<table>
<thead>
<tr>
<th>REVISION NUMBER</th>
<th>REVISION DATE</th>
<th>DESCRIPTION</th>
<th>PAGES CHANGED</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4/99</td>
<td>Initial release</td>
<td>—</td>
</tr>
<tr>
<td>1</td>
<td>11/14</td>
<td>Removed automotive reference from data sheet</td>
<td>1</td>
</tr>
</tbody>
</table>

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated’s website at www.maximintegrated.com.

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