

# LM66

## Dual Output Internally Preset Thermostat

### General Description

The LM66 is a precision low power thermostat. Two stable temperature trip points ( $V_{T1}$  and  $V_{T2}$ ) are generated by dividing down the LM66 1.250V bandgap voltage reference using a resistors divider network. The LM66 has two digital outputs. OUT1 goes LOW when the temperature exceeds T1 and goes HIGH when the the temperature goes below ( $T1 - T_{HYST}$ ). Similarly, OUT2 goes LOW when the temperature exceeds T2 and goes HIGH when the temperature goes below ( $T2 - T_{HYST}$ ).  $T_{HYST}$  is an internally set 5°C typical hysteresis.

The LM66 is currently available in an 8-lead small outline package.

### Applications

- Microprocessor Thermal Management
- Appliances
- Portable Battery Powered 3.0V or 5V Systems
- Fan Control
- Industrial Process Control
- HVAC Systems
- Remote Temperature Sensing
- Electronic System Protection

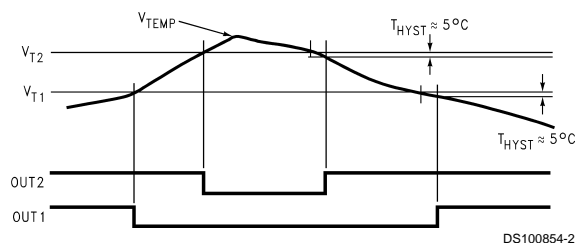
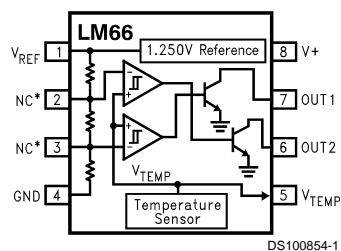
### Features

- Digital outputs support TTL logic levels
- Internal temperature sensor
- 2 internal comparators with hysteresis
- Internal voltage reference
- Currently available in 8-pin SO plastic package

### Key Specifications

■ Power Supply Voltage	2.7V to 10V
■ Power Supply Current	250 $\mu$ A (max)
■ $V_{REF}$	1.250V $\pm$ 1.4% (max)
■ Hysteresis Temperature	5°C
■ Internal Temperature Sensor Output Voltage	(+6.20 mV/°C x T) +400mV
■ Temperature Trip Point Accuracy	$\pm$ 3°C (max)
■ T1 set point	+73°C
■ T2 set point	+82°C

### Simplified Block Diagram and Connection Diagram

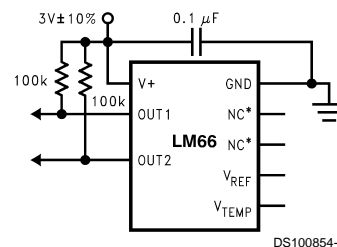


### Ordering Information

**TABLE 1.**

Order Number	LM66CIM-RLSKB	LM66CIMX-RLSKB
NS Tackage Number	M08A	M08A
Transport Media	Bulk Rail	2500 Units Tape & Reel

### Typical Application



**Absolute Maximum Ratings** (Note 1)

Input Voltage	12V
Input Current at any pin (Note 2)	5 mA
Package Input Current (Note 2)	20 mA
Package Dissipation at $T_A = 25^\circ\text{C}$ (Note 3)	900 mW
ESD Susceptibility (Note 4)	
Human Body Model	1000V
Machine Model	200V
Soldering Information	
SO Package (Note 5) :	

Vapor Phase (60 seconds)	215°C
Infrared (15 seconds)	220°C
Storage Temperature	-65°C to +150°C

**Operating Ratings** (Note 1)

Operating Temperature Range	$T_{\text{MIN}} \leq T_A \leq T_{\text{MAX}}$
LM66CIM	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$
Positive Supply Voltage ( $V^+$ )	+2.7V to +10V
Maximum $V_{\text{OUT1}}$ and $V_{\text{OUT2}}$	+10V

**LM66 Electrical Characteristics**

The following specifications apply for  $V^+ = 2.7 V_{\text{DC}}$ , and  $V_{\text{REF}}$  load current = 0  $\mu\text{A}$  unless otherwise specified. **Boldface limits apply for  $T_A = T_J = T_{\text{MIN}}$  to  $T_{\text{MAX}}$** ; all other limits  $T_A = T_J = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Typical (Note 6)	LM66CIM Limits (Note 7)	Units (Limits)
<b>Temperature Sensor</b>					
	Trip Point Accuracy (Includes $V_{\text{REF}}$ , Comparator Offset, and Temperature Sensitivity errors)	$+25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$		$\pm 3$	$^\circ\text{C}$ (max)
	Trip Point Hysteresis	$T_A = +73^\circ\text{C}$	6	4.5 7.5	$^\circ\text{C}$ (min) $^\circ\text{C}$ (max)
		$T_A = +82^\circ\text{C}$	6	4.5 7.5	$^\circ\text{C}$ (min) $^\circ\text{C}$ (max)
	Internal Temperature Sensitivity		+6.20		mV/ $^\circ\text{C}$
	Temperature Sensitivity Error	$+25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$		<b><math>\pm 3</math></b>	$^\circ\text{C}$ (max)
		$-25^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		<b><math>\pm 4</math></b>	$^\circ\text{C}$ (max)
		$-40^\circ\text{C} \leq T_A \leq -25^\circ\text{C}$		<b><math>\pm 5</math></b>	$^\circ\text{C}$ (max)
	Output Impedance	$-1 \mu\text{A} \leq I_L \leq +40 \mu\text{A}$		<b>1500</b>	$\Omega$ (max)
	Line Regulation	$+3.0\text{V} \leq V^+ \leq +10\text{V}$ , $+25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$		<b><math>\pm 0.36</math></b>	mV/V (max)
		$+3.0\text{V} \leq V^+ \leq +10\text{V}$ , $-40^\circ\text{C} \leq T_A < 25^\circ\text{C}$		<b><math>\pm 0.61</math></b>	mV/V (max)
		$+2.7\text{V} \leq V^+ \leq +3.3\text{V}$		<b><math>\pm 2.3</math></b>	mV (max)
<b><math>V_{\text{REF}}</math> Output</b>					
$V_{\text{REF}}$	$V_{\text{REF}}$ Nominal		1.250V		V
	$V_{\text{REF}}$ Error			<b><math>\pm 1.4</math></b>	% (max)
					<b><math>\pm 17.5</math></b>
$\Delta V_{\text{REF}}/\Delta V^+$	Line Regulation	$+3.0\text{V} \leq V^+ \leq +10\text{V}$	0.13	<b>0.21</b>	mV/V (max)
		$+2.7\text{V} \leq V^+ \leq +3.3\text{V}$	0.15	<b>1.5</b>	mV (max)

## LM66 Electrical Characteristics

The following specifications apply for  $V^+ = 2.7 V_{DC}$ , and  $V_{REF}$  load current = 50  $\mu A$  unless otherwise specified. **Boldface limits apply for  $T_A = T_J = T_{MIN}$  to  $T_{MAX}$** ; all other limits  $T_A = T_J = 25^\circ C$  unless otherwise specified.

Symbol	Parameter	Conditions	Typical (Note 6)	Limits (Note 7)	Units (Limits)
<b>V<sup>+</sup> Power Supply</b>					
$I_S$	Supply Current	$V^+ = +10V$		<b>250</b>	$\mu A$ (max)
		$V^+ = +2.7V$		<b>250</b>	$\mu A$ (max)
<b>Digital Output(s)</b>					
$I_{OUT("1")}$	Logical "1" Output Leakage Current	$V^+ = +5.0V$		<b>1</b>	$\mu A$ (max)
$V_{OUT("0")}$	Logical "0" Output Voltage	$I_{OUT} = +50 \mu A$		<b>0.4</b>	V (max)

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

**Note 2:** When the input voltage ( $V_I$ ) at any pin exceeds the power supply ( $V_I < GND$  or  $V_I > V^+$ ), the current at that pin should be limited to 5 mA. The 20 mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of 5 mA to four.

**Note 3:** The maximum power dissipation must be derated at elevated temperatures and is dictated by  $T_{Jmax}$  (maximum junction temperature),  $\theta_{JA}$  (junction to ambient thermal resistance) and  $T_A$  (ambient temperature). The maximum allowable power dissipation at any temperature is  $P_D = (T_{Jmax} - T_A) / \theta_{JA}$  or the number given in the Absolute Maximum Ratings, whichever is lower. For this device,  $T_{Jmax} = 125^\circ C$ . For this device the typical thermal resistance ( $\theta_{JA}$ ) of the different package types when board mounted follow:

Package Type	$\theta_{JA}$
M08A	110°C/W

**Note 4:** The human body model is a 100 pF capacitor discharge through a 1.5 k $\Omega$  resistor into each pin. The machine model is a 200 pF capacitor discharged directly into each pin.

**Note 5:** See AN450 "Surface Mounting Methods and Their Effects on Product Reliability" or the section titled "Surface Mount" found in any post 1986 National Semiconductor Linear Data Book for other methods of soldering surface mount devices.

**Note 6:** Typical values are at  $T_J = T_A = 25^\circ C$  and represent most likely parametric norm.

**Note 7:** Limits are guaranteed to National's AOQL (Average Outgoing Quality Level).

**Part Number Template** The series of digits labeled vw xy z in the part number LM66CIM-vw xy z, describe the set points and the function of OUT1 and OUT2 as follows:

The place holders v w describe the set point of T1 as shown in the following table.

The place holders xy describe the set point of T2 as shown in the following table. z=0 (Other assignments are reserved.)

For example the part number LM66CIM-RLSKB has: T1 = 73°C, T2 = 82°C, OUT1 and OUT2 set as active-low open-collector outputs with OUT1 mapped to pin 7 and OUT2 mapped to pin 6.

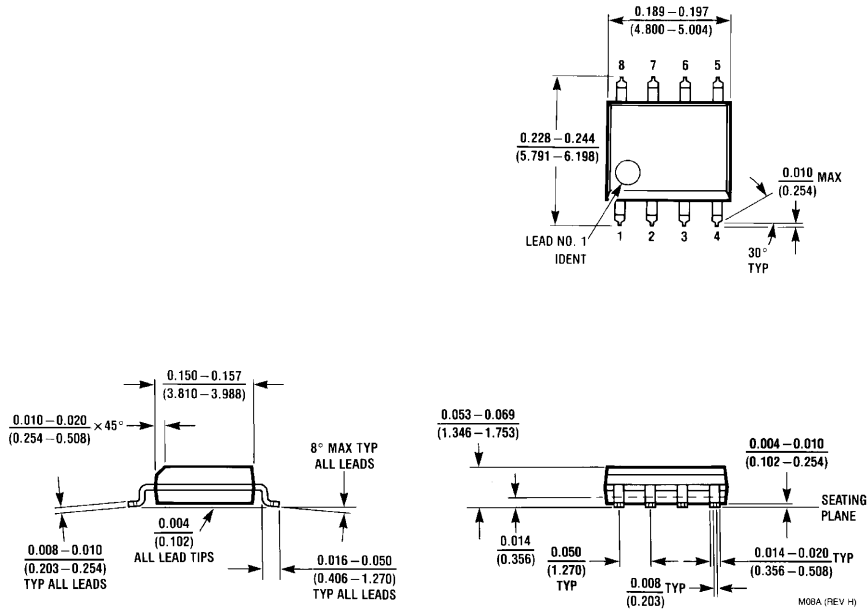
v, w, x and y	Temperature (°C)
B	-5
C	-4
D	-3
F	-2
G	-1
H	-0
J	1
K	2
L	3
N	4

v, w, x and y	Temperature (°C)
P	5
Q	6
R	7
S	8
T	9
V	10
X	11
Y	12
Z	13

The value of z describes the assignment/function of OUT1 and OUT2 as shown in the following table:

Active Low/High	Open Collector/Totem Pole	Mapping	Value of z	Function of OUT1 and OUT2
0	0	0	B	Active-Low, Open-Collector, OUT1 mapped to pin 7, OUT2 mapped to pin 6
0	0	1	C	Active-Low, Open-Collector, OUT1 mapped to pin 6, OUT2 mapped to pin 7
0	1	0	D	Active-Low, Totem Pole, OUT1 mapped to pin 7, OUT2 mapped to pin 6
0	1	1	F	Active-Low, Totem Pole, OUT1 mapped to pin 6, OUT2 mapped to pin 7
1	0	0	G	Active-High, Open-Collector, OUT1 mapped to pin 7, OUT2 mapped to pin 6
1	0	1	H	Active-High, Open-Collector, OUT1 mapped to pin 6, OUT2 mapped to pin 7
1	1	0	J	Active-High, Totem Pole, OUT1 mapped to pin 7, OUT2 mapped to pin 6
1	1	1	K	Active-High, Totem Pole, OUT1 mapped to pin 6, OUT2 mapped to pin 7

**Physical Dimensions** inches (millimeters) unless otherwise noted



**8-Lead (0.150" Wide) Molded Small Outline Package, JEDEC**  
**Order Number LM66CIM or LM66CIMX**  
**NS Package Number M08A**

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