April 2000

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

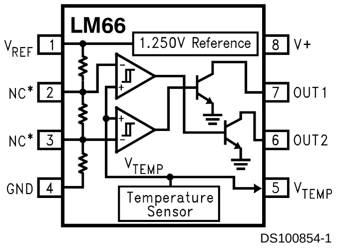
Features

- 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 µA (max)
V_{REF}	1.250V ±1.4% (max)
Hysteresis Temperature	5˚C
Internal Temperature Sensor Output Voltage	(+6.20 mV/˚C x T) +400 mV
Temperature Trip Point Accuracy	±3˚C (max)
T1 set point	+73˚C
T2 set point	+82˚C

Simplified Block Diagram and Connection Diagram



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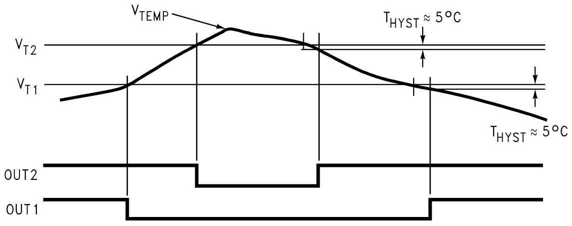

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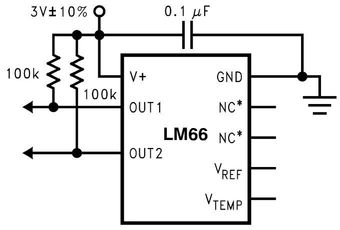
Ordering Information

TABLE 1.

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

Typical Application



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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°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	$\mathbf{T_{MIN} \le T_A \le T_{MAX}}$
LM66CIM	−40°C ≤ T_A ≤ +125°C
Positive Supply Voltage (V^+)	+2.7V to +10V
Maximum V_{OUT1} and V_{OUT2}	+10V

LM66 Electrical Characteristics

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

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

LM66 Electrical Characteristics

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

Symbol	Parameter	Conditions	Typical (Note 6)	Limits (Note 7)	Units **(Limits)**
V^+ Power Supply					
I_S	Supply Current	$V^+ = +10V$		**250**	µA (max)
		$V^+ = +2.7V$		**250**	µA (max)
Digital Output(s)					
$I_{OUT(“1”)}$	Logical “1” Output Leakage Current	$V^+ = +5.0V$		**1**	µA (max)
$V_{OUT(“0”)}$	Logical “0” Output Voltage	$I_{OUT} = +50\ \mu A$		**0.4**	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), θ_{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, $T_{Jmax} = 125°C$. For this device the typical thermal resistance (θ_{JA}) of the different package types when board mounted follow:

Package Type	θ_{JA}
M08A	110˚C/W

Note 4: The human body model is a 100 pF capacitor discharge through a 1.5 kΩ 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: Typicals are at $T_J = T_A = 25°C$ 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 labled 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.

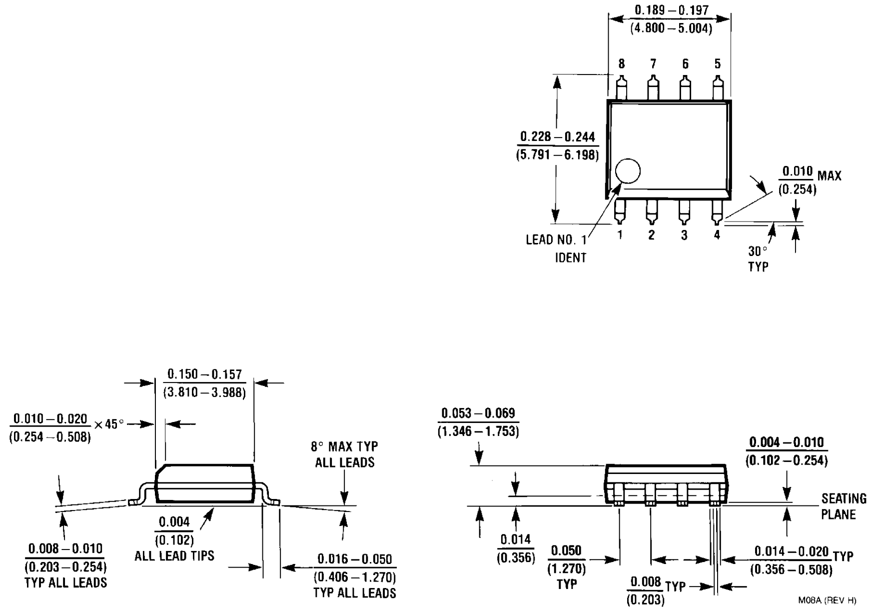
v, w, x and y	Temperature (˚C)
B	−5
C	−4
D	−3
F	−2
G	−1
H	−0
J	1
K	2
L	3
N	4

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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National Semiconductor Corporation
Americas
Tel: 1-800-272-9959
Fax: 1-800-737-7018
Email: support@nsc.com
www.national.com

National Semiconductor Europe
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor Asia Pacific Customer Response Group
Tel: 65-2544466
Fax: 65-2504466
Email: ap.support@nsc.com

National Semiconductor Japan Ltd.
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507