# LM66 Dual Output Internally Preset Thermostat

**Check for Samples: LM66**

## FEATURES

- **Digital Outputs Support TTL Logic Levels**
- **Internal Temperature Sensor**
- **2 Internal Comparators with Hysteresis**
- **Internal Voltage Reference**
- **Currently Available in 8-pin SOIC 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) +400mV**
- **Temperature Trip Point Accuracy: ±3°C (max)**
- **T1 Set Point: +73°C**
- **T2 Set Point :+82°C**

## APPLICATIONS

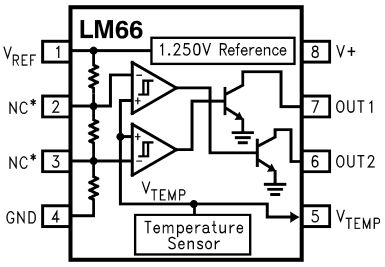
- **Microprocessor Thermal Management**
- **Appliances**
- **Portable Battery Powered 3.0V or 5V Systems**
- **Fan Control**
- **Industrial Process Control**
- **HVAC Systems**
- **Remote Temperature Sensing**
- **Electronic System Protection**

## DESCRIPTION

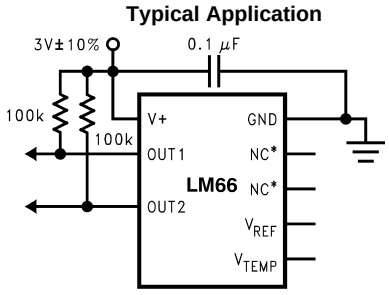
The LM66 is a precision low power thermostat. Two stable temperature trip points ($V_{T1}$ and $V_{T2}$) are generated by dividing down the LM66 1.250V bandgap voltage reference using a resistors divider network. The LM66 has two digital outputs. OUT1 goes LOW when the temperature exceeds T1 and goes HIGH when the 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.

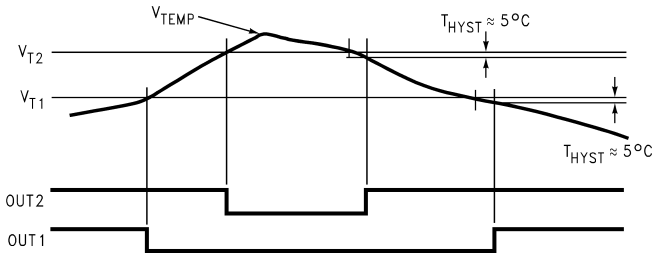
The LM66 is currently available in an 8-lead small outline package.

### Simplified Block Diagram and Connection Diagram




**Typical Application**



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings(1)

| | | |
|---|---|---|
| Input Voltage | | 12V |
| Input Current at any pin(2) | | 5 mA |
| Package Input Current(2) | | 20 mA |
| Package Dissipation at $T_A$ = 25°C(3) | | 900 mW |
| ESD Susceptibility(4) | Human Body Model | 1000V |
| | Machine Model | 200V |
| Soldering Information | | |
| SOIC Package | Vapor Phase (60 seconds) | 215°C |
| | Infrared (15 seconds) | 220°C |
| Storage Temperature | | −65°C to + 150°C |

(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 ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

(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.

(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°C. For this device the typical thermal resistance ($\theta_{JA}$) of the different package types when board mounted follow: **Package Type**: D0008A, $\boldsymbol{\theta_{JA}}$: 110°C/W

(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.

## Operating Ratings(1)

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

(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 ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

## 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 (1) | LM66CIM Limits (2) | Units (Limits) |
|---|---|---|---|---|---|
| **Temperature Sensor** | | | | | |
| | Trip Point Accuracy (Includes | | | | |
| | $V_{REF}$, Comparator Offset, and | +25°C ≤ $T_A$ ≤ +85°C | | ±3 | °C (max) |
| | Temperature Sensitivity errors) | | | | |
| | 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) |

(1) Typicals are at $T_J = T_A$ = 25°C and represent most likely parametric norm.
(2) Limits are ensured to AOQL (Average Outgoing Quality Level).

## 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 (1) | Limits (2) | 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 µA | | **0.4** | V (max) |

(1) Typicals are at $T_J = T_A$ = 25°C and represent most likely parametric norm.
(2) Limits are ensured to 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 Table 1 below.

The place holders xy describe the set point of T2 as shown in Table 1 below.

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.

**Table 1.**

| 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 |
| P | 5 |
| Q | 6 |
| R | 7 |
| S | 8 |
| T | 9 |
| V | 10 |
| X | 11 |
| Y | 12 |
| Z | 13 |

**Table 2.**

| Active Low//High | Open Collector/ Totem Pole | Mapping | Value of z(1) | 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 |

(1) The value of z describes the assignment/function of OUT1 and OUT2 as shown in the table.

## REVISION HISTORY

| Changes from Revision C (April 2013) to Revision D | Page |
|---|---|
| • Changed layout of National Data Sheet to TI format | 4 |

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