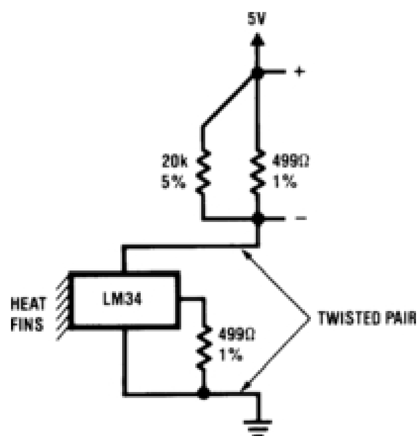
# LM34 - Precision Fahrenheit Temperature Sensor

## Features

- Calibrated directly in degrees Fahrenheit
- Linear +10.0 mV/°F scale factor
- 1.0°F accuracy guaranteed (at +77°F)
- Rated for full -50° to +300°F range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 5 to 30 volts
- Less than 90 µA current drain
- Low self-heating, 0.18°F in still air
- Nonlinearity only ±0.5°F typical
- Low-impedance output, 0.4Ohm for 1 mA load

## Typical Application




**Parametric Table** expand

| | |
|---|---|
| Supply Min | 5 Volt |
| Quiescent Current_ | 75 uA |
| Temperature Min | -45.5555, -40, 0 deg C |
| Temperature Max | 148.889008, 100, 110 deg C |
| Sensor Gain | 10 mV/Deg F |

## General Description

The LM34 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Fahrenheit temperature.

National Semiconductor

# LM34
# Precision Fahrenheit Temperature Sensors

## General Description

The LM34 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Fahrenheit temperature. The LM34 thus has an advantage over linear temperature sensors calibrated in degrees Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Fahrenheit scaling. The LM34 does not require any external calibration or trimming to provide typical accuracies of ±½˚F at room temperature and ±1½˚F over a full −50 to +300˚F temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM34's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies or with plus and minus supplies. As it draws only 75 µA from its supply, it has very low self-heating, less than 0.2˚F in still air. The LM34 is rated to operate over a −50˚ to +300˚F temperature range, while the LM34C is rated for a −40˚ to +230˚F range (0˚F with improved accuracy). The LM34 series is available packaged in hermetic TO-46 transistor packages, while the LM34C, LM34CA and LM34D are also available in the plastic TO-92 transistor package. The LM34D is also available in an 8-lead surface mount small outline package. The LM34 is a complement to the LM35 (Centigrade) temperature sensor.

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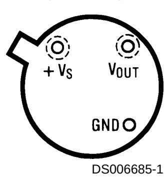
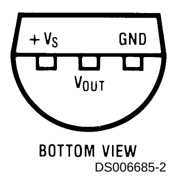
## Connection Diagrams

**TO-46**
**Metal Can Package**
(Note 1)



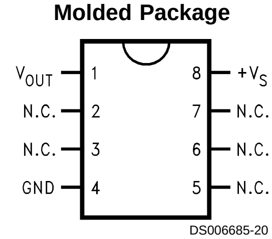

**Order Numbers LM34H, LM34AH, LM34CH, LM34CAH or LM34DH**
**See NS Package Number H03H**

**TO-92**
**Plastic Package**




**Order Number LM34CZ, LM34CAZ or LM34DZ**
**See NS Package Number Z03A**

**SO-8**
**Small Outline Molded Package**




N.C. = No Connection

**Top View**
**Order Number LM34DM**
**See NS Package Number M08A**

**Note 1:** Case is connected to negative pin (GND).

## Absolute Maximum Ratings (Note 11)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.**

| | |
|---|---|
| Supply Voltage | +35V to −0.2V |
| Output Voltage | +6V to −1.0V |
| Output Current | 10 mA |
| Storage Temperature, | |
| TO-46 Package | −76˚F to +356˚F |
| TO-92 Package | −76˚F to +300˚F |
| SO-8 Package | −65˚C to +150˚C |
| ESD Susceptibility (Note 12) | 800V |
| Lead Temp. | |
| TO-46 Package | |
| (Soldering, 10 seconds) | +300˚C |
| TO-92 Package | |
| (Soldering, 10 seconds) | +260˚C |
| SO Package (Note 13) | |
| Vapor Phase (60 seconds) | 215˚C |
| Infrared (15 seconds) | 220˚C |
| Specified Operating Temp. Range (Note 3) | |
| | **$T_{MIN}$ to $T_{MAX}$** |
| LM34, LM34A | −50˚F to +300˚F |
| LM34C, LM34CA | −40˚F to +230˚F |
| LM34D | +32˚F to +212˚F |

## DC Electrical Characteristics (Notes 2, 7)

| Parameter | Conditions | LM34A | | | LM34CA | | | Units (Max) |
|---|---|---|---|---|---|---|---|---|
| | | Typical | Tested Limit (Note 5) | Design Limit (Note 6) | Typical | Tested Limit (Note 5) | Design Limit (Note 6) | |
| Accuracy (Note 8) | $T_A$ = +77˚F | ±0.4 | ±1.0 | | ±0.4 | ±1.0 | | ˚F |
| | $T_A$ = 0˚F | ±0.6 | | | ±0.6 | | ±2.0 | ˚F |
| | $T_A = T_{MAX}$ | ±0.8 | ±2.0 | | ±0.8 | ±2.0 | | ˚F |
| | $T_A = T_{MIN}$ | ±0.8 | ±2.0 | | ±0.8 | | ±3.0 | ˚F |
| Nonlinearity (Note 9) | $T_{MIN} \le T_A \le T_{MAX}$ | **±0.35** | | **±0.7** | **±0.30** | | **±0.6** | ˚F |
| Sensor Gain (Average Slope) | $T_{MIN} \le T_A \le T_{MAX}$ | **+10.0** | **+9.9,** | | **+10.0** | | **+9.9,** | mV/˚F, min |
| | | | **+10.1** | | | | **+10.1** | mV/˚F, max |
| Load Regulation (Note 4) | $T_A$ = +77˚F | ±0.4 | ±1.0 | | ±0.4 | ±1.0 | | mV/mA |
| | $T_{MIN} \le T_A \le T_{MAX}$ | **±0.5** | | **±3.0** | **±0.5** | | **±3.0** | mV/mA |
| | $0 \le I_L \le 1$ mA | | | | | | | |
| Line Regulation (Note 4) | $T_A$ = +77˚F | ±0.01 | ±0.05 | | ±0.01 | ±0.05 | | mV/V |
| | $5V \le V_S \le 30V$ | **±0.02** | | **±0.1** | **±0.02** | | **±0.1** | mV/V |
| Quiescent Current (Note 10) | $V_S$ = +5V, +77˚F | 75 | 90 | | 75 | 90 | | µA |
| | $V_S$ = +5V | **131** | | **160** | **116** | | **139** | µA |
| | $V_S$ = +30V, +77˚F | 76 | 92 | | 76 | 92 | | µA |
| | $V_S$ = +30V | **132** | | **163** | **117** | | **142** | µA |
| Change of Quiescent Current (Note 4) | $4V \le V_S \le 30V$, +77˚F | +0.5 | 2.0 | | 0.5 | 2.0 | | µA |
| | $5V \le V_S \le 30V$ | **+1.0** | | **3.0** | **1.0** | | **3.0** | µA |
| Temperature Coefficient of Quiescent Current | | **+0.30** | | **+0.5** | **+0.30** | | **+0.5** | µA/˚F |
| Minimum Temperature for Rated Accuracy | In circuit of *Figure 1*, $I_L$ = 0 | +3.0 | | +5.0 | +3.0 | | +5.0 | ˚F |
| Long-Term Stability | $T_j = T_{MAX}$ for 1000 hours | ±0.16 | | | ±0.16 | | | ˚F |

**Note 2:** Unless otherwise noted, these specifications apply: −50˚F ≤ $T_j$ ≤ + 300˚F for the LM34 and LM34A; −40˚F ≤ $T_j$ ≤ +230˚F for the LM34C and LM34CA; and +32˚F ≤ $T_j$ ≤ + 212˚F for the LM34D. $V_S$ = +5 Vdc and $I_{LOAD}$ = 50 µA in the circuit of *Figure 2*; +6 Vdc for LM34 and LM34A for 230˚F ≤ $T_j$ ≤ 300˚F. These specifications also apply from +5˚F to $T_{MAX}$ in the circuit of *Figure 1*.

**Note 3:** Thermal resistance of the TO-46 package is 720˚F/W junction to ambient and 43˚F/W junction to case. Thermal resistance of the TO-92 package is 324˚F/W junction to ambient. Thermal resistance of the small outline molded package is 400˚F/W junction to ambient. For additional thermal resistance information see table in the Typical Applications section.

**Note 4:** Regulation is measured at constant junction temperature using pulse testing with a low duty cycle. Changes in output due to heating effects can be computed by multiplying the internal dissipation by the thermal resistance.

**Note 5:** Tested limits are guaranteed and 100% tested in production.

**Note 6:** Design limits are guaranteed (but not 100% production tested) over the indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels.

**Note 7:** Specification in **BOLDFACE TYPE** apply over the full rated temperature range.

## DC Electrical Characteristics (Notes 2, 7) (Continued)

**Note 8:** Accuracy is defined as the error between the output voltage and 10 mV/˚F times the device's case temperature at specified conditions of voltage, current, and temperature (expressed in ˚F).

**Note 9:** Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line over the device's rated temperature range.

**Note 10:** Quiescent current is defined in the circuit of *Figure 1*.

**Note 11:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its rated operating conditions (Note 2).

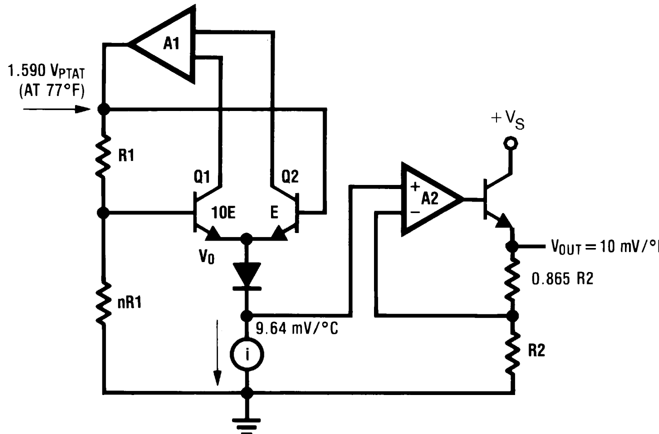
**Note 12:** Human body model, 100 pF discharged through a 1.5 kΩ resistor.

**Note 13:** See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" or the section titled "Surface Mount" found in a current National Semiconductor Linear Data Book for other methods of soldering surface mount devices.

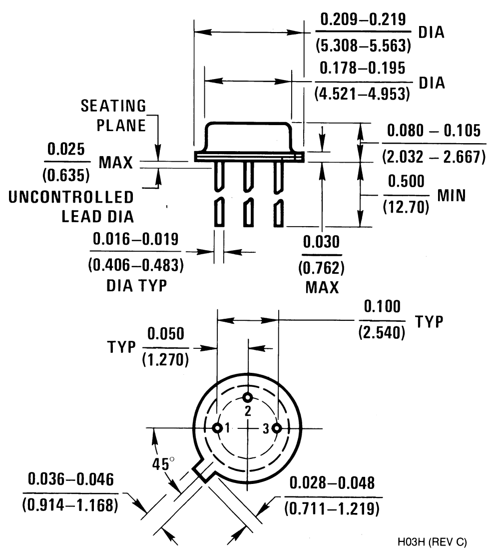
## DC Electrical Characteristics (Notes 2, 7)

| Parameter | Conditions | LM34 | | | LM34C, LM34D | | | Units (Max) |
|---|---|---|---|---|---|---|---|---|
| | | Typical | Tested Limit (Note 5) | Design Limit (Note 6) | Typical | Tested Limit (Note 5) | Design Limit (Note 6) | |
| Accuracy, LM34, LM34C (Note 8) | $T_A$ = +77˚F | ±0.8 | ±2.0 | | ±0.8 | ±2.0 | | ˚F |
| | $T_A$ = 0˚F | ±1.0 | | | ±1.0 | | ±3.0 | ˚F |
| | $T_A = T_{MAX}$ | ±1.6 | ±3.0 | | ±1.6 | | ±3.0 | ˚F |
| | $T_A = T_{MIN}$ | ±1.6 | | ±3.0 | ±1.6 | | ±4.0 | ˚F |
| Accuracy, LM34D (Note 8) | $T_A$ = +77˚F | | | | ±1.2 | ±3.0 | | ˚F |
| | $T_A = T_{MAX}$ | | | | ±1.8 | | ±4.0 | ˚F |
| | $T_A = T_{MIN}$ | | | | ±1.8 | | ±4.0 | ˚F |
| Nonlinearity (Note 9) | $T_{MIN} \le T_A \le T_{MAX}$ | **±0.6** | | **±1.0** | **±0.4** | | **±1.0** | ˚F |
| Sensor Gain (Average Slope) | $T_{MIN} \le T_A \le T_{MAX}$ | **+10.0** | **+9.8,** | | **+10.0** | | **+9.8,** | mV/˚F, min |
| | | | **+10.2** | | | | **+10.2** | mV/˚F, max |
| Load Regulation (Note 4) | $T_A$ = +77˚F | ±0.4 | ±2.5 | | ±0.4 | ±2.5 | | mV/mA |
| | $T_{MIN} \le T_A \le$ +150˚F | **±0.5** | | **±6.0** | **±0.5** | | **±6.0** | mV/mA |
| | $0 \le I_L \le 1$ mA | | | | | | | |
| Line Regulation (Note 4) | $T_A$ = +77˚F | ±0.01 | ±0.1 | | ±0.01 | ±0.1 | | mV/V |
| | $5V \le V_S \le 30V$ | **±0.02** | | **±0.2** | **±0.02** | | **±0.2** | mV/V |
| Quiescent Current (Note 10) | $V_S$ = +5V, +77˚F | 75 | 100 | | 75 | 100 | | µA |
| | $V_S$ = +5V | **131** | | **176** | **116** | | **154** | µA |
| | $V_S$ = +30V, +77˚F | 76 | 103 | | 76 | 103 | | µA |
| | $V_S$ = +30V | **132** | | **181** | **117** | | **159** | µA |
| Change of Quiescent Current (Note 4) | $4V \le V_S \le 30V$, +77˚F | +0.5 | 3.0 | | 0.5 | 3.0 | | µA |
| | $5V \le V_S \le 30V$ | **+1.0** | | **5.0** | **1.0** | | **5.0** | µA |
| Temperature Coefficient of Quiescent Current | | **+0.30** | | **+0.7** | **+0.30** | | **+0.7** | µA/˚F |
| Minimum Temperature for Rated Accuracy | In circuit of *Figure 1*, $I_L$ = 0 | +3.0 | | +5.0 | +3.0 | | +5.0 | ˚F |
| Long-Term Stability | $T_j = T_{MAX}$ for 1000 hours | ±0.16 | | | ±0.16 | | | ˚F |

## Block Diagram




## Physical Dimensions inches (millimeters) unless otherwise noted




**Order Number LM34H, LM34AH, LM34CH, LM34CAH or LM34DH**
**NS Package H03H**