



## LM335A - Precision Temperature Sensor



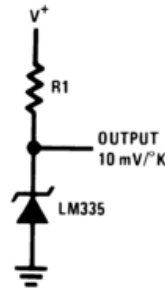
### Features

- Directly calibrated in °Kelvin
- 1°C initial accuracy available
- Operates from 400 µA to 5 mA
- Less than 10Ω dynamic impedance
- Easily calibrated
- Wide operating temperature range
- 200°C overrange
- Low cost

### General Description

The LM135 series are precision, easily-calibrated, integrated circuit temperature sensors.

### Typical Application



### Parametric Table [expand](#)

Supply Min	5 Volt
Quiescent Current_	1000 uA
Temperature Min	-40 deg C
Temperature Max	100 deg C
Sensor Gain	10 mV/Deg K

## LM135/LM235/LM335, LM135A/LM235A/LM335A Precision Temperature Sensors

### General Description

The LM135 series are precision, easily-calibrated, integrated circuit temperature sensors. Operating as a 2-terminal zener, the LM135 has a breakdown voltage directly proportional to absolute temperature at +10 mV/°K. With less than 1Ω dynamic impedance the device operates over a current range of 400 μA to 5 mA with virtually no change in performance. When calibrated at 25°C the LM135 has typically less than 1°C error over a 100°C temperature range. Unlike other sensors the LM135 has a linear output.

Applications for the LM135 include almost any type of temperature sensing over a -55°C to +150°C temperature range. The low impedance and linear output make interfacing to readout or control circuitry especially easy.

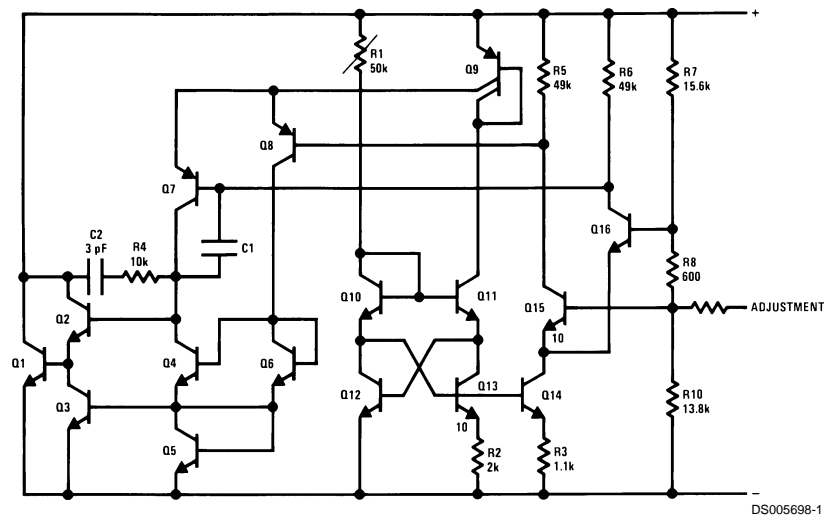
The LM135 operates over a -55°C to +150°C temperature range while the LM235 operates over a -40°C to +125°C

temperature range. The LM335 operates from -40°C to +100°C. The LM135/LM235/LM335 are available packaged in hermetic TO-46 transistor packages while the LM335 is also available in plastic TO-92 packages.

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### Schematic Diagram



**Absolute Maximum Ratings** (Note 4)

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

Reverse Current	15 mA
Forward Current	10 mA
Storage Temperature	
TO-46 Package	-60°C to +180°C
TO-92 Package	-60°C to +150°C
SO-8 Package	-65°C to +150°C

## Specified Operating Temp. Range

	Continuous	Intermittent (Note 2)
LM135, LM135A	-55°C to +150°C	150°C to 200°C
LM235, LM235A	-40°C to +125°C	125°C to 150°C
LM335, LM335A	-40°C to +100°C	100°C to 125°C
Lead Temp. (Soldering, 10 seconds)		
TO-92 Package:		260°C
TO-46 Package:		300°C
SO-8 Package:		300°C
Vapor Phase (60 seconds):		215°C
Infrared (15 seconds):		220°C

**Temperature Accuracy** (Note 1)

LM135/LM235, LM135A/LM235A

Parameter	Conditions	LM135A/LM235A			LM135/LM235			Units
		Min	Typ	Max	Min	Typ	Max	
Operating Output Voltage	$T_C = 25^\circ\text{C}$ , $I_R = 1\text{ mA}$	2.97	2.98	2.99	2.95	2.98	3.01	V
Uncalibrated Temperature Error	$T_C = 25^\circ\text{C}$ , $I_R = 1\text{ mA}$		0.5	1		1	3	°C
Uncalibrated Temperature Error	$T_{\text{MIN}} \leq T_C \leq T_{\text{MAX}}$ , $I_R = 1\text{ mA}$		1.3	2.7		2	5	°C
Temperature Error with 25°C Calibration	$T_{\text{MIN}} \leq T_C \leq T_{\text{MAX}}$ , $I_R = 1\text{ mA}$		0.3	1		0.5	1.5	°C
Calibrated Error at Extended Temperatures	$T_C = T_{\text{MAX}}$ (Intermittent)		2			2		°C
Non-Linearity	$I_R = 1\text{ mA}$		0.3	0.5		0.3	1	°C

**Temperature Accuracy** (Note 1)

LM335, LM335A

Parameter	Conditions	LM335A			LM335			Units
		Min	Typ	Max	Min	Typ	Max	
Operating Output Voltage	$T_C = 25^\circ\text{C}$ , $I_R = 1\text{ mA}$	2.95	2.98	3.01	2.92	2.98	3.04	V
Uncalibrated Temperature Error	$T_C = 25^\circ\text{C}$ , $I_R = 1\text{ mA}$		1	3		2	6	°C
Uncalibrated Temperature Error	$T_{\text{MIN}} \leq T_C \leq T_{\text{MAX}}$ , $I_R = 1\text{ mA}$		2	5		4	9	°C
Temperature Error with 25°C Calibration	$T_{\text{MIN}} \leq T_C \leq T_{\text{MAX}}$ , $I_R = 1\text{ mA}$		0.5	1		1	2	°C
Calibrated Error at Extended Temperatures	$T_C = T_{\text{MAX}}$ (Intermittent)		2			2		°C
Non-Linearity	$I_R = 1\text{ mA}$		0.3	1.5		0.3	1.5	°C

**Electrical Characteristics** (Note 1)

Parameter	Conditions	LM135/LM235 LM135A/LM235A			LM335 LM335A			Units
		Min	Typ	Max	Min	Typ	Max	
Operating Output Voltage Change with Current	$400\ \mu\text{A} \leq I_R \leq 5\text{ mA}$ At Constant Temperature		2.5	10		3	14	mV
Dynamic Impedance	$I_R = 1\text{ mA}$		0.5			0.6		$\Omega$
Output Voltage Temperature Coefficient			+10			+10		mV/°C
Time Constant	Still Air		80			80		sec
	100 ft/Min Air		10			10		sec
	Stirred Oil		1			1		sec
Time Stability	$T_C = 125^\circ\text{C}$		0.2			0.2		°C/khr

## Electrical Characteristics (Note 1) (Continued)

**Note 1:** Accuracy measurements are made in a well-stirred oil bath. For other conditions, self heating must be considered.

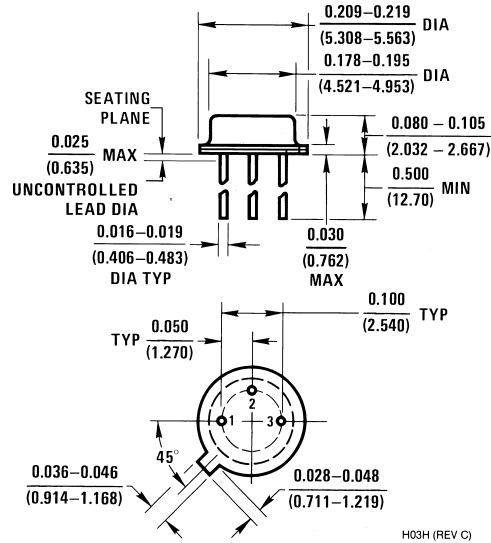
**Note 2:** Continuous operation at these temperatures for 10,000 hours for H package and 5,000 hours for Z package may decrease life expectancy of the device.

**Note 3:**

Thermal Resistance	TO-92	TO-46	SO-8
$\theta_{JA}$ (junction to ambient)	202°C/W	400°C/W	165°C/W
$\theta_{JC}$ (junction to case)	170°C/W	N/A	N/A

**Note 4:** Refer to RETS135H for military specifications.

## Physical Dimensions inches (millimeters) unless otherwise noted



### Metal Can Package (H)

Order Number LM135H, LM235H, LM335H, LM135AH, LM235AH or LM335AH  
NS Package Number H03H