

# LM185/LM285/LM385 Adjustable Micropower Voltage References

## General Description

The LM185/LM285/LM385 are micropower 3-terminal adjustable band-gap voltage reference diodes. Operating from 1.24 to 5.3V and over a 10 $\mu$ A to 20mA current range, they feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming is used to provide tight voltage tolerance. Since the LM185 band-gap reference uses only transistors and resistors, low noise and good long-term stability result.

Careful design of the LM185 has made the device tolerant of capacitive loading, making it easy to use in almost any reference application. The wide dynamic operating range allows its use with widely varying supplies with excellent regulation. The extremely low power drain of the LM185 makes it useful for micropower circuitry. This voltage reference can be used to make portable meters, regulators or general purpose analog circuitry with battery life approaching shelf life. Further, the

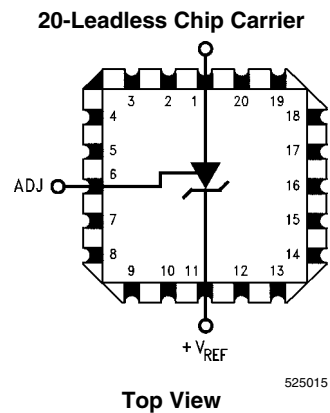
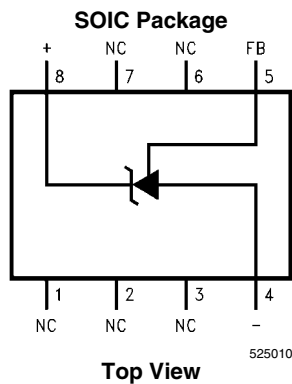
wide operating current allows it to replace older references with a tighter tolerance part.

The LM185 is rated for operation over a  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  temperature range, while the LM285 is rated  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  and the LM385  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ . The LM185 is available in a hermetic TO-46 package and a leadless chip carrier package, while the LM285/LM385 are available in a low-cost TO-92 molded package, as well as S.O.

## Features

- Adjustable from 1.24V to 5.30V
- Operating current of 10 $\mu$ A to 20mA
- 1% and 2% initial tolerance
- 1 $\Omega$  dynamic impedance
- Low temperature coefficient

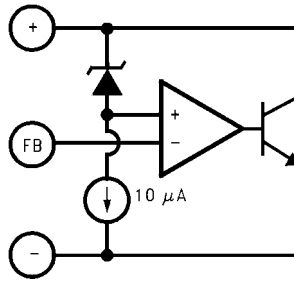
## Connection Diagrams



## Ordering Information

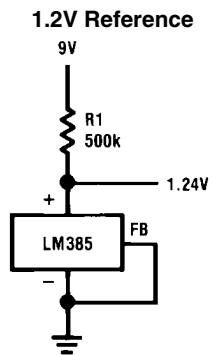
Package	Temperature Range			NSC Drawing
	-55°C to 125°C	-40°C to 85°C	0°C to 70°C	
TO-46	LM185BH			H03H
	LM185BH/883			
	LM185BYH			
	LM185BYH/883			
TO-92		LM285BXZ	LM385BXZ	Z03A
		LM285BYZ	LM385BYZ	
		LM285Z	LM385BZ	
			LM385Z	
8-Pin SOIC		LM285M	LM385M	M08A
		LM285BYM	LM385BM	
20-Leadless Chip Carrier	LM185BE/883			E20A

## Block Diagram

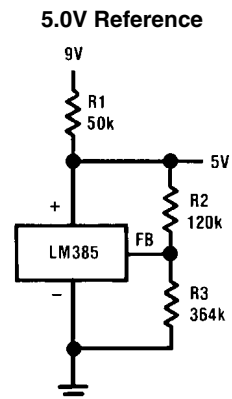


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## Typical Applications



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$$V_{OUT} = 1.24 \left( \frac{R3}{R2} + 1 \right)$$

**Absolute Maximum Ratings** (Note 1)

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

(Note 2)

Reverse Current	30mA
Forward Current	10mA
Operating Temperature Range (Note 3)	
LM185 Series	-55°C to 125°C
LM285 Series	-40°C to 85°C
LM385 Series	0°C to 70°C

ESD Susceptibility (Note 8)

2kV

Storage Temperature

-55°C to 150°C

Soldering Information

TO-92 Package (10 sec.)

260°C

TO-46 Package (10 sec.)

300°C

SO Package

Vapor Phase (60 sec.)

215°C

Infrared (15 sec.)

220°C

See An-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

**Electrical Characteristics** (Note 4)

Parameter	Conditions	LM185, LM285					LM385					Units (Limit)
		Typ	LM185BX, LM185BY LM185B, LM285BX, LM285BY		LM285		Typ	LM385BX, LM385BY		LM385		
			Tested Limit (Note 5)	Design Limit (Note 6)	Tested Limit (Note 5)	Design Limit (Note 6)		Tested Limit (Note 5)	Design Limit (Note 6)	Tested Limit (Note 5)	Design Limit (Note 6)	
Reference Voltage	$I_R = 100\mu A$	1.240	1.252  1.255 1.228 1.215		1.265  1.215	1.270  1.205	1.240	1.252  1.228	1.255  1.215	1.265  1.215	1.270  1.205	V  (max) V (min)
Reference Voltage	$I_{MIN} < I_R < 1mA$	0.2	1	1.5	1	1.5	0.2	1	1.5	1	1.5	mV
Change with Current	$1mA < I_R < 20mA$	4	10	20	10	20	5	15	25	15	25	(max)
Dynamic Output Impedance	$I_R = 100\mu A, f = 100Hz$ $I_{AC} = 0.1 I_R, V_{OUT} = V_{REF}$ $V_{OUT} = 5.3V$	0.3  0.7					0.4  1					$\Omega$
Reference Voltage Change with Output Voltage	$I_R = 100\mu A$	1	3	6	3	6	2	5	10	5	10	mV (max)
Feedback Current		13	20	25	20	25	16	30	35	30	35	nA (max)
Minimum Operating Current (see curve)	$V_{OUT} = V_{REF}$ $V_{OUT} = 5.3V$	6 30	9 45	10 50	9 45	10 50	7 35	11 55	13 60	11 55	13 60	$\mu A$ (max)
Output Wideband Noise	$I_R = 100\mu A, 10Hz < f < 10kHz$ $V_{OUT} = V_{REF}$ $V_{OUT} = 5.3V$	50 170					50 170					$\mu V_{rms}$

Parameter	Conditions	LM185, LM285				LM385				Units (Limit)		
		Typ	LM185BX, LM185BY LM185B, LM285BX, LM285BY		LM285		Typ	LM385BX, LM385BY			LM385	
			Tested Limit (Note 5)	Design Limit (Note 6)	Tested Limit (Note 5)	Design Limit (Note 6)		Tested Limit (Note 5)	Design Limit (Note 6)		Tested Limit (Note 5)	Design Limit (Note 6)
Average Temperature Coefficient (Note 7)	$I_R = 100\mu A$ X Suffix  Y Suffix  All Others		<b>30</b>  <b>50</b>					<b>30</b>  <b>50</b>				ppm/ ° c (max)
Long Term Stability	$I_R = 100\mu A$ , T = 1000 Hr, $T_A = 25^\circ C \pm 0.1^\circ C$	20					20					ppm

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be 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.

**Note 2:** Refer to RETS185H for military specifications.

**Note 3:** For elevated temperature operation,  $T_{Jmax}$  is:

LM185	150°C
LM285	125°C
LM385	100°C

Thermal Resistance	TO-92	TO-46	SO-8
$\theta_{JA}$ (Junction to Ambient)	180°C/W (0.4 leads) 170°C/W (0.125 leads)	440°C/W	165°C/W
$\theta_{JC}$ (Junction to Case)	N/A	80°C/W	N/A

**Note 4:** Parameters identified with **boldface type** apply at temperature extremes. All other numbers apply at  $T_A = T_J = 25^\circ C$ . Unless otherwise specified, all parameters apply for  $V_{REF} < V_{OUT} < 5.3V$ .

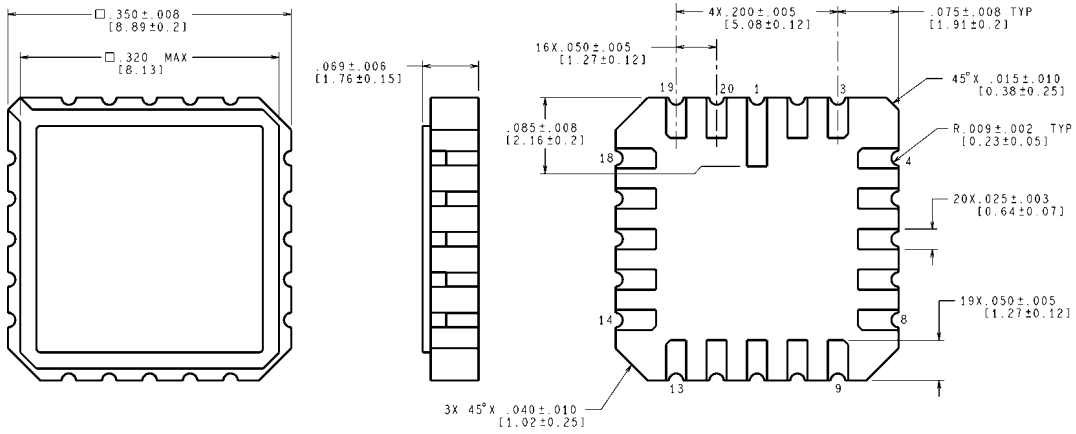
**Note 5:** Guaranteed and 100% production tested.

**Note 6:** Guaranteed, but not 100% production tested. These limits are not to be used to calculate average outgoing quality levels.

**Note 7:** The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures from  $T_{MIN}$  to  $T_{MAX}$ , divided by  $T_{MAX} - T_{MIN}$ . The measured temperatures are -55, -40, 0, 25, 70, 85, 125°C.

**Note 8:** The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin.

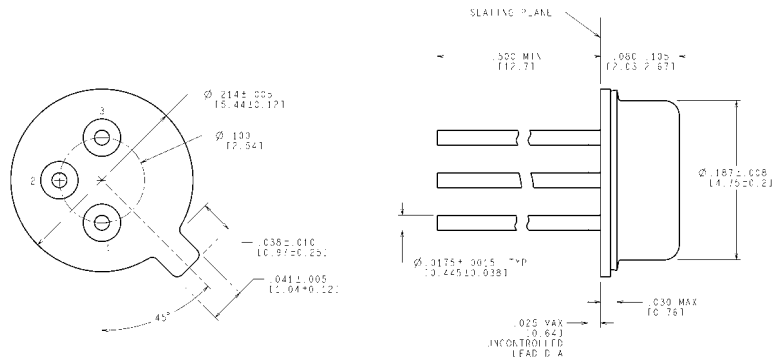
**Physical Dimensions** inches (millimeters) unless otherwise noted



CONTROLLING DIMENSION IS INCH  
 VALUES IN [ ] ARE MILLIMETERS

**20-Leadless Chip Carrier (E)  
 NS Package Number E20A**

E20A (Rev F)



CONTROLLING DIMENSION IS INCH  
 VALUES IN [ ] ARE IN MILLIMETERS

**TO-46 Metal Can Package (H)  
 NS Package Number H03H**

H03H (Rev F)