

# 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.

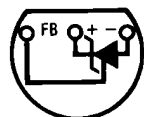
The LM185 is rated for operation over a  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  temperature range, while the LM285 is rated  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  and the LM385  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ . The LM185 is available in a hermetic TO-46 package and 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

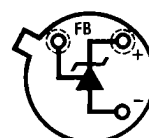
### Connection Diagrams

**TO-92  
Plastic Package**



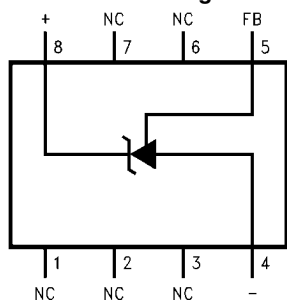
525009  
**Bottom View**

**TO-46  
Metal Can Package**



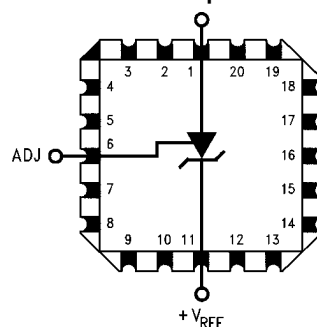
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**Bottom View**

**SOIC Package**



525010  
**Top View**

**20-Leadless Chip Carrier**

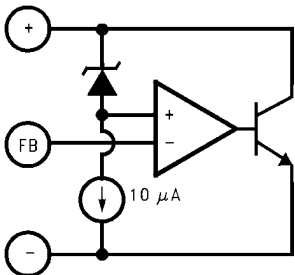


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**Top View**

Ordering Information

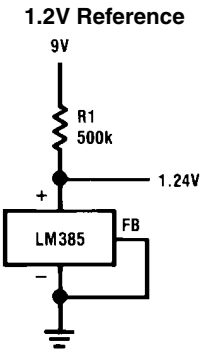
Package	Temperature Range			NSC Drawing
	-55°C to 125°C	-40°C to 85°C	0°C to 70°C	
TO-46		LM185BH		H03H
		LM185BH/883		
		LM185BYH		
		LM185BYH/883		
TO-92			LM285BXZ	Z03A
			LM285BYZ	
			LM285Z	
8-Pin SOIC			LM285M	M08A
			LM285BYM	
20-Leadless Chip Carrier		LM185BE/883		E20A

Block Diagram

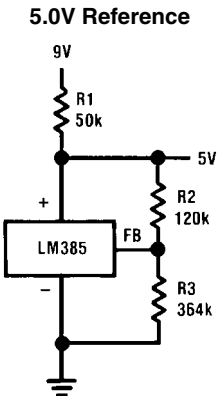


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Typical Applications



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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 <sub>R</sub> = 100μA	1.240	1.252  <b>1.255</b> 1.228 <b>1.215</b>		1.265  1.215 <b>1.205</b>	<b>1.270</b>	1.240	1.252  1.228	<b>1.255</b>  <b>1.215</b>	1.265  1.215	<b>1.270</b>  <b>1.205</b>	V  (max) V (min)
Reference Voltage Change with Current	I <sub>MIN</sub> < I <sub>R</sub> < 1mA  1mA < I <sub>R</sub> < 20mA	0.2  4	1  10	<b>1.5</b>  <b>20</b>	1  10	<b>1.5</b>  <b>20</b>	0.2  5	1  15	<b>1.5</b>  <b>25</b>	1  15	<b>1.5</b>  <b>25</b>	mV  (max)
Dynamic Output Impedance	I <sub>R</sub> = 100μA,    f = 100Hz I <sub>AC</sub> = 0.1 I <sub>R</sub> V <sub>OUT</sub> = V <sub>REF</sub> V <sub>OUT</sub> = 5.3V	0.3  0.7					0.4  1					Ω
Reference Voltage Change with Output Voltage	I <sub>R</sub> = 100μA	1	3	<b>6</b>	3	<b>6</b>	2	5	<b>10</b>	5	<b>10</b>	mV  (max)
Feedback Current		13	20	<b>25</b>	20	<b>25</b>	16	30	<b>35</b>	30	<b>35</b>	nA (max)
Minimum Operating Current (see curve)	V <sub>OUT</sub> = V <sub>REF</sub>  V <sub>OUT</sub> = 5.3V	6  30	9  45	<b>10</b>  <b>50</b>	9  45	<b>10</b>  <b>50</b>	7  35	11  55	<b>13</b>  <b>60</b>	11  55	<b>13</b>  <b>60</b>	μA  (max)
Output Wideband Noise	I <sub>R</sub> = 100μA, 10Hz < f < 10kHz  V <sub>OUT</sub> = V <sub>REF</sub> V <sub>OUT</sub> = 5.3V	50  170					50  170					μV <sub>rms</sub>

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 <sub>R</sub> = 100μA    X Suffix  Y Suffix  All Others		30  50  150			150		30  50  150			150	ppm/° c (max)
Long Term Stability	I <sub>R</sub> = 100μA, T = 1000 Hr, T <sub>A</sub> = 25°C ± 0.1°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  $V_{REF} < V_{OUT} < 5.3V$ .

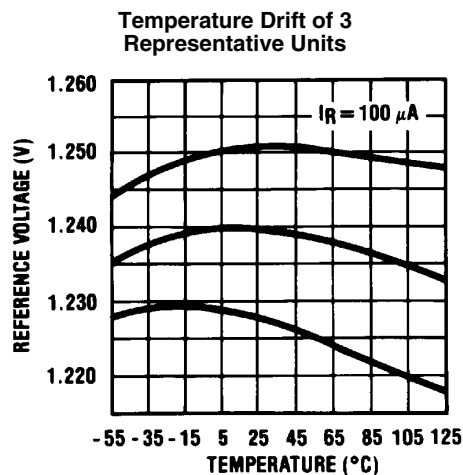
**Note 5:** Guaranteed and 100% production tested.

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

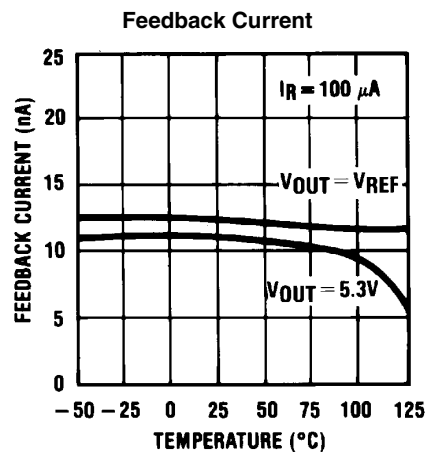
**Note 7:** The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures from  $T_{MIN}$  to  $T_{MAX}$ , divided by  $T_{MAX} - T_{MIN}$ . The measured temperatures are -55, -40, 0, 25, 70, 85, 125°C.

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

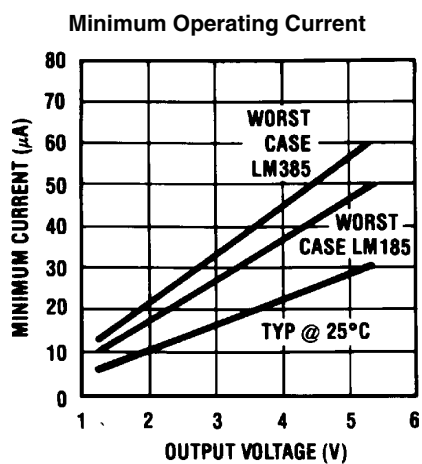
# Typical Performance Characteristics



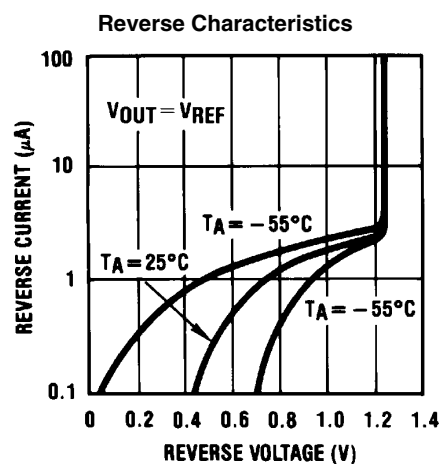
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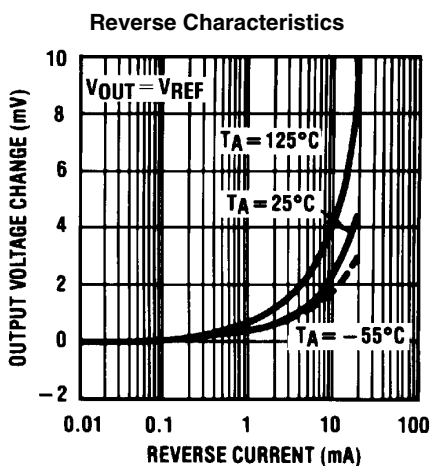
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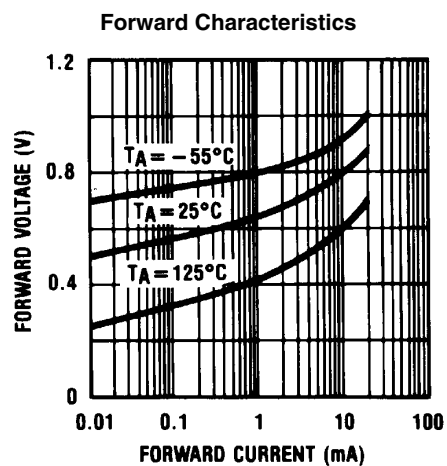
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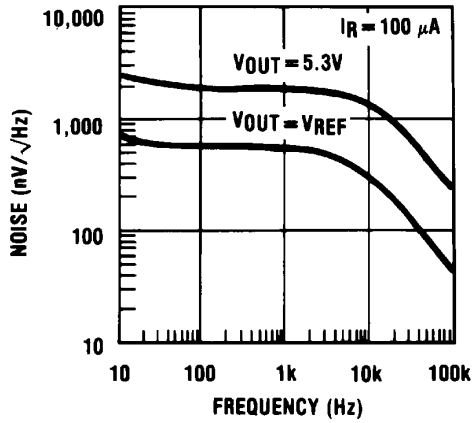


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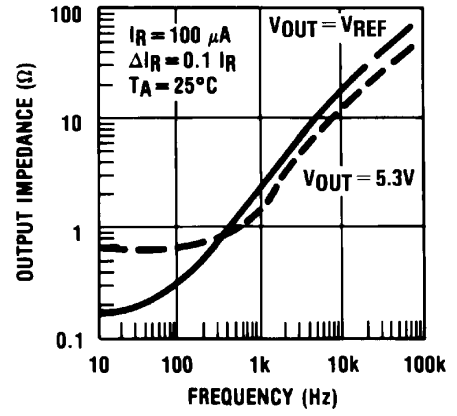
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Output Noise Voltage



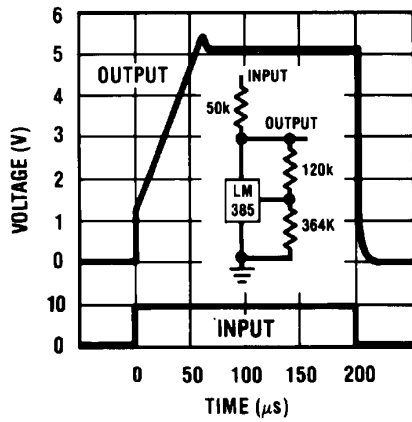
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Dynamic Output Impedance



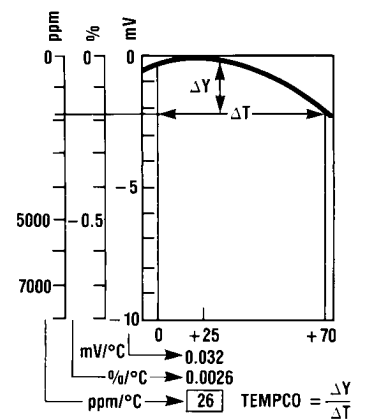
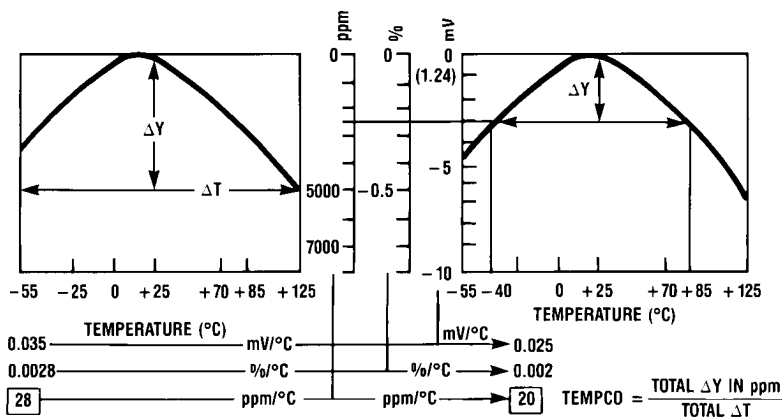
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Response Time



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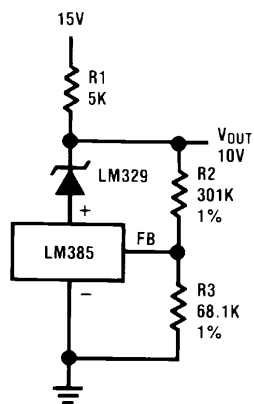
Temperature Coefficient Typical  
LM185 LM285 LM385



525004

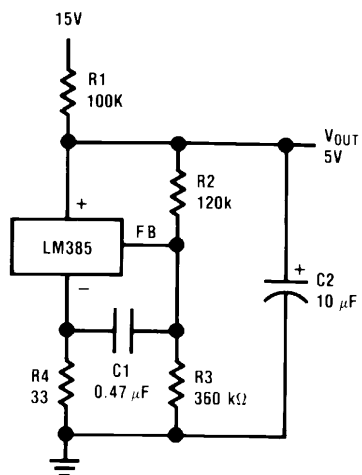
## Typical Applications

### Precision 10V Reference



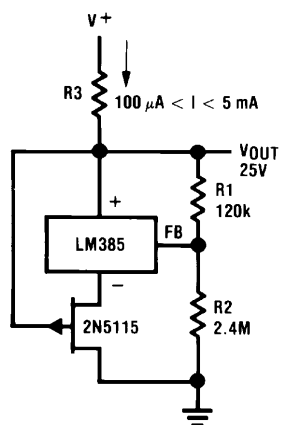
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### Low AC Noise Reference



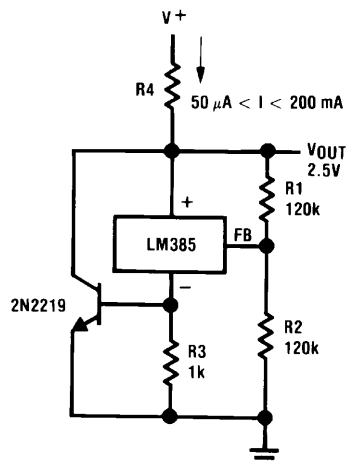
525026

### 25V Low Current Shunt Regulator



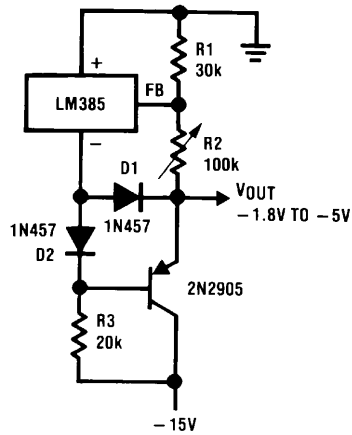
525027

### 200 mA Shunt Regulator



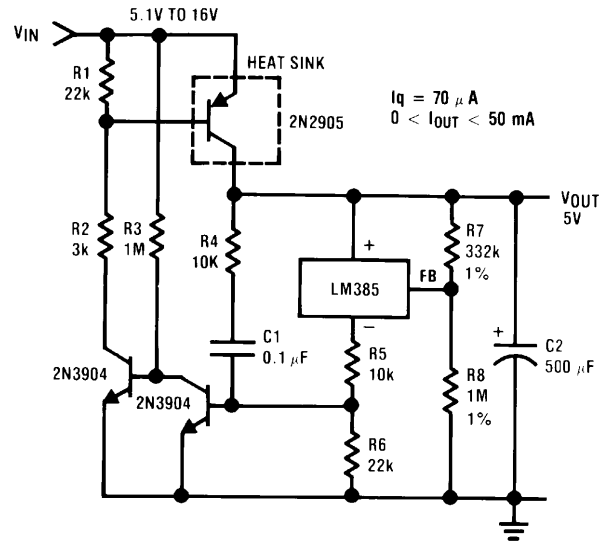
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Series-Shunt 20 mA Regulator



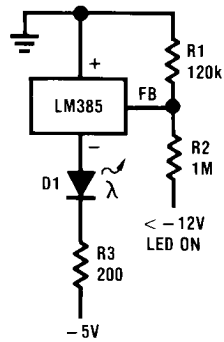
525029

High Efficiency Low Power Regulator



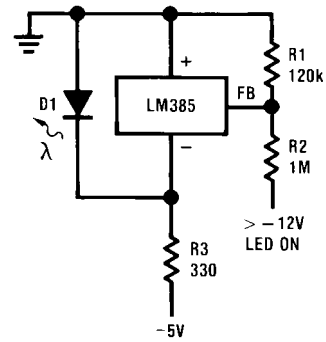
525030

Voltage Level Detector

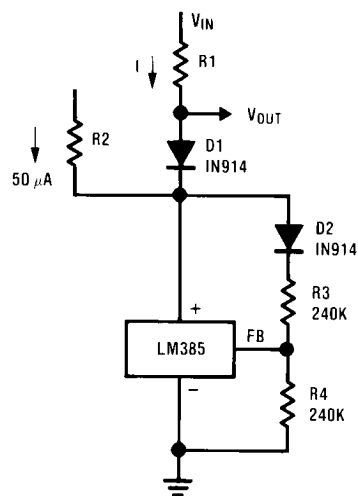


525031

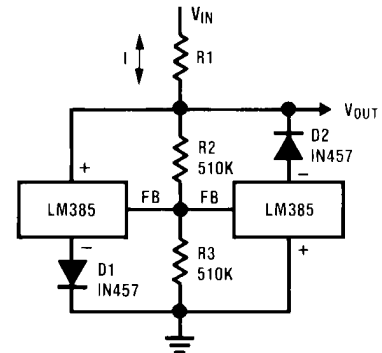
Voltage Level Detector



525032

Fast Positive Clamp  
 $2.4V + \Delta V_{D1}$ 

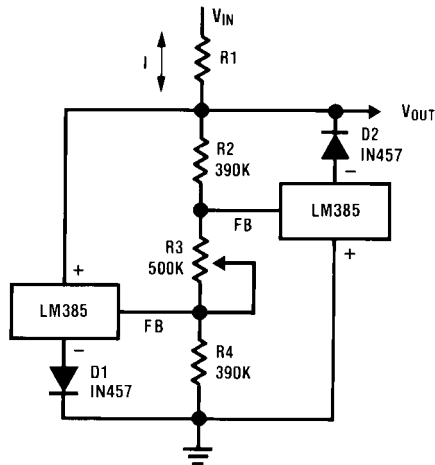
525033

Bidirectional Clamp  
 $\pm 2.4V$ 

525034

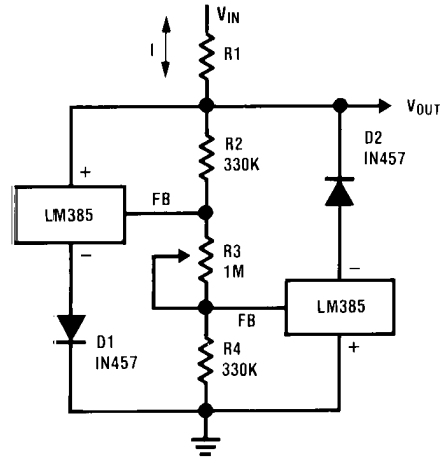


**Bidirectional Adjustable Clamp**  
 $\pm 1.8V$  to  $\pm 2.4V$



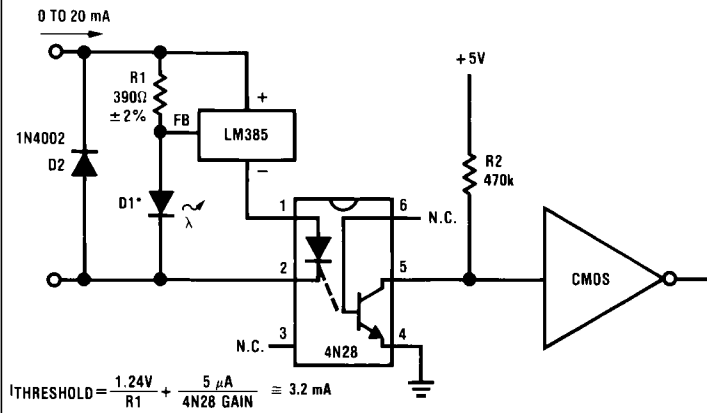
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**Bidirectional Adjustable Clamp**  
 $\pm 2.4V$  to  $\pm 6V$



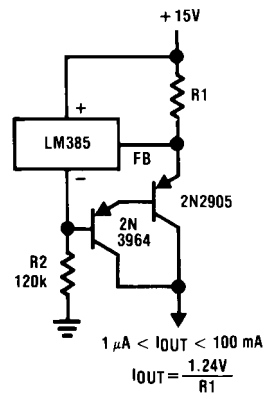
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**Simple Floating Current Detector**



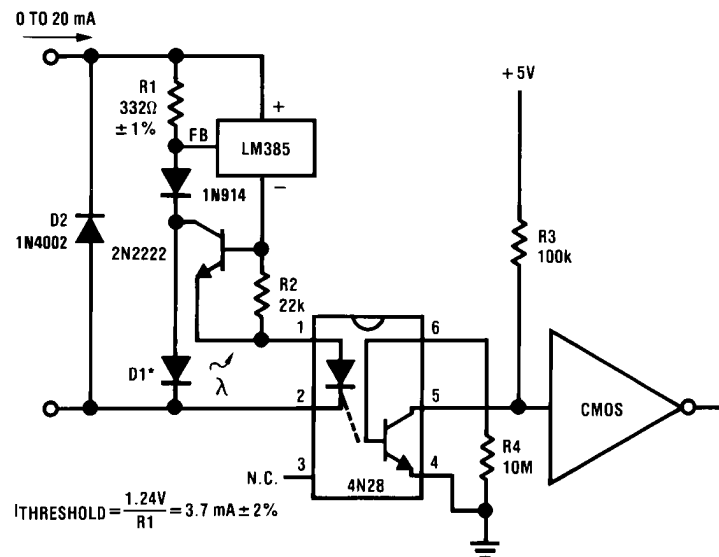
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**Current Source**



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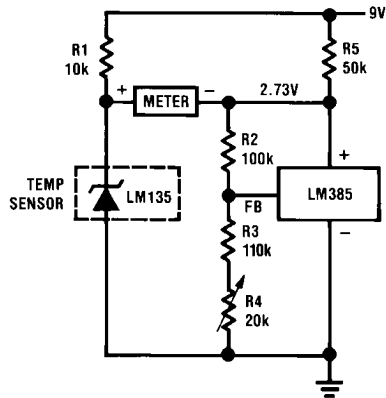
**Precision Floating Current Detector**



525039

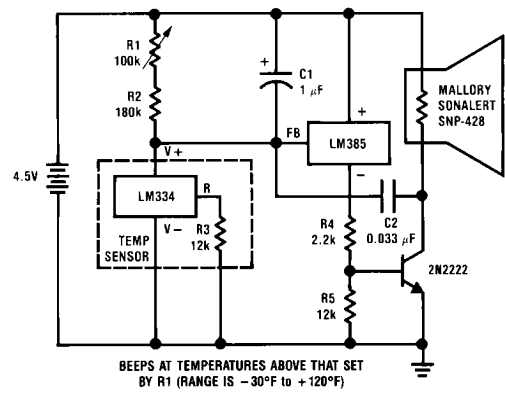
\*D1 can be any LED,  $V_F=1.5V$  to  $2.2V$  at  $3mA$ . D1 may act as an indicator. D1 will be on if  $I_{THRESHOLD}$  falls below the threshold current, except with  $I=0$ .

Centigrade Thermometer,  $10mV/^{\circ}C$



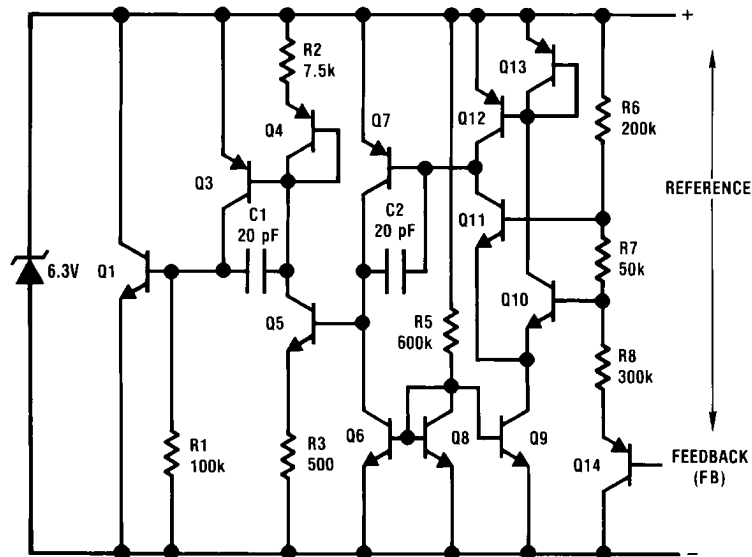
525011

Freezer Alarm



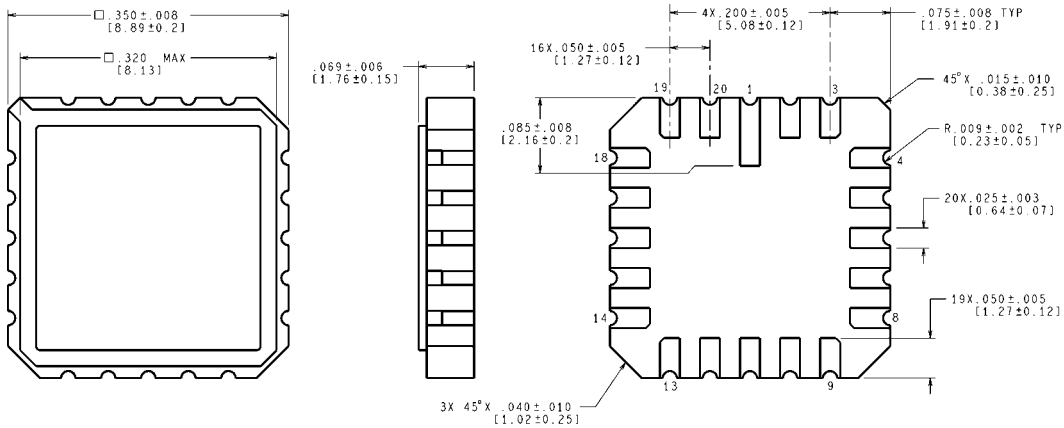
525012

## Schematic Diagram



525008

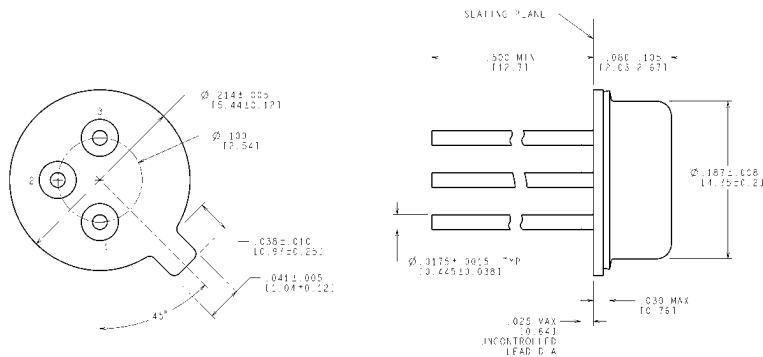
# Physical Dimensions inches (millimeters) unless otherwise noted



CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS

E20A (Rev F)

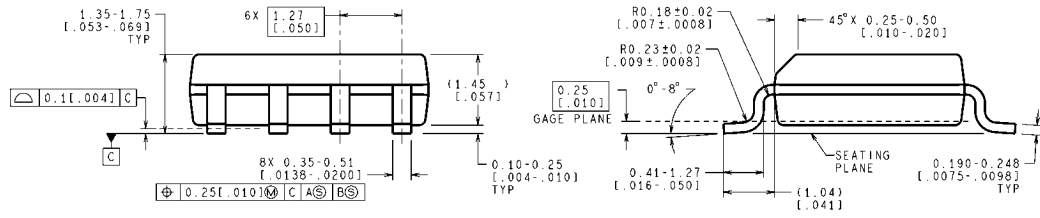
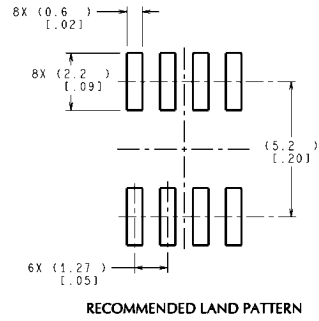
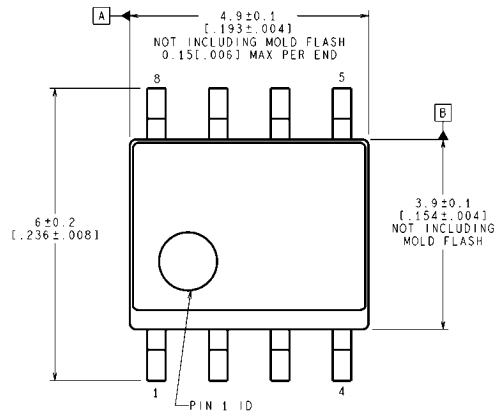
## 20-Leadless Chip Carrier (E) NS Package Number E20A



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H03H (Rev F)

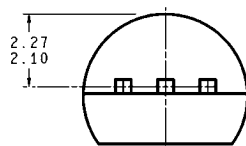
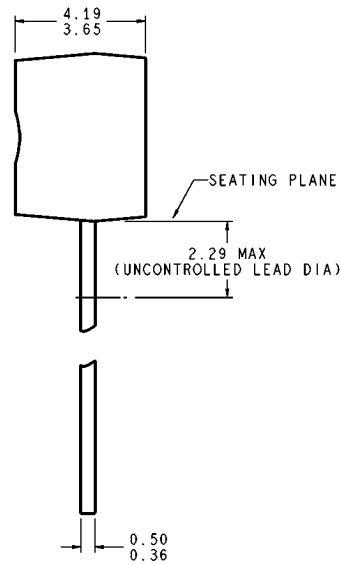
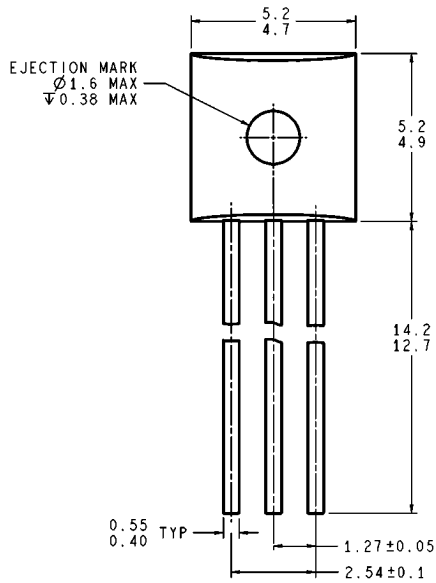
## TO-46 Metal Can Package (H) NS Package Number H03H



CONTROLLING DIMENSION IS MILLIMETER  
VALUES IN [ ] ARE INCHES  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

SO Package (M)  
NS Package Number M08A

M08A (Rev L)



DIMENSIONS ARE IN MILLIMETERS

TO-92 Plastic Package (Z)  
NS Package Number Z03A

Z03A (Rev G)

## Notes

## Notes

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Data Converters	<a href="http://www.national.com/adc">www.national.com/adc</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
Displays	<a href="http://www.national.com/displays">www.national.com/displays</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
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Interface	<a href="http://www.national.com/interface">www.national.com/interface</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LVDS	<a href="http://www.national.com/lvds">www.national.com/lvds</a>	Reference Designs	<a href="http://www.national.com/refdesigns">www.national.com/refdesigns</a>
Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Feedback	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>		
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>		
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>		
PowerWise	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>		
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>		
Temperature Sensors	<a href="http://www.national.com/tempsensors">www.national.com/tempsensors</a>		
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Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

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