

National Semiconductor is now part of
Texas Instruments.

Search <http://www.ti.com/> for the latest technical
information and details on our current products and services.

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 μ 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.

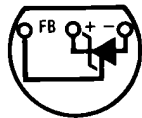
The LM185 is rated for operation over a -55°C to 125°C temperature range, while the LM285 is rated -40°C to 85°C and the LM385 0°C to 70°C . The LM185 is available in a hermetic TO-46 package and a leadless chip carrier package, while the LM285/LM385 are available in a low-cost TO-92 molded package,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

Features

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

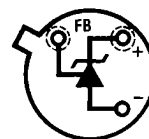
Connection Diagrams

TO-92
Plastic Package



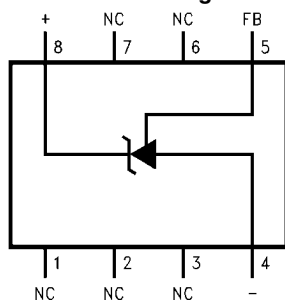
525009
Bottom View

TO-46
Metal Can Package



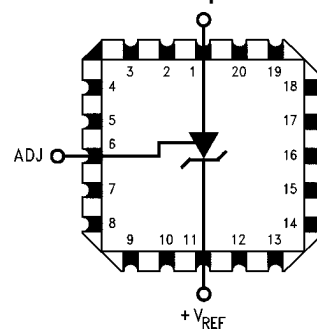
525001
Bottom View

SOIC Package



525010
Top View

20-Leadless Chip Carrier

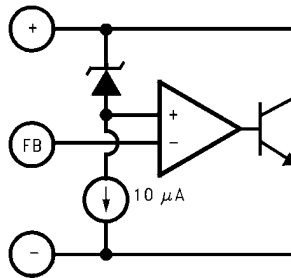


525015
Top View

Ordering Information

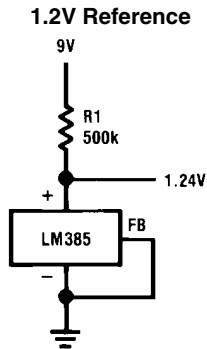
Package	Temperature Range			NSC Drawing
	-55°C to 125°C	-40°C to 85°C	0°C to 70°C	
TO-46	LM185BH			H03H
	LM185BH/883			
	LM185BYH			
	LM185BYH/883			
TO-92		LM285BXZ	LM385BXZ	Z03A
		LM285BYZ	LM385BYZ	
		LM285Z	LM385BZ	
			LM385Z	
8-Pin SOIC		LM285M	LM385M	M08A
		LM285BYM	LM385BM	
20-Leadless Chip Carrier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

Block Diagram

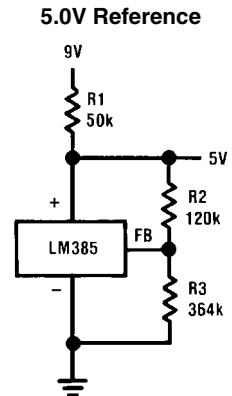


525013

Typical Applications



525014



525002

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

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	$I_R = 100\mu\text{A}$	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 Change with Current	$I_{\text{MIN}} < I_R < 1\text{mA}$ $1\text{mA} < I_R < 20\text{mA}$	0.2 4	1 10	1.5 20	1 10	1.5 20	0.2 5	1 15	1.5 25	1 15	1.5 25	mV (max)
Dynamic Output Impedance	$I_R = 100\mu\text{A}$, $f = 100\text{Hz}$ $I_{\text{AC}} = 0.1 I_R$ $V_{\text{OUT}} = V_{\text{REF}}$ $V_{\text{OUT}} = 5.3\text{V}$	0.3 0.7					0.4 1					Ω
Reference Voltage Change with Output Voltage	$I_R = 100\mu\text{A}$	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)	$V_{\text{OUT}} = V_{\text{REF}}$ $V_{\text{OUT}} = 5.3\text{V}$	6 30	9 45	10 50	9 45	10 50	7 35	11 55	13 60	11 55	13 60	μA (max)
Output Wideband Noise	$I_R = 100\mu\text{A}$, $10\text{Hz} < f < 10\text{kHz}$ $V_{\text{OUT}} = V_{\text{REF}}$ $V_{\text{OUT}} = 5.3\text{V}$	50 170					50 170					μV_{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		30					30				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, $T_{j,max}$ is:

LM185	150°C
LM285	125°C
LM385	100°C

Thermal Resistance	TO-92	TO-46	SO-8
θ_{JA} (Junction to Ambient)	180°C/W (0.4 leads) 170°C/W (0.125 leads)	440°C/W	165°C/W
θ_{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 $V_{REF} < V_{OUT} < 5.3V$.

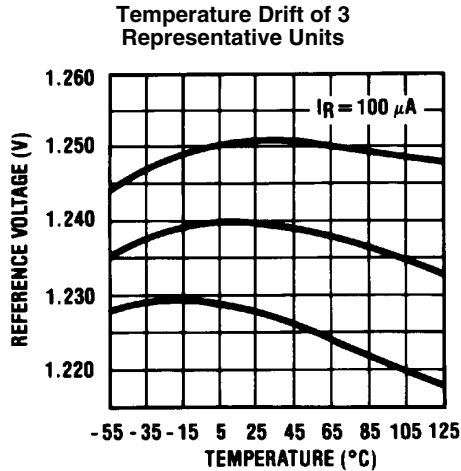
Note 5: Guaranteed and 100% production tested.

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

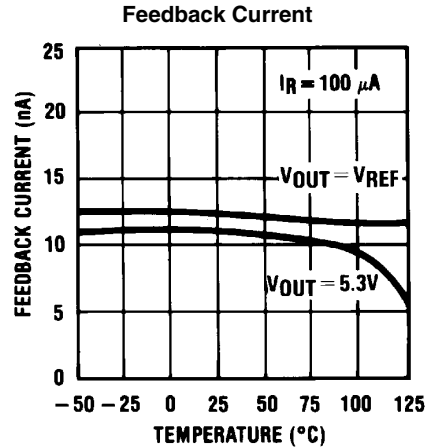
Note 7: The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures from T_{MIN} to T_{MAX} , divided by $T_{MAX} - T_{MIN}$. The measured temperatures are -55, -40, 0, 25, 70, 85, 125°C.

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

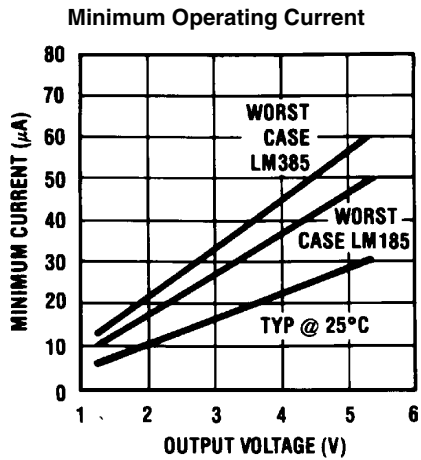
Typical Performance Characteristics



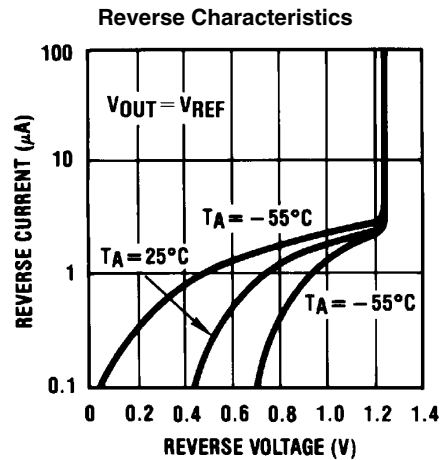
525016



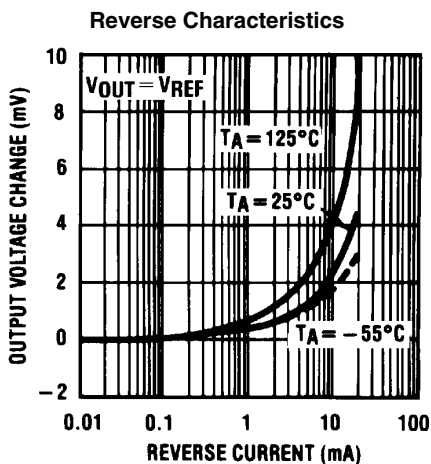
525017



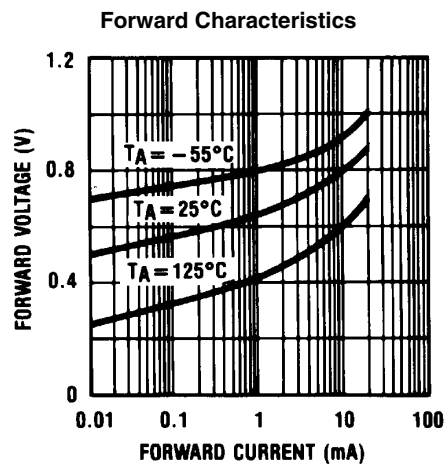
525018



525019

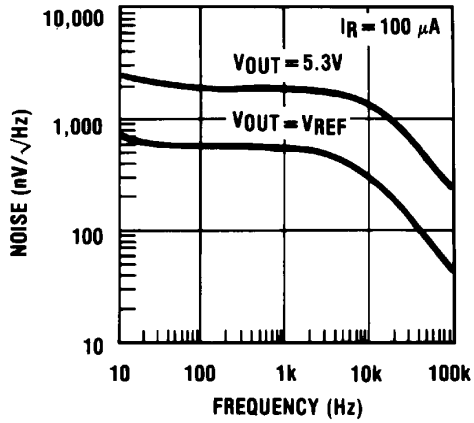


525020



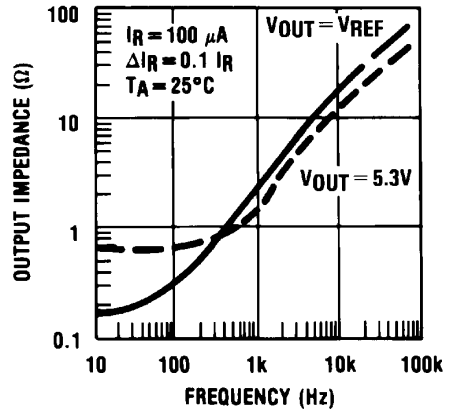
525021

Output Noise Voltage



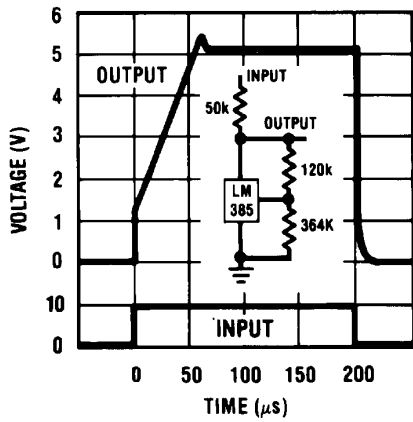
525022

Dynamic Output Impedance



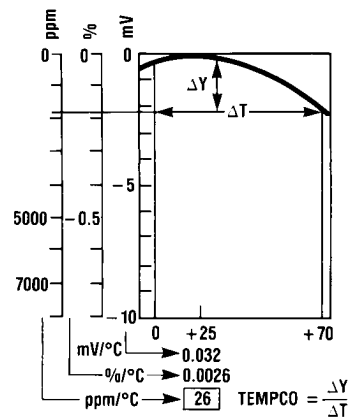
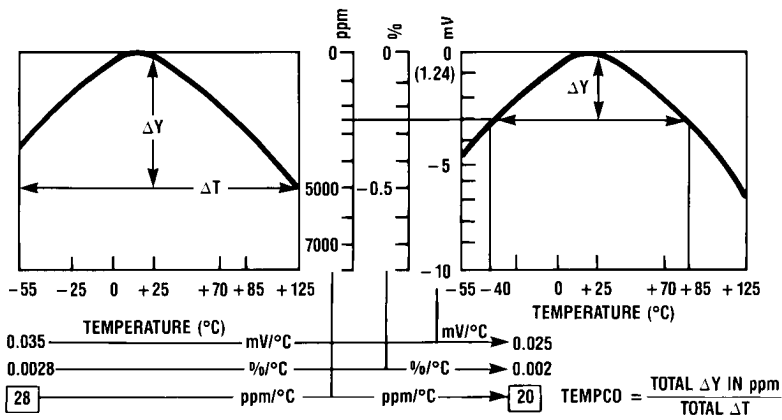
525023

Response Time



525024

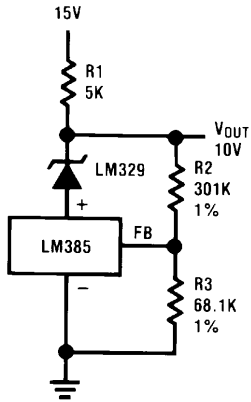
Temperature Coefficient Typical
LM185 LM285 LM385



525004

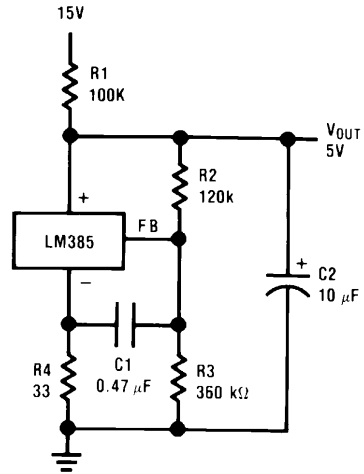
Typical Applications

Precision 10V Reference



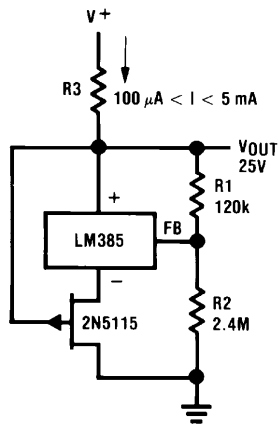
525025

Low AC Noise Reference



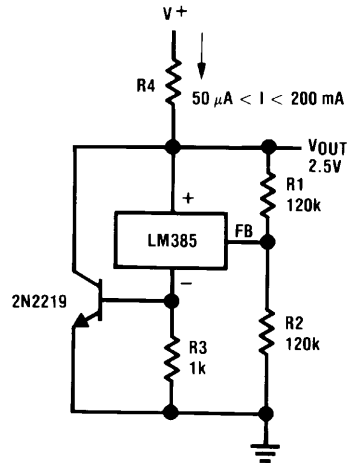
525026

25V Low Current Shunt Regulator



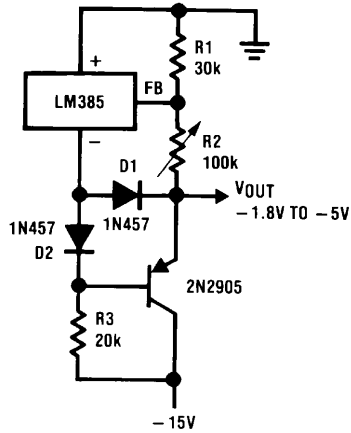
525027

200 mA Shunt Regulator



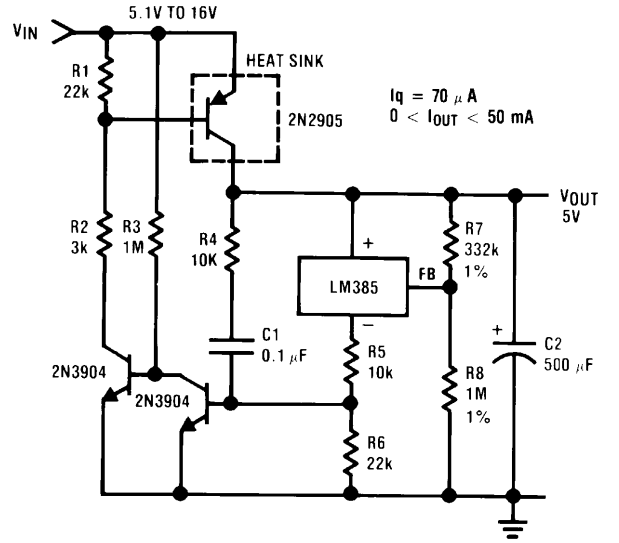
525028

Series-Shunt 20 mA Regulator



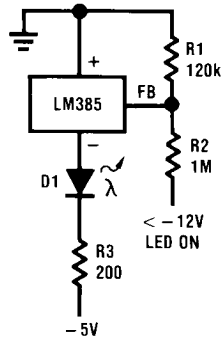
525029

High Efficiency Low Power Regulator



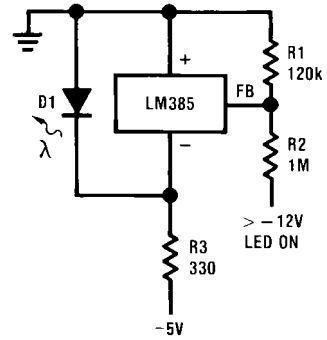
525030

Voltage Level Detector



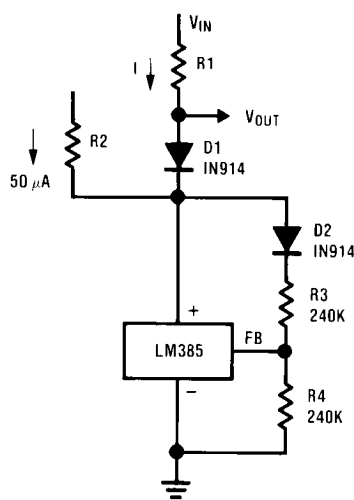
525031

Voltage Level Detector



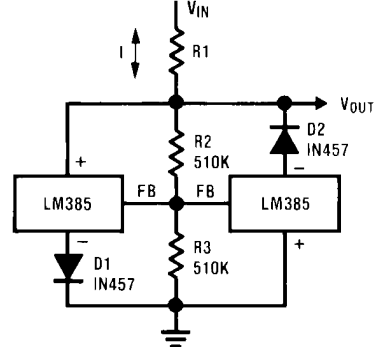
525032

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



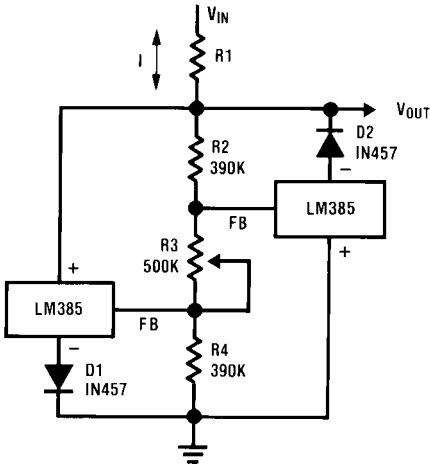
525033

Bidirectional Clamp
 $\pm 2.4V$



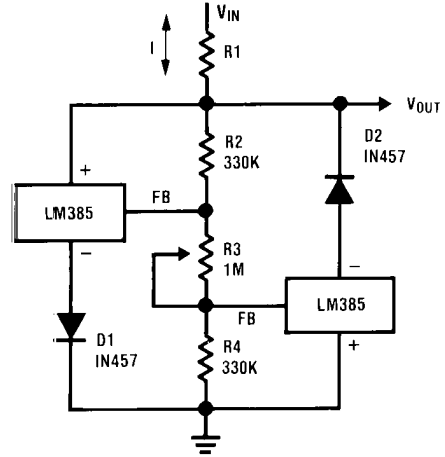
525034

Bidirectional Adjustable Clamp
±1.8V to ±2.4V



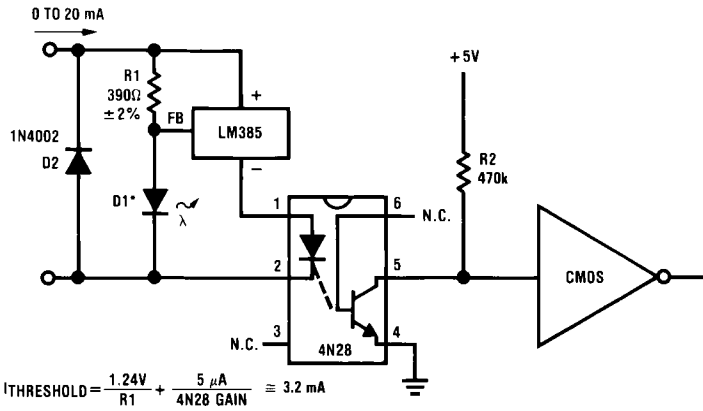
525035

Bidirectional Adjustable Clamp
±2.4V to ±6V



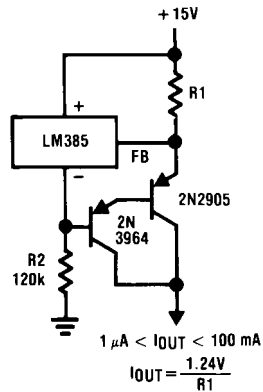
525036

Simple Floating Current Detector



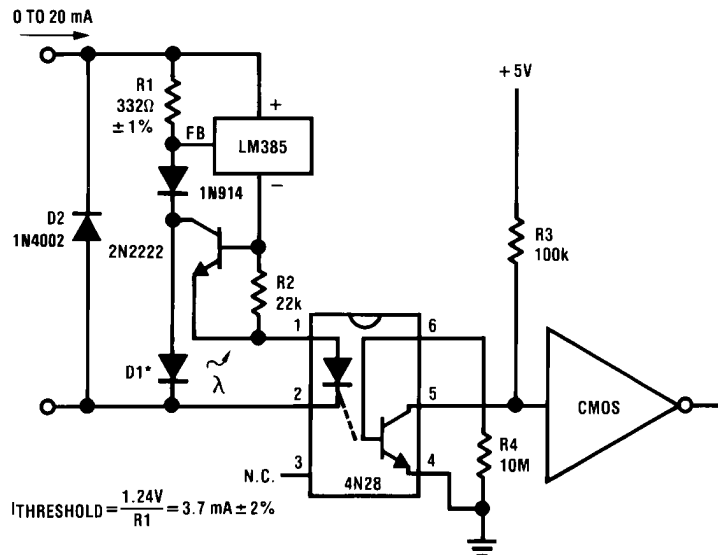
525037

Current Source



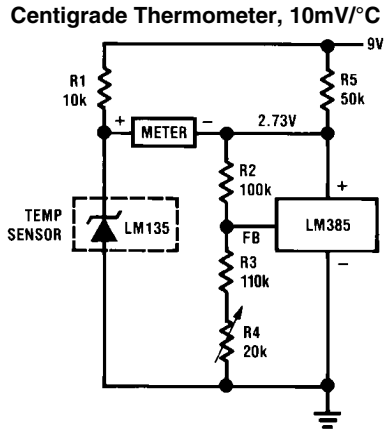
525038

Precision Floating Current Detector

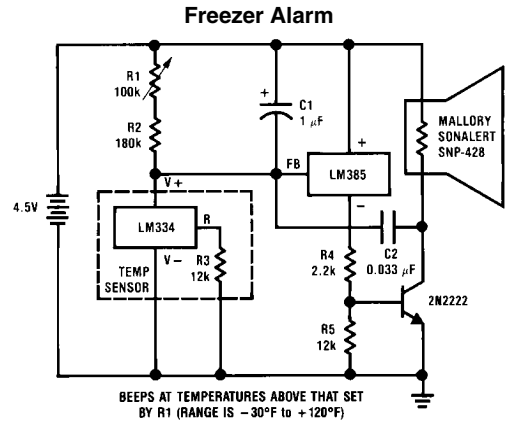


525039

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

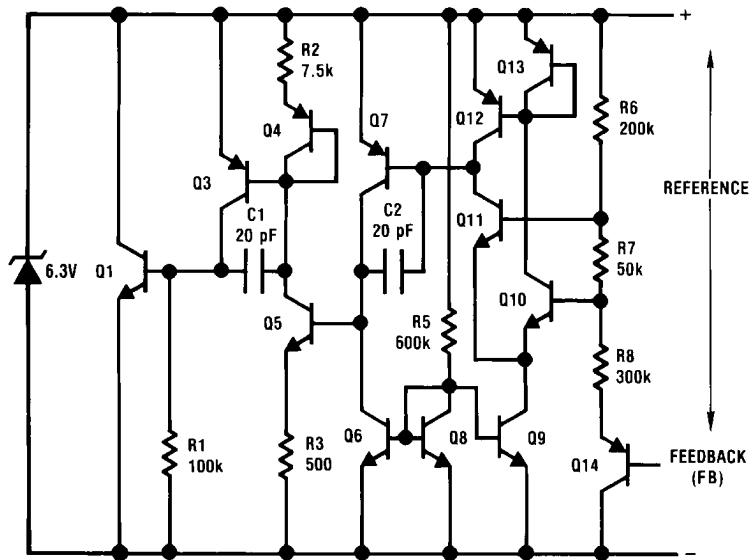


525011



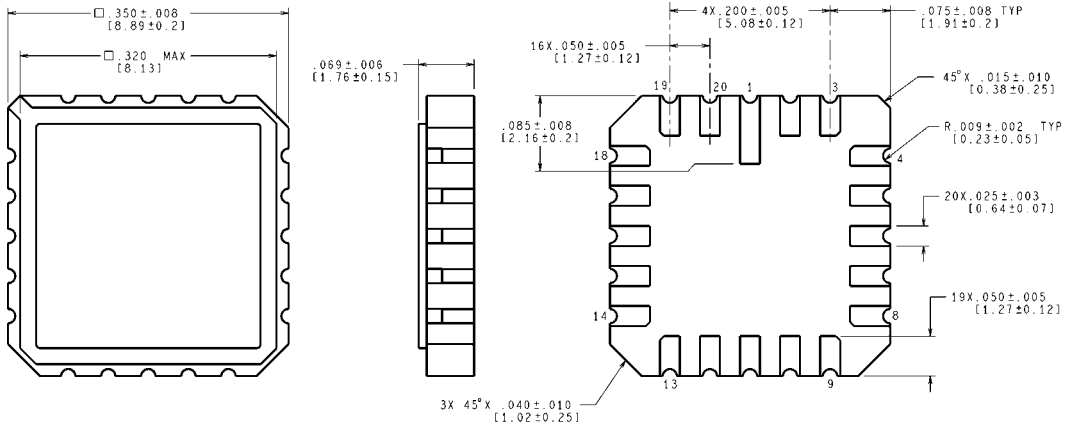
525012

Schematic Diagram



525008

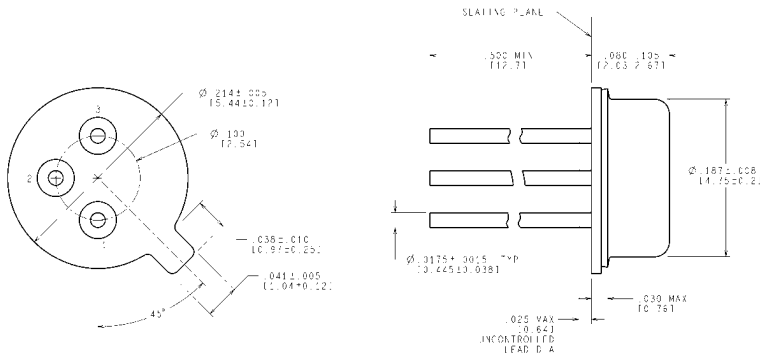
Physical Dimensions inches (millimeters) unless otherwise noted



CONTROLLING DIMENSION IS INCH
 VALUES IN [] ARE MILLIMETERS

E20A (Rev F)

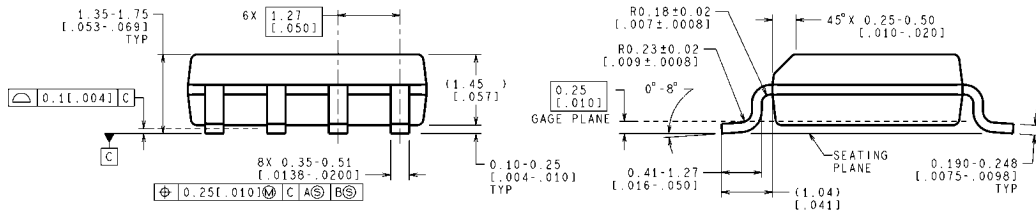
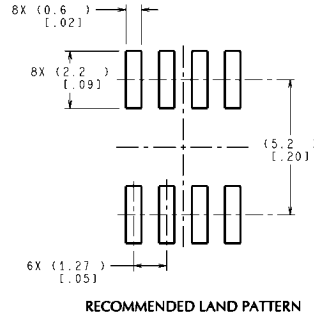
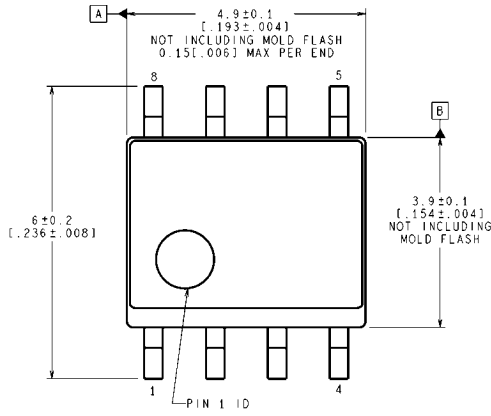
**20-Leadless Chip Carrier (E)
 NS Package Number E20A**



CONTROLLING DIMENSION IS INCH
 VALUES IN [] ARE IN MILLIMETERS

H03H (Rev F)

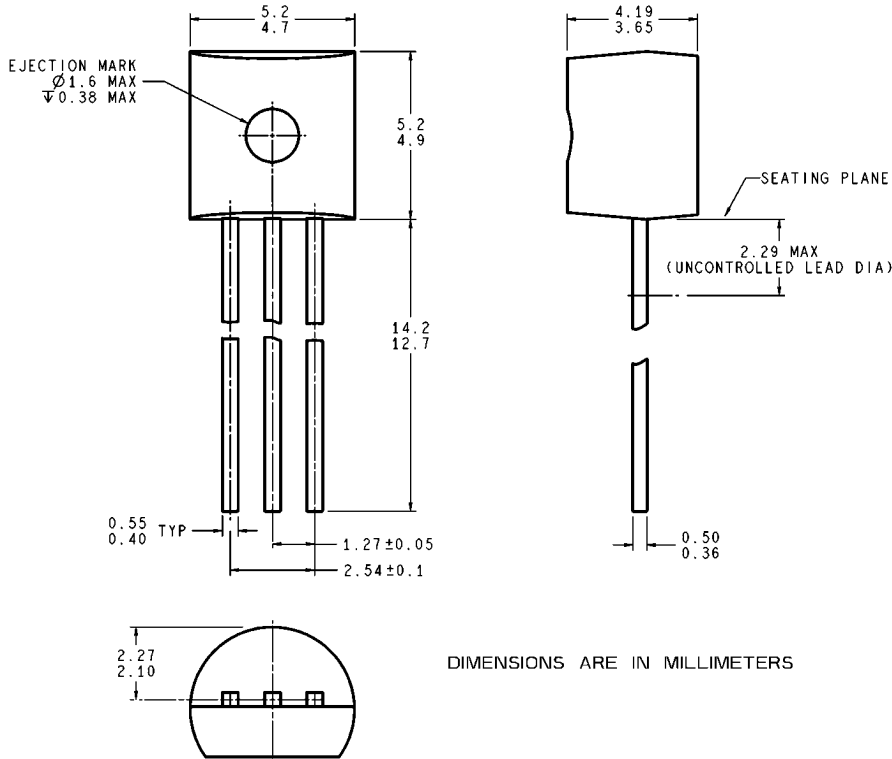
**TO-46 Metal Can Package (H)
 NS Package Number H03H**



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

M08A (Rev L)

SO Package (M)
NS Package Number M08A



DIMENSIONS ARE IN MILLIMETERS

Z03A (Rev G)

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

Notes

LM185/LM285/LM385

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:

Products		Design Support	
Amplifiers	www.national.com/amplifiers	WEBENCH	www.national.com/webench
Audio	www.national.com/audio	Analog University	www.national.com/AU
Clock Conditioners	www.national.com/timing	App Notes	www.national.com/appnotes
Data Converters	www.national.com/adc	Distributors	www.national.com/contacts
Displays	www.national.com/displays	Green Compliance	www.national.com/quality/green
Ethernet	www.national.com/ethernet	Packaging	www.national.com/packaging
Interface	www.national.com/interface	Quality and Reliability	www.national.com/quality
LVDS	www.national.com/lvds	Reference Designs	www.national.com/refdesigns
Power Management	www.national.com/power	Feedback	www.national.com/feedback
Switching Regulators	www.national.com/switchers		
LDOs	www.national.com/ldo		
LED Lighting	www.national.com/led		
PowerWise	www.national.com/powerwise		
Serial Digital Interface (SDI)	www.national.com/sdi		
Temperature Sensors	www.national.com/tempsensors		
Wireless (PLL/VCO)	www.national.com/wireless		

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

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.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2008 National Semiconductor Corporation

For the most current product information visit us at www.national.com



**National Semiconductor
Americas Technical
Support Center**
Email:
new.feedback@nsc.com
Tel: 1-800-272-9959

**National Semiconductor Europe
Technical Support Center**
Email: europe.support@nsc.com
German Tel: +49 (0) 180 5010 771
English Tel: +44 (0) 870 850 4288

**National Semiconductor Asia
Pacific Technical Support Center**
Email: ap.support@nsc.com

**National Semiconductor Japan
Technical Support Center**
Email: jpn.feedback@nsc.com