National Semiconductor

February 2000

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 10µA 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.

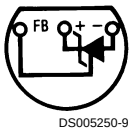
The LM185 is rated for operation over a −55˚C to 125˚C temperature range, while the LM285 is rated −40˚C to 85˚C and the LM385 0˚C to 70˚C. The LM185 is available in a hermetic TO-46 package and a leadless chip carrier package, while the LM285/LM385 are available in a low-cost TO-92 molded package, as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

Features

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

Connection Diagrams

TO-92
Plastic Package



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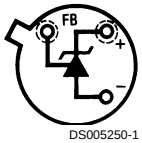
Bottom View

TO-46
Metal Can Package



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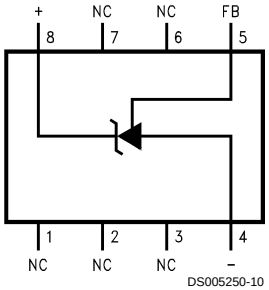
Bottom View

SOIC Package



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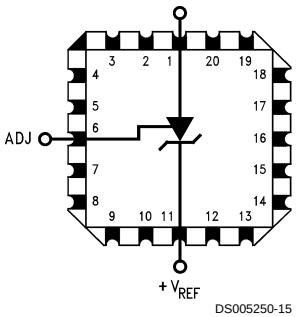
Top View

20-Leadless Chip Carrier



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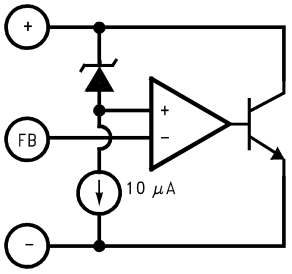
Top View

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	LM385BXZ	Z03A
		LM285BYZ	LM385BYZ	
		LM285Z	LM385BZ	
			LM385Z	
8-Pin SOIC		LM285M	LM385M	M08A
		LM285BYM	LM385BM	
20-Leadless Chip Carrier	LM185BE/883			E20A

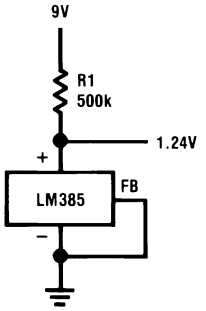
Block Diagram



DS005250-13

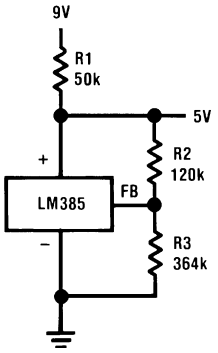
Typical Applications

1.2V Reference



DS005250-14

5.0V Reference



DS005250-2

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

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
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 = 100µA	1.240	1.252		1.265	**1.270**	1.240	1.252	**1.255**	1.265	**1.270**	V
			1.255									(max)
			1.228		1.215	**1.205**		1.228	**1.215**	1.215	**1.205**	V
			1.215									(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 = 100µA, $I_{AC} = 0.1\ I_R$, f = 100Hz											
	$V_{OUT} = V_{REF}$	0.3					0.4					Ω
	V_{OUT} = 5.3V	0.7					1					
Reference Voltage Change with Output Voltage	I_R = 100µA	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)	$V_{OUT} = V_{REF}$	6	9	**10**	9	**10**	7	11	**13**	11	**13**	µA
	V_{OUT} = 5.3V	30	45	**50**	45	**50**	35	55	**60**	55	**60**	(max)
Output Wideband Noise	I_R = 100µA, 10Hz < f < 10kHz											
	$V_{OUT} = V_{REF}$	50					50					μV_{rms}
	V_{OUT} = 5.3V	170					170					
Average Temperature Coefficient (Note 7)	I_R = 100µA, X Suffix		**30**					**30**				ppm/˚c
	Y Suffix		**50**					**50**				(max)
	All Others			**150**		**150**			**150**		**150**	
Long Term Stability	I_R = 100µA, T = 1000 Hr, T_A = 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, $T_J$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

Electrical Characteristics (Note 4) (Continued)

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 $V_{REF} < V_{OUT} < 5.3V$.

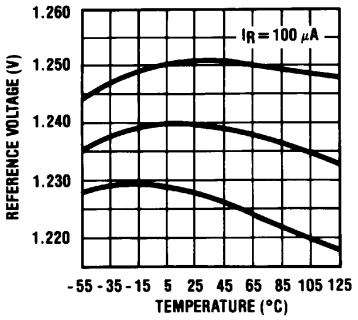
Note 5: Guaranteed and 100% production tested.

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.

Typical Performance Characteristics

Temperature Drift of 3 Representative Units



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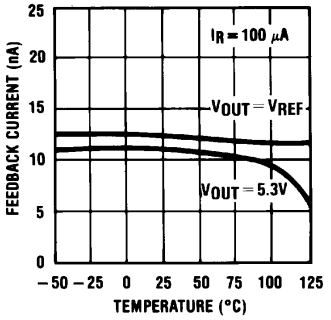
Feedback Current



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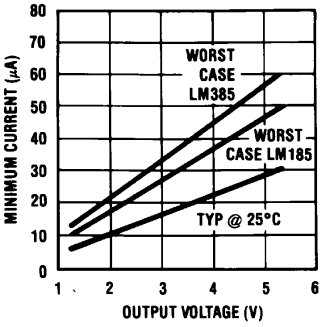
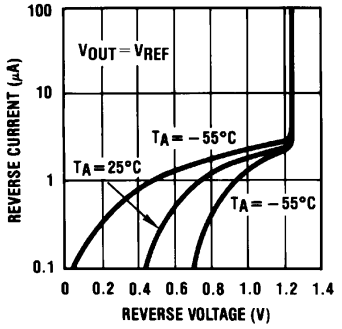
Minimum Operating Current



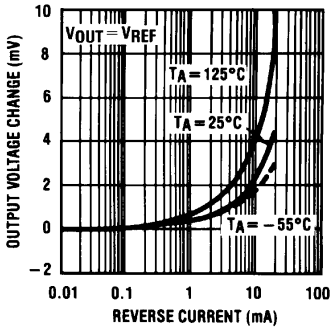
DS005250-18

Reverse Characteristics



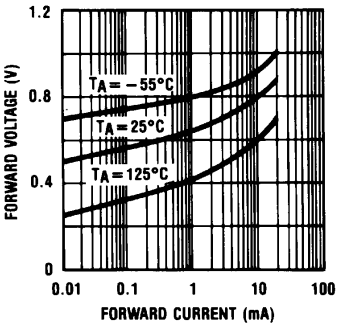
DS005250-19

Reverse Characteristics



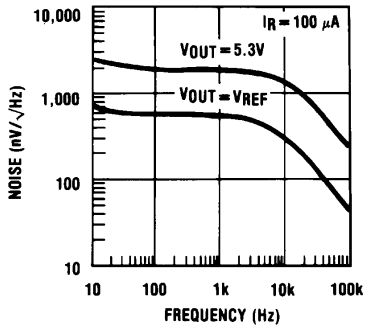
DS005250-20

Forward Characteristics



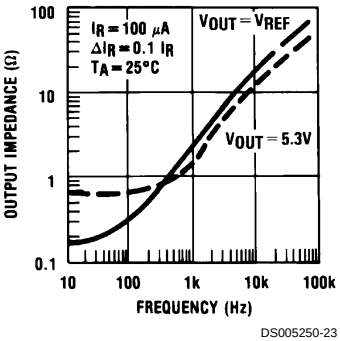
DS005250-21

Output Noise Voltage



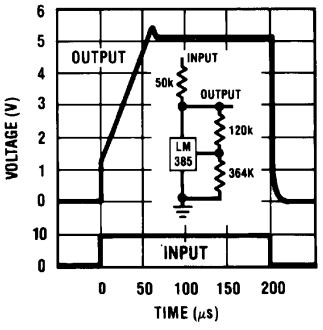
DS005250-22

Dynamic Output Impedance



DS005250-23

Response Time

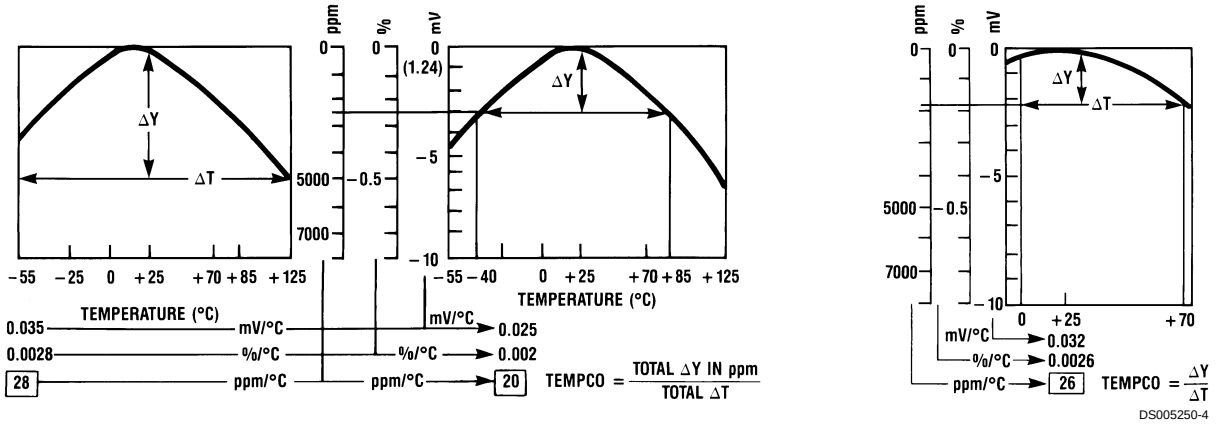


DS005250-24

Typical Performance Characteristics (Continued)

Temperature Coefficient Typical

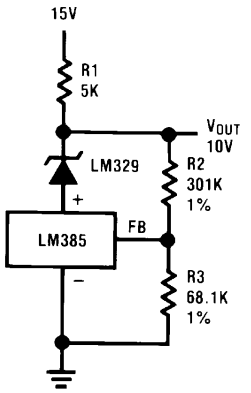
LM185 **LM285** **LM385**



DS005250-4

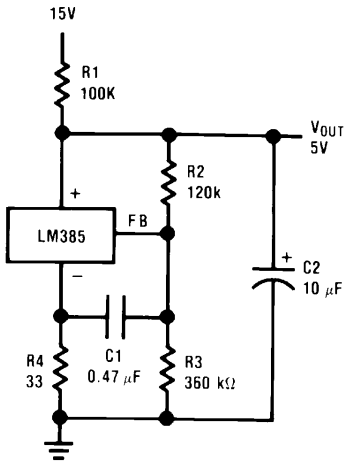
Typical Applications

Precision 10V Reference



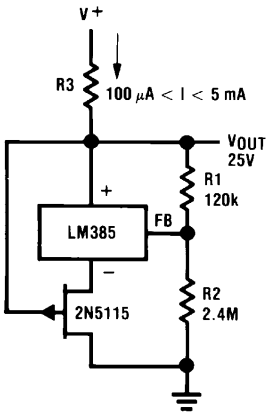
DS005250-25

Low AC Noise Reference



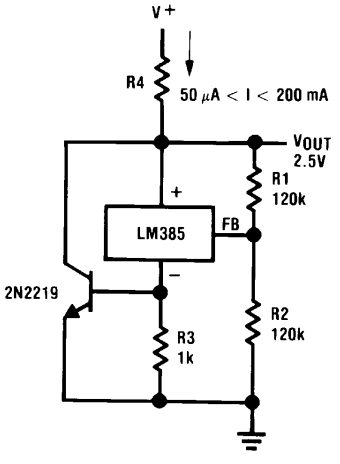
DS005250-26

25V Low Current Shunt Regulator



DS005250-27

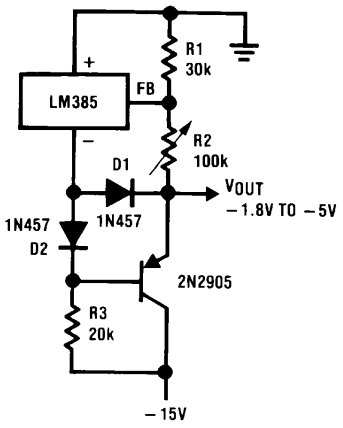
200 mA Shunt Regulator



DS005250-28

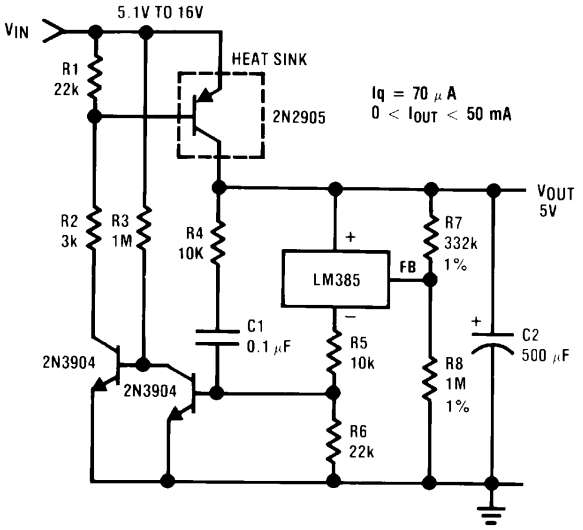
Typical Applications (Continued)

Series-Shunt 20 mA Regulator



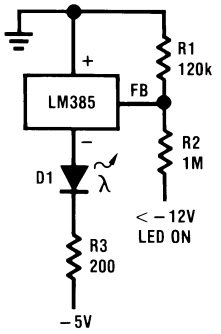
DS005250-29

High Efficiency Low Power Regulator



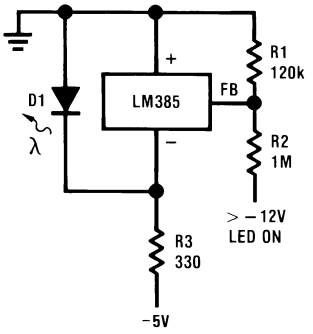
DS005250-30

Voltage Level Detector



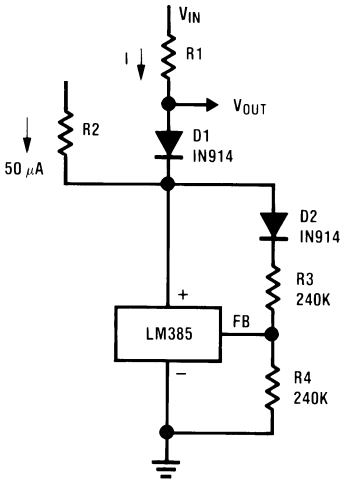
DS005250-31

Voltage Level Detector



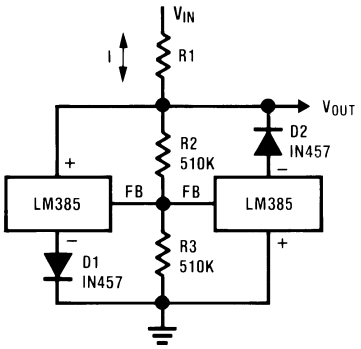
DS005250-32

Fast Positive Clamp
2.4V + ΔV_{D1}



DS005250-33

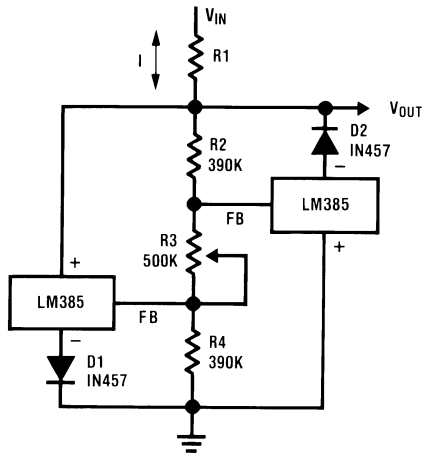
Bidirectional Clamp
±2.4V



DS005250-34

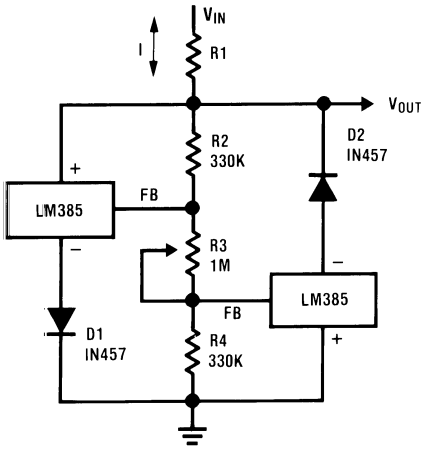
Typical Applications (Continued)

Bidirectional Adjustable Clamp
±1.8V to ±2.4V



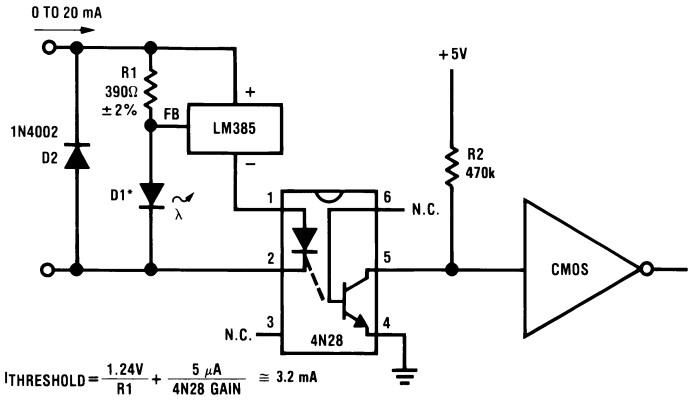
DS005250-35

Bidirectional Adjustable Clamp
±2.4V to ±6V



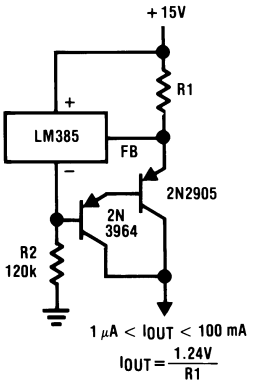
DS005250-36

Simple Floating Current Detector



DS005250-37

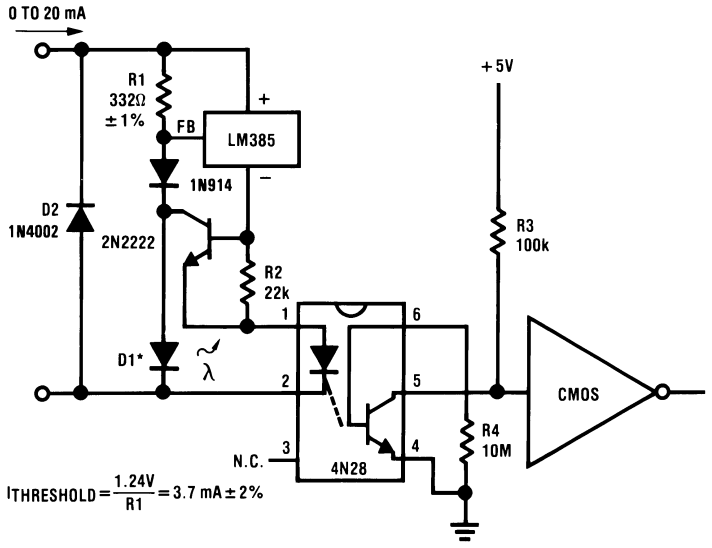
Current Source



DS005250-38

Typical Applications (Continued)

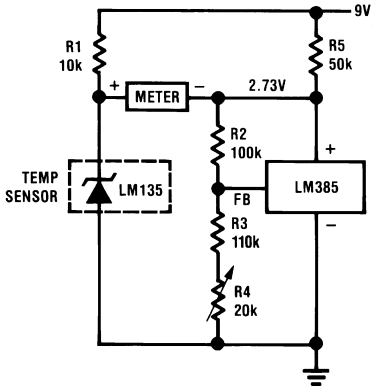
Precision Floating Current Detector



DS005250-39

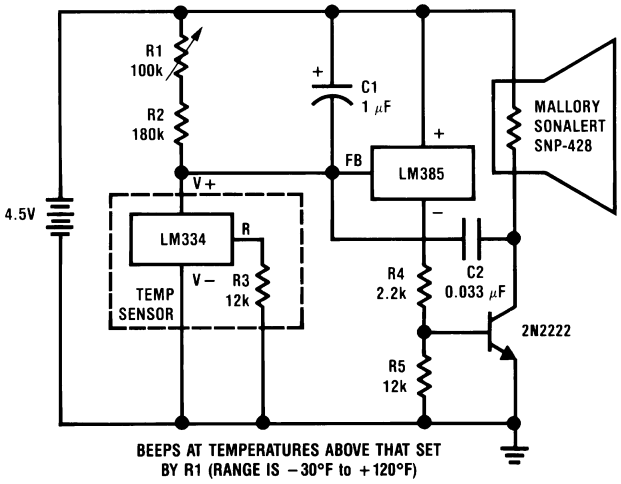
*D1 can be any LED, V_F=1.5V to 2.2V at 3 mA. D1 may act as an indicator. D1 will be on if $I_{THRESHOLD}$ falls below the threshold current, except with I=O.

Centigrade Thermometer, 10mV/°C



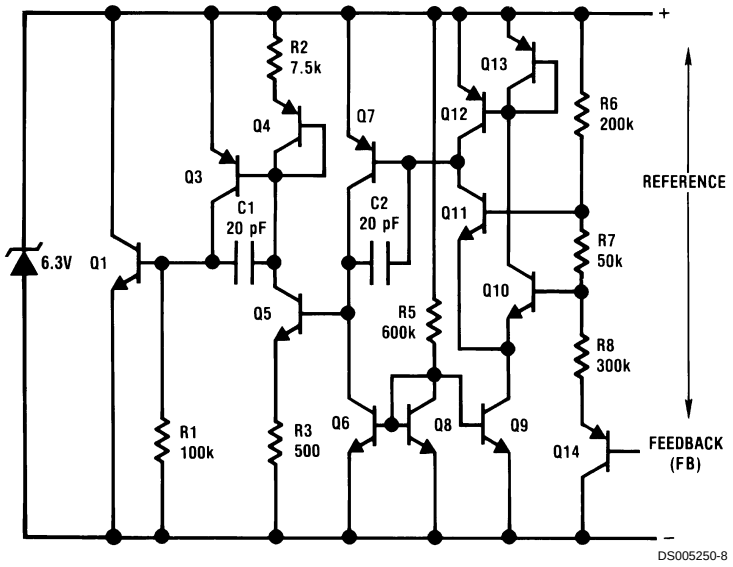
DS005250-11

Freezer Alarm

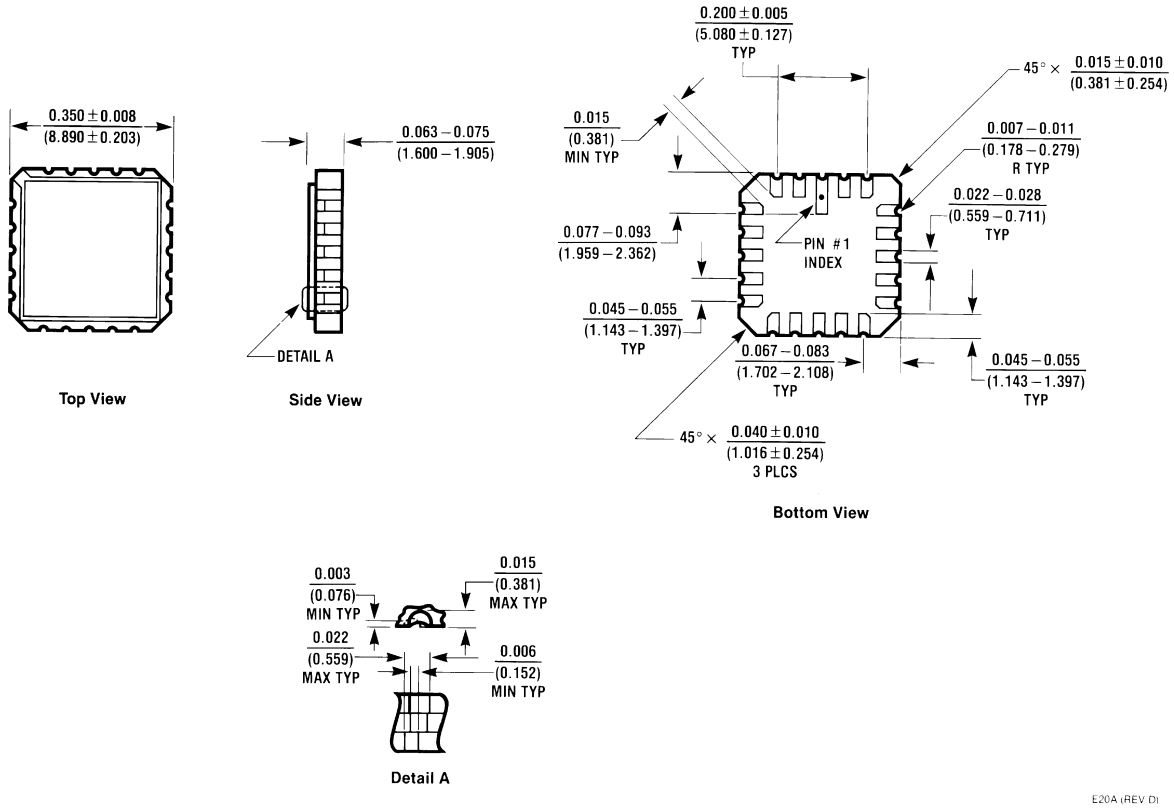


DS005250-12

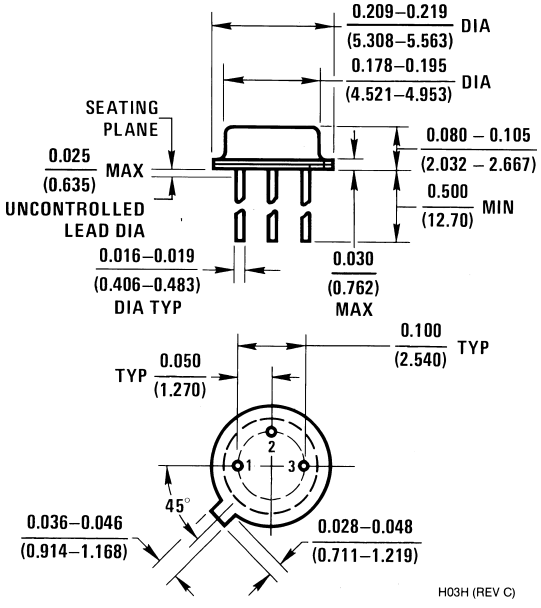
Schematic Diagram



Physical Dimensions inches (millimeters) unless otherwise noted

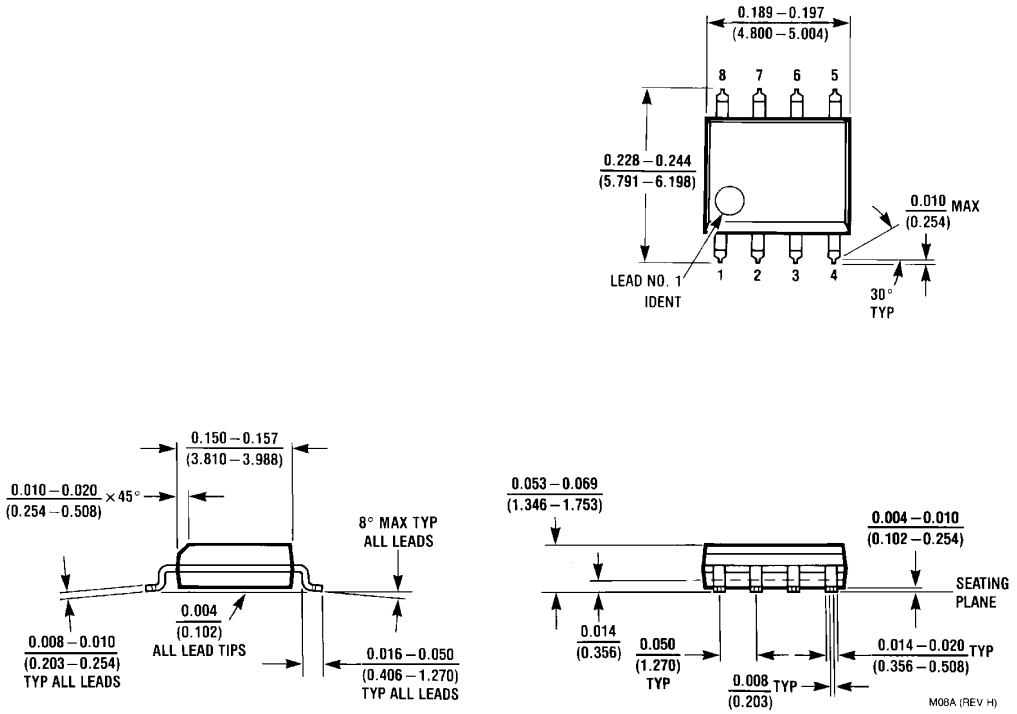


20-Leadless Chip Carrier (E)
NS Package Number E20A

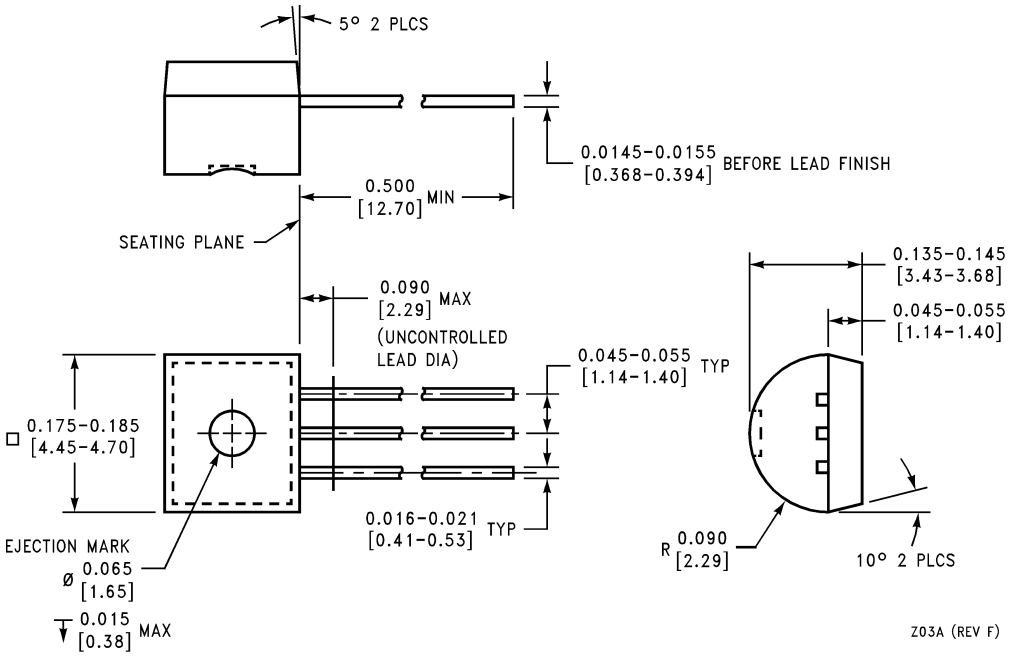


TO-46 Metal Can Package (H)
NS Package Number H03H

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



SO Package (M)
NS Package Number M08A



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

Notes

LIFE SUPPORT POLICY

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2. A critical component is any component of 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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