



June 1999

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 20 mA 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.

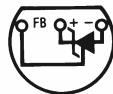
The LM185 is rated for operation over a -55°C to 125°C temperature range, while the LM285 is rated -40°C to 85°C and the LM385 0°C to 70°C . The LM185 is available in a hermetic TO-46 package and a leadless chip carrier package, while the LM285/LM385 are available in a low-cost TO-92 molded package,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

Features

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

Connection Diagrams

TO-92
Plastic Package

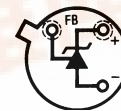


DS005250-9

Bottom View

Order Number LM285BXZ, LM285BYZ, LM285Z,
LM385BXZ, LM385BYZ, LM385BZ or LM385Z
See NS Package Number Z03A

TO-46
Metal Can Package

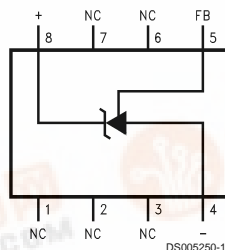


DS005250-1

Bottom View

Order Number LM185BH, LM185BH/883, LM185BYH or
LM185BYH/883
See NS Package Number H03H

SO Package



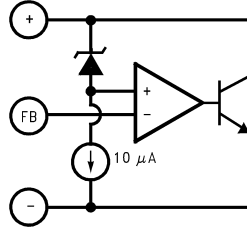
DS005250-10

Order Number LM285M, LM285BYM, LM385BM or LM385M
See NS Package Number M08A

LM185/285/385 Adjustable Micropower Voltage Reference



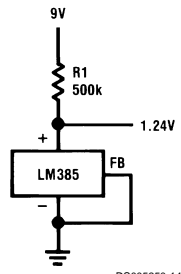
Block Diagram



DS005250-13

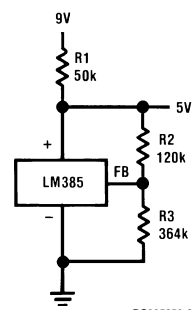
Typical Applications

1.2V Reference



DS005250-14

5.0V Reference



DS005250-2

$$V_{OUT} = 1.24 \left(\frac{R_3}{R_2} + 1 \right)$$

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	30 mA
Forward Current	10 mA
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		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 Change with Current	$I_{MIN} < I_R < 1 \text{ mA}$ $1 \text{ mA} < I_R < 20 \text{ mA}$	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	$I_R = 100 \mu A$, $f = 100 \text{ Hz}$ $I_{AC} = 0.1 I_R$ $V_{OUT} = V_{REF}$ $V_{OUT} = 5.3V$	0.3 0.7					0.4 1					Ω
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	μA (max)
Output Wideband Noise	$I_R = 100 \mu A$, $10 \text{ Hz} < f < 10 \text{ kHz}$ $V_{OUT} = V_{REF}$ $V_{OUT} = 5.3V$	50 170					50 170					μV_{rms}
Average Temperature Coefficient (Note 7)	$I_R = 100 \mu A$ X Suffix Y Suffix All Others		30 50			150		30 50			150	ppm/°C (max)
Long Term Stability	$I_R = 100 \mu A$, $T = 1000 \text{ Hr}$, $T_A = 25^\circ C \pm 0.1^\circ C$	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
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 $T_A = T_J = 25^\circ\text{C}$. Unless otherwise specified, all parameters apply for $V_{\text{REF}} < V_{\text{OUT}} < 5.3\text{V}$.

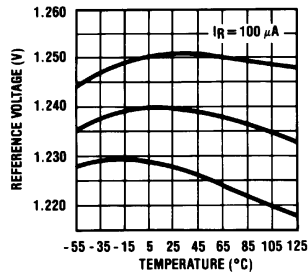
Note 5: Guaranteed and 100% production tested.

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

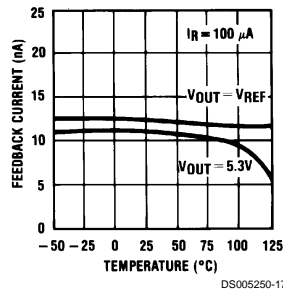
Note 7: The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures from T_{min} to T_{max} , divided by $T_{\text{max}} - T_{\text{min}}$. The measured temperatures are $-55, -40, 0, 25, 70, 85, 125^\circ\text{C}$.

Typical Performance Characteristics

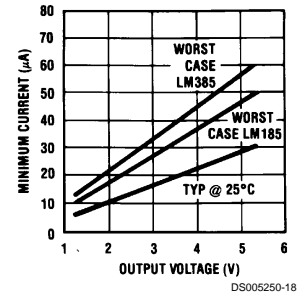
Temperature Drift of 3 Representative Units



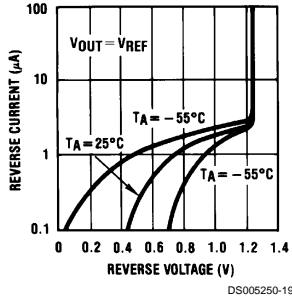
Feedback Current



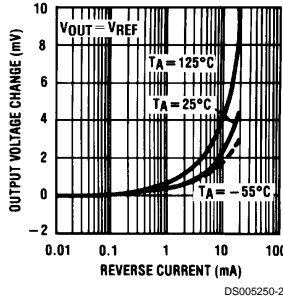
Minimum Operating Current



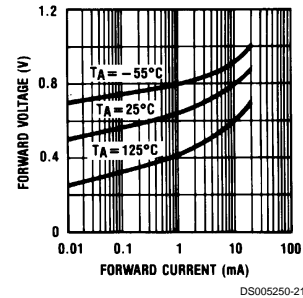
Reverse Characteristics



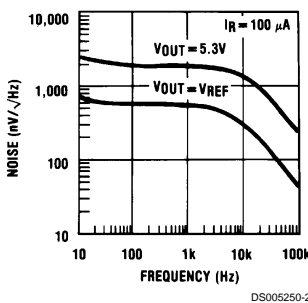
Reverse Characteristics



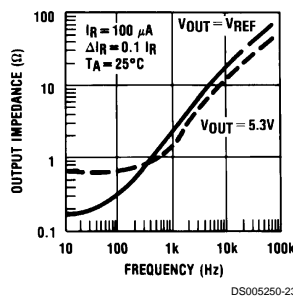
Forward Characteristics



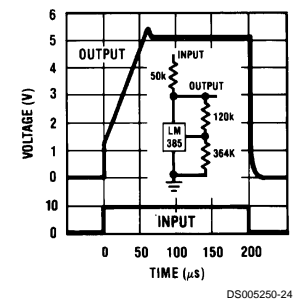
Output Noise Voltage



Dynamic Output Impedance

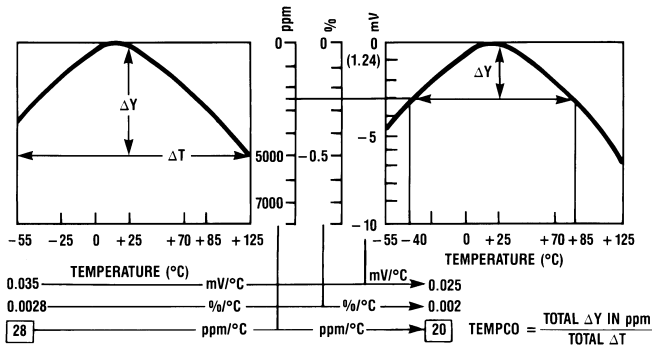


Response Time



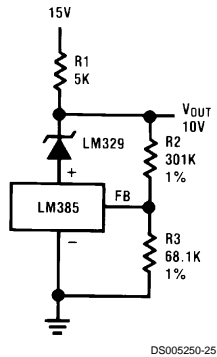
Typical Performance Characteristics (Continued)

Temperature Coefficient Typical
LM185

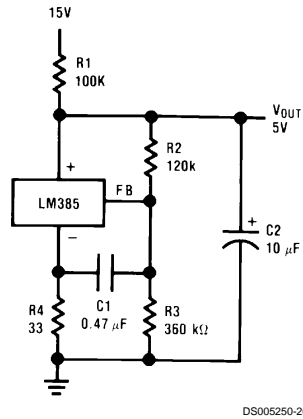


Typical Applications

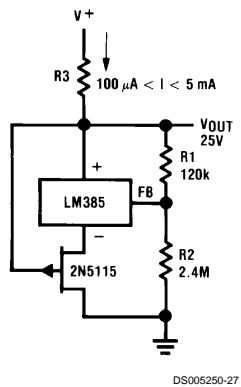
Precision 10V Reference



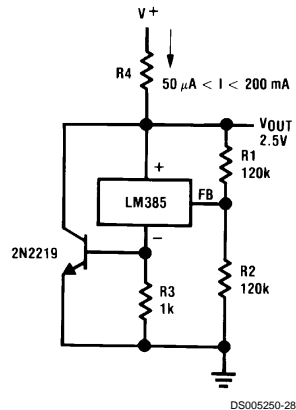
Low AC Noise Reference



25V Low Current Shunt Regulator

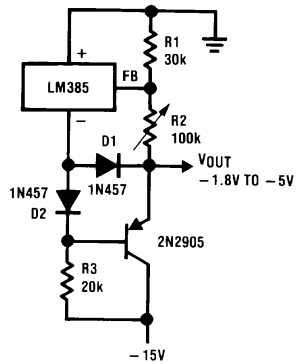


200 mA Shunt Regulator



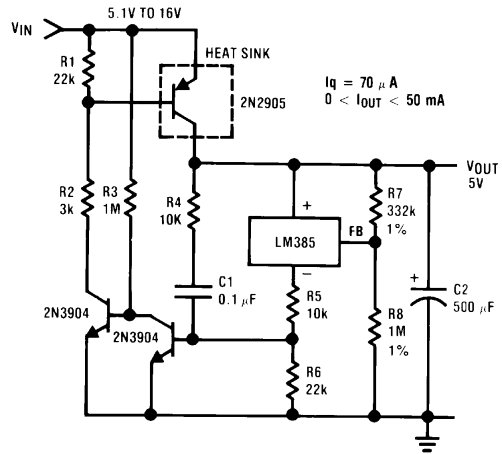
Typical Applications (Continued)

Series-Shunt 20 mA Regulator



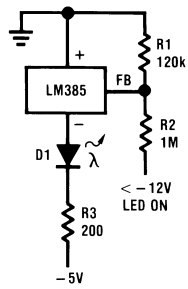
DS005250-29

High Efficiency Low Power Regulator



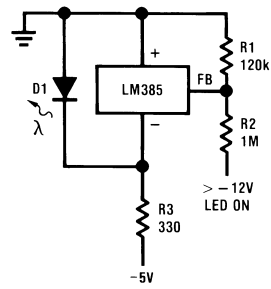
DS005250-30

Voltage Level Detector



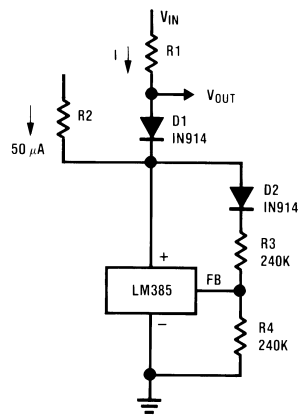
DS005250-31

Voltage Level Detector



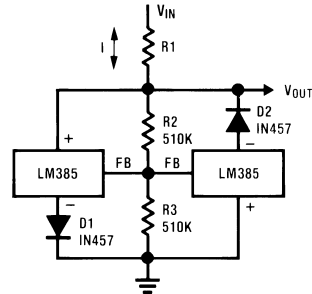
DS005250-32

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



DS005250-33

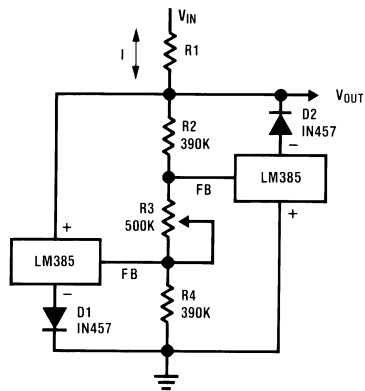
Bidirectional Clamp
 $\pm 2.4V$



DS005250-34

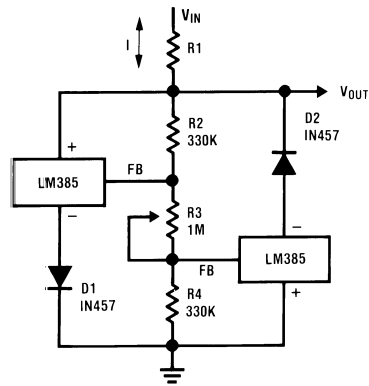
Typical Applications (Continued)

Bidirectional Adjustable Clamp
±1.8V to ±2.4V



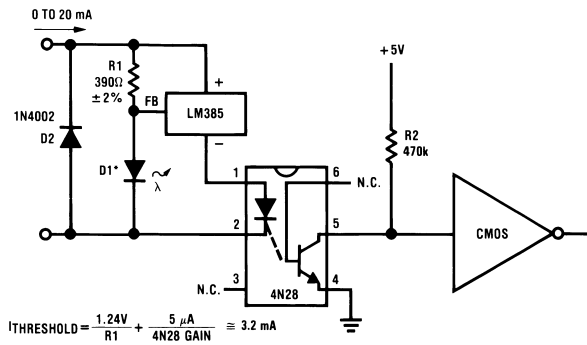
DS005250-35

Bidirectional Adjustable Clamp
±2.4V to ±6V



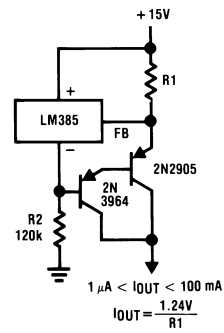
DS005250-36

Simple Floating Current Detector



DS005250-37

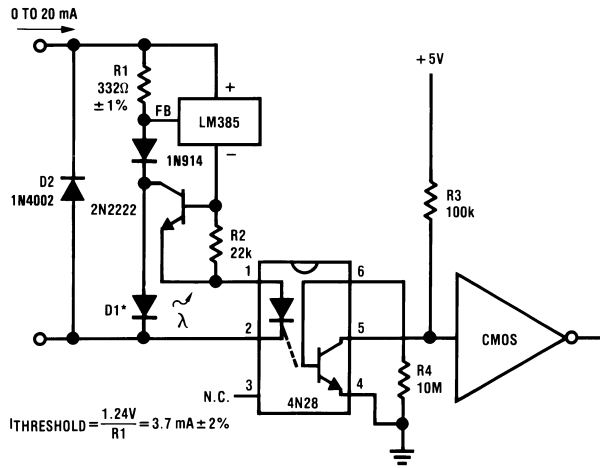
Current Source



DS005250-38

Typical Applications (Continued)

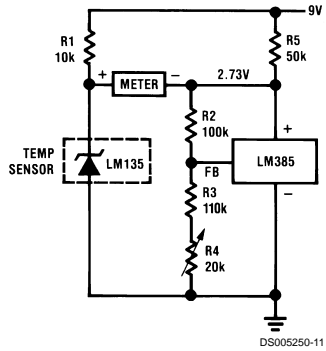
Precision Floating Current Detector



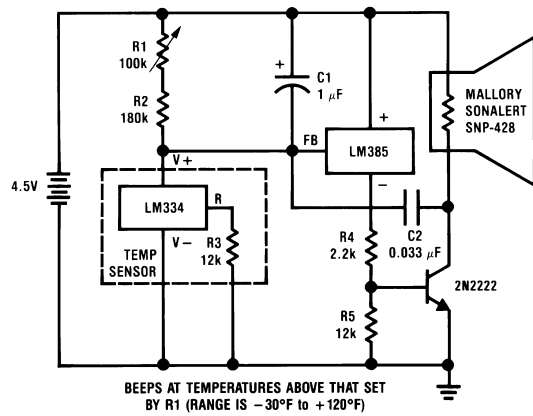
DS005250-39

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

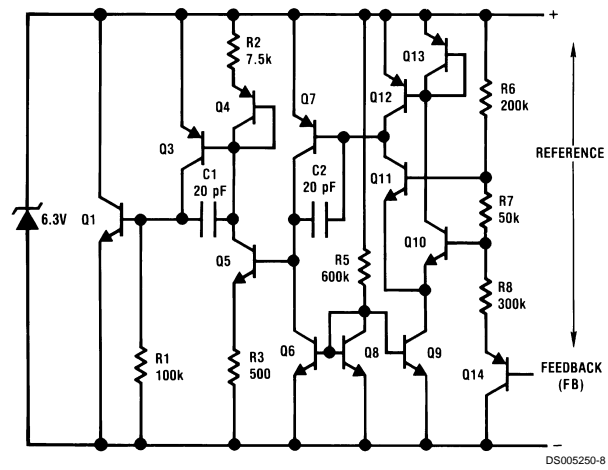
Centigrade Thermometer, 10 mV/°C



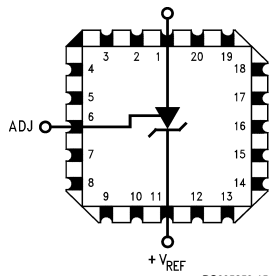
Freezer Alarm



Schematic Diagram

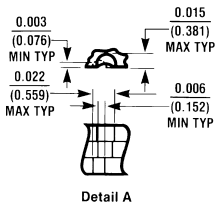
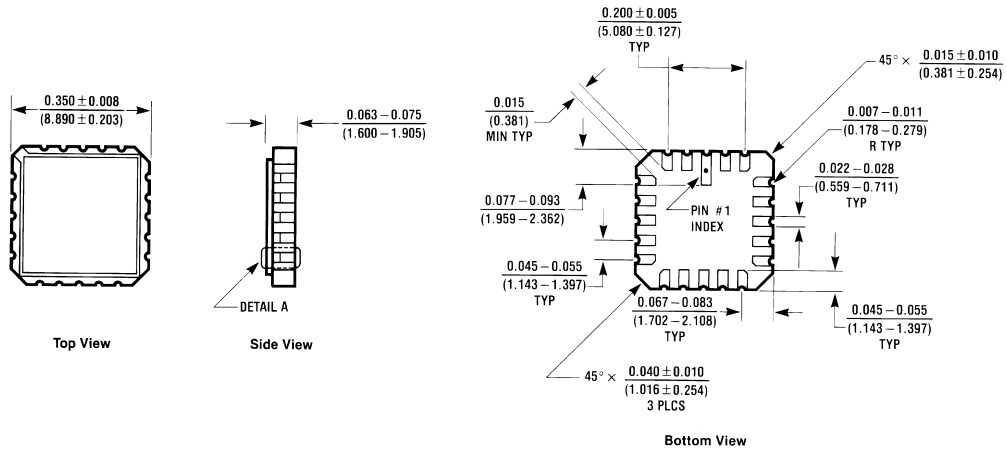


Connection Diagrams



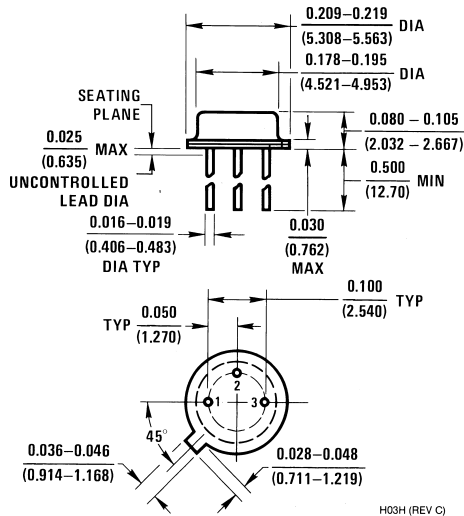
Order Number LM185BE/883
See NS Package Number E20A

Physical Dimensions inches (millimeters) unless otherwise noted



E20A (REV D)

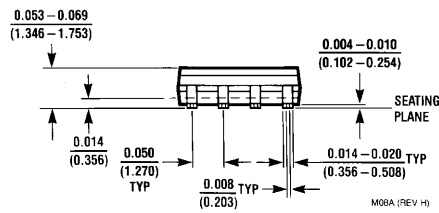
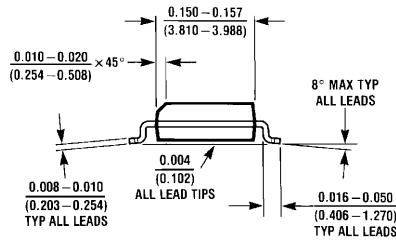
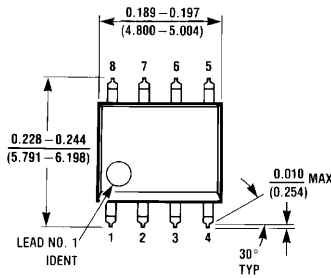
20-Leadless Chip Carrier (E)
Order Number LM185BE/883
NS Package Number E20A



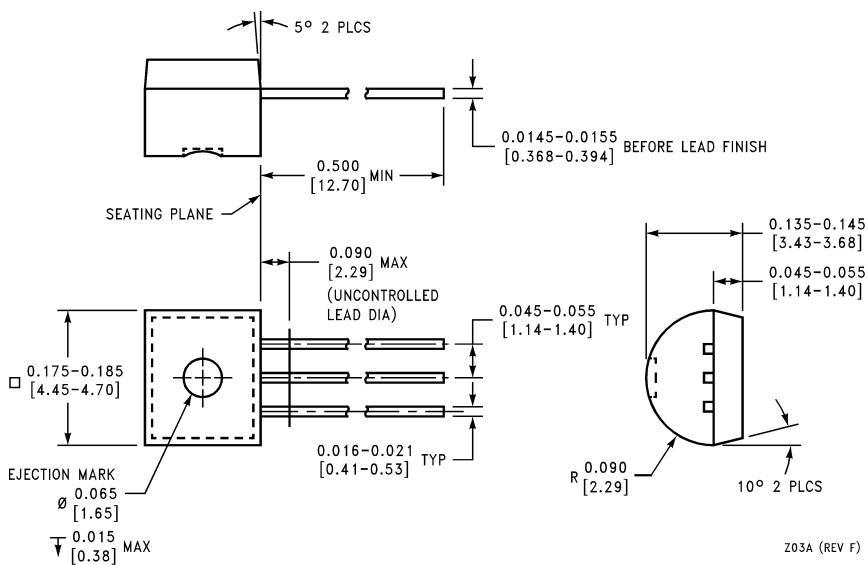
H03H (REV C)

TO-46 Metal Can Package (H)
Order Number LM185BH, LM185BH/883,
LM185BYH or LM185BYH/883
NS Package Number H03H

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



SO Package (M)
Order Number LM285M, LM285BYM, LM385BM or LM385M
NS Package Number M08A



TO-92 Plastic Package (Z)
Order Number LM385BZ, LM385Z, LM385BXZ, LM385BYZ, LM285Z, LM285BXZ or LM285BYZ
NS Package Number Z03A

Notes

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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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