National Semiconductor

December 1994

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 μA 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.

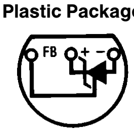
The LM185 is rated for operation over a −55°C to 125°C temperature range, while the LM285 is rated −40°C to 85°C and the LM385 0°C to 70°C. The LM185 is available in a hermetic TO-46 package and a leadless chip carrier package, while the LM285/LM385 are available in a low-cost TO-92 molded package, as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

Features

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

Connection Diagrams

TO-92
Plastic Package

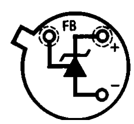


TL/H/5250–9

Bottom View

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

TO-46
Metal Can Package

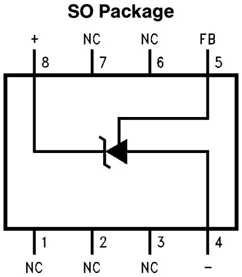


TL/H/5250–1

Bottom View

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

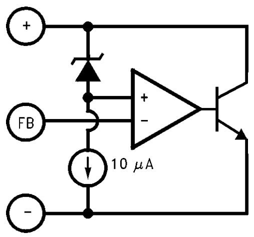
SO Package



TL/H/5250–10

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

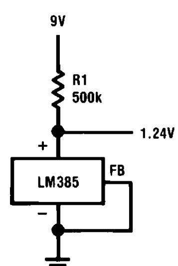
Block Diagram



TL/H/5250–13

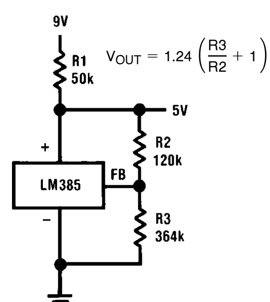
Typical Applications

1.2V Reference



TL/H/5250–14

5.0V Reference



TL/H/5250–2

©1995 National Semiconductor Corporation TL/H/5250 RRD-B30M115/Printed in U. S. A.

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 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 μA	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 mA 1 mA < I_R < 20 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 μA, f = 100 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 μA	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 μA, 10 Hz < f < 10 kHz V_{OUT} = V_{REF} V_{OUT} = 5.3V	 50 170					 50 170					μV_{rms}
Average Temperature Coefficient (Note 7)	I_R = 100 μA X Suffix Y Suffix All Others		**30** **50**	 **150**	**30** **50**	 **150**		**30** **50**	 **150**	**30** **50**	 **150**	ppm/°c (max)
Long Term Stability	I_R = 100 μA, 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

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

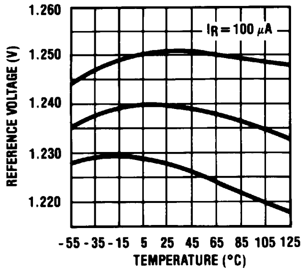
Note 5: Guaranteed and 100% production tested.

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

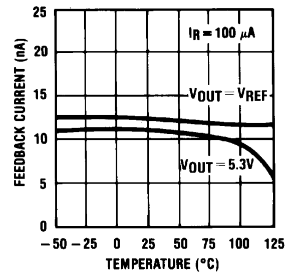
Note 7: The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures from T_{min} to T_{max}, divided by T_{max} − T_{min}. The measured temperatures are −55, −40, 0, 25, 70, 85, 125°C.

Typical Performance Characteristics

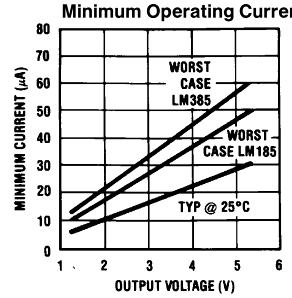
Temperature Drift of 3 Representative Units



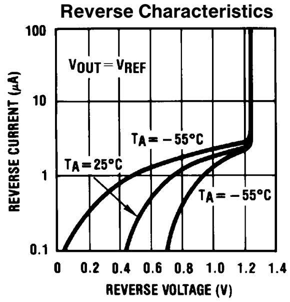
Feedback Current



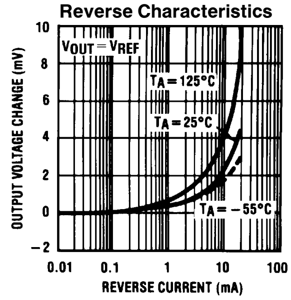
Minimum Operating Current



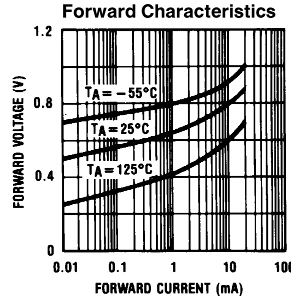
Reverse Characteristics



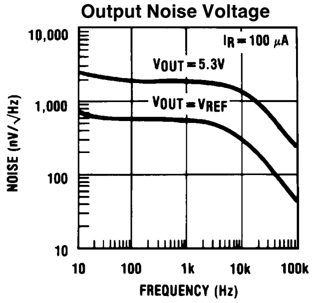
Reverse Characteristics



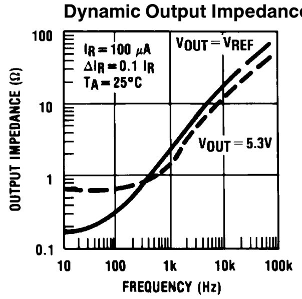
Forward Characteristics



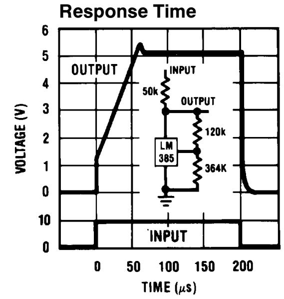
Output Noise Voltage



Dynamic Output Impedance



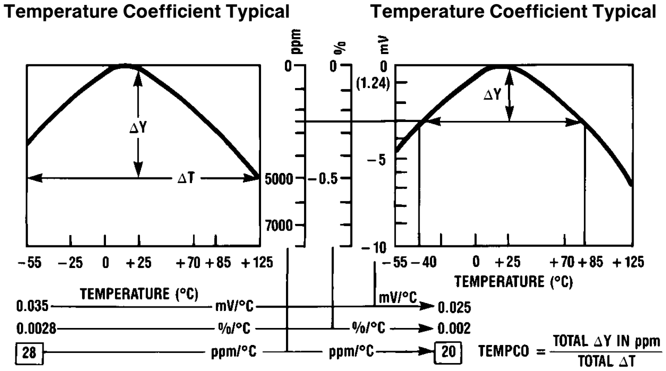
Response Time



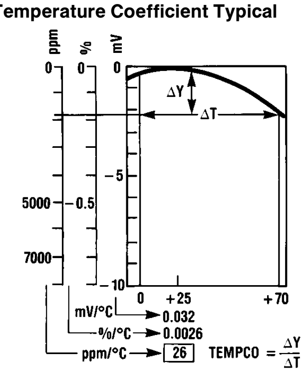
TL/H/5250–3

LM185 Temperature Coefficient Typical

LM285 Temperature Coefficient Typical



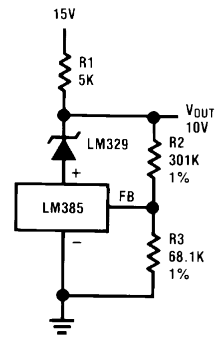
LM385 Temperature Coefficient Typical



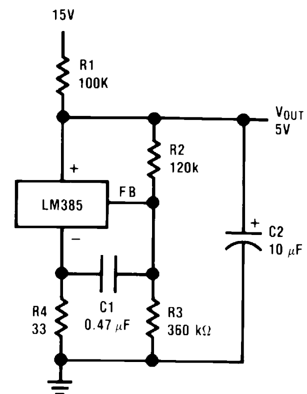
TL/H/5250–4

Typical Applications (Continued)

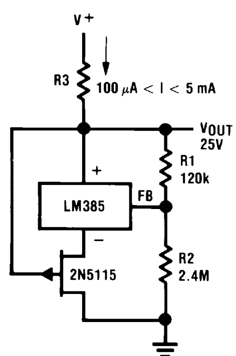
Precision 10V Reference



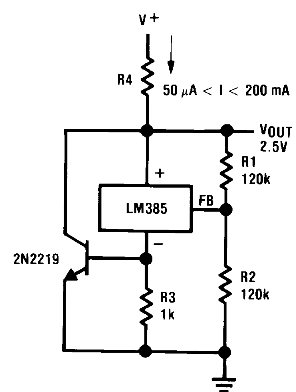
Low AC Noise Reference



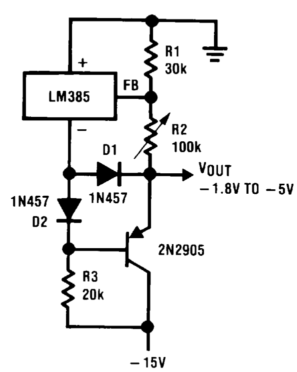
25V Low Current Shunt Regulator



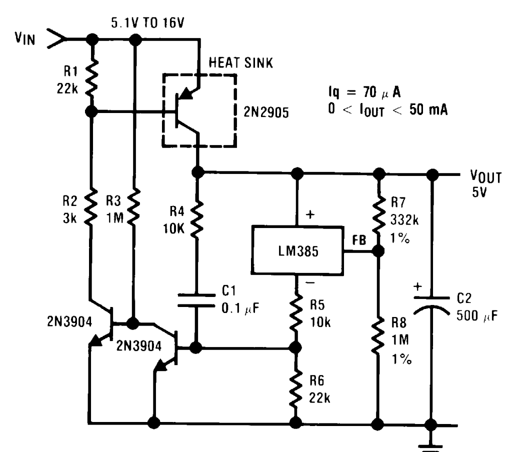
200 mA Shunt Regulator



Series-Shunt 20 mA Regulator



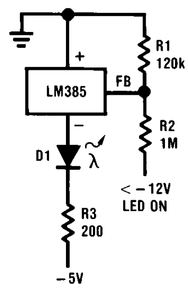
High Efficiency Low Power Regulator



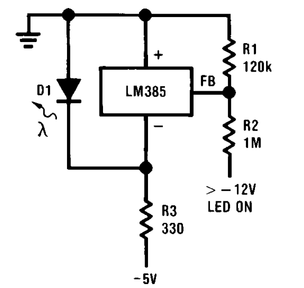
TL/H/5250–5

Typical Applications (Continued)

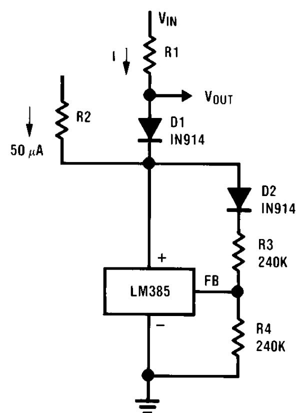
Voltage Level Detector



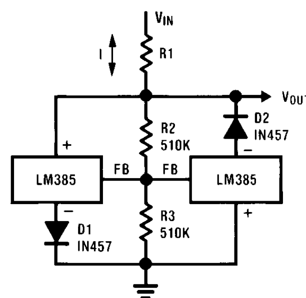
Voltage Level Detector



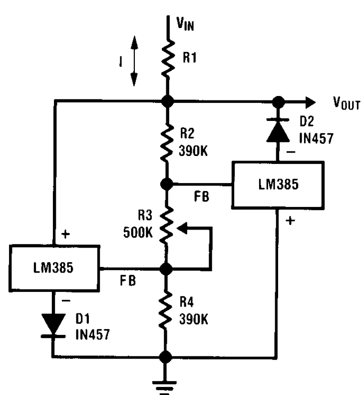
Fast Positive Clamp
2.4V + ΔV_{D1}



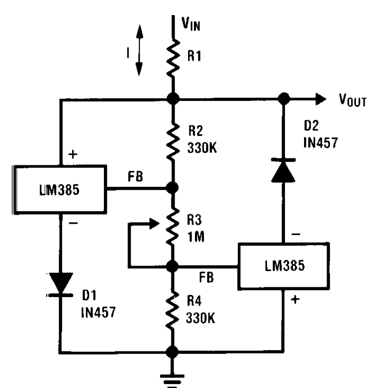
Bidirectional Clamp
±2.4V



Bidirectional Adjustable Clamp
±1.8V to ±2.4V



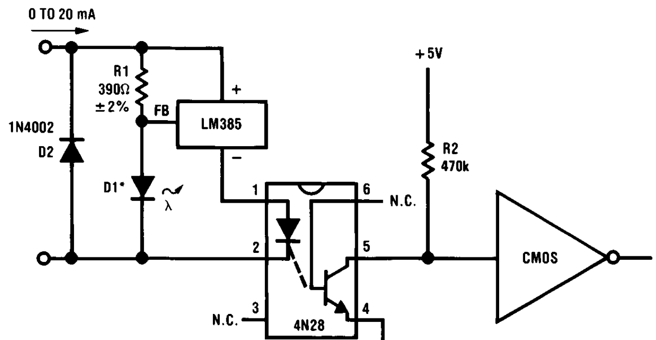
Bidirectional Adjustable Clamp
±2.4V to ±6V



TL/H/5250–6

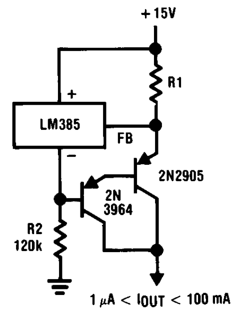
Typical Applications (Continued)

Simple Floating Current Detector



$$I_{THRESHOLD} = \frac{1.24V}{R1} + \frac{5\ \mu A}{4N28\ GAIN} \cong 3.2\ mA$$

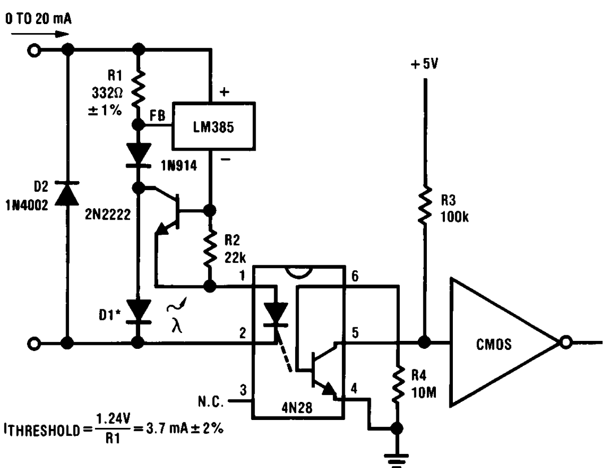
Current Source



$1\ \mu A < I_{OUT} < 100\ mA$

$$I_{OUT} = \frac{1.24V}{R1}$$

Precision Floating Current Detector



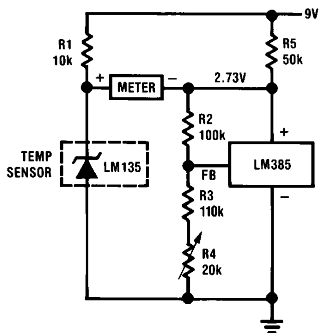
$$I_{THRESHOLD} = \frac{1.24V}{R1} = 3.7\ mA \pm 2\%$$

TL/H/5250–7

* 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.

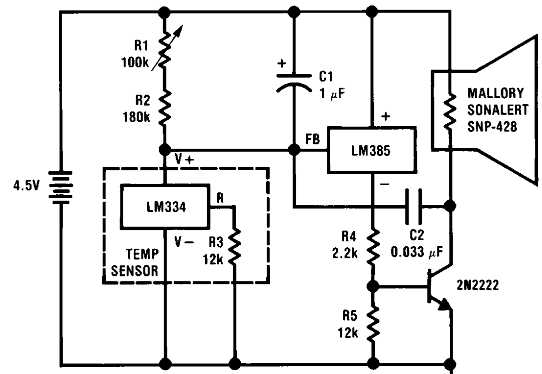
Typical Applications (Continued)

Centigrade Thermometer, 10 mV/°C



TL/H/5250–11

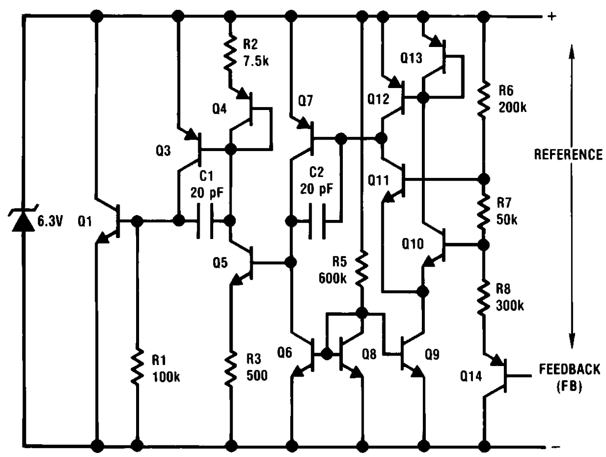
Freezer Alarm



BEEPS AT TEMPERATURES ABOVE THAT SET BY R1 (RANGE IS −30°F to +120°F)

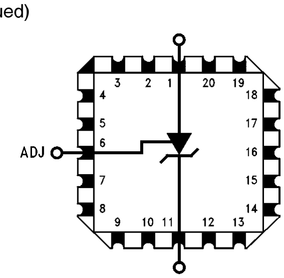
TL/H/5250–12

Schematic Diagram



TL/H/5250–8

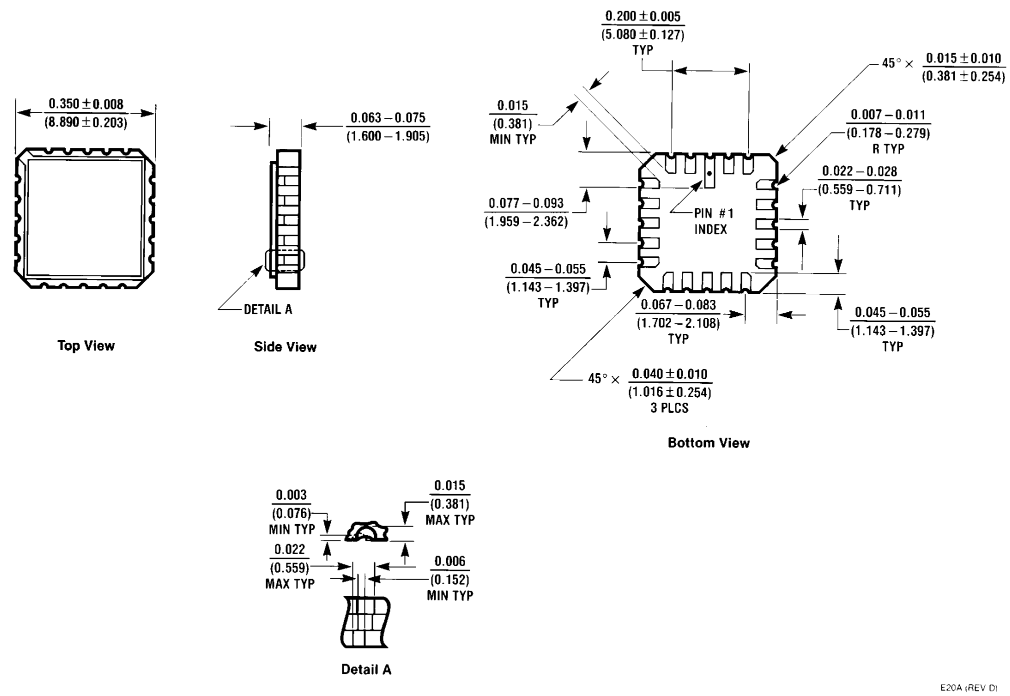
Connection Diagrams (Continued)



TL/H/5250–15

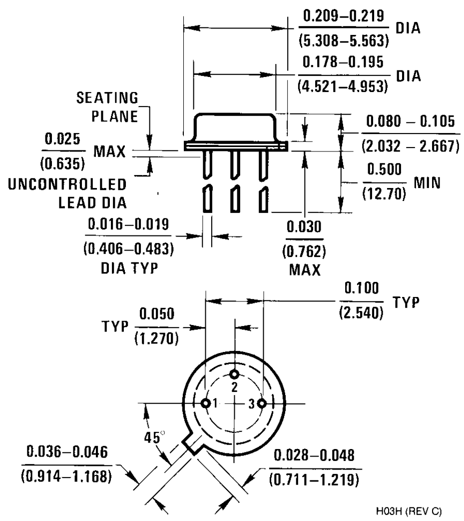
Order Number LM185BE/883
See NS Package Number E20A

Physical Dimensions inches (millimeters)

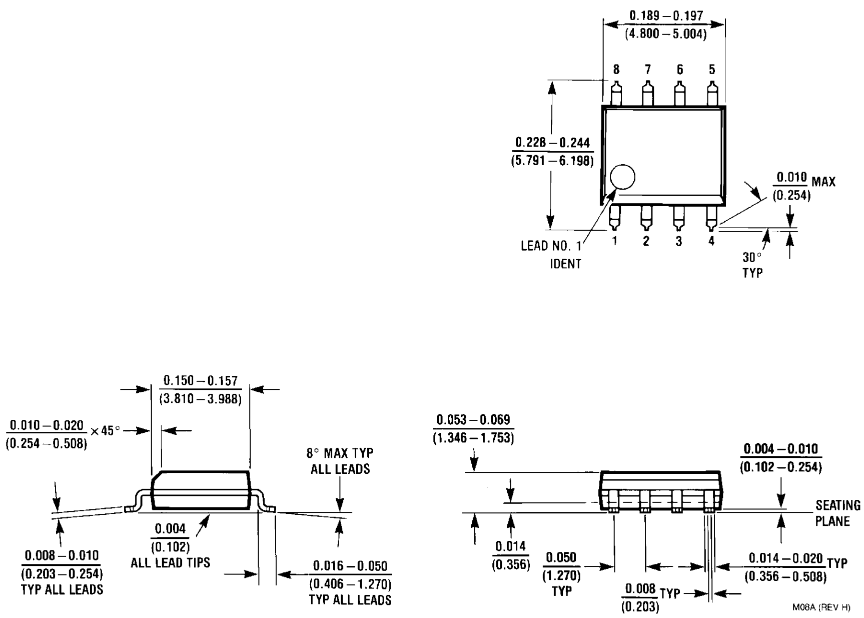


20-Leadless Chip Carrier (E)
Order Number LM185BE/883
NS Package Number E20A

Physical Dimensions inches (millimeters) (Continued)

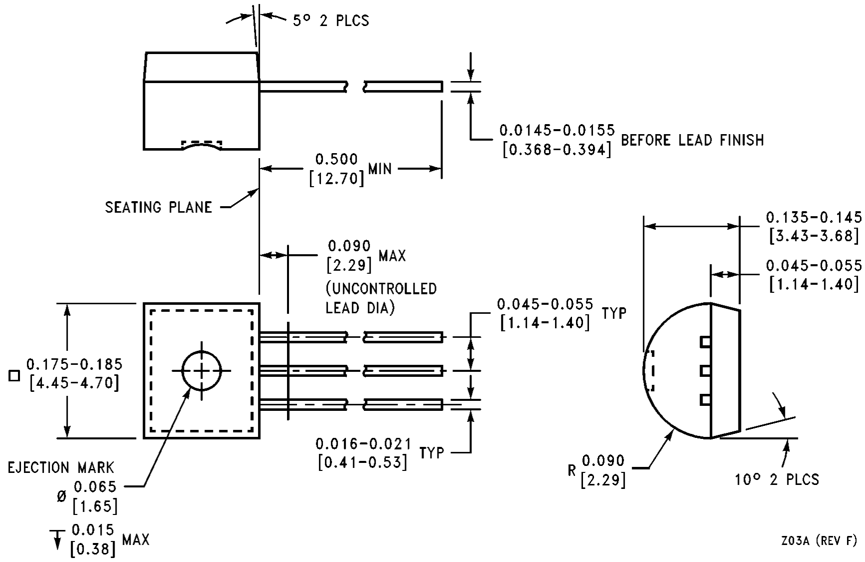


TO-46 Metal Can Package (H)
Order Number LM185BH, LM185BH/883,
LM185BYH or LM185BYH/883
NS Package Number H03H



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

Physical Dimensions inches (millimeters) (Continued)



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

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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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