National Semiconductor

April 2006

LM185QML
Adjustable Micropower Voltage References

General Description

The LM185 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.

Features

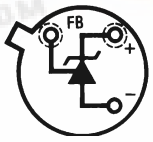
- Adjustable from 1.24V to 5.30V
- Operating current of 10μA to 20mA
- 1Ω dynamic impedance
- Low temperature coefficient

Ordering Information

NS Part Number	SMD Part Number	NS Package Number	Package Description
LM185BE/883		E20A	20LD Leadless Chip Carrier
LM185BH/883		H03H	3LD; T0–46 Metal Can
LM185BYH/883		H03H	3LD; T0–46 Metal Can
LM185BYH-SMD	5962–9091401MXA	H03H	3LD; T0–46 Metal Can
LM185BWG/883	5962–9091402QYA	WG10A	10LD Ceramic SOIC

Connection Diagrams

TO-46
Metal Can Package



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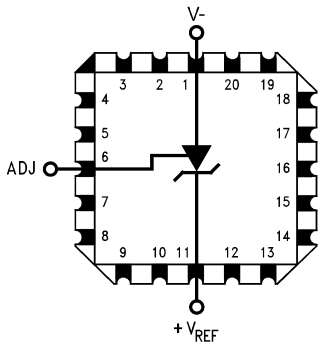
Bottom View

Connection Diagrams (Continued)

20-Leadless Chip Carrier



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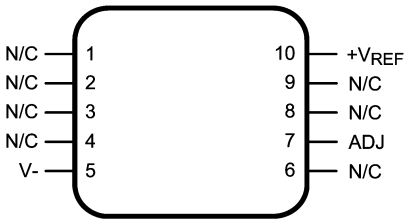
Top View

10-Lead Ceramic SOIC



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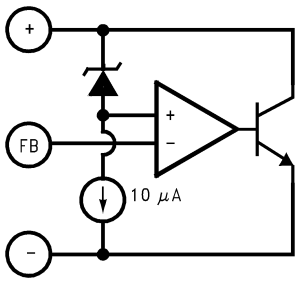
Top View

Block Diagram



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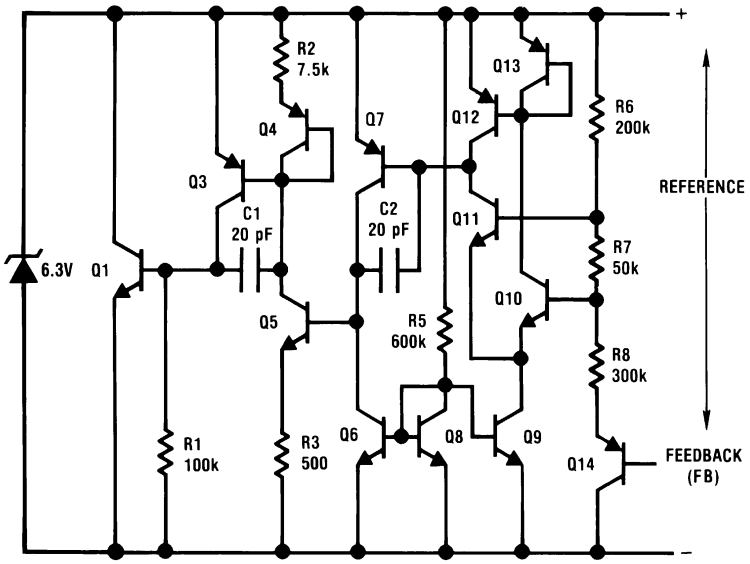
Schematic Diagram



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Absolute Maximum Ratings (Note 1)

Reverse Current	30mA
Forward Current	10mA
Operating Temperature Range	$-55^{\circ}C \le T_A \le 125^{\circ}C$
Storage Temperature	$-55^{\circ}C \le T_A \le 150^{\circ}C$
Maximum Junction Temperature T_{Jmax}	150˚C
Lead Temperature (soldering, 10 seconds)	300˚C
Thermal Resistance	
θ_{JA}	
LCC Package (Still Air)	100˚C/W
LCC Package (500LF/Min Air flow)	73˚C/W
Metal Can Package (Still Air)	300˚C/W
Metal Can Package (500LF/Min Air flow)	139˚C/W
Ceramic SOIC Package (Still Air)	194˚C/W
Ceramic SOIC Package (500LF/Min Air flow)	128˚C/W
θ_{JC}	
LCC Package	25˚C/W
Metal Can Package	57˚C/W
Ceramic SOIC Package	23˚C/W
Package Weight (Typical)	
LCC Package	TBD
Metal Can Package	TBD
Ceramic SOIC Package	210mg
ESD Tolerance (Note 2)	500V

Quality Conformance Inspection

Mil-Std-883, Method 5005 - Group A

Subgroup	Description	Temp ˚C
1	Static tests at	25
2	Static tests at	125
3	Static tests at	-55
4	Dynamic tests at	25
5	Dynamic tests at	125
6	Dynamic tests at	-55
7	Functional tests at	25
8A	Functional tests at	125
8B	Functional tests at	-55
9	Switching tests at	25
10	Switching tests at	125
11	Switching tests at	-55
12	Settling time at	25
13	Settling time at	125
14	Settling time at	-55

LM185B Electrical Characteristics
DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Ref}	Reference Voltage	I_R = 100µA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		I_R = 9µA		1.228	1.252	V	1
		I_R = 10µA		1.215	1.255	V	2, 3
		I_R = 1mA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		I_R = 20mA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 100µA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 45µA		1.288	1.252	V	1
		V_R = 5.3V, I_R = 50µA		1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 1.0mA		1.288	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 20mA		1.288	1.252	V	1
				1.215	1.255	V	2, 3
$\Delta V_{Ref}/\Delta I_R$	Reference Voltage Change with Current	9µA ≤ I_R ≤ 1mA			1.0	mV	1
		10µA ≤ I_R ≤ 1mA			1.5	mV	2, 3
		1mA ≤ I_R ≤ 20mA			10	mV	1
					20	mV	2, 3
		V_R = 5.3V, 45µA ≤ I_R ≤ 1mA			1.0	mV	1
		V_R = 5.3V, 50µA ≤ I_R ≤ 1mA			1.5	mV	2, 3
		V_R = 5.3V, 1mA ≤ I_R ≤ 20mA			10	mV	1
					20	mV	2, 3
ΔV_{Ref} / ΔV_O	Reference Voltage Change with Output Voltage	V_R = 5.3V, I_R = 100µA			3.0	mV	1
					6.0	mV	2, 3
I_F	Feedback Current	I_R = 9µA			20	nA	1
		I_R = 10µA			25	nA	2, 3
		I_R = 20mA			20	nA	1
					25	nA	2, 3
		V_R = 5.3V, I_R = 45µA			20	nA	1
		V_R = 5.3V, I_R = 50µA			25	nA	2, 3
		V_R = 5.3V, I_R = 20mA			20	nA	1
					25	nA	2, 3
I_C	Minimum Operating Current	V_R = V_{Ref}	(Note 3)	9.0		µA	1
			(Note 3)	10		µA	2, 3
		V_R = 5.3V	(Note 3)	45		µA	1
			(Note 3)	50		µA	2, 3

LM185BY Electrical Characteristics
DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Ref}	Reference Voltage	I_R = 100µA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		I_R = 9µA		1.228	1.252	V	1
		I_R = 10µA		1.215	1.255	V	2, 3
		I_R = 1mA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		I_R = 20mA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 100µA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 45µA		1.288	1.252	V	1
		V_R = 5.3V, I_R = 50µA		1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 1.0mA		1.288	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 20mA		1.288	1.252	V	1
				1.215	1.255	V	2, 3
$\Delta V_{Ref}/\Delta I_R$	Reference Voltage Change with Current	9µA ≤ I_R ≤ 1mA			1.0	mV	1
		10µA ≤ I_R ≤ 1mA			1.5	mV	2, 3
		1mA ≤ I_R ≤ 20mA			10	mV	1
					20	mV	2, 3
		V_R = 5.3V, 45µA ≤ I_R ≤ 1mA			1.0	mV	1
		V_R = 5.3V, 50µA ≤ I_R ≤ 1mA			1.5	mV	2, 3
		V_R = 5.3V, 1mA ≤ I_R ≤ 20mA			10	mV	1
					20	mV	2, 3
ΔV_{Ref} / ΔV_O	Reference Voltage Change with Output Voltage	V_R = 5.3V, I_R = 100µA			3.0	mV	1
					6.0	mV	2, 3
I_F	Feedback Current	I_R = 9µA			20	nA	1
		I_R = 10µA			25	nA	2, 3
		I_R = 20mA			20	nA	1
					25	nA	2, 3
		V_R = 5.3V, I_R = 45µA			20	nA	1
		V_R = 5.3V, I_R = 50µA			25	nA	2, 3
		V_R = 5.3V, I_R = 20mA			20	nA	1
					25	nA	2, 3
I_C	Minimum Operating Current	V_R = V_{Ref}	(Note 3)	9.0		µA	1
			(Note 3)	10		µA	2, 3
		V_R = 5.3V	(Note 3)	45		µA	1
			(Note 3)	50		µA	2, 3
T_C	Temperature Coefficient		(Note 4)		50	PPM/°C	1, 2, 3

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is 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. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

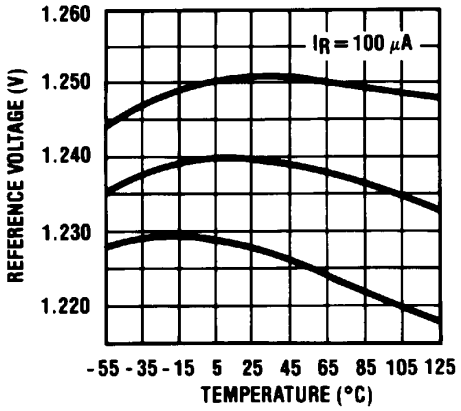
Note 2: Human body model, 1.5 kΩ in series with 100 pF.

Note 3: Functional test.

Note 4: The average temperature coefficient is defined as the maximum deviation of reference voltage, at all measured temperatures between the operating T_{Min} & T_{Max}, divided by (T_{Max} – T_{Min}). The measured temperatures ($T_{Measured}$) are –55°C, 25°C, & 125°C or ΔV_{Ref} / (T_{Max} – T_{Min})

Typical Performance Characteristics

Temperature Drift of 3 Representative Units



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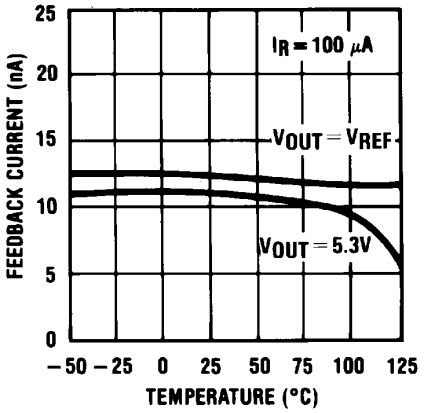
Feedback Current



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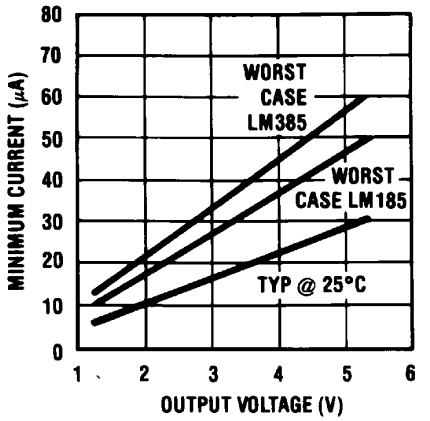
Minimum Operating Current



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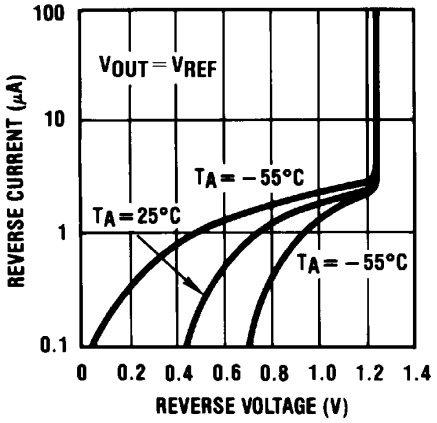
Reverse Characteristics



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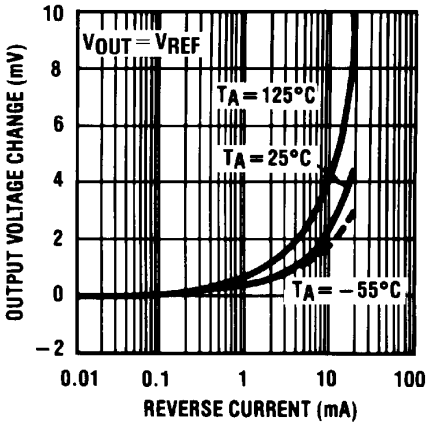
Reverse Characteristics



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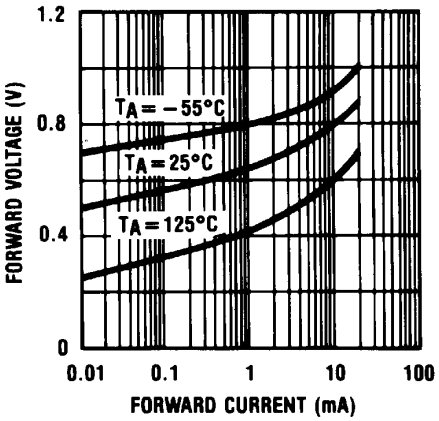
Forward Characteristics



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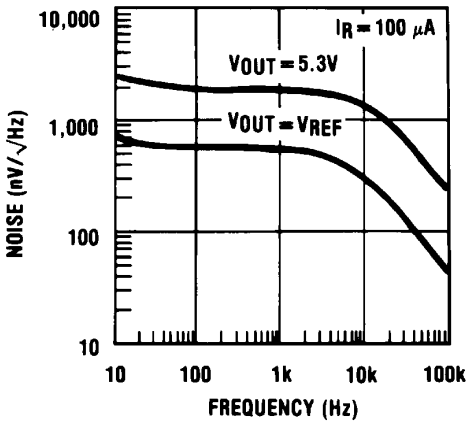
Typical Performance Characteristics (Continued)

Output Noise Voltage



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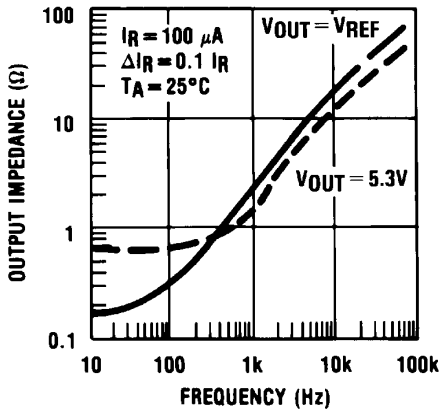
Dynamic Output Impedance



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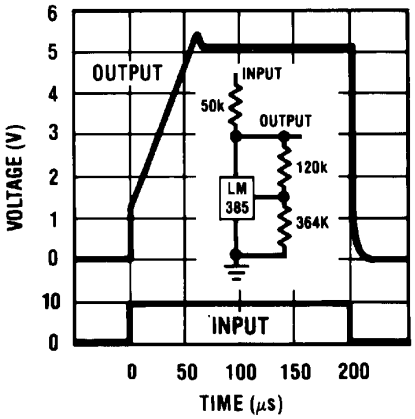
Response Time



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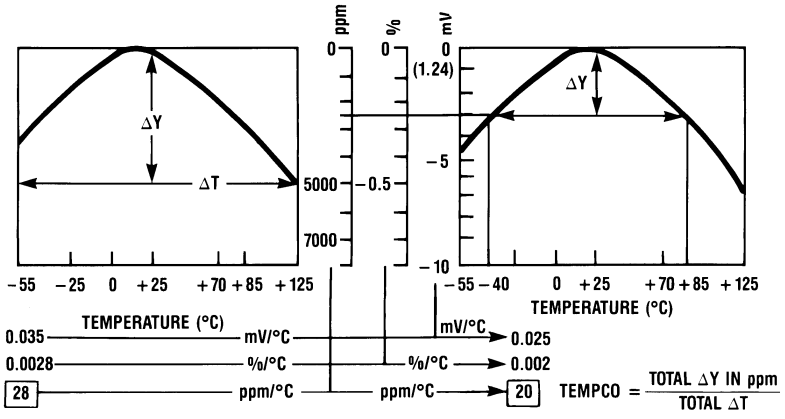
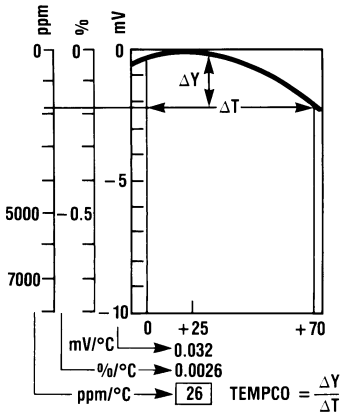
Temperature Coefficient Typical
LM185





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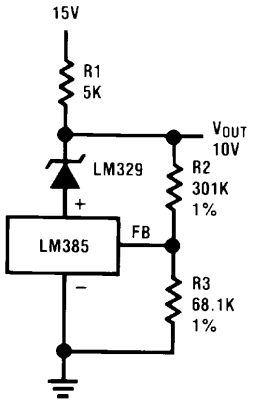
Typical Applications

Precision 10V Reference



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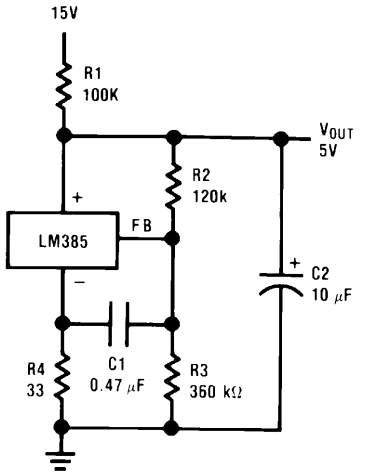
Low AC Noise Reference



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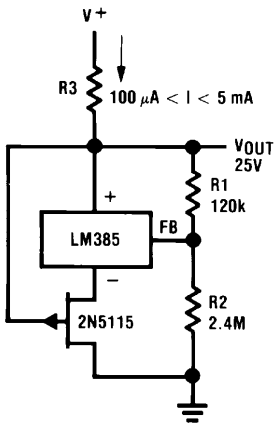
25V Low Current Shunt Regulator



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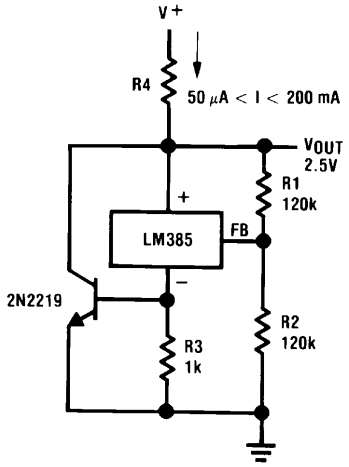
200 mA Shunt Regulator



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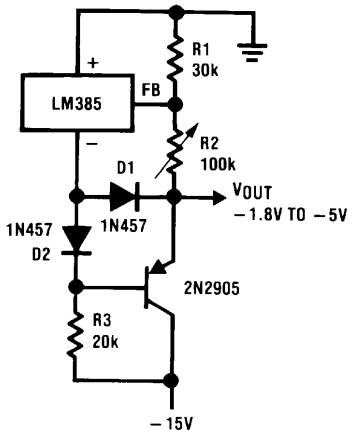
Typical Applications (Continued)

Series-Shunt 20 mA Regulator



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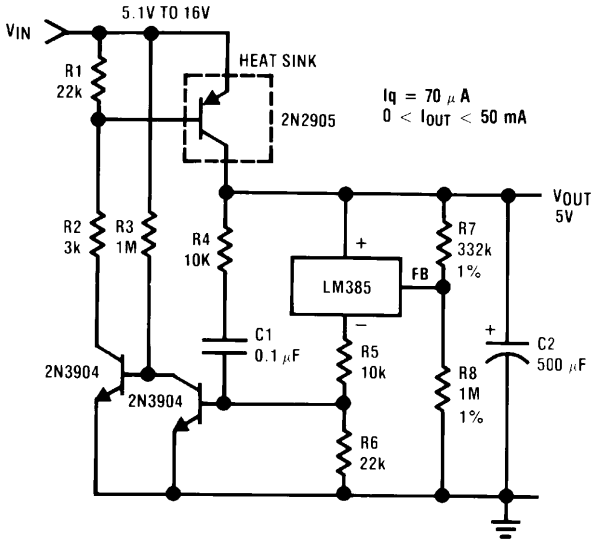
High Efficiency Low Power Regulator



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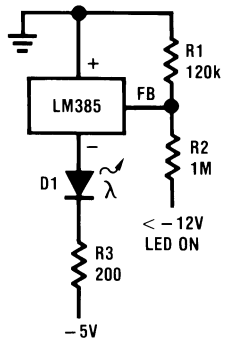
Voltage Level Detector



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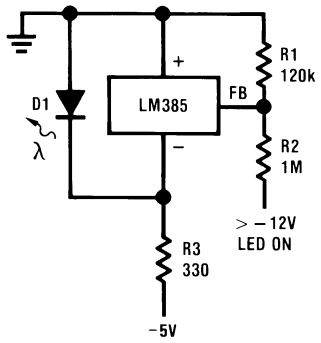
Voltage Level Detector



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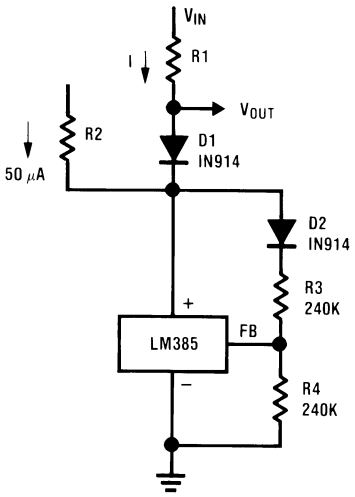
Fast Positive Clamp
2.4V + ΔV_{D1}



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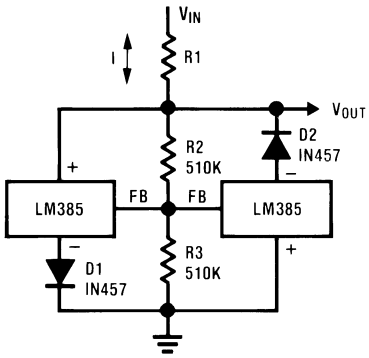
Bidirectional Clamp
±2.4V



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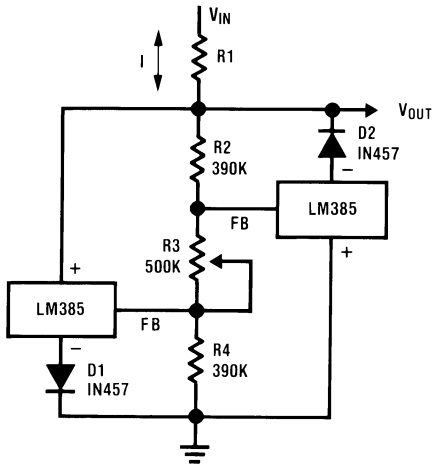
Typical Applications (Continued)

Bidirectional Adjustable Clamp
±1.8V to ±2.4V



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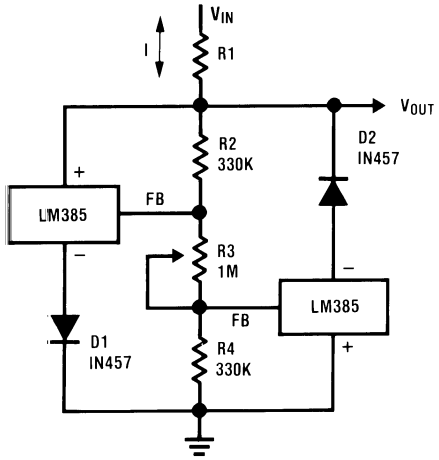
Bidirectional Adjustable Clamp
±2.4V to ±6V



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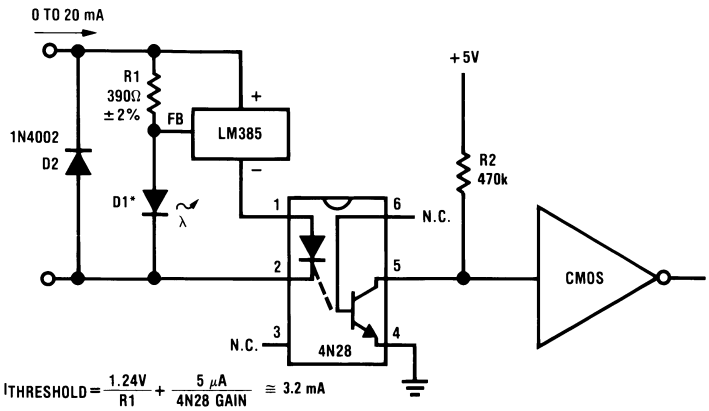
Simple Floating Current Detector



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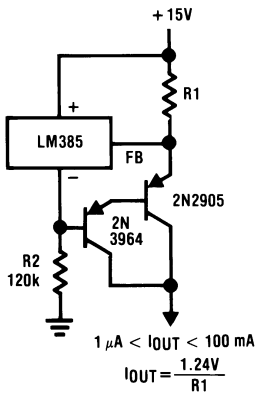
Current Source



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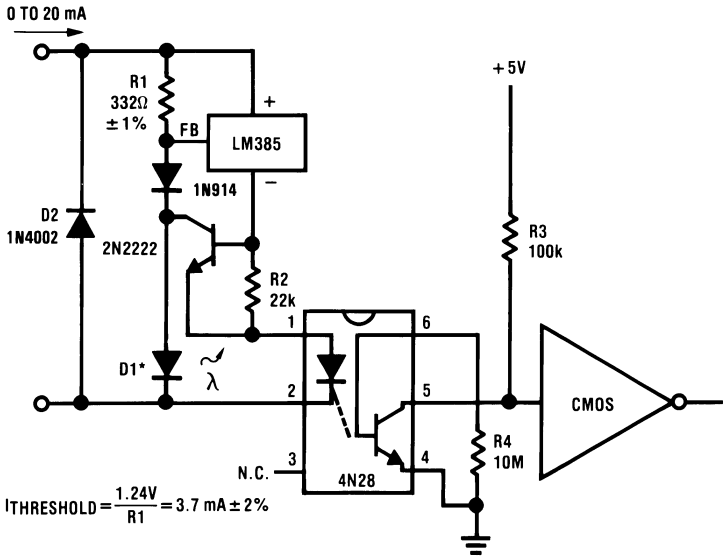
Typical Applications (Continued)

Precision Floating Current Detector



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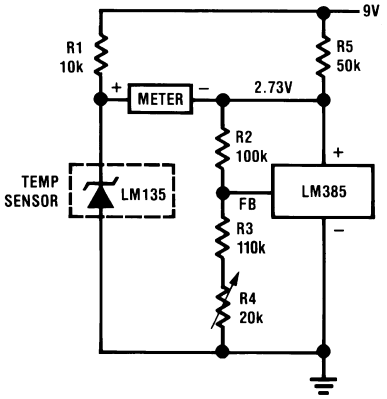
*D1 can be any LED, V_F=1.5V to 2.2V at 3 mA. D1 may act as an indicator. D1 will be on if $I_{THRESHOLD}$ falls below the threshold current, except with I=O.

Centigrade Thermometer, 10mV/°C



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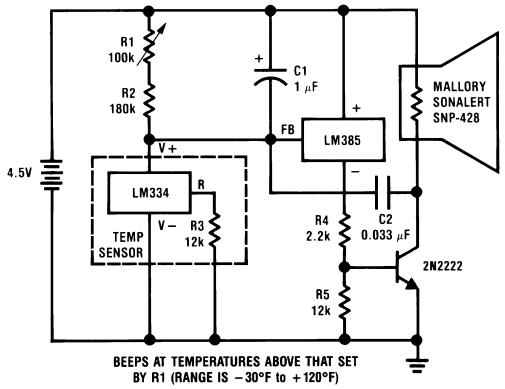
Freezer Alarm



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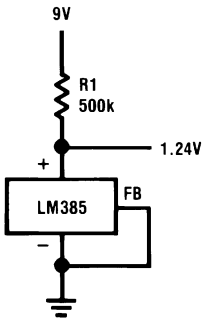
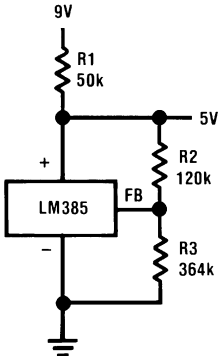
1.2V Reference



20156314

5.0V Reference



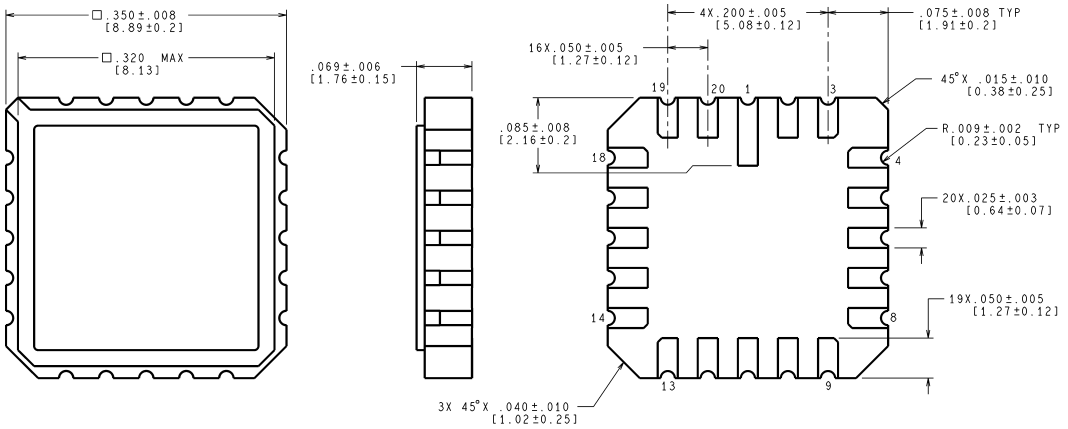
20156302

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

Revision History Section

Released	Revision	Section	Originator	Changes
11/08/05	A	New Release, Corporate format	L. Lytle	2 MDS data sheets converted into one Corp. data sheet format. MNLM185B-X Rev 0B0 and MNLM185BY-X Rev 0B0 will be archived.
04/06/06	B	Ordering Information Table, WG Connection Diagram, Absolute Maximum Ratings Section, Physical Dimensions Section	R. Malone	Added NSID, Connection Diagram, Physical Dimension Dwg, Thermal Resistance and Package Weight for WG package. Revision A will be Archived.

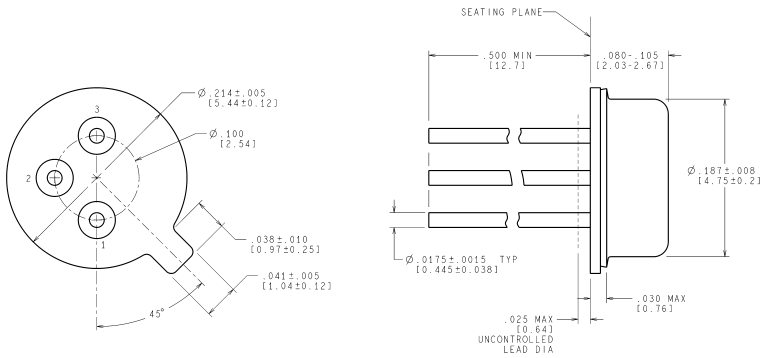
Physical Dimensions inches (millimeters) unless otherwise noted



CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

E20A (Rev F)

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

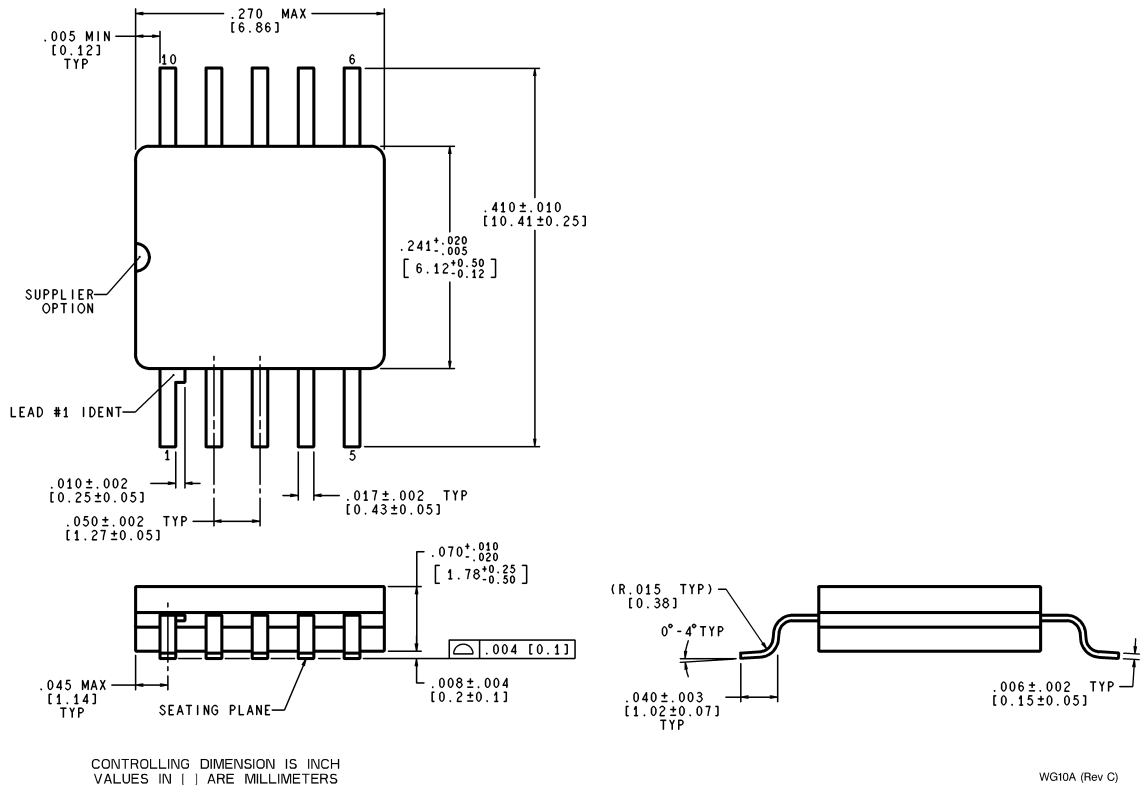


CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE IN MILLIMETERS

H03H (Rev F)

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

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



Ceramic SOIC Package (WG)
NS Package Number WG10A

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