National Semiconductor

November 2005

LM185-2.5QML
Micropower Voltage Reference Diode

General Description

The LM185-2.5 are micropower 2-terminal band-gap voltage regulator diodes. Operating over a 20 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 LM185-2.5 band-gap reference uses only transistors and resistors, low noise and good long term stability result.

Careful design of the LM185-2.5 has made the device exceptionally 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 LM185-2.5 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. For applications requiring 1.2V see LM185-1.2.

Features

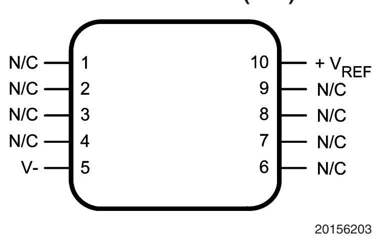
- Operating current of 20 μA to 20 mA
- 0.6Ω dynamic impedance (A grade)
- Low temperature coefficient
- Low voltage reference — 2.5V

Ordering Information

NS Part Number	JAN Part Number	NS Package Number	Package Description
LM185H-2.5-SMD	5962–8759402XA	H02A	2LD, T0–46 Metal Can
LM185H-2.5/883		H02A	2LD, T0–46 Metal Can
LM185WG-2.5-QV	5962–8759402VYA	WG10A	10LD Ceramic SOIC
LM185WG-2.5/883	5962–8759402YA	WG10A	10LD Ceramic SOIC
LM185BYH2.5/883		H02A	2LD, T0–46 Metal Can
LM185BYH2.5-SMD	5962–8759406XA	H02A	2LD, T0–46 Metal Can
LM185BYH2.5-QV	5962–8759406VXA	H02A	2LD, T0–46 Metal Can

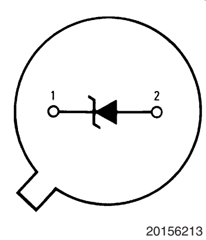
Connection Diagrams

Ceramic SOIC (WG)



See NS Package Number WG10A

TO-46 Metal Can Package (H)



Bottom View
See NS Package Number H02A

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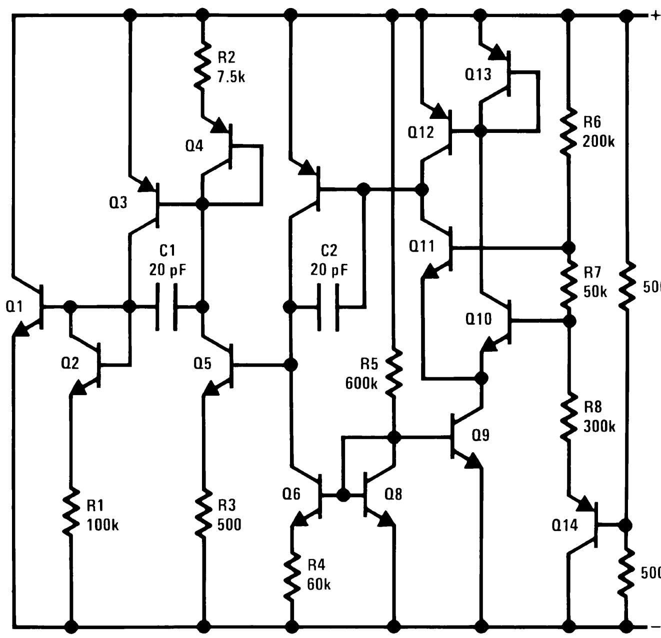
Schematic Diagram



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Absolute Maximum Ratings (Note 1)

Reverse Current	30 mA
Forward Current	10 mA
Operating Temperature Range	$-55^{\circ}C \leq T_A \leq +125^{\circ}C$
Storage Temperature	$-55^{\circ}C \leq T_A \leq +150^{\circ}C$
Maximum Junction Temperature (T_{Jmax}) (Note 2)	150˚C
Lead Temperature (Soldering, 10 sec)	
TO-46 Metal Can	300˚C
Ceramic SOIC	260˚C
Thermal Resistance	
θ_{JA}	
T0–46 Metal Can (Still Air)	300˚C/W
T0–46 Metal Can (500LF / Min Air Flow)	139˚C/W
Ceramic SOIC (Still Air)	194˚C/W
Ceramic SOIC (500LF / Min Air Flow)	128˚C/W
θ_{JC}	
T0–46 Metal Can	57˚C/W
Ceramic SOIC	23˚C/W
Package Weight (Typical)	
T0–46 Metal Can	TBD
Ceramic SOIC	210 mg
ESD Tolerance (Note 3)	4000V

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

LM185–2.5 Electrical Characteristics

DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{Ref}	Reverse Breakdown Voltage	I_R = 20μA		2.462	2.538	V	1
		I_R = 30μA		2.425	2.575	V	2, 3
		I_R = 1mA		2.462	2.538	V	1
				2.425	2.575	V	2, 3
		I_R = 20mA		2.462	2.538	V	1
				2.425	2.575	V	2, 3
$\Delta V_{Ref} / \Delta I_R$	Reverse Breakdown Voltage Change with Current	20μA ≤ I_R ≤ 1mA		-1.0	1.0	mV	1
		30μA ≤ I_R ≤ 1mA		-1.5	1.5	mV	2, 3
		1mA ≤ I_R ≤ 20mA		-10.0	10.0	mV	1
				-20.0	20.0	mV	2, 3
V_F	Forward Bias Voltage	I_F = 2mA		-1.0	-0.4	V	1

DC Drift Parameters

Delta calculations performed on QMLV devices at group B , subgroup 5, unless otherwise specified on IPI.

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{Ref}	Reverse Breakdown Voltage	I_R = 20μA		-10	10	mV	1
		I_R = 20mA		-10	10	mV	1

LM185BY–2.5 Electrical Characteristics

DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{Ref}	Reverse Breakdown Voltage	I_R = 20μA		2.462	2.538	V	1
		I_R = 30μA		2.425	2.575	V	2, 3
		I_R = 1mA		2.462	2.538	V	1
				2.425	2.575	V	2, 3
		I_R = 20mA		2.462	2.538	V	1
				2.425	2.575	V	2, 3
$\Delta V_{Ref} / \Delta I_R$	Reverse Breakdown Voltage Change with Current	20μA ≤ I_R ≤ 1mA		-1.0	1.0	mV	1
		30μA ≤ I_R ≤ 1mA		-1.5	1.5	mV	2, 3
		1mA ≤ I_R ≤ 20mA		-10.0	10.0	mV	1
				-20.0	20.0	mV	2, 3
V_F	Forward Bias Voltage	I_F = 2mA		–1.0	–0.4	V	1
T_C	Temperature Coefficient		(Note 4)		50	PPM/˚C	2, 3

DC Drift Parameters

Delta calculations performed on QMLV devices at group B , subgroup 5, unless otherwise specified on IPI.

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{Ref} 1	Reverse Breakdown Voltage	I_R = 20μA		-10	10	mV	1
V_{Ref} 2	Reverse Breakdown Voltage	I_R = 20mA		-10	10	mV	1

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.

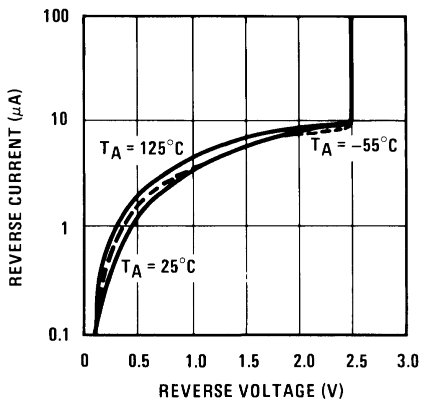
Note 2: The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), θ_{JA} (package junction to ambient thermal resistance), and T_A (ambient temperature). The maximum allowable power dissipation at any temperature is $P_{Dmax} = (T_{Jmax} - T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower.

Note 3: Human body model, 1.5 kΩ in series with 100 pF

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

Reverse Characteristics



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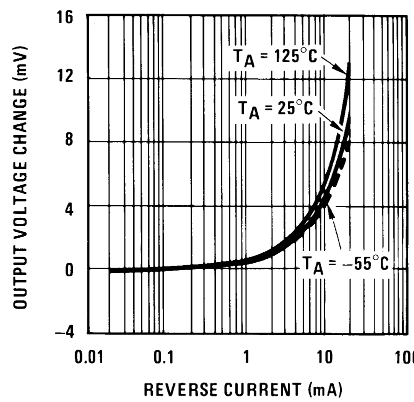
Reverse Characteristics



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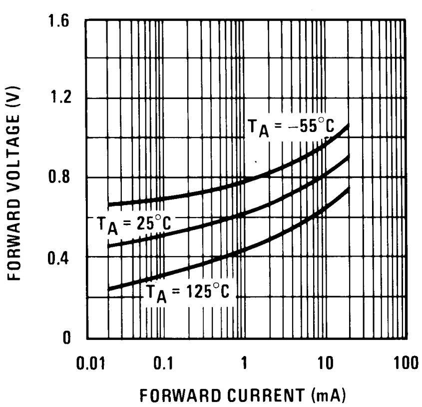
Forward Characteristics



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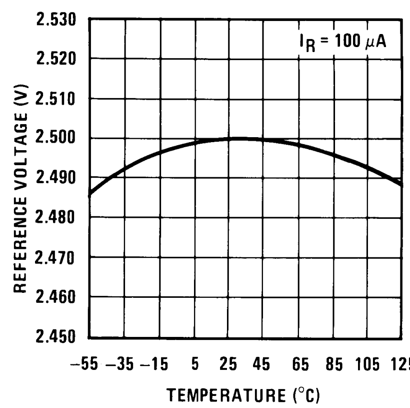
Temperature Drift



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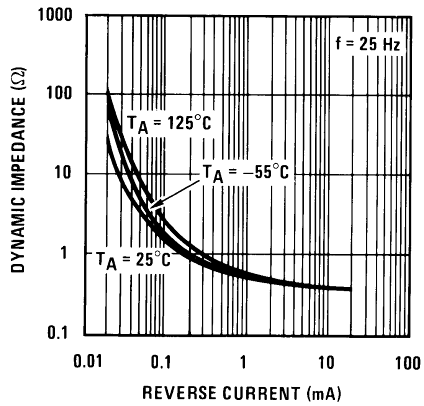
Typical Performance Characteristics (Continued)

Reverse Dynamic Impedance



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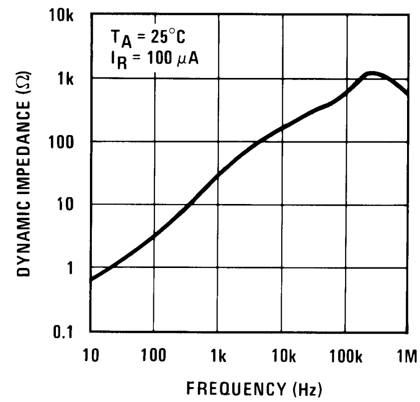
Reverse Dynamic Impedance



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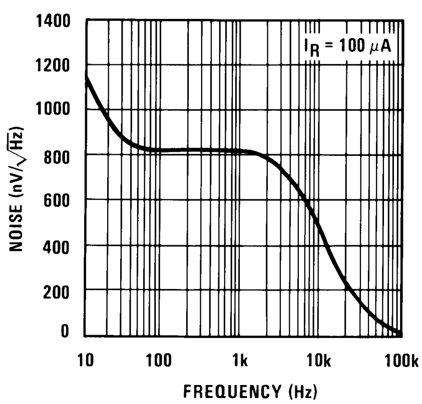
Noise Voltage



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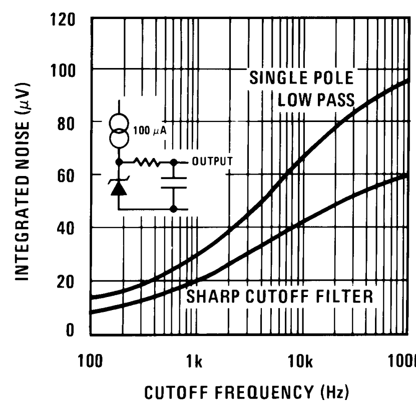
Filtered Output Noise



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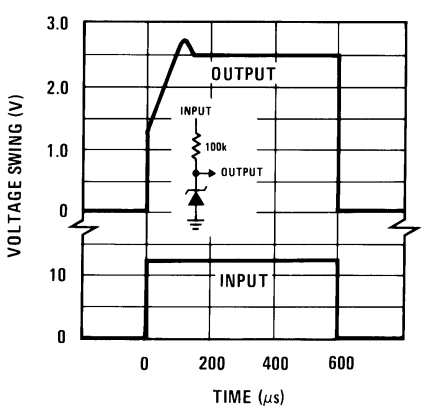
Response Time



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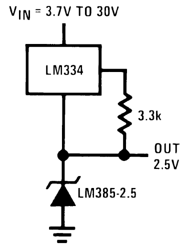
Applications

Wide Input Range Reference



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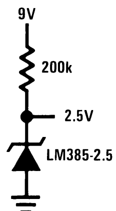
Micropower Reference from 9V Battery



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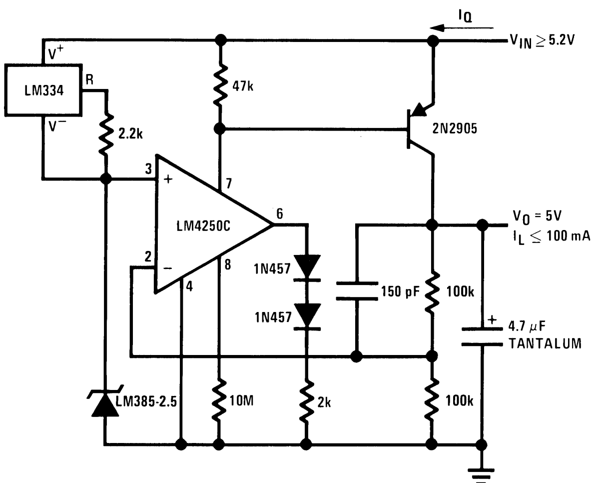
Micropower 5V Reference (Note 5)



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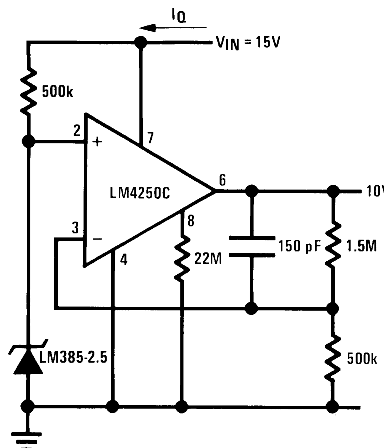
Note 5: $I_Q \simeq 40\ \mu A$

Micropower 10V Reference (Note 6)



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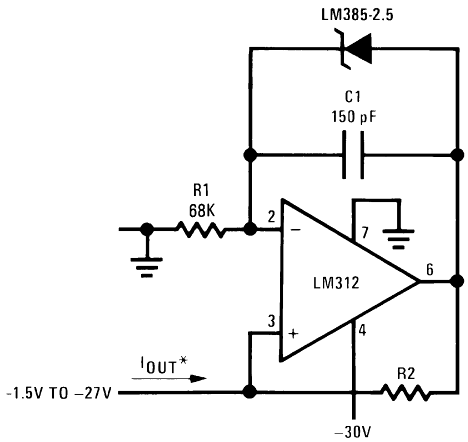
Note 6: $I_Q \simeq 30\ \mu A$ standby current

Applications (Continued)

Precision 1 μA to 1 mA Current Sources



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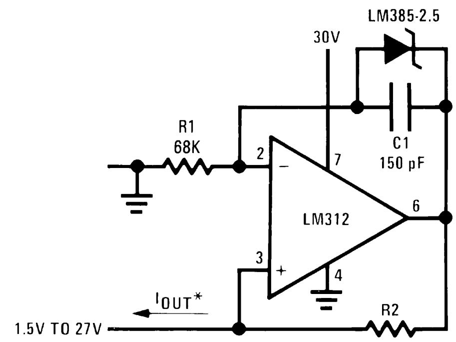

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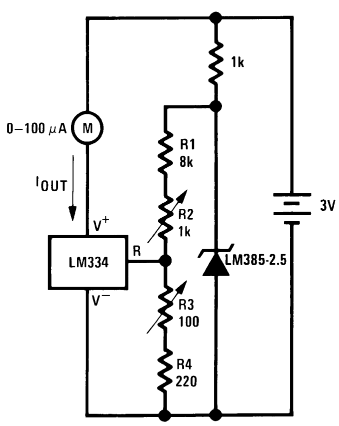
$$*I_{OUT} = \frac{2.5V}{R2}$$

METER THERMOMETERS

0˚C–100˚C Thermometer



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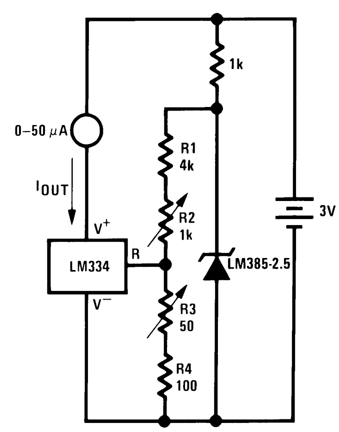
Calibration

1. Short LM385-2.5, adjust R3 for I_{OUT}=temp at 1μA/˚K
2. Remove short, adjust R2 for correct reading in centigrade

0˚F–50˚F Thermometer



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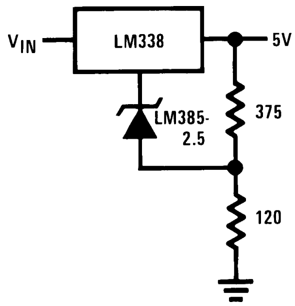
Calibration

1. Short LM385-2.5, adjust R3 for I_{OUT}=temp at 1.8 μA/˚K
2. Remove short, adjust R2 for correct reading in ˚F

Applications (Continued)

Improving Regulation of Adjustable Regulators



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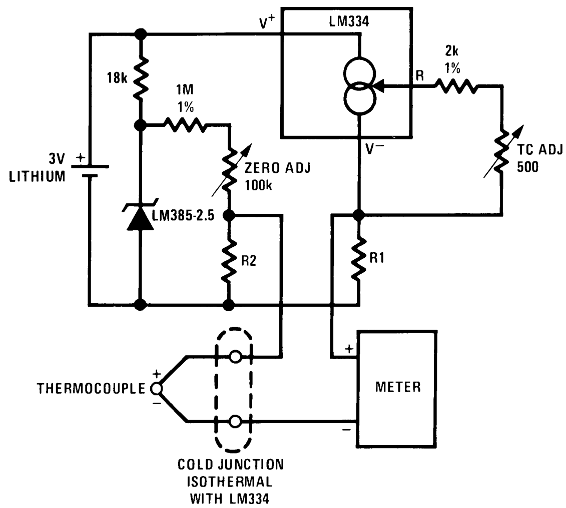
Micropower Thermocouple Cold Junction Compensator



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Adjustment Procedure

1. Adjust TC ADJ pot until voltage across R1 equals Kelvin temperature multiplied by the thermocouple Seebeck coefficient.
2. Adjust zero ADJ pot until voltage across R2 equals the thermocouple Seebeck coefficient multiplied by 273.2.

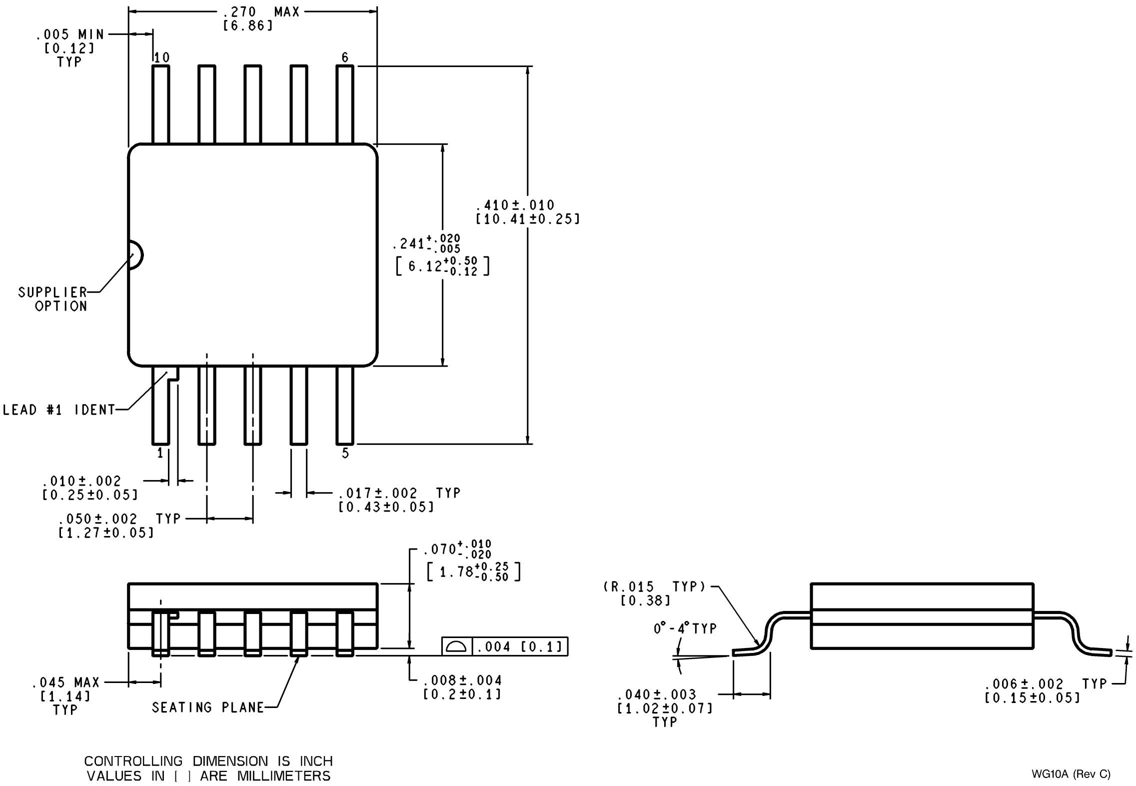
Thermocouple Type	Seebeck Co-efficient (µV/˚C)	R1 (Ω)	R2 (Ω)	Voltage Across R1 @25˚C (mV)	Voltage Across R2 (mV)
J	52.3	523	1.24k	15.60	14.32
T	42.8	432	1k	12.77	11.78
K	40.8	412	953Ω	12.17	11.17
S	6.4	63.4	150Ω	1.908	1.766

Typical supply current 50 µA

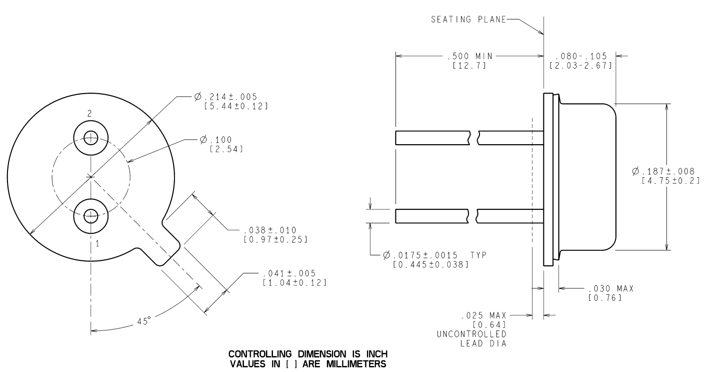
Revision History Section

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. MNLM185-2.5-X Rev 2A2 and MNLM185-2.5BY-X Rev 1B1 will be archived.

Physical Dimensions inches (millimeters) unless otherwise noted



Ceramic SOIC Package (WG)
NS Package Number WG10A



H02A (Rev F)

TO-46 Metal Can Package (H)
NS Package Number H02A

Notes

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