

Micropower Voltage Reference Diode

Check for Samples: [LM185-2.5QML](#)

FEATURES

- **Operating Current of 20 μ A to 20 mA**
- **0.6 Ω Dynamic Impedance (A grade)**
- **Low Temperature Coefficient**
- **Low Voltage Reference—2.5V**

DESCRIPTION

The LM185-2.5 are micropower 2-terminal band-gap voltage regulator diodes. Operating over a 20 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 LM185-2.5 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.

Connection Diagram

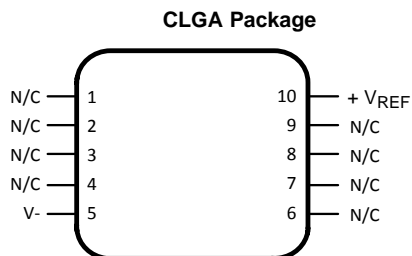


Figure 1. Top View
See Package Number NAC

PFM Metal Can Package

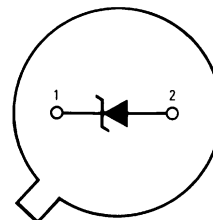


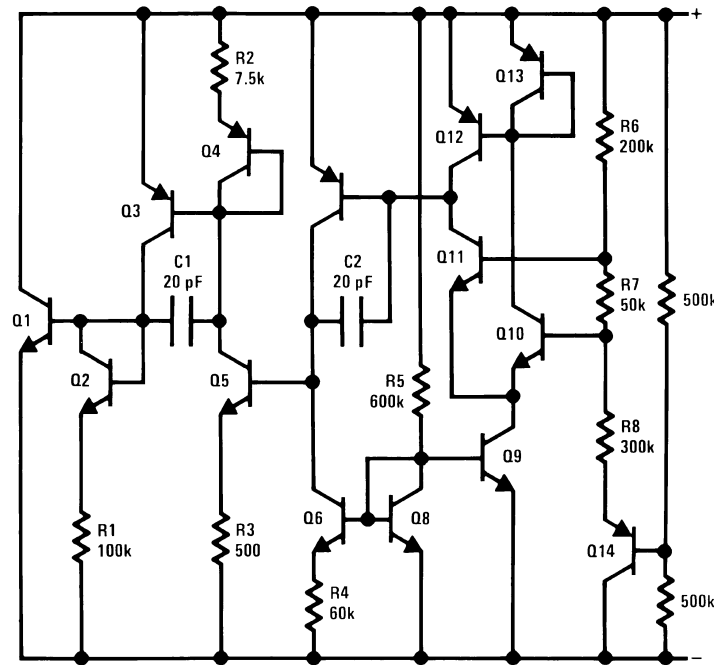
Figure 2. Bottom View
See Package Number NDU



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Schematic Diagram



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings⁽¹⁾

Reverse Current		30 mA	
Forward Current		10 mA	
Operating Temperature Range		-55°C ≤ T _A ≤ +125°C	
Storage Temperature		-55°C ≤ T _A ≤ +150°C	
Maximum Junction Temperature (T _{Jmax}) ⁽²⁾		150°C	
Lead Temperature (Soldering, 10 sec)	PFM Metal Can	300°C	
	Ceramic CLGA	260°C	
Thermal Resistance	θ _{JA}	PFM Metal Can (Still Air)	300°C/W
		PFM Metal Can (500LF / Min Air Flow)	139°C/W
		Ceramic CLGA (Still Air)	194°C/W
		Ceramic CLGA (500LF / Min Air Flow)	128°C/W
	θ _{JC}	PFM Metal Can	57°C/W
		Ceramic CLGA	23°C/W
Package Weight (Typical)	PFM Metal Can	TBD	
	Ceramic CLGA	210 mg	
ESD Tolerance ⁽³⁾		4000V	

- (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 ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
- (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)/θ_{JA} or the number given in the Absolute Maximum Ratings, whichever is lower.
- (3) Human body model, 1.5 kΩ in series with 100 pF

Table 1. Quality Conformance Inspection⁽¹⁾

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

(1) Mil-Std-883, Method 5005 - Group A

LM185–2.5 Electrical Characteristics DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{Ref}	Reverse Breakdown Voltage	$I_R = 20\mu A$		2.462	2.538	V	1
		$I_R = 30\mu A$		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	$20\mu A \leq I_R \leq 1mA$		-1.0	1.0	mV	1
		$30\mu A \leq I_R \leq 1mA$		-1.5	1.5	mV	2, 3
		$1mA \leq I_R \leq 20mA$		-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

LM185–2.5 Electrical Characteristics 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	$I_R = 20\mu A$		-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	$I_R = 20\mu A$		2.462	2.538	V	1
		$I_R = 30\mu A$		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	$20\mu A \leq I_R \leq 1mA$		-1.0	1.0	mV	1
		$30\mu A \leq I_R \leq 1mA$		-1.5	1.5	mV	2, 3
		$1mA \leq I_R \leq 20mA$		-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		(1)		50	PPM/°C	2, 3

(1) 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 $-55^\circ C$, $25^\circ C$, & $125^\circ C$ or $\Delta V_{Ref} / (T_{Max} - T_{Min})$

LM185BY–2.5 Electrical Characteristics 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	$I_R = 20\mu A$		-10	10	mV	1
$V_{Ref} 2$	Reverse Breakdown Voltage	$I_R = 20mA$		-10	10	mV	1

Typical Performance Characteristics

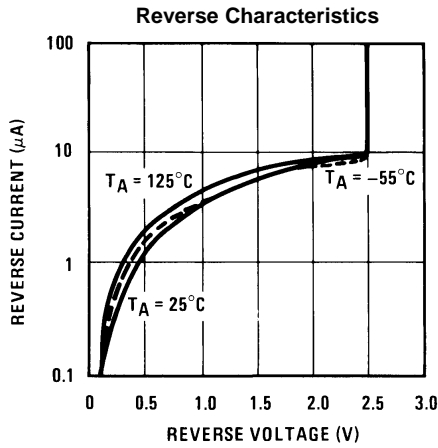


Figure 3.

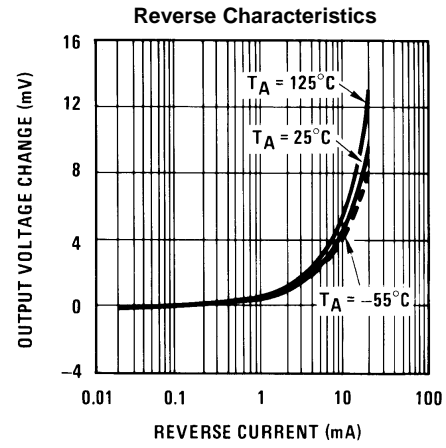


Figure 4.

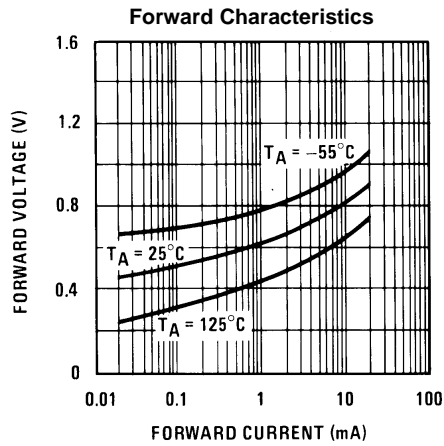


Figure 5.

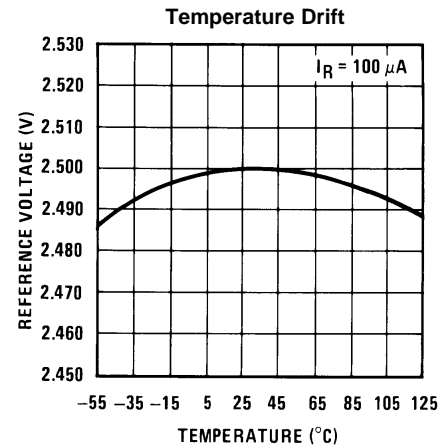


Figure 6.

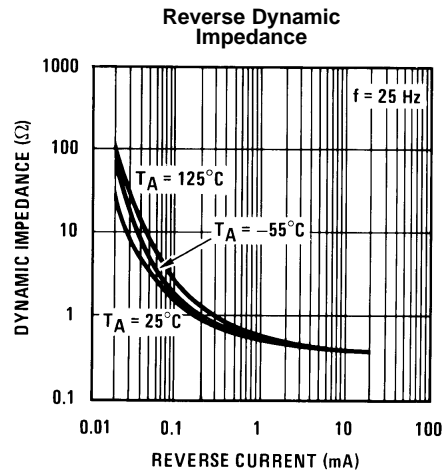


Figure 7.

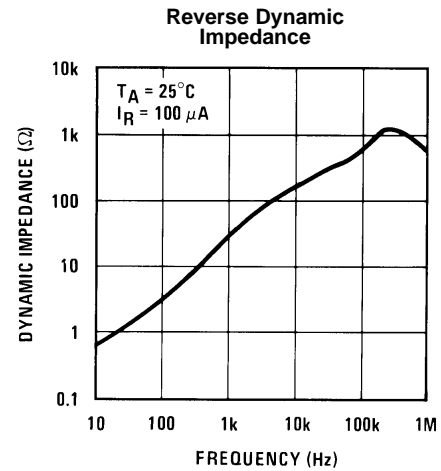


Figure 8.

Typical Performance Characteristics (continued)

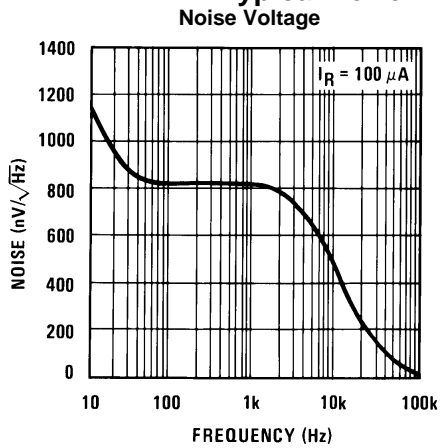


Figure 9.

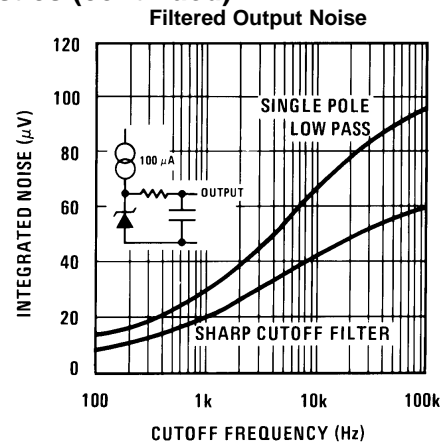


Figure 10.

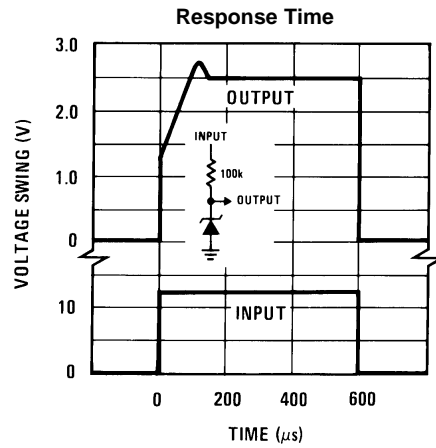


Figure 11.

APPLICATIONS

Figure 12. Wide Input Range Reference

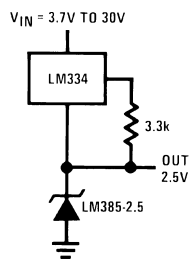


Figure 13. Micropower Reference from 9V Battery

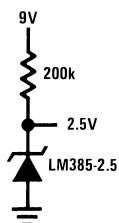
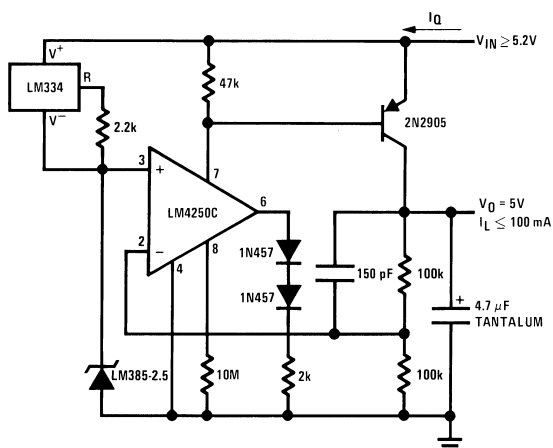
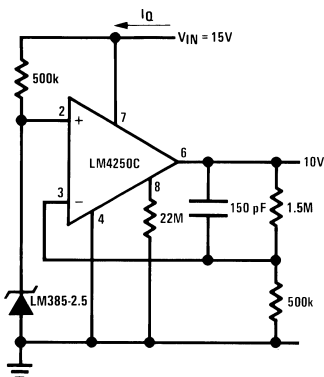


Figure 14. Micropower 5V Reference



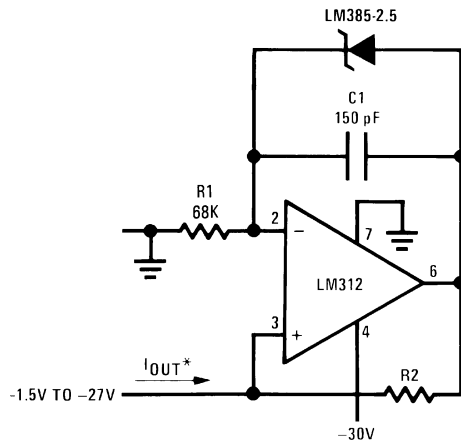
$I_Q \approx 40 \mu A$

Figure 15. Micropower 10V Reference

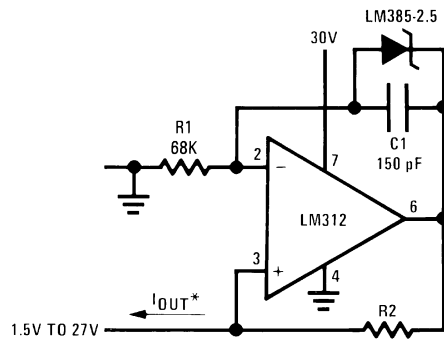


$I_Q \approx 30 \mu A$ standby current

Precision 1 μ A to 1 mA Current Sources

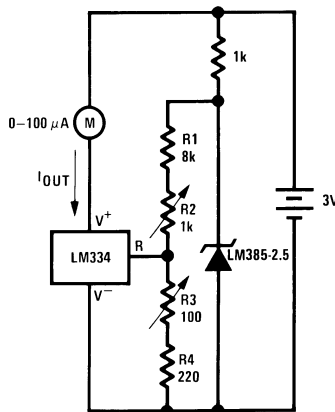


$$I_{OUT} = \frac{2.5V}{R_2}$$



METER THERMOMETERS

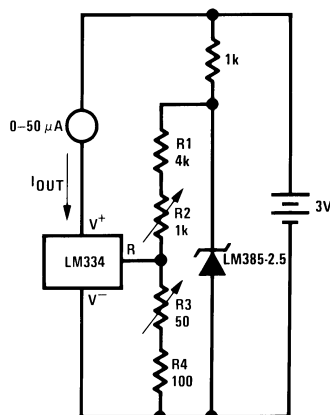
Figure 16. 0°C–100°C Thermometer



Calibration

1. Short LM385-2.5, adjust R3 for $I_{OUT} = \text{temp}$ at $1\mu A/^\circ K$
2. Remove short, adjust R2 for correct reading in centigrade

Figure 17. 0°F–50°F Thermometer



Calibration

1. Short LM385-2.5, adjust R3 for $I_{OUT} = \text{temp}$ at $1.8 \mu\text{A}/^\circ\text{K}$
2. Remove short, adjust R2 for correct reading in $^\circ\text{F}$

Figure 18. Improving Regulation of Adjustable Regulators

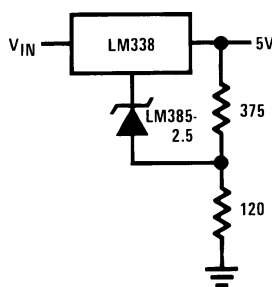
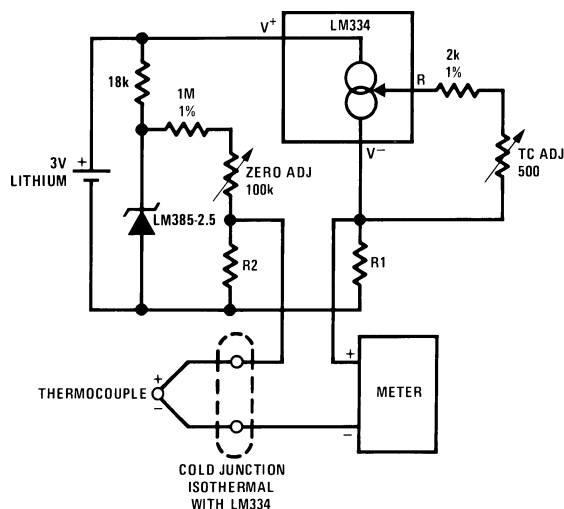


Figure 19. Micropower Thermocouple Cold Junction Compensator



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 ($\mu\text{V}/^\circ\text{C}$)	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	953 Ω	12.17	11.17
S	6.4	63.4	150 Ω	1.908	1.766

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.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
5962-8759402XA	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759402XA Q	Samples
5962-8759402YA	ACTIVE	CLGA	NAC	10	54	TBD	Call TI	Call TI	-55 to 125	LM185WG- 2.5/883 Q 5962-87594 02YA ACO 02YA >T	Samples
5962-8759406VXA	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759406VXA Q	Samples
LM185BYH2.5-QV	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759406VXA Q	Samples
LM185BYH2.5/883	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	LM185BY2.5 Q	Samples
LM185H-2.5-SMD	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759402XA Q	Samples
LM185H-2.5/883	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	LM185-2.5 Q	Samples
LM185WG-2.5/883	ACTIVE	CLGA	NAC	10	54	TBD	Call TI	Call TI	-55 to 125	LM185WG- 2.5/883 Q 5962-87594 02YA ACO 02YA >T	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

⁽⁴⁾ Only one of markings shown within the brackets will appear on the physical device.

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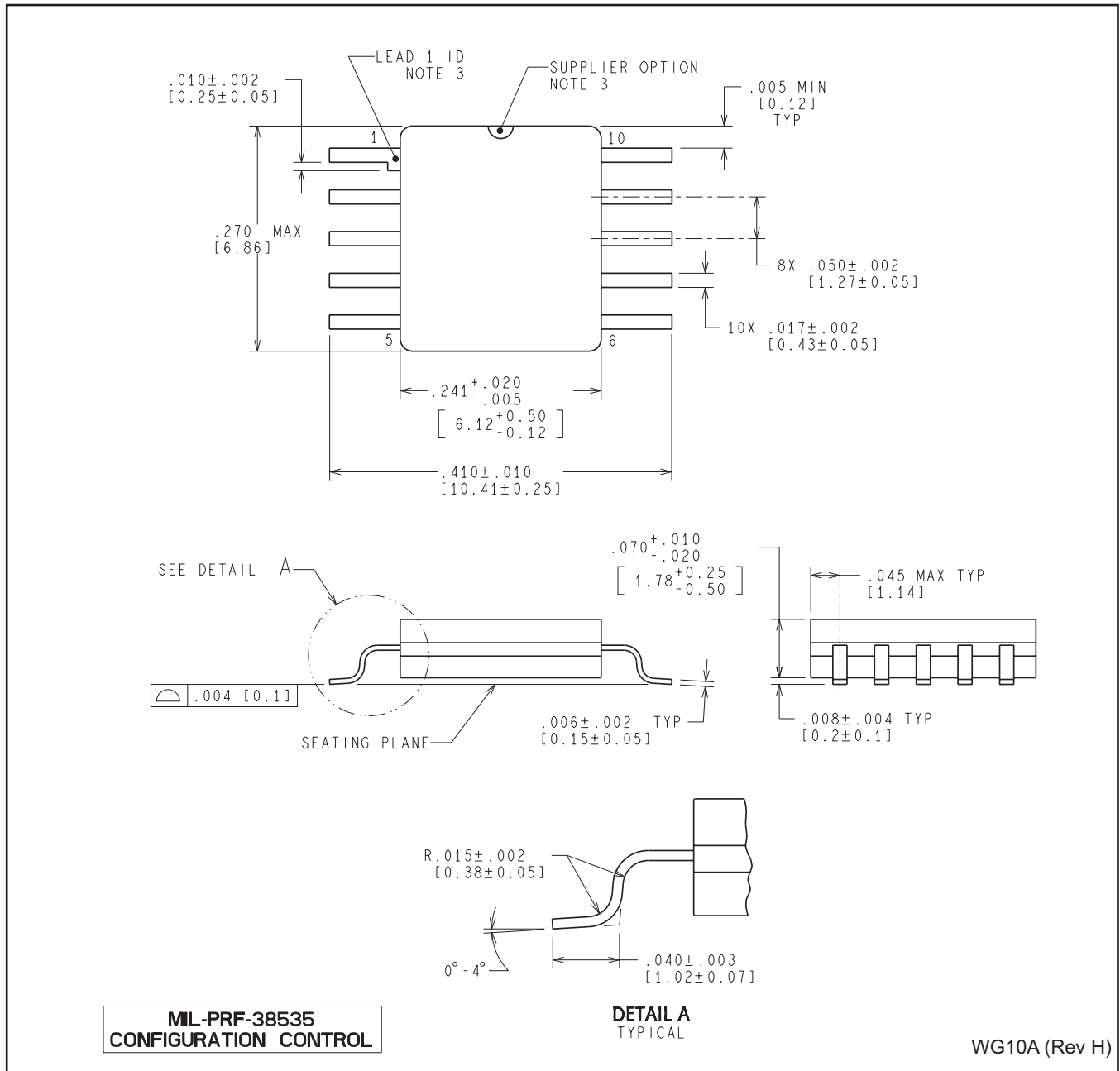
OTHER QUALIFIED VERSIONS OF LM185-2.5QML, LM185-2.5QML-SP :

- Military: [LM185-2.5QML](#)
- Space: [LM185-2.5QML-SP](#)

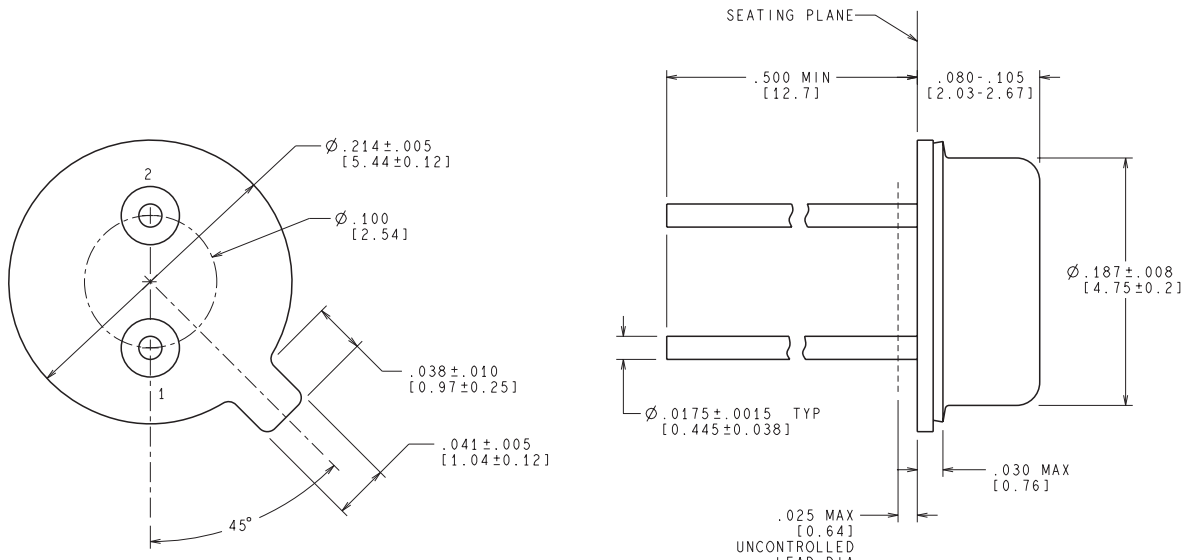
NOTE: Qualified Version Definitions:

- Military - QML certified for Military and Defense Applications
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

NAC0010A



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