

Micropower Voltage Reference Diode

Check for Samples: LM185-2.5QML

FEATURES

- Operating Current of 20 µA to 20 mA
- 0.6Ω 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

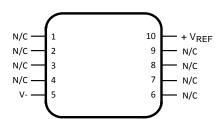


Figure 1. CLGA Package-Top View See Package Number NAC

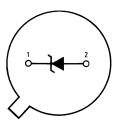
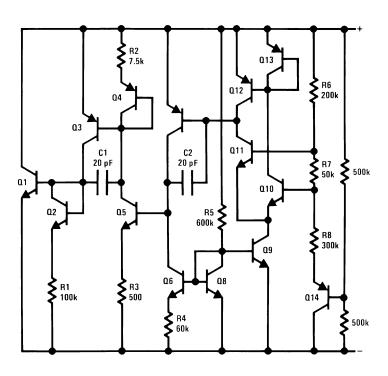


Figure 2. PFM Metal Can Package- Bottom View See Package Number NDU

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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	Operating Temperature Range				
Storage Temperature	-55°C ≤ T _A ≤ + 150°C				
Maximum Junction Temperatu	150°C				
1 1 T (O-114	40>	PFM Metal Can	300°C		
Lead Temperature (Soldering, 10 sec)		Ceramic CLGA	260°C		
		PFM Metal Can (Still Air)	300°C/W		
		PFM Metal Can (500LF / Min Air Flow)	139°C/W		
The second Desciotes as	θ_{JA}	Ceramic CLGA (Still Air)	194°C/W		
Thermal Resistance		Ceramic CLGA (500LF / Min Air Flow)	128°C/W		
	0	PFM Metal Can	57°C/W		
	θ_{JC}	Ceramic CLGA	23°C/W		
Dealer and Maintel (Tominal)		PFM Metal Can	TBD		
Package Weight (Typical)		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.
- 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. Human body model, 1.5 k Ω 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
A8	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} R	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	
$\Delta V_{Ref} / \Delta I_{R}$		20µA ≤ I _R ≤ 1mA		-1.0	1.0	mV	1
	Change with Current	$30\mu A \le I_R \le 1mA$		-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

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
		$I_R = 20 \text{mA}$		-10	10	mV	1

Product Folder Links: LM185-2.5QML



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
ΔV_{Ref} / ΔI_{R}	Reverse Breakdown Voltage	$20\mu A \le I_R \le 1mA$		-1.0	1.0	mV	1
	Change with Current	30μA ≤ I _R ≤ 1mA		-1.5	1.5	mV	2, 3
		$1mA \le I_R \le 20mA$		-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°C, 25°C, & 125°C or ΔV_{Ref} / (T_{Max} -T_{Min})

LM185BY-2.5 Electrical Characteristics DC Drift Parameters

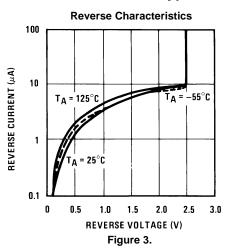
Delta calculations performed on QMLV devices at group B, subgroup 5, unless otherwise specified on IPI.

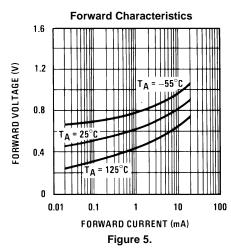
Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub- groups
V _{Ref} 1	Reverse Breakdown Voltage	$I_R = 20\mu A$		-10	10	mV	1
V _{Ref} 2	Reverse Breakdown Voltage	$I_R = 20mA$		-10	10	mV	1

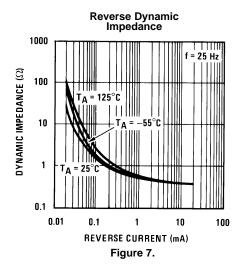
Product Folder Links: LM185-2.5QML

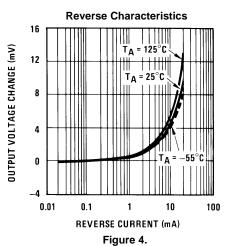


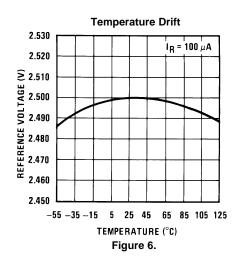
Typical Performance Characteristics

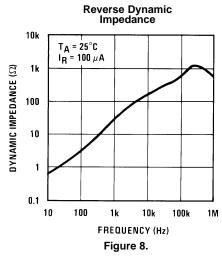






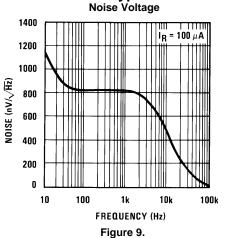


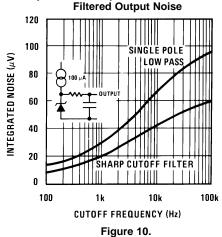


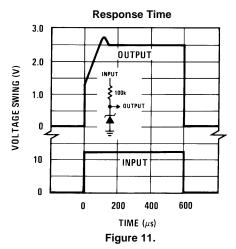




Typical Performance Characteristics (continued) ise Voltage Filtered Output Noise









APPLICATIONS

Figure 12. Wide Input Range Reference

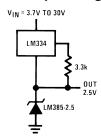


Figure 13. Micropower Reference from 9V Battery

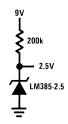
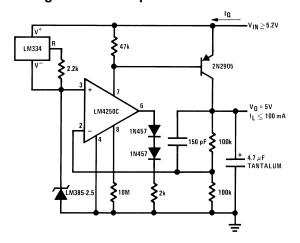
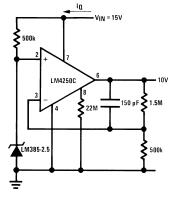


Figure 14. Micropower 5V Reference



 $I_Q \simeq 40 \mu A$

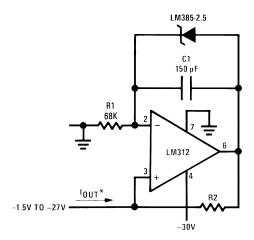
Figure 15. Micropower 10V Reference



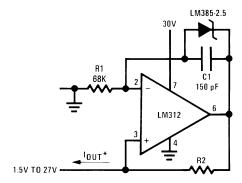
 $I_Q \simeq 30 \ \mu A$ standby current



Precision 1 µA to 1 mA Current Sources

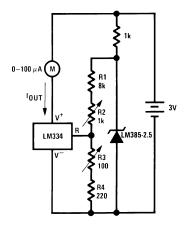


 $*I_{OUT} = \frac{2.5V}{R2}$



METER THERMOMETERS

Figure 16. 0°C-100°C Thermometer

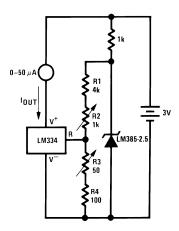


Calibration

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

Figure 18. Improving Regulation of Adjustable Regulators

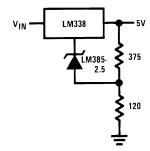
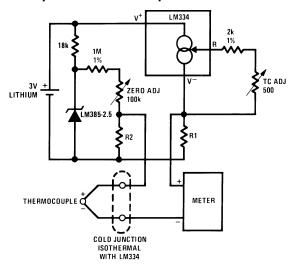


Figure 19. Micropower Thermocouple Cold Junction Compensator



Adjustment Procedure

- 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.

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NSTRUMENTS

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
Т	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

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.
03/20/13	А	All		Changed layout of National Data Sheet to TI format.

Product Folder Links: LM185-2.5QML





26-Jul-2016

PACKAGING INFORMATION

Orderable Device	Status	Package Type	Package Drawing	Pins	Package Qty	Eco Plan	Lead/Ball Finish	MSL Peak Temp	Op Temp (°C)	Device Marking (4/5)	Samples
5962-8759402XA	ACTIVE	ТО	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759402XA Q	Samples
5962-8759402YA	ACTIVE	CFP	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	ТО	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759406VXA Q	Samples
LM185-2.5 MD8	ACTIVE	DIESALE	Y	0	100	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
LM185BYH2.5-QV	ACTIVE	ТО	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759406VXA Q	Samples
LM185BYH2.5/883	ACTIVE	ТО	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	LM185BY2.5 Q	Samples
LM185H-2.5-SMD	ACTIVE	ТО	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759402XA Q	Samples
LM185H-2.5/883	ACTIVE	ТО	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	LM185-2.5 Q	Samples
LM185WG-2.5/883	ACTIVE	CFP	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.

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.

⁽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.





26-Jul-2016

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) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.
- (5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.
- (6) Lead/Ball Finish Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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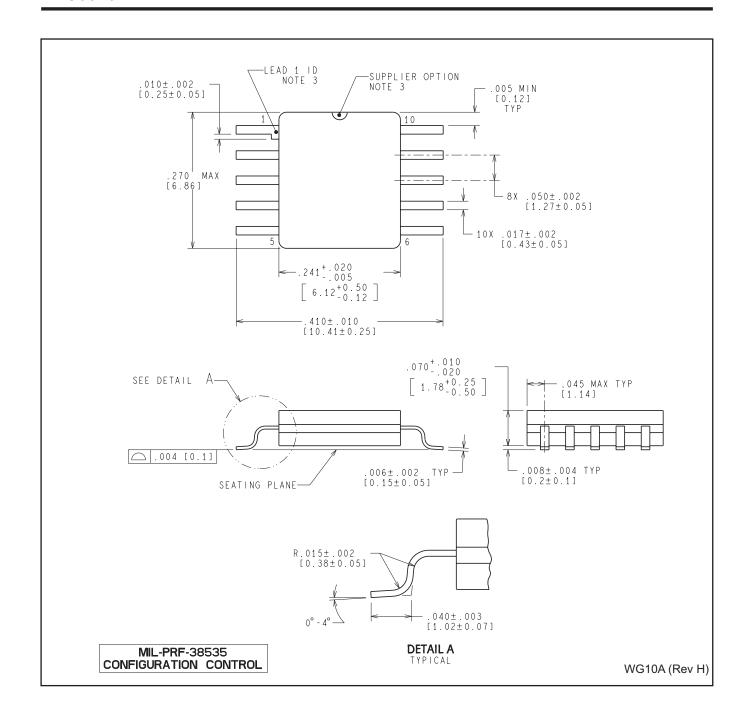
OTHER QUALIFIED VERSIONS OF LM185-2.5QML. LM185-2.5QML-SP:

Military: LM185-2.5QML

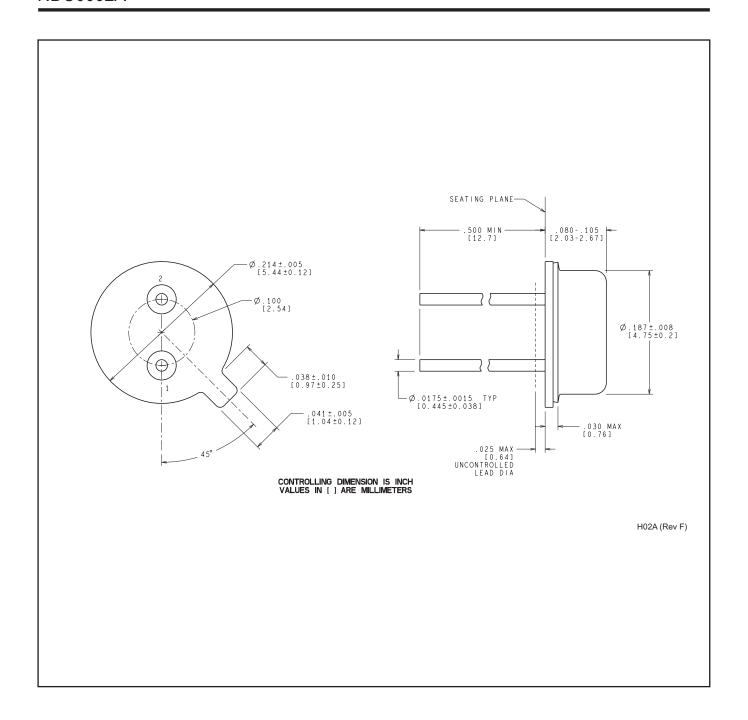
Space: LM185-2.5QML-SP

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







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