LM185-1.2QML Micropower Voltage Reference Diode

Check for Samples: LM185-1.2QML

FEATURES

- **Operating Current of 10µA to 20mA**
- **1Ω Maximum Dynamic Impedance (Typical)**
- **Low Temperature Coefficient**
- **Radiation Qualified Option**
  - **100 krad**
  - **Low Dose Rate Tested at 10 mrad/s**

DESCRIPTION

The LM185-1.2 is a micropower 2-terminal band-gap voltage regulator diodes. Operating over a 10µA to 20mA current range, it features exceptionally low dynamic impedance and good temperature stability. On-chip trimming is used to provide tight voltage tolerance. Since the LM185-1.2 band-gap reference uses only transistors and resistors, low noise and good long term stability result.

Careful design of the LM185-1.2 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 LM185-1.2 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.

Connection Diagrams

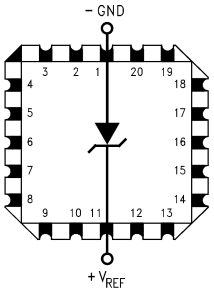


Figure 1. LCCC Package
See Package Number NAJ0020A

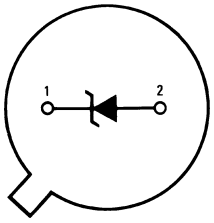


Figure 2. TO Package – Bottom View
See Package Number NDU0002A

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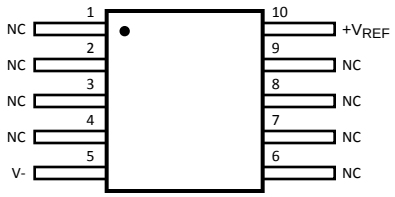
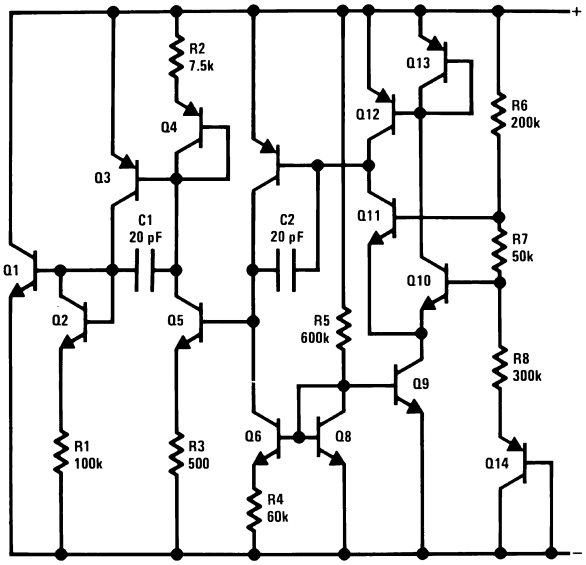


Figure 3. CLGA Package
See Package Number NAC0010A

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.

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Absolute Maximum Ratings[1]

Reverse Current			30mA
Forward Current			10mA
Operating Temperature Range			$-55°C \le T_A \le +125°C$
Maximum Junction Temperature (T_{Jmax})[2]			+150°C
Storage Temperature			$-55°C \le T_A \le +150°C$
Lead Temperature (Soldering 10 Seconds)	CLGA		260°C
	TO package		300°C
	20LD LCCC package		300°C
Thermal Resistance	θ_{JA}	TO (Still Air)	300°C/W
		TO (500LF / Min Air Flow)	139°C/W
		20LD LCCC (Still Air)	100°C/W
		20LD LCCC (500LF / Min Air Flow)	73°C/W
		CLGA (Still Air)	194°C/W
		CLGA (500LF / Min Air Flow)	128°C/W
	θ_{JC}	TO	57°C/W
		20LD LCCC	25°C/W
		CLGA	23°C/W
Package Weight (Typical)		TO	TBD
		20LD LCCC	TBD
		CLGA	210mg
ESD Tolerance[3]			4KV

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional. For specifications and test conditions, see the Electrical Characteristics. The 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 $P_{Dmax} = (T_{Jmax} - T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower.

(3) Human body model, 1.5KΩ in series with 100pF.

Quality Conformance Inspection

Table 1. 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

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LM185–1.2 Electrical Characteristics DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{Ref}	Reverse Breakdown Voltage	I_R = 10µA		1.223	1.247	V	1
		I_R = 20µA		1.205	1.26	V	2, 3
		I_R = 1mA		1.223	1.247	V	1
				1.205	1.26	V	2, 3
		I_R = 20mA		1.223	1.247	V	1
				1.205	1.26	V	2, 3
$\Delta V_{Ref} / \Delta I_R$	Reverse Breakdown Voltage Change with Current	10µA ≤ I_R ≤ 1mA		-1.0	1.0	mV	1
		20µA ≤ 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

LM185–1.2 Electrical Characteristics DC Drift Parameters

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

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_R	Reverse Breakdown Voltage	I_R = 10µA		-0.01	0.01	V	1
		I_R = 20mA		-0.01	0.01	V	1

LM185BY–1.2 Electrical Characteristics DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{Ref}	Reverse Breakdown Voltage	I_R = 10µA		1.223	1.247	V	1
		I_R = 20µA		1.205	1.26	V	2, 3
		I_R = 1mA		1.223	1.247	V	1
				1.205	1.26	V	2, 3
		I_R = 20mA		1.223	1.247	V	1
				1.205	1.26	V	2, 3
$\Delta V_{Ref} / \Delta I_R$	Reverse Breakdown Voltage Change with Current	10µA ≤ I_R ≤ 1mA		-1.0	1.0	mV	1
		20µA ≤ 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		(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})

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LM185-1.2RLQV SMD 5962R8759461 Post 100 krad Electrical Characteristics DC Parameters(1)(2)

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
ΔV_{Ref}	Change in Reverse Breakdown Voltage	I_R = 10µA	(3)	-3	3	%	1
		I_R = 1mA	(3)	-3	3	%	1
		I_R = 20mA	(3)	-2.5	2.5	%	1
ΔV_{Ref} / ΔI_R	Reverse Breakdown Voltage Change with Current	10µA ≤ I_R ≤ 1mA		-15	15	mV	1
		1mA ≤ I_R ≤ 20mA		-25	25	mV	1
V_F	Forward Bias Voltage	I_F = 2mA		-1.0	-0.4	V	1

(1) Radiation hardness assured (RHA) products are those with an "RLQV" suffix in the Texas Instruments' part number or those with an "R" in the SMD number, following "5962".
(2) Testing and qualification for RHA products is done on a wafer level according to MIL-STD-883, Test Method 1019. Testing is performed with a 1.5X overtest. To be rated at 100 krad(Si) units are tested to 150 krad(Si) with all parameters remaining inside the post 100 krad Electrical DC test limits in this table. Interim test points are taken at 50, 75 and 100 krad(Si).
(3) Change from the 0 rad reading.

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Typical Performance Characteristics

Reverse Characteristics

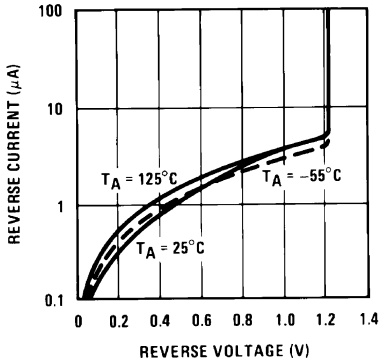


Figure 4.

Reverse Characteristics

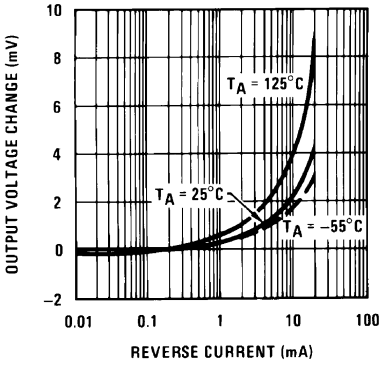


Figure 5.

Forward Characteristics

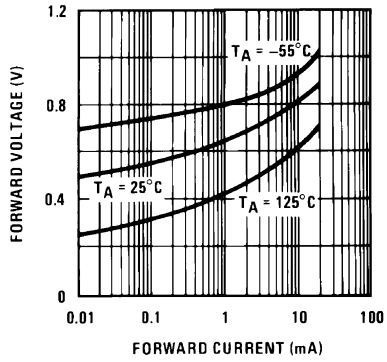


Figure 6.

Temperature Drift of 3 Representative Units

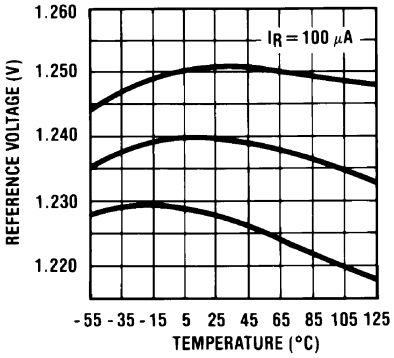


Figure 7.

Reverse Dynamic Impedance

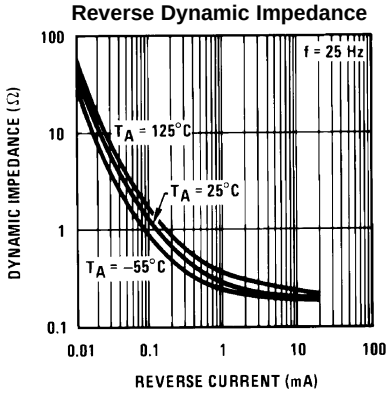


Figure 8.

Reverse Dynamic Impedance

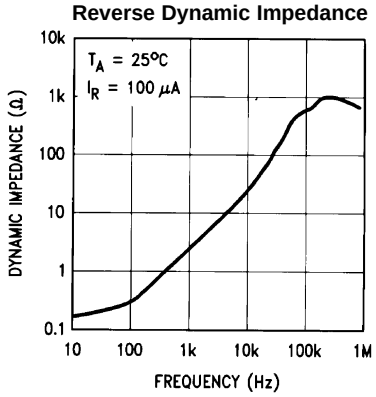


Figure 9.

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Typical Performance Characteristics (continued)

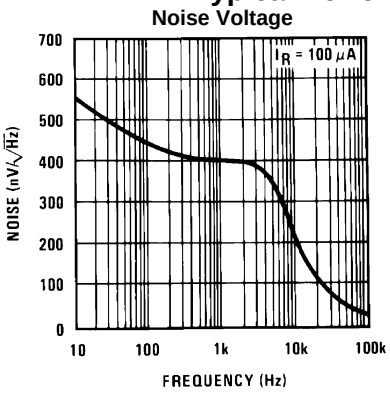


Figure 10.

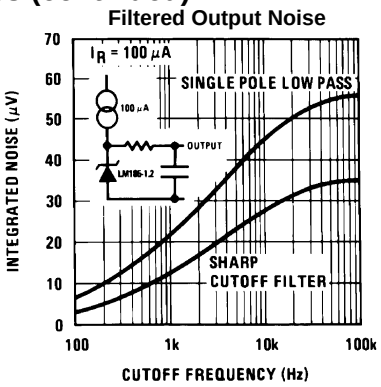


Figure 11.

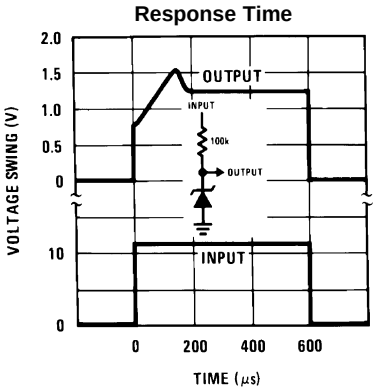


Figure 12.

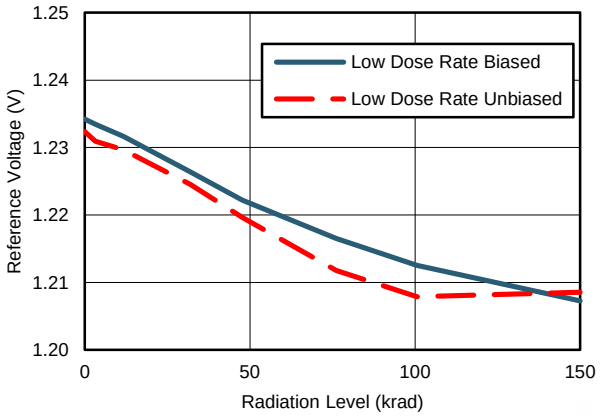


Figure 13. V_{Ref} Radiation Drift at I_R = 10 µA

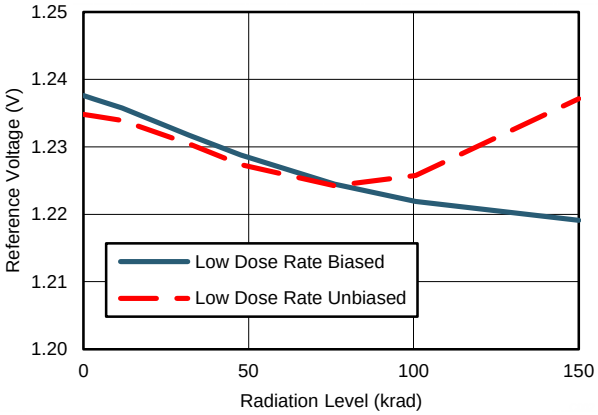


Figure 14. V_{Ref} Radiation Drift at I_R = 20 mA

Typical Applications

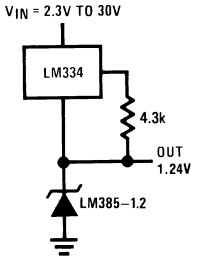


Figure 15. Wide Input Range Reference

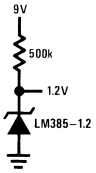


Figure 16. Micropower Reference from 9V Battery

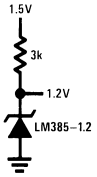
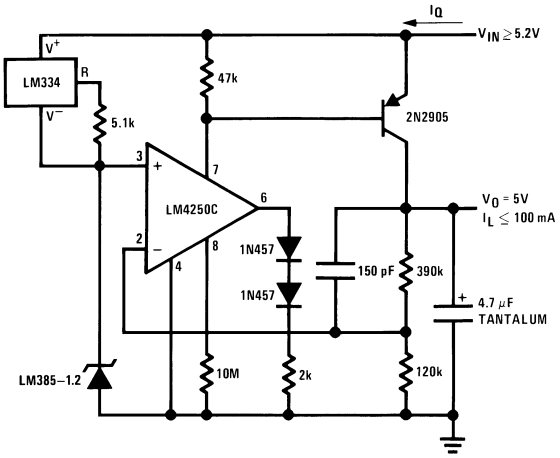


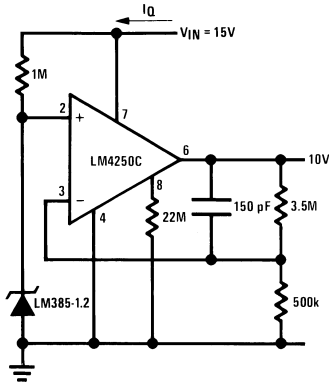
Figure 17. Reference from 1.5V Battery



*I_Q ≈ 30μA

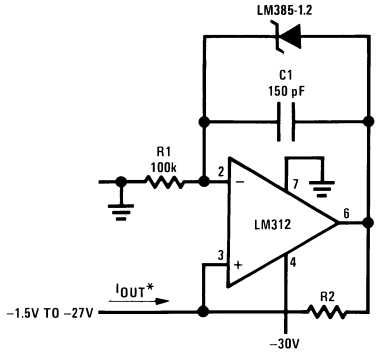
Figure 18. Micropower* 5V Regulator

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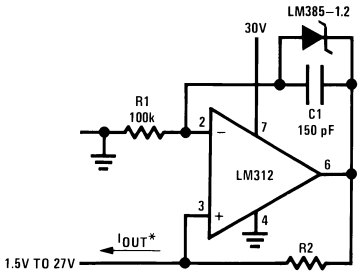
*I_Q ≈20µA standby current

Figure 19. Micropower* 10V Reference

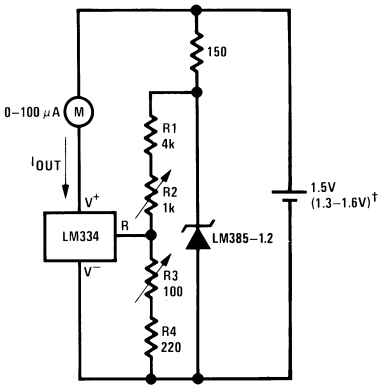


$$*I_{OUT} = \frac{1.23V}{R2}$$

Figure 20. Precision 1µA to 1mA Current Sources



METER THERMOMETERS

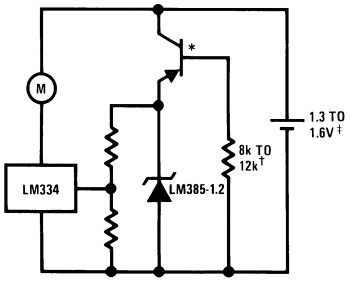


Calibration

1. Short LM385-1.2, adjust R3 for I_{OUT}= temp at 1μA/°K
2. Remove short, adjust R2 for correct reading in centigrade

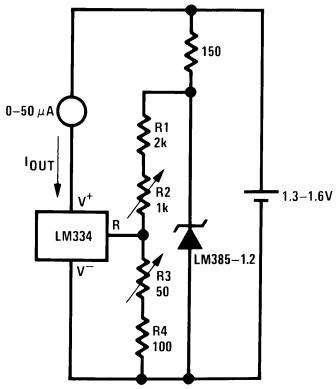
†I_Q at 1.3V≅500μA
I_Q at 1.6V≅2.4mA

Figure 21. 0°C−100°C Thermometer



*2N3638 or 2N2907 select for inverse H_{FE} ≅ 5
†Select for operation at 1.3V
‡I_Q ≅ 600μA to 900μA

Figure 22. Lower Power Thermometer

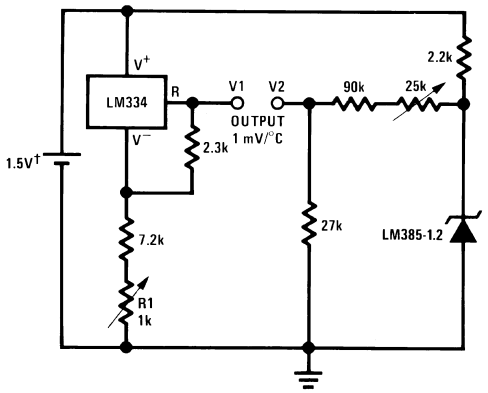


Calibration

1. Short LM385-1.2, adjust R3 for I_{OUT}= temp at 1.8μA/°K
2. Remove short, adjust R2 for correct reading in °F

Figure 23. 0°F−50°F Thermometer

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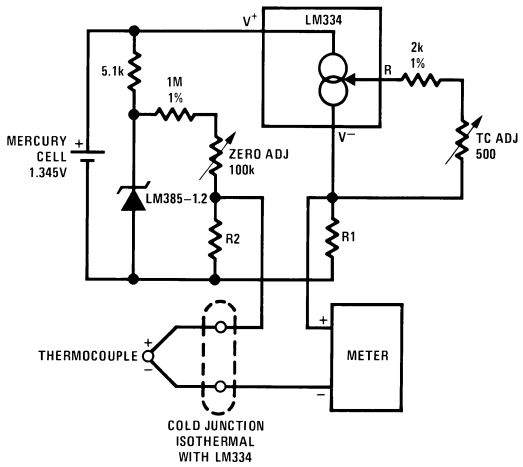
Calibration

1. Adjust R1 so that V1 = temp at 1mV/°K
2. Adjust V2 to 273.2mV

†I_Q for 1.3V to 1.6V battery voltage = 50µA to 150µA

Typical supply current 50µA

Figure 24. Centigrade Thermometer



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.

Figure 25. Micropower Thermocouple Cold Junction Compensator

Thermocouple Type	Seebeck Coefficient (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	953	12.17	11.17
S	6.4	63.4	150	1.908	1.766

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REVISION HISTORY SECTION

Released	Revision	Section	Originator	Changes
10/07/05	A	New Release, Corporate format	L. Lytle	2 MDS data sheets converted into one Corp. data sheet format. MNLM185-1.2-X Rev 2A3 and MNLM185BY-1.2-X Rev 0B0 data sheets will be archived.
03/27/13	A	All		Changed layout of National Data Sheet to TI format
01/07/14	B	Features, Electrical Characteristics, Typical Performance Characteristics	K. Kruckmeyer	Added post irradiation test limits and typical radiation drift plots for radiation qualified option.

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-8759401VXA	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759401VXA Q	Samples
5962-8759401VYA	ACTIVE	CFP	NAC	10	54	TBD	Call TI	Call TI	-55 to 125	LM185WG -1.2-QV Q 5962-87594 01VYA ACO 01VYA >T	Samples
5962-8759401XA	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759401XA Q	Samples
5962-8759401YA	ACTIVE	CFP	NAC	10	54	TBD	Call TI	Call TI	-55 to 125	LM185WG -1.2/883 Q 5962-87594 01YA ACO 01YA >T	Samples
5962-8759405XA	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759405XA Q	Samples
5962R8759461VXA	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	R8759461VXA Q	Samples
LM185BYH1.2-SMD	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759405XA Q	Samples
LM185H-1.2-QV	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759401VXA Q	Samples
LM185H-1.2-SMD	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	8759401XA Q	Samples
LM185H-1.2/883	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	LM185-1.2 Q	Samples
LM185H-1.2RLQV	ACTIVE	TO	NDU	2	20	TBD	Call TI	Call TI	-55 to 125	R8759461VXA Q	Samples
LM185WG-1.2-QV	ACTIVE	CFP	NAC	10	54	TBD	Call TI	Call TI	-55 to 125	LM185WG -1.2-QV Q 5962-87594 01VYA ACO 01VYA >T	Samples
LM185WG-1.2/883	ACTIVE	CFP	NAC	10	54	TBD	Call TI	Call TI	-55 to 125	LM185WG -1.2/883 Q 5962-87594 01YA ACO 01YA >T	Samples
LM185WG-1.2RLQV	PREVIEW	CFP	NAC	10	54	TBD	Call TI	Call TI	-55 to 125	LM185WG	

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
										-1.2RLQV Q (5962-87594 ~ 5962R87594) (01VYA ACO ~ 61VYA ACO) 01VYA >T	

(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) 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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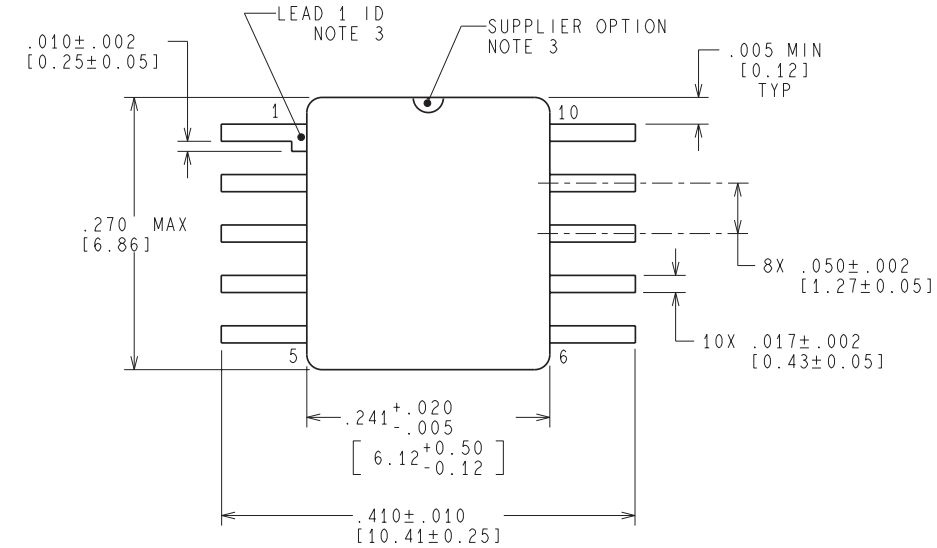
OTHER QUALIFIED VERSIONS OF LM185-1.2QML, LM185-1.2QML-SP :

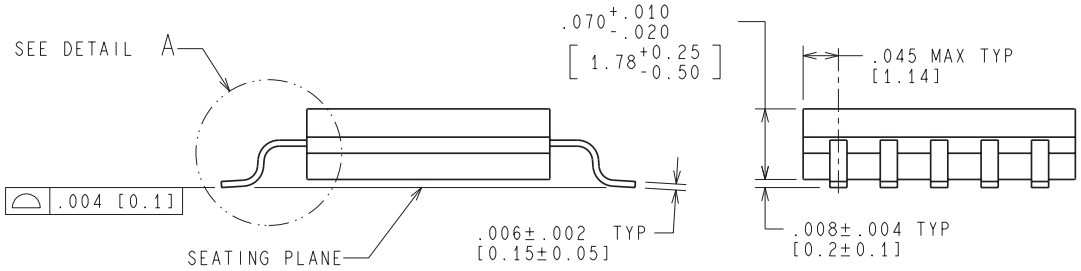
- Military: LM185-1.2QML
- Space: LM185-1.2QML-SP

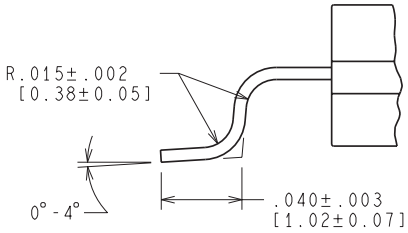
NOTE: Qualified Version Definitions:

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

NAC0010A





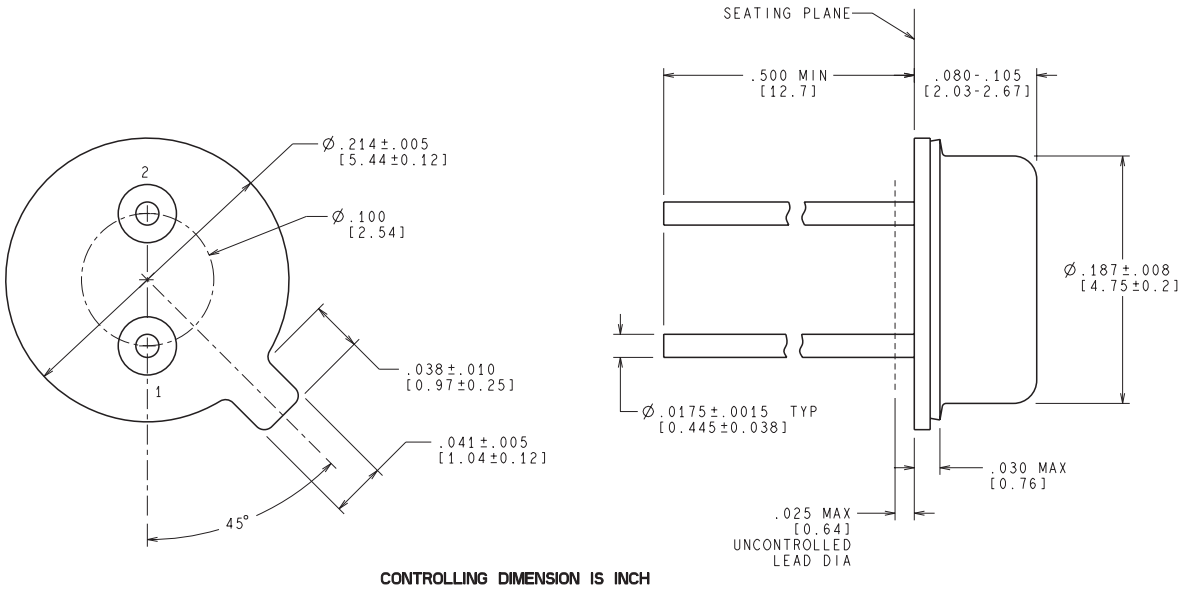


DETAIL A
TYPICAL

MIL-PRF-38535
CONFIGURATION CONTROL

WG10A (Rev H)

NDU0002A



CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

H02A (Rev F)

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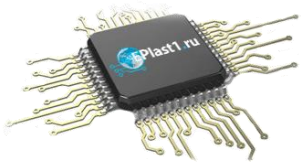
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