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 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.

Connection Diagram

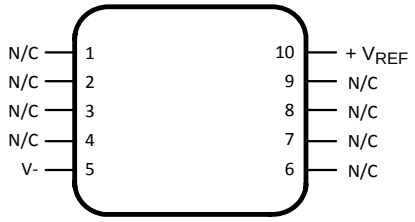


Figure 1. CLGA Package-Top View
See Package Number NAC

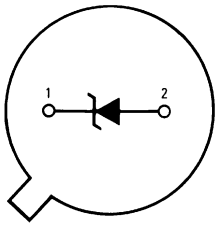


Figure 2. PFM Metal Can Package- Bottom View
See Package Number NDU

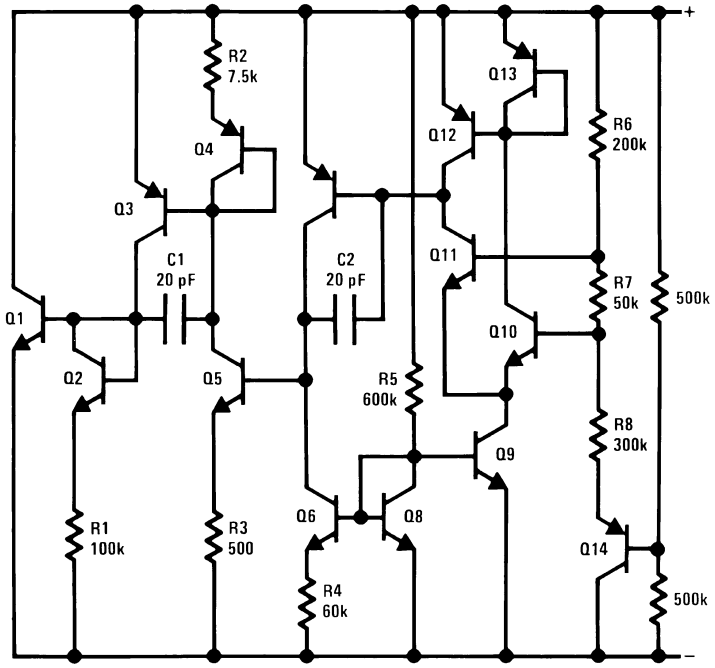
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Schematic Diagram



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			$-55°C \le T_A \le +125°C$
Storage Temperature			$-55°C \le T_A \le +150°C$
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 $P_{Dmax} = (T_{Jmax} - T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower.

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

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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 = 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

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 = 20µA		-10	10	mV	1
		I_R = 20mA		-10	10	mV	1

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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		(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 = 20µA		-10	10	mV	1
V_{Ref} 2	Reverse Breakdown Voltage	I_R = 20mA		-10	10	mV	1

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Typical Performance Characteristics

Reverse Characteristics

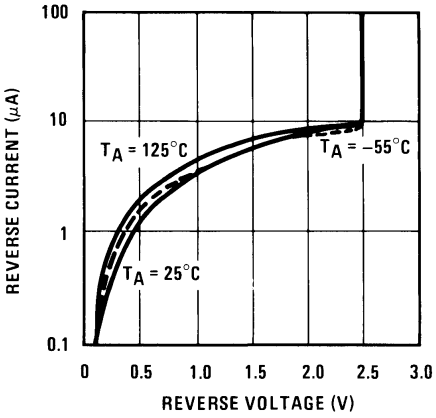


Figure 3.

Reverse Characteristics

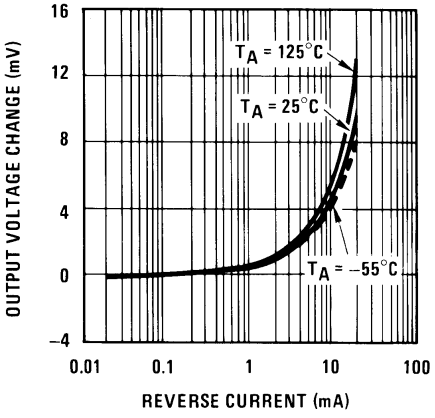


Figure 4.

Forward Characteristics

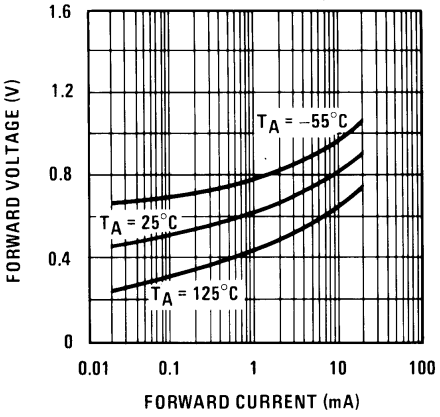


Figure 5.

Temperature Drift

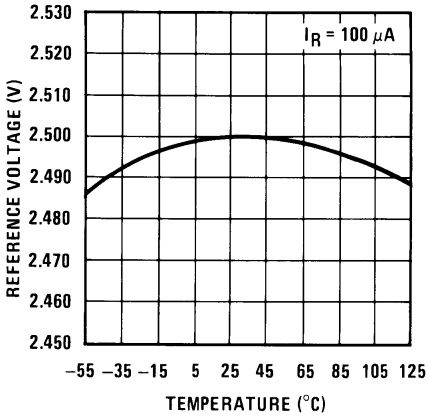


Figure 6.

Reverse Dynamic Impedance

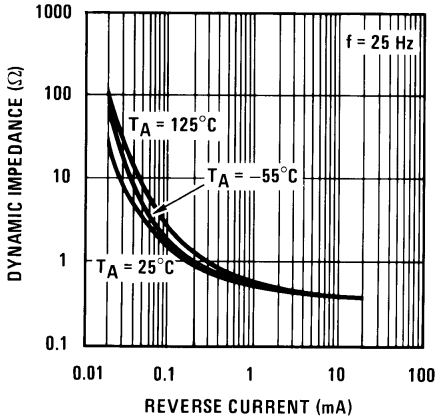


Figure 7.

Reverse Dynamic Impedance

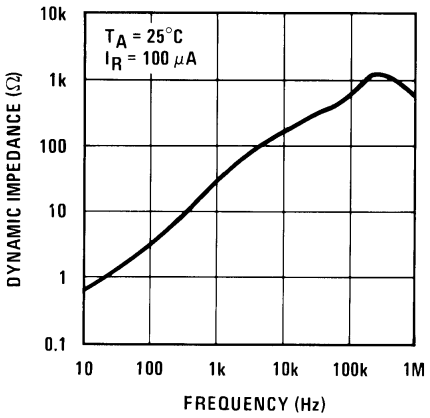


Figure 8.

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Typical Performance Characteristics (continued)

Noise Voltage

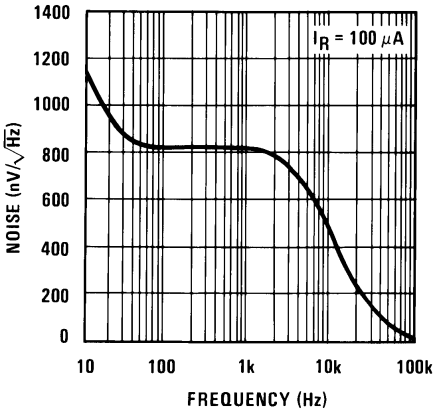


Figure 9.

Filtered Output Noise

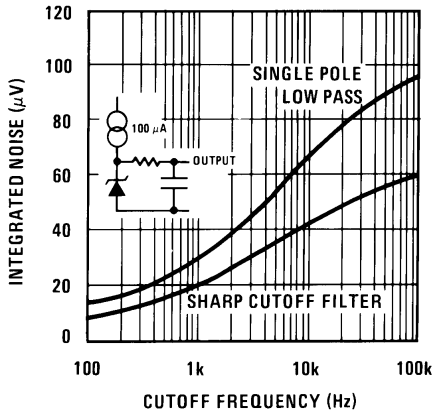


Figure 10.

Response Time

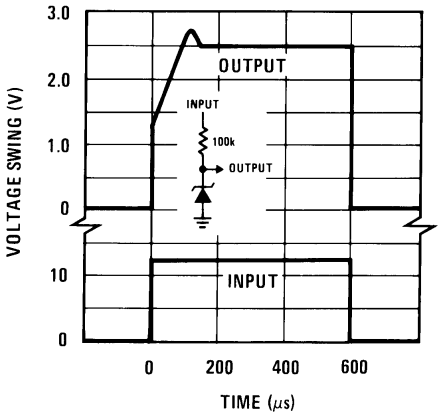


Figure 11.

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APPLICATIONS

Figure 12. Wide Input Range Reference

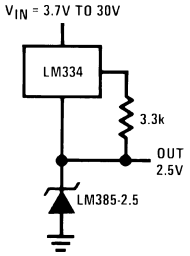


Figure 13. Micropower Reference from 9V Battery

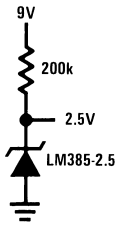
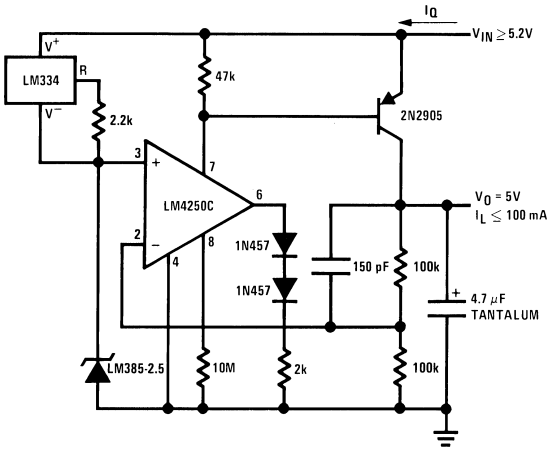
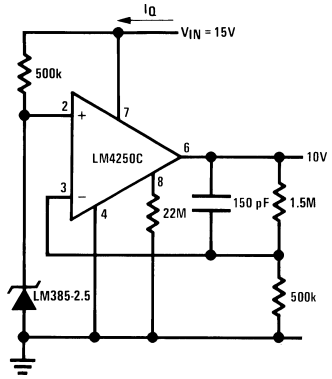


Figure 14. Micropower 5V Reference



$I_Q \approx 40\ \mu A$

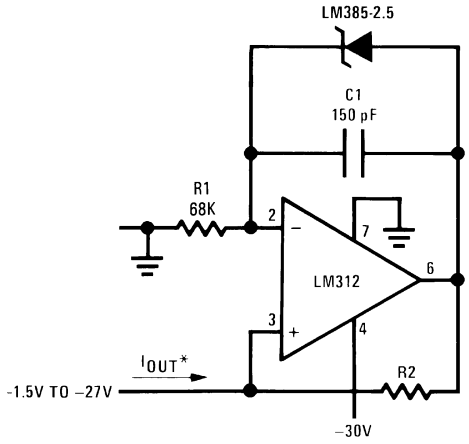
Figure 15. Micropower 10V Reference



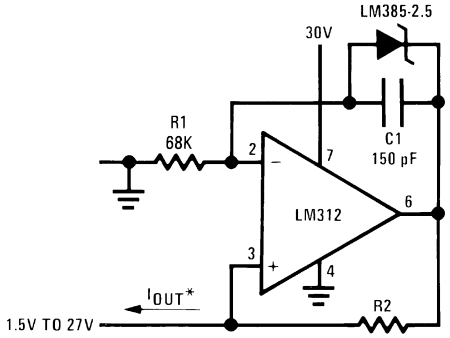
$I_Q \approx 30\ \mu A$ standby current

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Precision 1 µA to 1 mA Current Sources

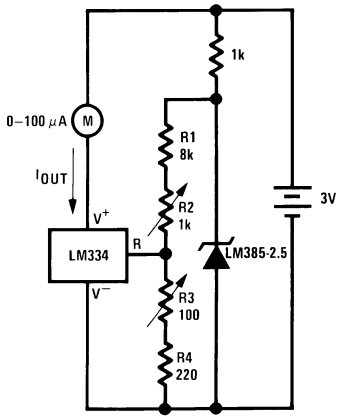


$^*I_{OUT} = \frac{2.5V}{R2}$



METER THERMOMETERS

Figure 16. 0°C–100°C Thermometer

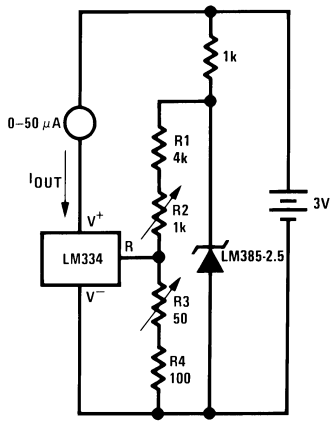


Calibration

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

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Figure 17. 0°F–50°F Thermometer



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

Figure 18. Improving Regulation of Adjustable Regulators

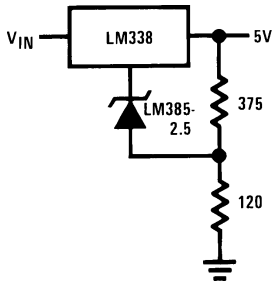
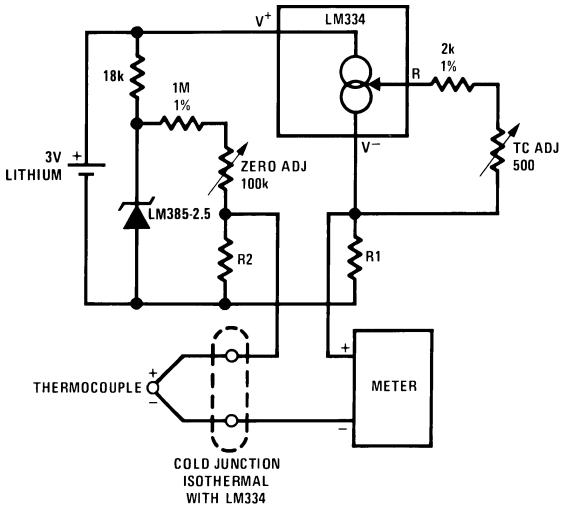


Figure 19. Micropower Thermocouple Cold Junction Compensator



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.

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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

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	A	All		Changed layout of National Data Sheet to TI format.

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PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
5962-8759402XA	Active	Production	TO (NDU) | 2	20 | TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	8759402XA Q
5962-8759402YA	Active	Production	CFP (NAC) | 10	54 | TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM185WG-2.5/883 Q 5962-87594 02YA ACO 02YA >T
5962-8759406VXA	Active	Production	TO (NDU) | 2	20 | JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	8759406VXA Q
LM185-2.5 MD8	Active	Production	DIESALE (Y) | 0	100 | JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	
LM185-2.5-MD8.A	Active	Production	DIESALE (Y) | 0	100 | JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	
LM185BYH2.5-QV	Active	Production	TO (NDU) | 2	20 | JEDEC TRAY (5+1)	No	Call TI	Level-1-NA-UNLIM	-55 to 125	8759406VXA Q
LM185BYH2.5-QV.A	Active	Production	TO (NDU) | 2	20 | JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	8759406VXA Q
LM185BYH2.5/883	Active	Production	TO (NDU) | 2	20 | TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	LM185BY2.5 Q
LM185H-2.5-SMD	Active	Production	TO (NDU) | 2	20 | TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	8759402XA Q
LM185H-2.5/883	Active	Production	TO (NDU) | 2	20 | TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	LM185-2.5 Q
LM185H-2.5/883.A	Active	Production	TO (NDU) | 2	20 | TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	LM185-2.5 Q
LM185WG-2.5/883	Active	Production	CFP (NAC) | 10	54 | TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM185WG-2.5/883 Q 5962-87594 02YA ACO 02YA >T
LM185WG-2.5/883.A	Active	Production	CFP (NAC) | 10	54 | TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM185WG-2.5/883 Q 5962-87594 02YA ACO 02YA >T

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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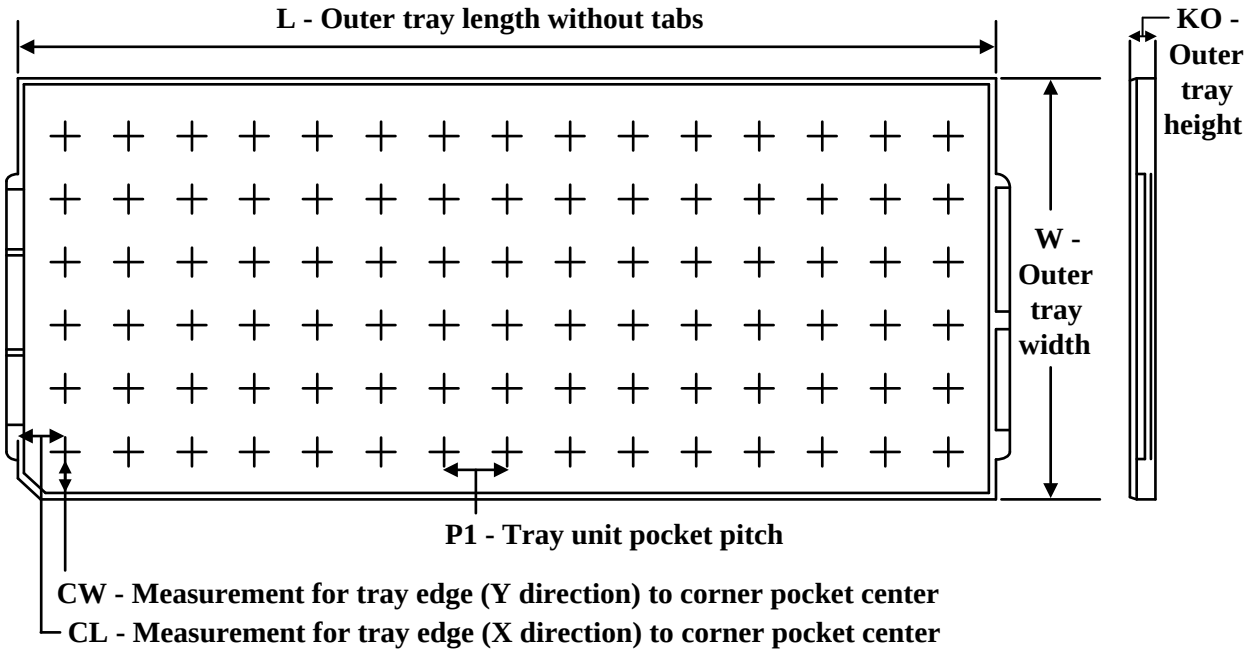
OTHER QUALIFIED VERSIONS OF LM185-2.5QML, LM185-2.5QML-SP :

- 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

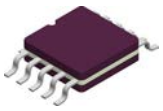
TRAY



Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
5962-8759402XA	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
5962-8759406VXA	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185BYH2.5-QV	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185BYH2.5-QV.A	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185BYH2.5/883	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185H-2.5-SMD	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185H-2.5/883	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185H-2.5/883.A	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2

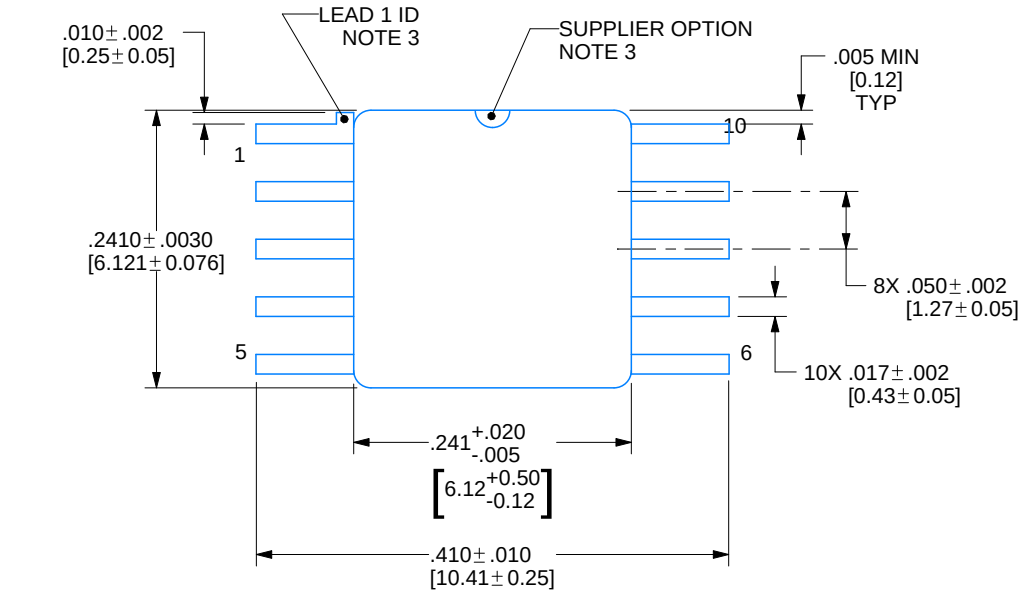


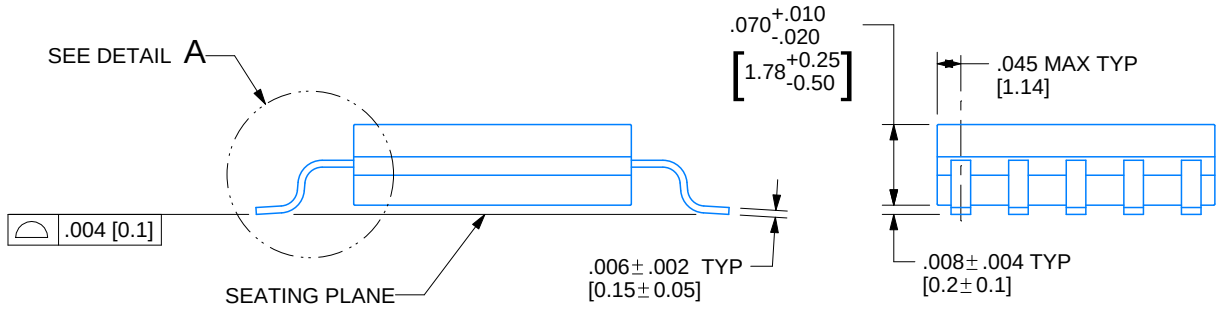
PACKAGE OUTLINE

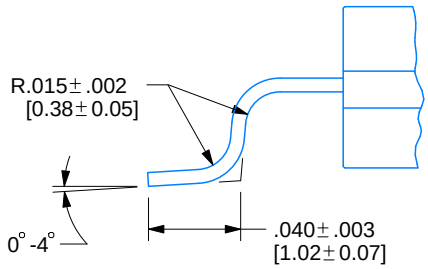
NAC0010A

CFP - 2.33mm max height

CERAMIC FLATPACK







DETAIL A
TYPICAL

4215196/D 08/2022

NOTES:

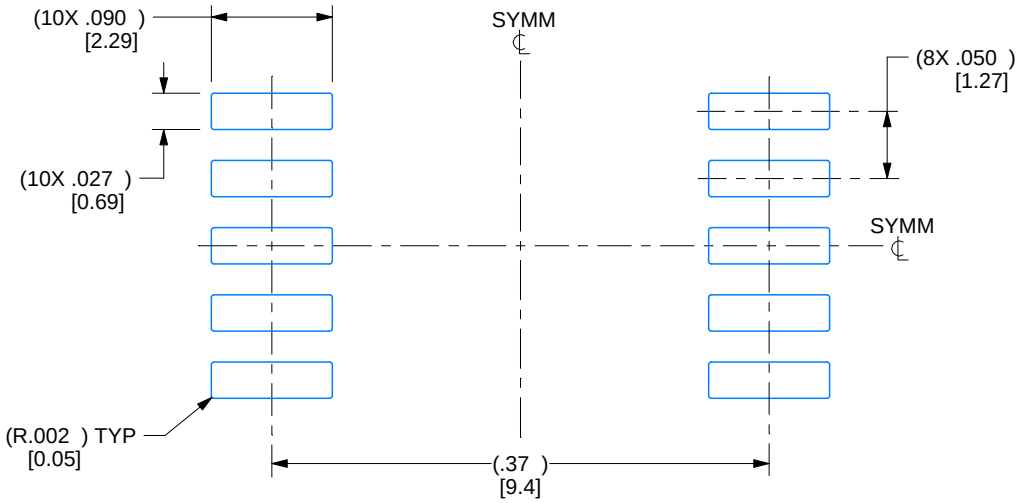
1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. For solder thickness and composition, see the "Lead Finish Composition/Thickness" link in the packaging section of the Texas Instruments website
3. Lead 1 identification shall be:
   a) A notch or other mark within this area
   b) A tab on lead 1, either side
4. No JEDEC registration as of December 2021

EXAMPLE BOARD LAYOUT

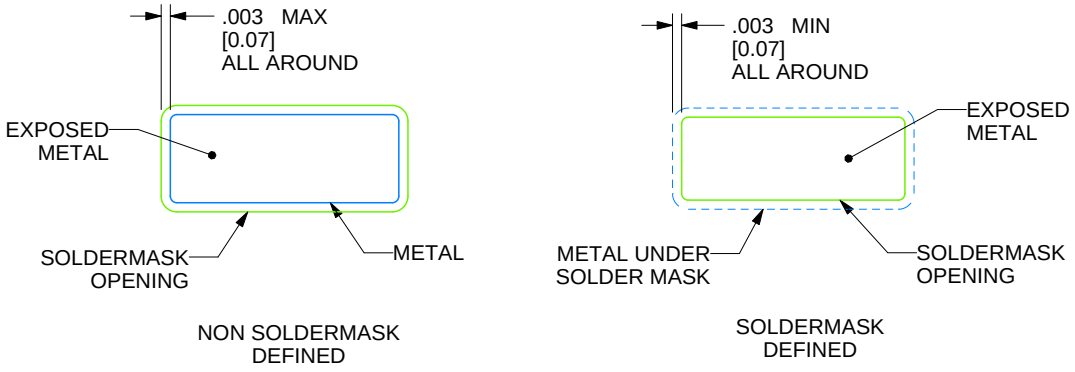
NAC0010A

CFP - 2.33mm max height

CERAMIC FLATPACK



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 7X



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REVISIONS

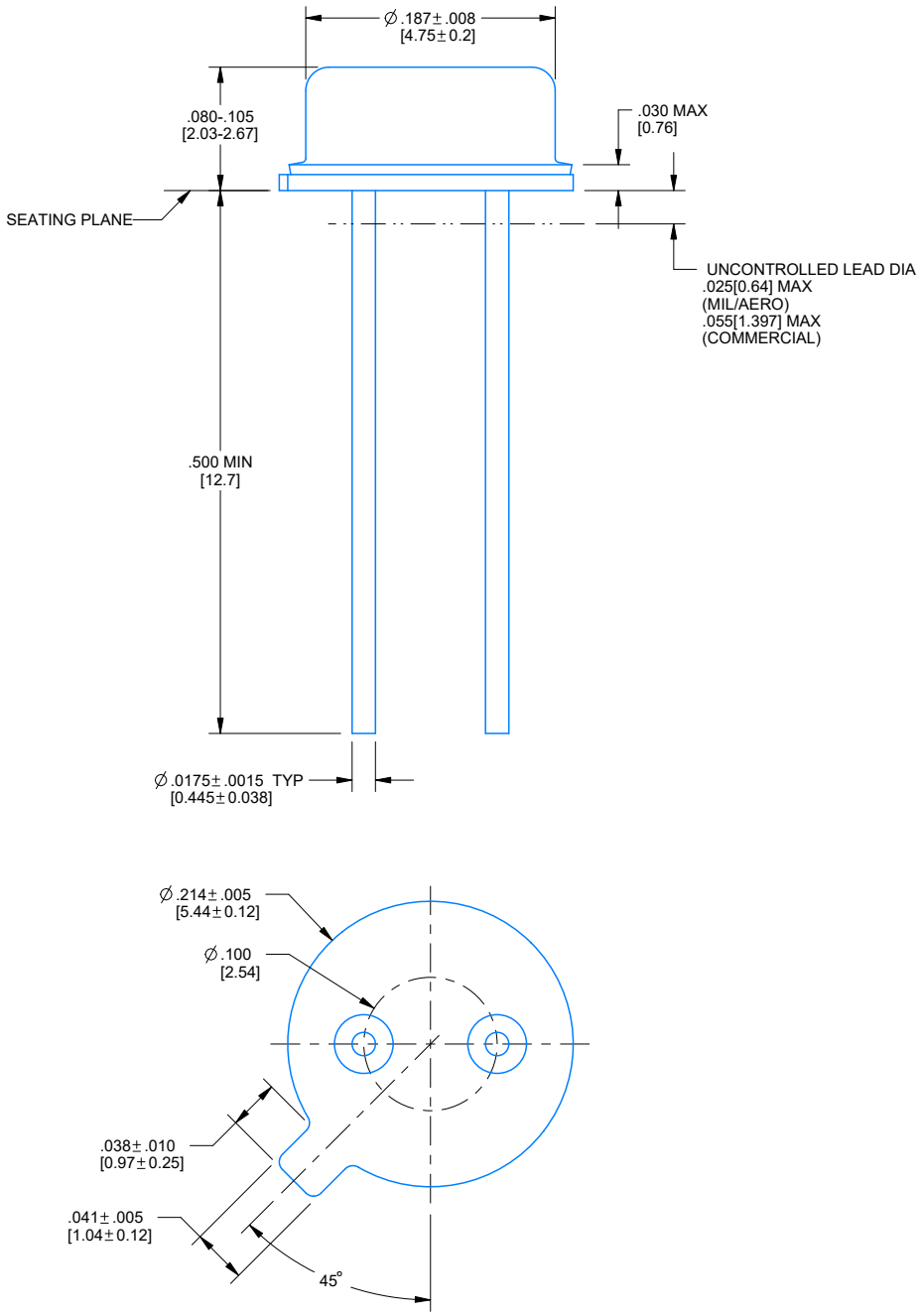
REV	DESCRIPTION	E.C.N.	DATE	BY/APP'D
A	RELEASE TO DOCUMENT CONTROL	2197877	12/30/2021	DAVID CHIN / ANIS FAUZI
B	NO CHANGE TO DRAWING; REVISION FOR YODA RELEASE;	2198820	02/14/2022	K. SINCERBOX
C	CHANGE PIN 1 ID LOCATION ON PIN	2198845	02/18/2022	D. CHIN / K. SINCERBOX
D	.2410± .0030 WAS .2700 +.0012/-.0002;	2200915	08/08/2022	D. CHIN / K. SINCERBOX

PACKAGE OUTLINE

NDU0002A

TO-CAN - 2.67 mm max height

TRANSISTOR OUTLINE



4214762/B 09/2024

NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

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