

## Micropower Voltage Reference Diode

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

### FEATURES

- **Operating Current of 20  $\mu$ A to 20 mA**
- **0.6 $\Omega$  Dynamic Impedance (A grade)**
- **Low Temperature Coefficient**
- **Low Voltage Reference—2.5V**

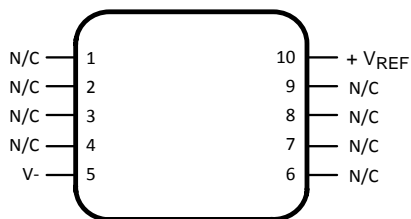
### DESCRIPTION

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

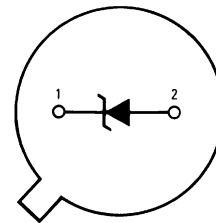
Careful design of the LM185-2.5 has made the device exceptionally tolerant of capacitive loading, making it easy to use in almost any reference application. The wide dynamic operating range allows its use with widely varying supplies with excellent regulation.

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



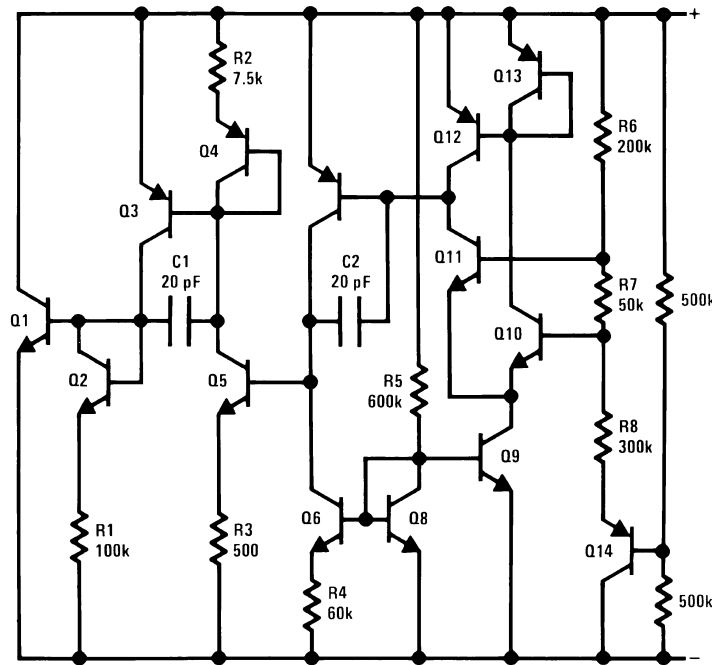
**Figure 2. PFM Metal Can Package- Bottom View**  
See Package Number NDU



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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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<sup>(1)</sup>

Reverse Current		30 mA	
Forward Current		10 mA	
Operating Temperature Range		-55°C ≤ T <sub>A</sub> ≤ +125°C	
Storage Temperature		-55°C ≤ T <sub>A</sub> ≤ +150°C	
Maximum Junction Temperature (T <sub>Jmax</sub> ) <sup>(2)</sup>		150°C	
Lead Temperature (Soldering, 10 sec)	PFM Metal Can	300°C	
	Ceramic CLGA	260°C	
Thermal Resistance	θ <sub>JA</sub>	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 <sub>JC</sub>	PFM Metal Can	57°C/W
		Ceramic CLGA	23°C/W
Package Weight (Typical)	PFM Metal Can	TBD	
	Ceramic CLGA	210 mg	
ESD Tolerance <sup>(3)</sup>		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<sub>Jmax</sub> (maximum junction temperature), θ<sub>JA</sub> (package junction to ambient thermal resistance), and T<sub>A</sub> (ambient temperature). The maximum allowable power dissipation at any temperature is P<sub>Dmax</sub> = (T<sub>Jmax</sub> - T<sub>A</sub>)/θ<sub>JA</sub> 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<sup>(1)</sup>**

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

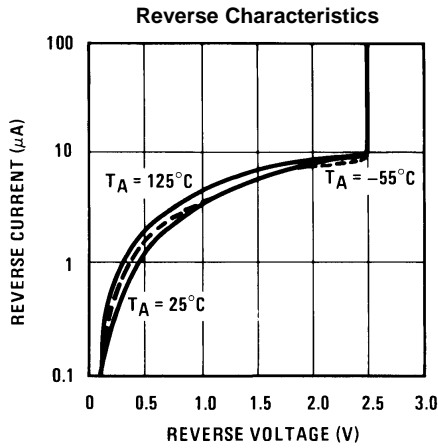


Figure 3.

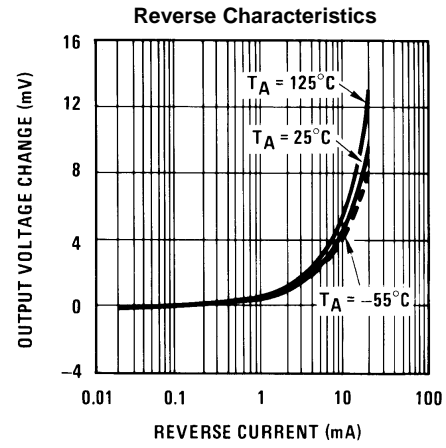


Figure 4.

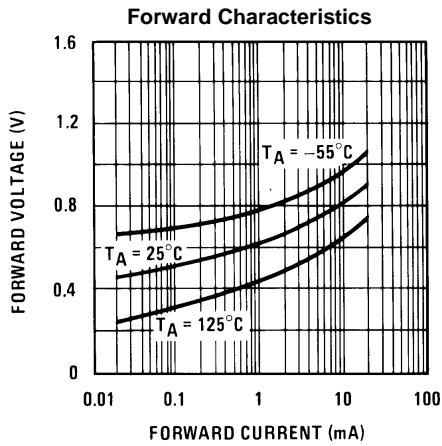


Figure 5.

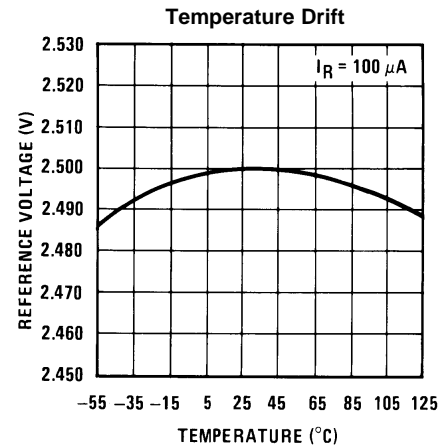


Figure 6.

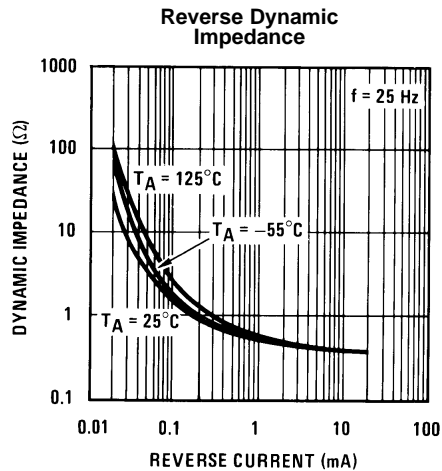


Figure 7.

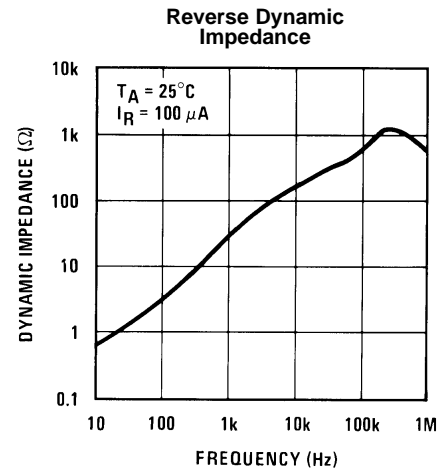


Figure 8.

Typical Performance Characteristics (continued)

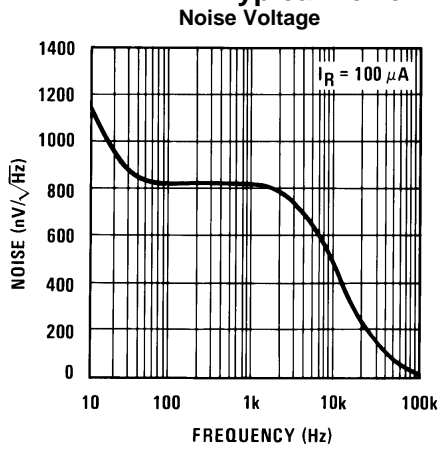


Figure 9.

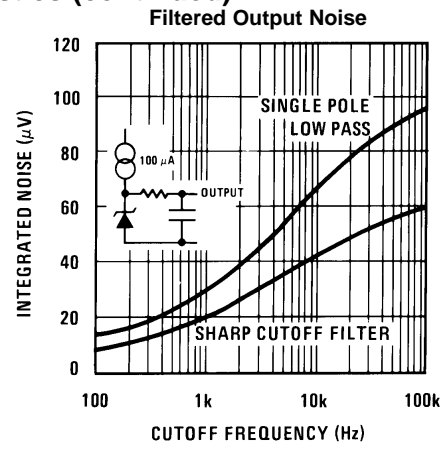


Figure 10.

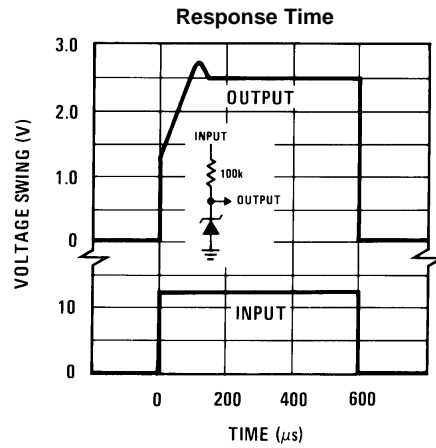


Figure 11.

APPLICATIONS

Figure 12. Wide Input Range Reference

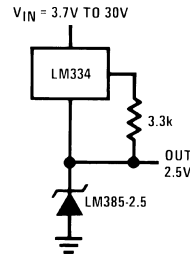


Figure 13. Micropower Reference from 9V Battery

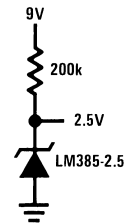
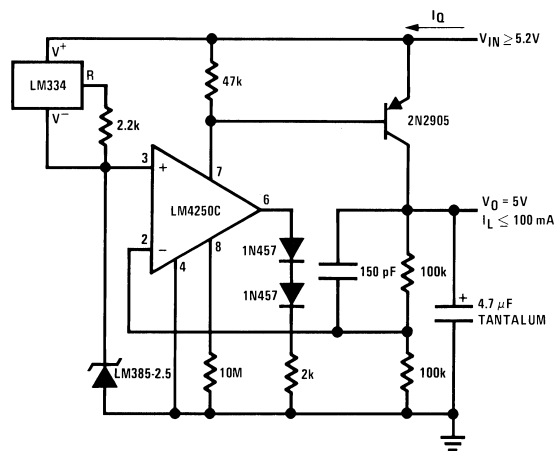
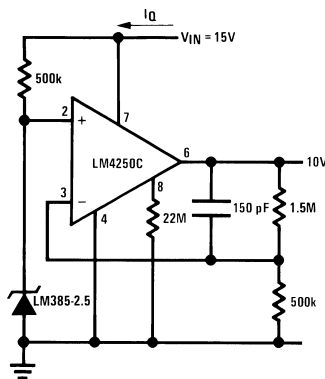


Figure 14. Micropower 5V Reference



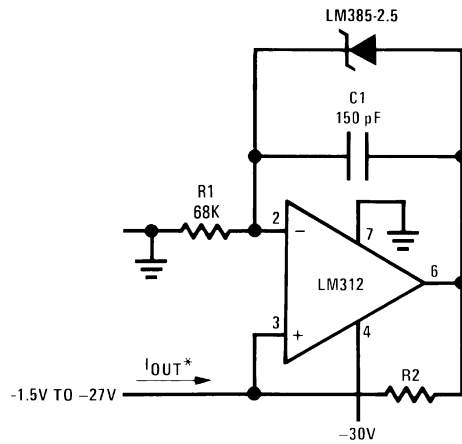
$I_Q \approx 40 \mu A$

Figure 15. Micropower 10V Reference

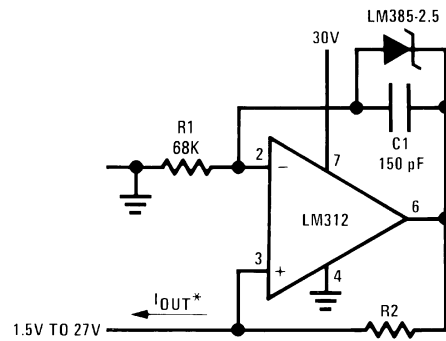


$I_Q \approx 30 \mu A$  standby current

Precision 1 μA to 1 mA Current Sources

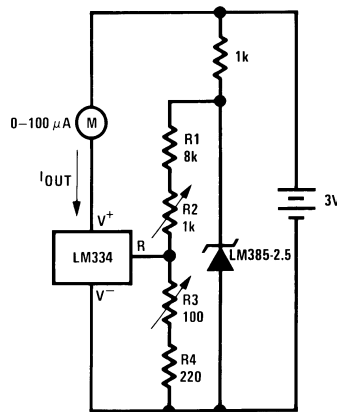


$$I_{OUT} = \frac{2.5V}{R_2}$$



METER THERMOMETERS

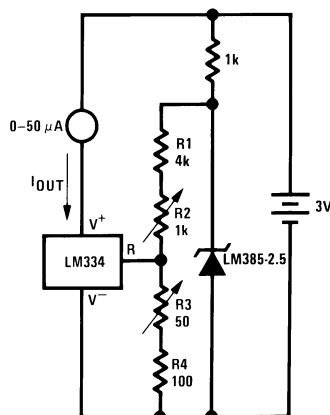
Figure 16. 0°C–100°C Thermometer



Calibration

1. Short LM385-2.5, adjust R3 for I<sub>OUT</sub>= temp at 1μA/°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

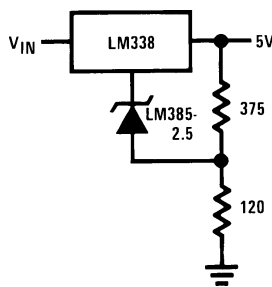
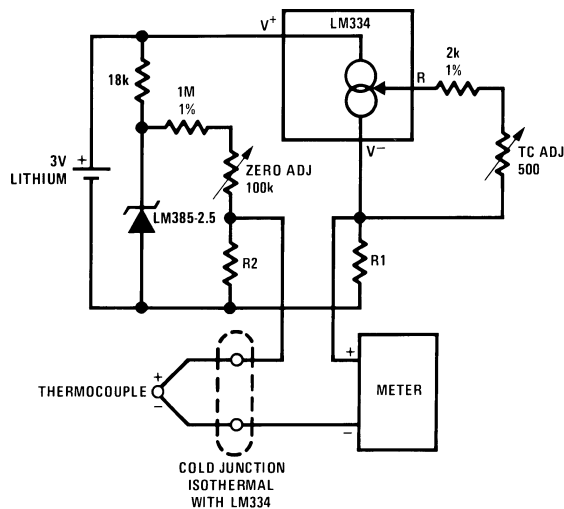


Figure 19. Micropower Thermocouple Cold Junction Compensator



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 ( $\Omega$ )	R2 ( $\Omega$ )	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 $\Omega$	12.17	11.17
S	6.4	63.4	150 $\Omega$	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.

**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)
<a href="#">5962-8759402XA</a>	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	
<a href="#">LM185BYH2.5-QV</a>	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)	No	Call TI	Call TI	-55 to 125	8759406VXA Q
<a href="#">LM185BYH2.5/883</a>	Active	Production	TO (NDU)   2	20   TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	LM185BY2.5 Q
<a href="#">LM185H-2.5-SMD</a>	Active	Production	TO (NDU)   2	20   TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	8759402XA Q
<a href="#">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
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
<a href="#">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
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.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

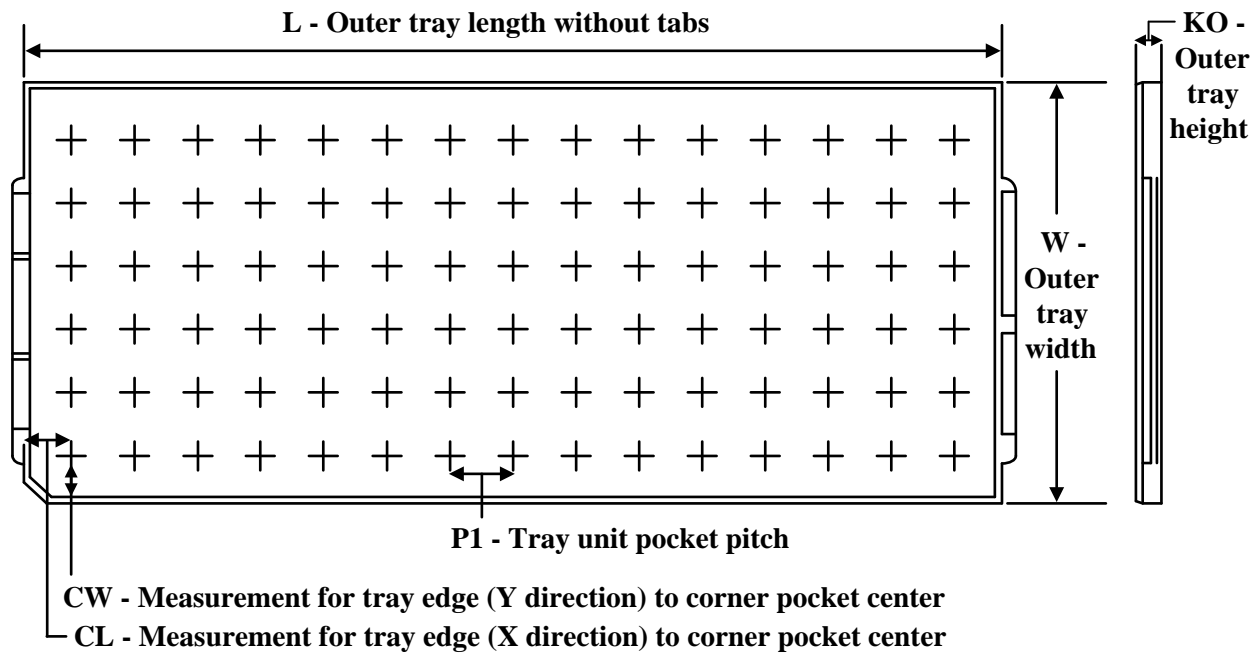
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**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

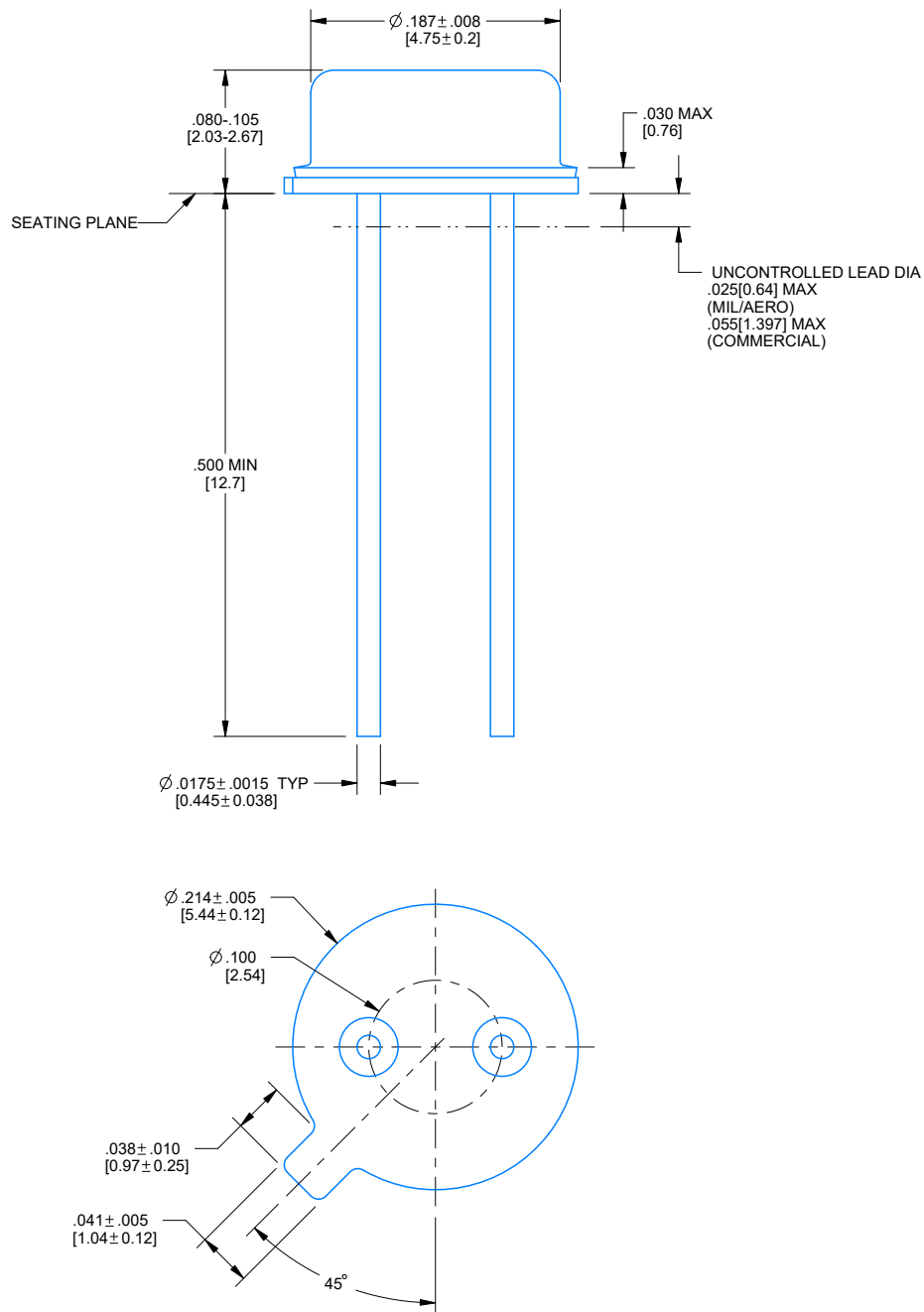
Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
5962-8759402XA	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
5962-8759402YA	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08
5962-8759406VXA	NDU	TO-CAN	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
LM185WG-2.5/883	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08
LM185WG-2.5/883.A	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08

# 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.

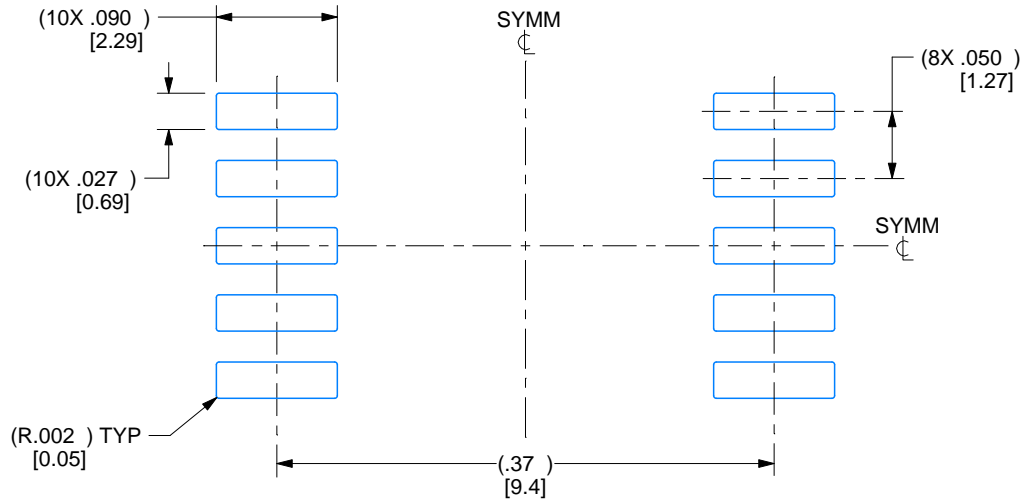


# EXAMPLE BOARD LAYOUT

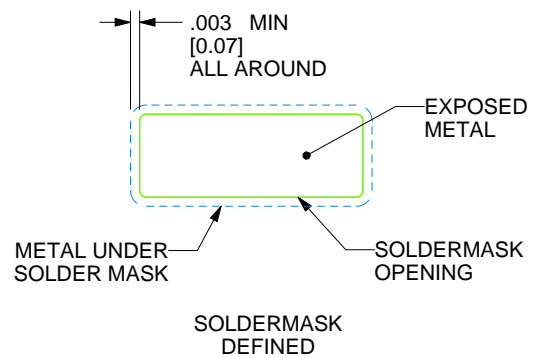
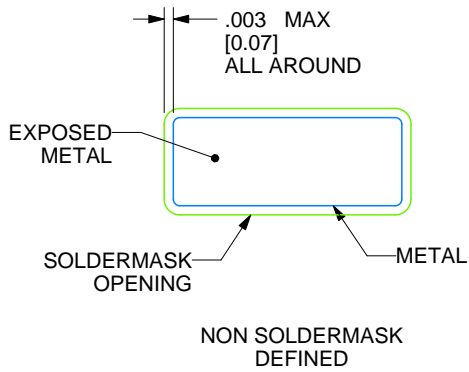
NAC0010A

CFP - 2.33mm max height

CERAMIC FLATPACK



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 7X



4215196/D 08/2022

## 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

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