

## LM185-1.2QML Micropower Voltage Reference Diode

Check for Samples: [LM185-1.2QML](#)

### FEATURES

- Operating Current of  $10\mu\text{A}$  to  $20\text{mA}$
- $1\Omega$  Maximum Dynamic Impedance (Typical)
- Low Temperature Coefficient
- Radiation Qualified Option
  - $100\text{ krad}$
  - Low Dose Rate Tested at  $10\text{ mrad/s}$

### DESCRIPTION

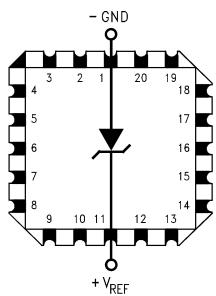
The LM185-1.2 is a micropower 2-terminal band-gap voltage regulator diodes. Operating over a  $10\mu\text{A}$  to  $20\text{mA}$  current range, it features exceptionally low dynamic impedance and good temperature stability. On-chip trimming is used to provide tight voltage tolerance. Since the LM185-1.2 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.

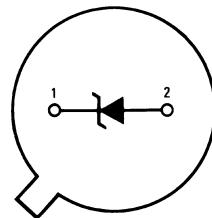
The extremely low power drain of the LM185-1.2 makes it useful for micropower circuitry. This voltage reference can be used to make portable meters, regulators or general purpose analog circuitry with battery life approaching shelf life.

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

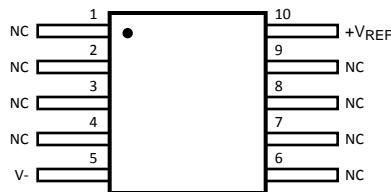


**Figure 2. TO Package – Bottom View**  
See Package Number NDU0002A



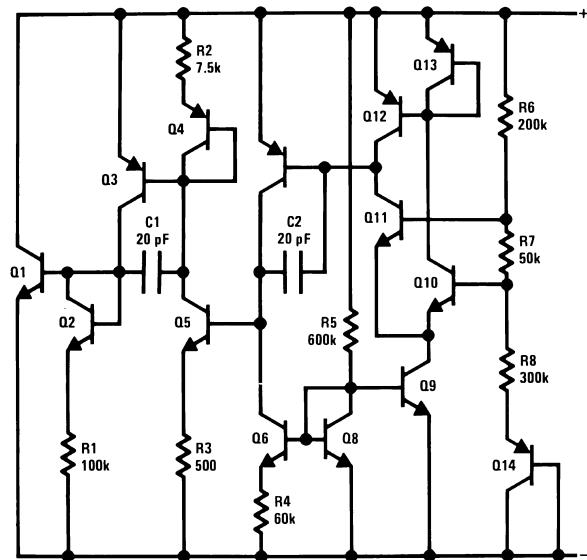
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**Figure 3. CLGA Package**  
See Package Number NAC0010A

### 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.

**Absolute Maximum Ratings<sup>(1)</sup>**

Reverse Current			30mA
Forward Current			10mA
Operating Temperature Range			-55°C ≤ T <sub>A</sub> ≤ +125°C
Maximum Junction Temperature (T <sub>Jmax</sub> ) <sup>(2)</sup>			+150°C
Storage Temperature			-55°C ≤ T <sub>A</sub> ≤ +150°C
Lead Temperature (Soldering 10 Seconds)	CLGA		260°C
	TO package		300°C
	20LD LCCC package		300°C
Thermal Resistance	θ <sub>JA</sub>	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 <sub>JC</sub>	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 <sup>(3)</sup>			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<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, 1.5KΩ 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

**LM185–1.2 Electrical Characteristics DC Parameters**

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
$V_{\text{Ref}}$	Reverse Breakdown Voltage	$I_R = 10\mu\text{A}$		1.223	1.247	V	1
		$I_R = 20\mu\text{A}$		1.205	1.26	V	2, 3
		$I_R = 1\text{mA}$		1.223	1.247	V	1
				1.205	1.26	V	2, 3
		$I_R = 20\text{mA}$		1.223	1.247	V	1
				1.205	1.26	V	2, 3
$\Delta V_{\text{Ref}} / \Delta I_R$	Reverse Breakdown Voltage Change with Current	$10\mu\text{A} \leq I_R \leq 1\text{mA}$		-1.0	1.0	mV	1
		$20\mu\text{A} \leq I_R \leq 1\text{mA}$		-1.5	1.5	mV	2, 3
		$1\text{mA} \leq I_R \leq 20\text{mA}$		-10.0	10.0	mV	1
				-20.0	20.0	mV	2, 3
$V_F$	Forward Bias Voltage	$I_F = 2\text{mA}$		-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	$I_R = 10\mu\text{A}$		-0.01	0.01	V	1
		$I_R = 20\text{mA}$		-0.01	0.01	V	1

**LM185BY–1.2 Electrical Characteristics DC Parameters**

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
$V_{\text{Ref}}$	Reverse Breakdown Voltage	$I_R = 10\mu\text{A}$		1.223	1.247	V	1
		$I_R = 20\mu\text{A}$		1.205	1.26	V	2, 3
		$I_R = 1\text{mA}$		1.223	1.247	V	1
				1.205	1.26	V	2, 3
		$I_R = 20\text{mA}$		1.223	1.247	V	1
				1.205	1.26	V	2, 3
$\Delta V_{\text{Ref}} / \Delta I_R$	Reverse Breakdown Voltage Change with Current	$10\mu\text{A} \leq I_R \leq 1\text{mA}$		-1.0	1.0	mV	1
		$20\mu\text{A} \leq I_R \leq 1\text{mA}$		-1.5	1.5	mV	2, 3
		$1\text{mA} \leq I_R \leq 20\text{mA}$		-10.0	10.0	mV	1
				-20.0	20.0	mV	2, 3
$V_F$	Forward Bias Voltage	$I_F = 2\text{mA}$		-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  $T_{\text{Min}}$  &  $T_{\text{Max}}$ , divided by  $(T_{\text{Max}} - T_{\text{Min}})$ . The measured temperatures ( $T_{\text{Measured}}$ ) are  $-55^{\circ}\text{C}$ ,  $25^{\circ}\text{C}$ , &  $125^{\circ}\text{C}$  or  $\Delta V_{\text{Ref}} / (T_{\text{Max}} - T_{\text{Min}})$

**LM185-1.2RLQV SMD 5962R8759461 Post 100 krad Electrical Characteristics DC Parameters<sup>(1)(2)</sup>**

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
$\Delta V_{\text{Ref}}$	Change in Reverse Breakdown Voltage	$I_R = 10\mu\text{A}$	(3)	-3	3	%	1
		$I_R = 1\text{mA}$	(3)	-3	3	%	1
		$I_R = 20\text{mA}$	(3)	-2.5	2.5	%	1
$\Delta V_{\text{Ref}} / \Delta I_R$	Reverse Breakdown Voltage Change with Current	$10\mu\text{A} \leq I_R \leq 1\text{mA}$		-15	15	mV	1
		$1\text{mA} \leq I_R \leq 20\text{mA}$		-25	25	mV	1
$V_F$	Forward Bias Voltage	$I_F = 2\text{mA}$		-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.

### Typical Performance Characteristics

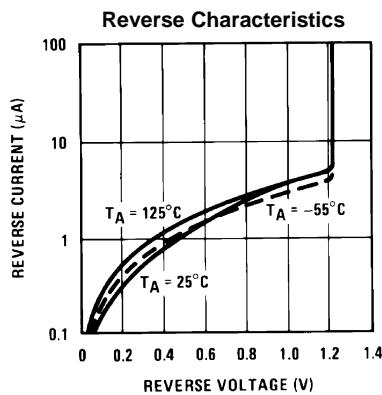


Figure 4.

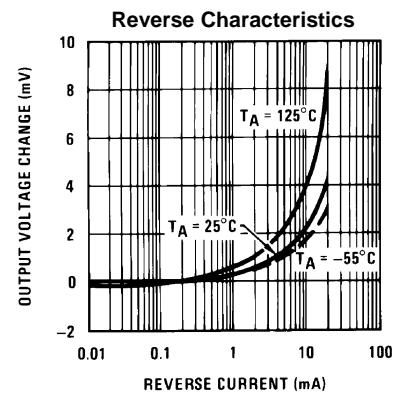


Figure 5.

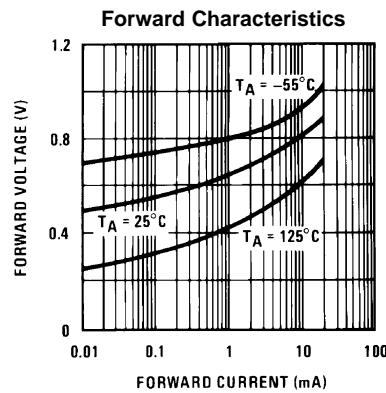


Figure 6.

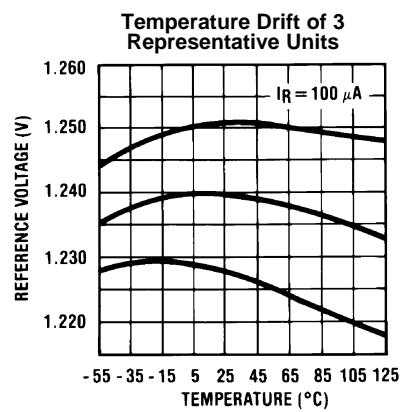


Figure 7.

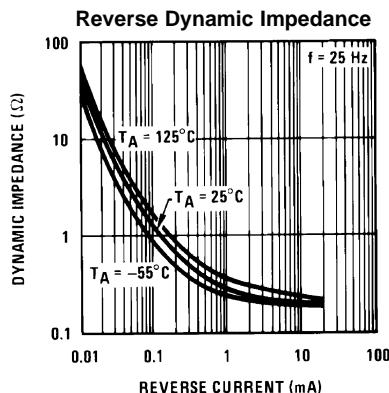


Figure 8.

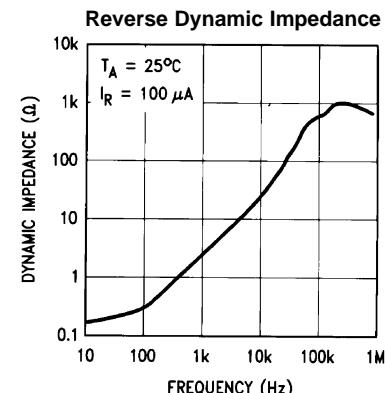
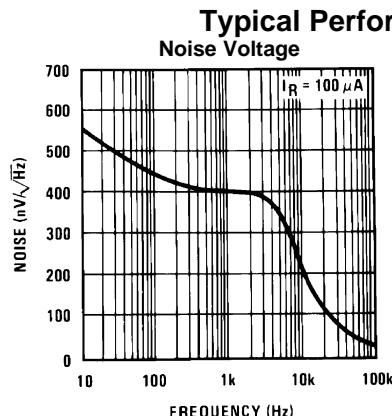
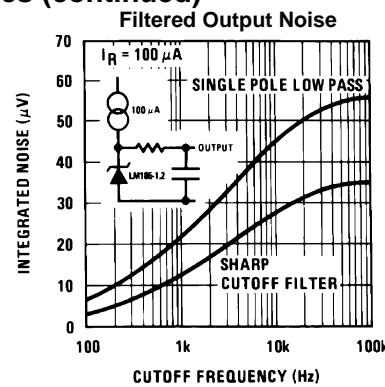
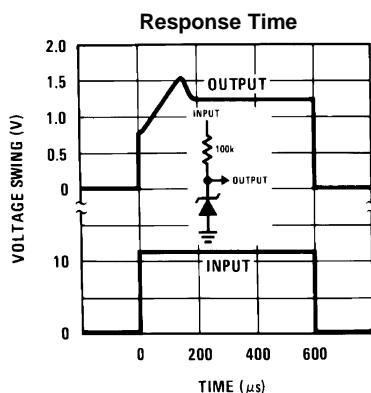
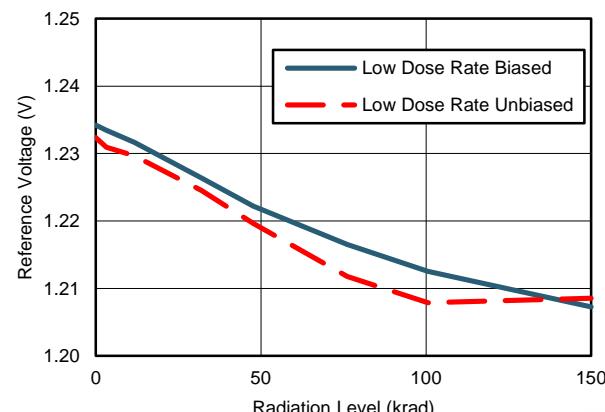
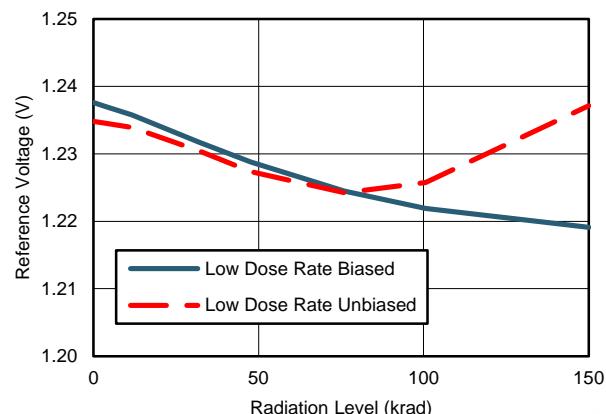


Figure 9.


**Figure 10.**

**Figure 11.**

**Figure 12.**

**Figure 13.  $V_{Ref}$  Radiation Drift at  $I_R = 10 \mu A$** 

**Figure 14.  $V_{Ref}$  Radiation Drift at  $I_R = 20 \text{ mA}$**

### Typical Applications

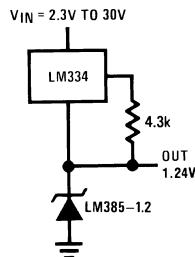


Figure 15. Wide Input Range Reference

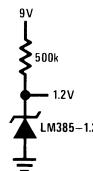


Figure 16. Micropower Reference from 9V Battery

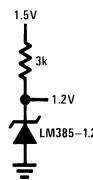
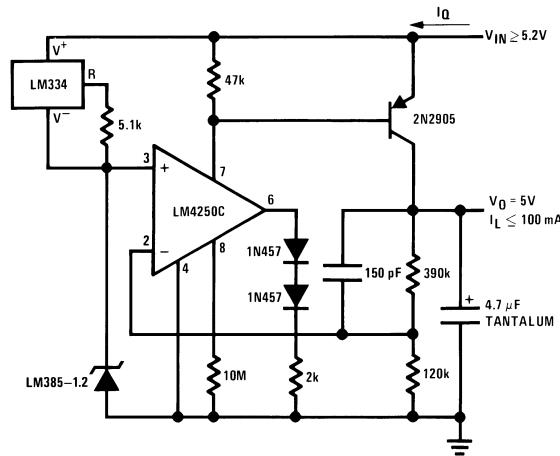
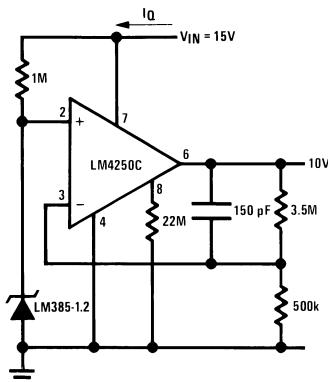


Figure 17. Reference from 1.5V Battery



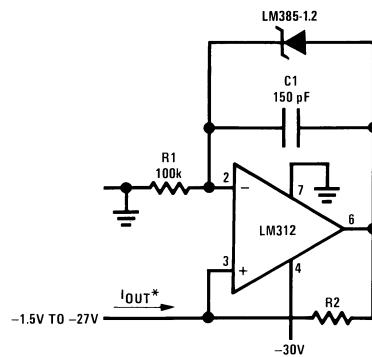
\* $I_Q \approx 30\mu A$

Figure 18. Micropower\* 5V Regulator



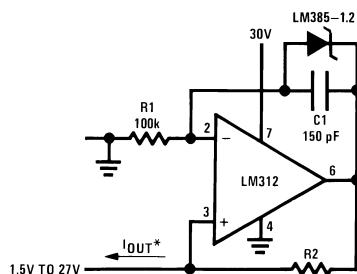
$*I_Q \approx 20\mu A$  standby current

**Figure 19. Micropower\* 10V Reference**

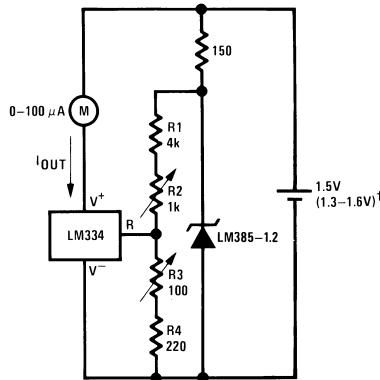


$$*I_{OUT} = \frac{1.23V}{R_2}$$

**Figure 20. Precision 1µA to 1mA Current Sources**



## METER THERMOMETERS



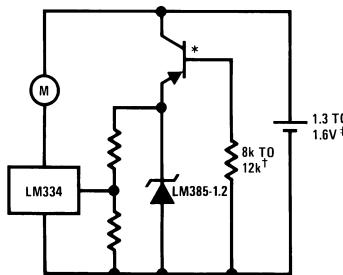
## Calibration

1. Short LM385-1.2, adjust R3 for  $I_{OUT} = \text{temp at } 1\mu\text{A}/\text{K}$
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

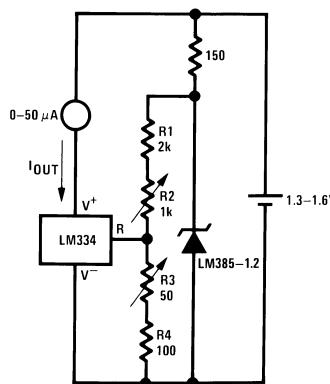


\*2N3638 or 2N2907 select for inverse  $H_{FE} \approx 5$

†Select for operation at 1.3V

‡ $I_Q \approx 600\mu\text{A}$  to 900μA

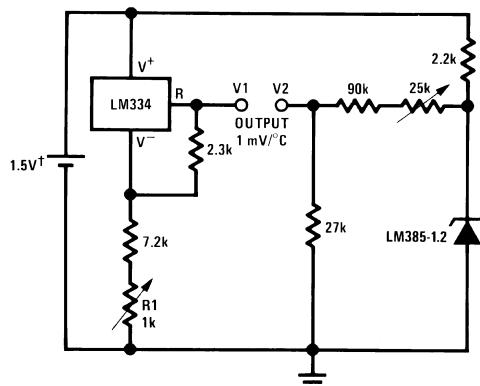
Figure 22. Lower Power Thermometer



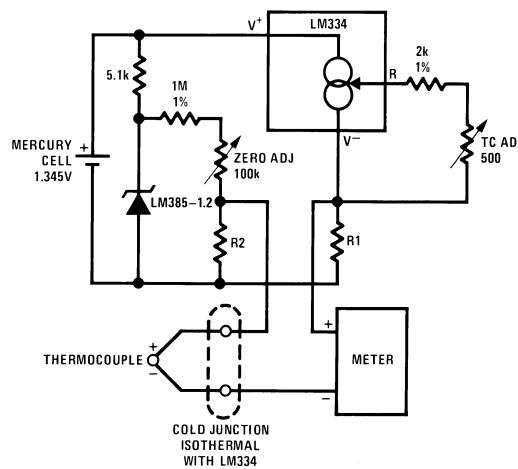
## Calibration

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

Figure 23. 0°F-50°F Thermometer


**Calibration**

1. Adjust R1 so that V1 = temp at 1mV/°K
  2. Adjust V2 to 273.2mV
- $\dagger I_Q$  for 1.3V to 1.6V battery voltage = 50 $\mu$ A to 150 $\mu$ A  
Typical supply current 50 $\mu$ A

**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 ( $\mu$ V/°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	12.17	11.17
S	6.4	63.4	150	1.908	1.766

**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.

**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)
5962-8759401XA	Active	Production	TO (NDU)   2	20   TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	8759401XA Q
5962-8759401YA	Active	Production	CFP (NAC)   10	54   TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM185WG -1.2/883 Q 5962-87594 01YA ACO 01YA >T
5962-8759405XA	Active	Production	TO (NDU)   2	20   TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	8759405XA Q
5962R8759461VXA	Active	Production	TO (NDU)   2	20   TUBE	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	R8759461VXA Q
LM185BYH1.2-SMD	Active	Production	TO (NDU)   2	20   TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	8759405XA Q
LM185H-1.2-SMD	Active	Production	TO (NDU)   2	20   TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	8759401XA Q
LM185H-1.2/883	Active	Production	TO (NDU)   2	20   TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	LM185-1.2 Q
LM185H-1.2RLQV	Active	Production	TO (NDU)   2	20   TUBE	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	R8759461VXA Q
LM185WG-1.2/883	Active	Production	CFP (NAC)   10	54   TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM185WG -1.2/883 Q 5962-87594 01YA ACO 01YA >T

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **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.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **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.

<sup>(5)</sup> **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.

<sup>(6)</sup> **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.

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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.

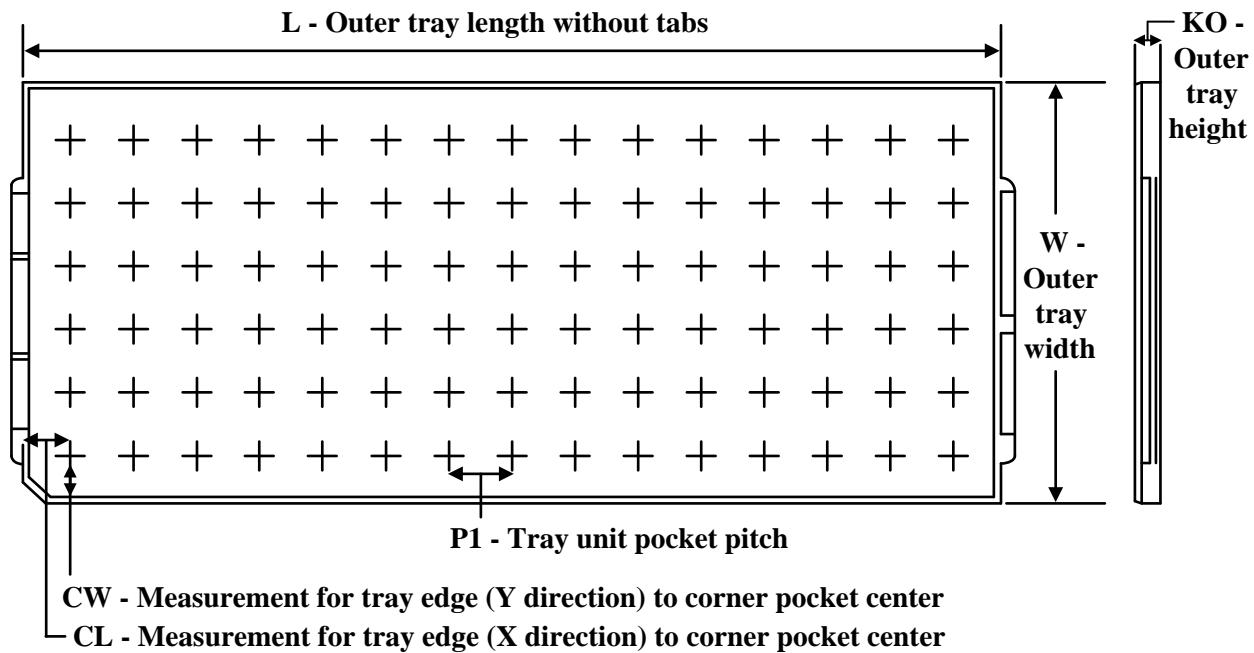
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF LM185-1.2QML, 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

**TRAY**


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

\*All dimensions are nominal

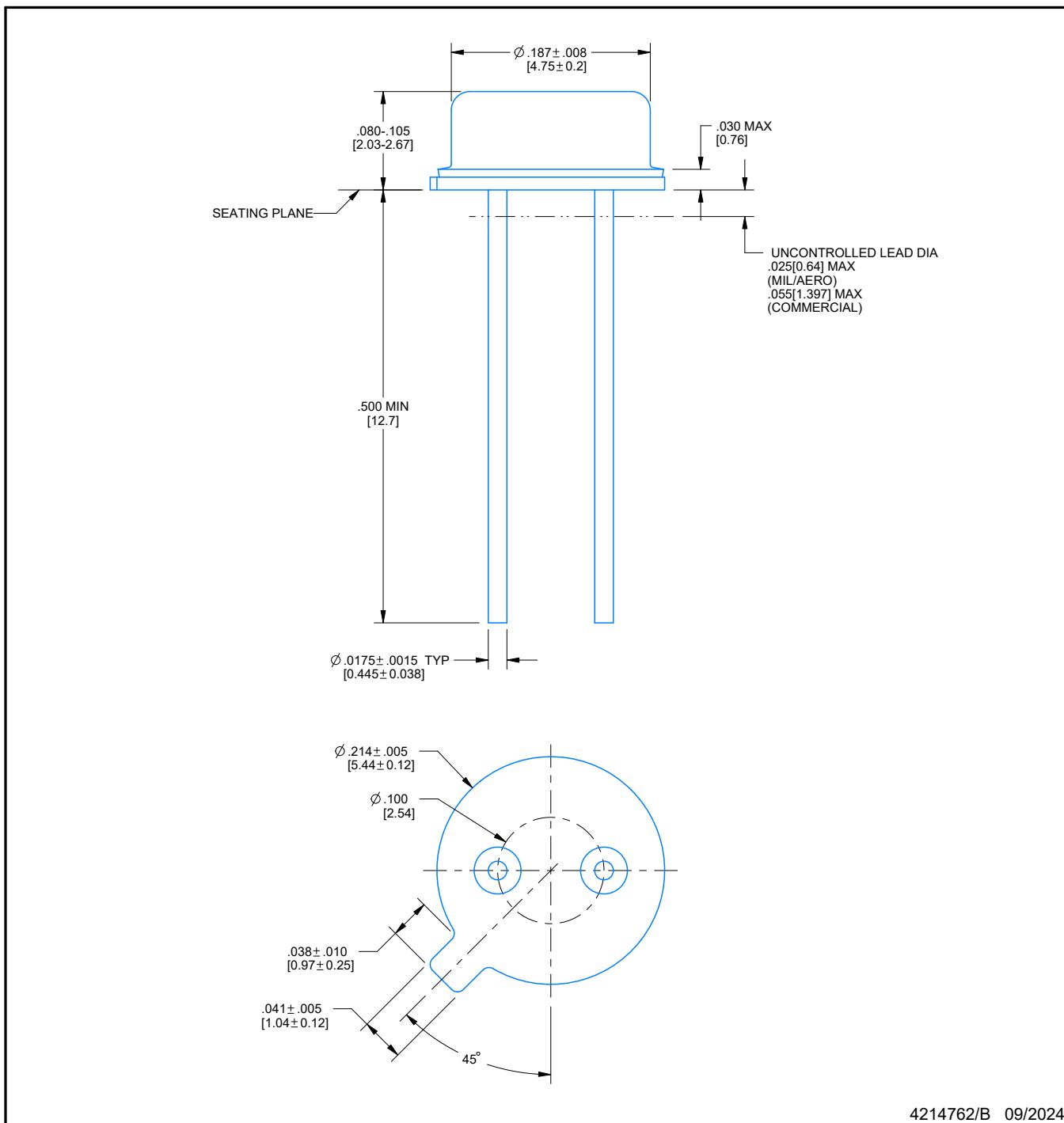
Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	KO (µm)	P1 (mm)	CL (mm)	CW (mm)
5962-8759401XA	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
5962-8759401YA	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08
5962-8759405XA	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
5962R8759461VXA	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185BYH1.2-SMD	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185H-1.2-SMD	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185H-1.2/883	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185H-1.2RLQV	NDU	TO-CAN	2	20	2 X 10	150	126.49	61.98	10922	11.43	11.81	19.2
LM185WG-1.2/883	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08

# PACKAGE OUTLINE

**NDU0002A**

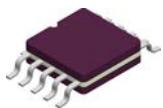
**TO-CAN - 2.67 mm max height**

TRANSISTOR OUTLINE



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.

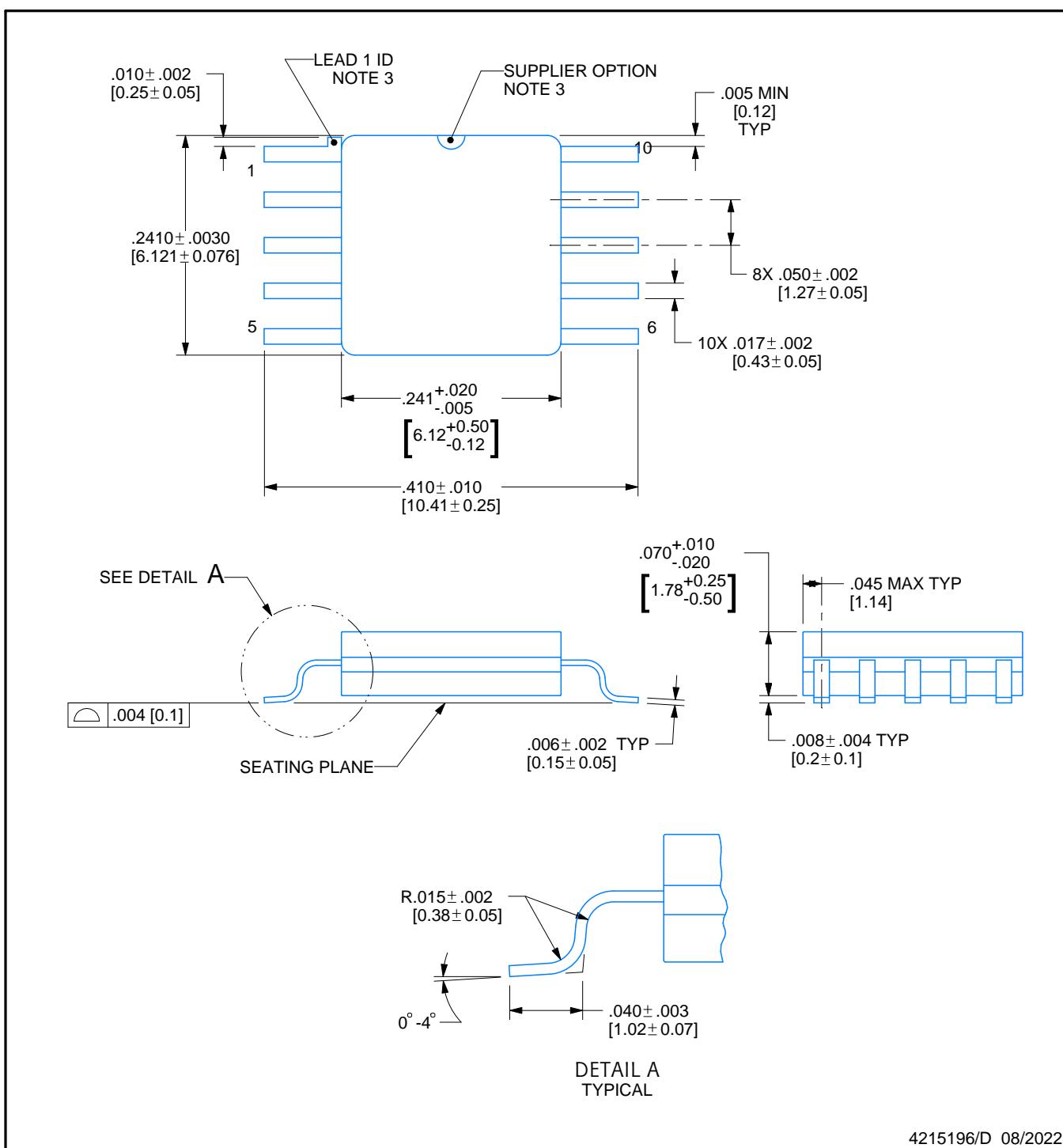


# PACKAGE OUTLINE

**NAC0010A**

**CFP - 2.33mm max height**

CERAMIC FLATPACK



NOTES:

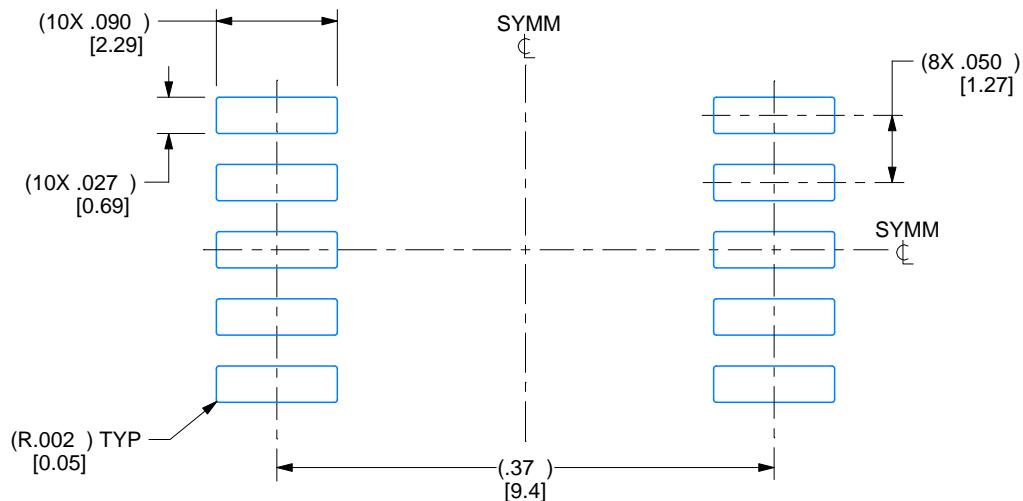
1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. For solder thickness and composition, see the "Lead Finish Composition/Thickness" link in the 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

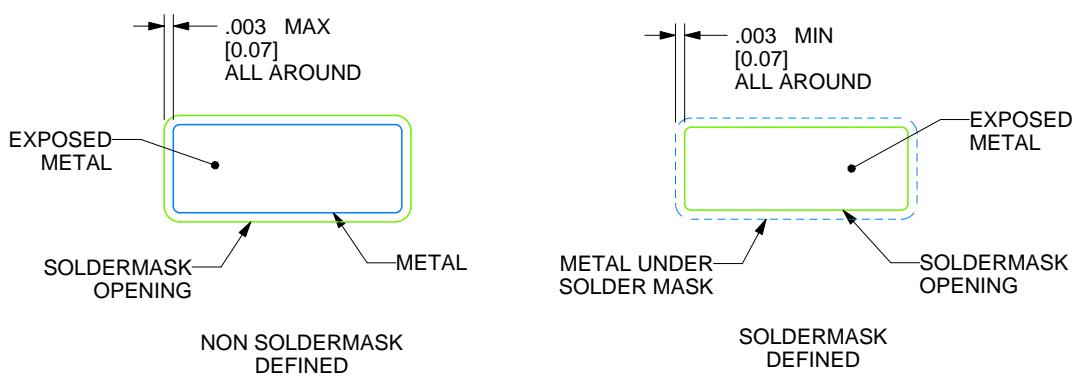
CERAMIC FLATPACK



## LAND PATTERN EXAMPLE

EXPOSED METAL SHOWN

SCALE: 7X



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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