LM185QML Adjustable Micropower Voltage References

Check for Samples: LM185QML

FEATURES

- **Adjustable from 1.24V to 5.30V**
- **Operating Current of 10µA to 20mA**
- **1Ω Dynamic Impedance**
- **Low Temperature Coefficient**

DESCRIPTION

The LM185 are micropower 3-terminal adjustable band-gap voltage reference diodes. Operating from 1.24 to 5.3V and over a 10µA to 20mA 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 band-gap reference uses only transistors and resistors, low noise and good long-term stability result.

Careful design of the LM185 has made the device 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 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

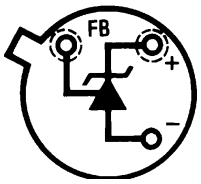

Figure 1. PFM Metal Can Package (Bottom View)
See Package Number NDV0003H

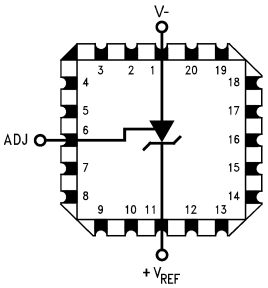

Figure 2. 20-Leadless Chip Carrier (Top View)
See Package Number NAJ0020A

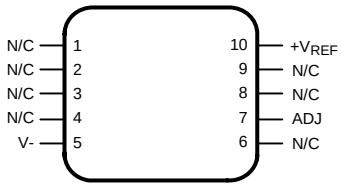

Figure 3. 10-Lead CLGA (Top View)
See Package Number NAC0010A

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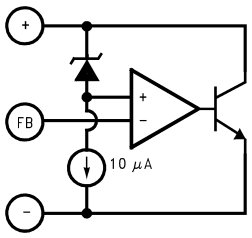
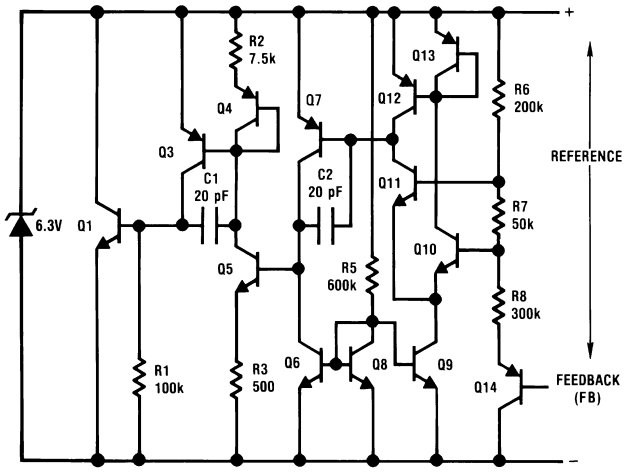
Block Diagram



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			$-55°C \le T_A \le 125°C$
Storage Temperature			$-55°C \le T_A \le 150°C$
Maximum Junction Temperature T_{Jmax}			150°C
Lead Temperature (soldering, 10 seconds)			300°C
Thermal Resistance	θ_{JA}	LCCC Package (Still Air)	100°C/W
		LCCC Package (500LF/Min Air flow)	73°C/W
		Metal Can Package (Still Air)	300°C/W
		Metal Can Package (500LF/Min Air flow)	139°C/W
		CLGA Package (Still Air)	194°C/W
		CLGA Package (500LF/Min Air flow)	128°C/W
	θ_{JC}	LCCC Package	25°C/W
		Metal Can Package	57°C/W
		CLGA Package	23°C/W
Package Weight (Typical)		LCCC Package	TBD
		Metal Can Package	TBD
		CLGA Package	210mg
ESD Tolerance[2]			500V

(1) Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Ratings are conditions under which operation of the device is intended to be functional. For guaranteed specifications and test conditions, see the Electrical Characteristics.
(2) Human body model, 1.5 kΩ in series with 100 pF.

Table 1. Quality Conformance Inspection
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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LM185B Electrical Characteristics DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Ref}	Reference Voltage	I_R = 100µA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		I_R = 9µA		1.228	1.252	V	1
		I_R = 10µA		1.215	1.255	V	2, 3
		I_R = 1mA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		I_R = 20mA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 100µA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 45µA		1.288	1.252	V	1
		V_R = 5.3V, I_R = 50µA		1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 1.0mA		1.288	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 20mA		1.288	1.252	V	1
				1.215	1.255	V	2, 3
$\Delta V_{Ref}/\Delta I_R$	Reference Voltage Change with Current	9µA ≤ I_R ≤ 1mA			1.0	mV	1
		10µA ≤ I_R ≤ 1mA			1.5	mV	2, 3
		1mA ≤ I_R ≤ 20mA			10	mV	1
					20	mV	2, 3
		V_R = 5.3V, 45µA ≤ I_R ≤ 1mA			1.0	mV	1
		V_R = 5.3V, 50µA ≤ I_R ≤ 1mA			1.5	mV	2, 3
		V_R = 5.3V, 1mA ≤ I_R ≤ 20mA			10	mV	1
					20	mV	2, 3
ΔV_{Ref} / ΔV_O	Reference Voltage Change with Output Voltage	V_R = 5.3V, I_R = 100µA			3.0	mV	1
					6.0	mV	2, 3
I_F	Feedback Current	I_R = 9µA			20	nA	1
		I_R = 10µA			25	nA	2, 3
		I_R = 20mA			20	nA	1
					25	nA	2, 3
		V_R = 5.3V, I_R = 45µA			20	nA	1
		V_R = 5.3V, I_R = 50µA			25	nA	2, 3
		V_R = 5.3V, I_R = 20mA			20	nA	1
					25	nA	2, 3
I_C	Minimum Operating Current	V_R = V_{Ref}	See (1)		9.0	µA	1
			See (1)		10	µA	2, 3
		V_R = 5.3V	See (1)		45	µA	1
			See (1)		50	µA	2, 3

(1) Functional test.

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LM185BY Electrical Characteristics DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Ref}	Reference Voltage	I_R = 100µA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		I_R = 9µA		1.228	1.252	V	1
		I_R = 10µA		1.215	1.255	V	2, 3
		I_R = 1mA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		I_R = 20mA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 100µA		1.228	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 45µA		1.288	1.252	V	1
		V_R = 5.3V, I_R = 50µA		1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 1.0mA		1.288	1.252	V	1
				1.215	1.255	V	2, 3
		V_R = 5.3V, I_R = 20mA		1.288	1.252	V	1
				1.215	1.255	V	2, 3
$\Delta V_{Ref}/\Delta I_R$	Reference Voltage Change with Current	9µA ≤ I_R ≤ 1mA			1.0	mV	1
		10µA ≤ I_R ≤ 1mA			1.5	mV	2, 3
		1mA ≤ I_R ≤ 20mA			10	mV	1
					20	mV	2, 3
		V_R = 5.3V, 45µA ≤ I_R ≤ 1mA			1.0	mV	1
		V_R = 5.3V, 50µA ≤ I_R ≤ 1mA			1.5	mV	2, 3
		V_R = 5.3V, 1mA ≤ I_R ≤ 20mA			10	mV	1
					20	mV	2, 3
ΔV_{Ref} / ΔV_O	Reference Voltage Change with Output Voltage	V_R = 5.3V, I_R = 100µA			3.0	mV	1
					6.0	mV	2, 3
I_F	Feedback Current	I_R = 9µA			20	nA	1
		I_R = 10µA			25	nA	2, 3
		I_R = 20mA			20	nA	1
					25	nA	2, 3
		V_R = 5.3V, I_R = 45µA			20	nA	1
		V_R = 5.3V, I_R = 50µA			25	nA	2, 3
		V_R = 5.3V, I_R = 20mA			20	nA	1
					25	nA	2, 3
I_C	Minimum Operating Current	V_R = V_{Ref}	See(1)		9.0	µA	1
			See(1)		10	µA	2, 3
		V_R = 5.3V	See(1)		45	µA	1
			See(1)		50	µA	2, 3
T_C	Temperature Coefficient		See(2)		50	PPM/°C	1, 2, 3

(1) Functional test.
(2) 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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Typical Performance Characteristics

Temperature Drift of 3 Representative Units

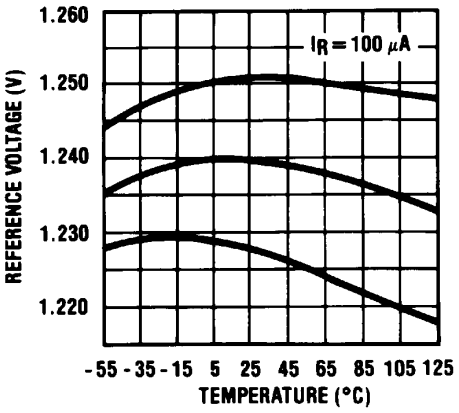

Figure 4.

Feedback Current

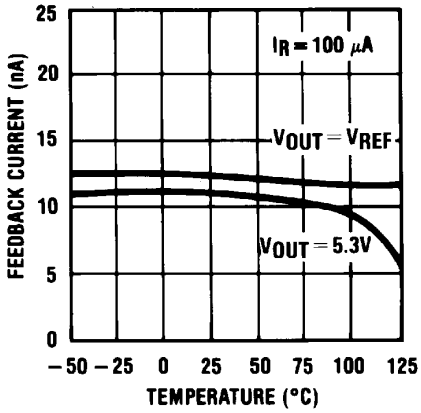

Figure 5.

Minimum Operating Current

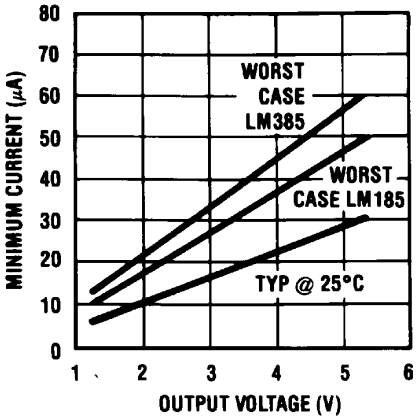

Figure 6.

Reverse Characteristics

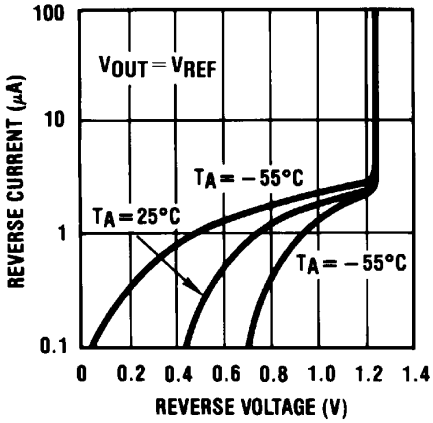

Figure 7.

Reverse Characteristics

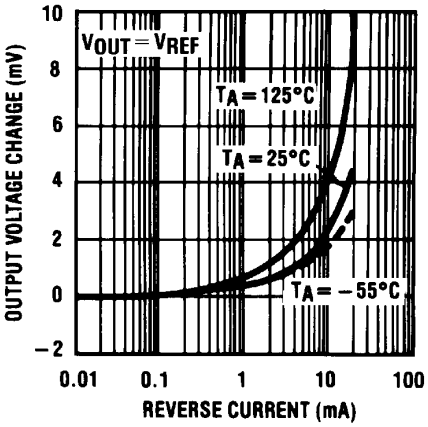

Figure 8.

Forward Characteristics

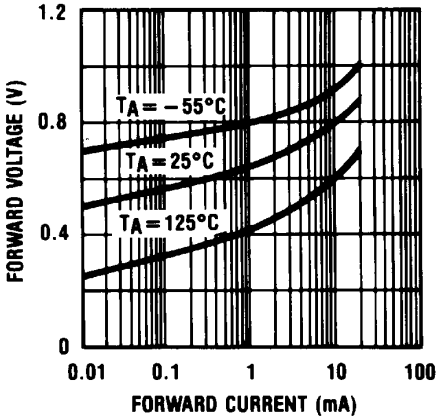

Figure 9.

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Typical Performance Characteristics (continued)

Output Noise Voltage

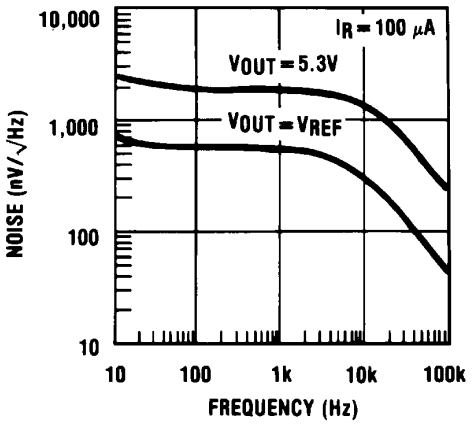


Figure 10.

Dynamic Output Impedance

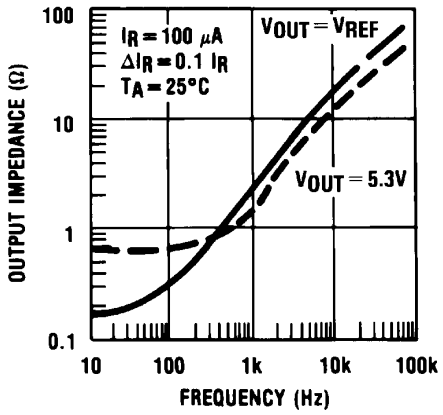


Figure 11.

Response Time

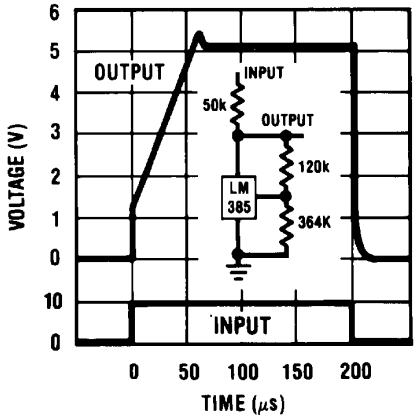
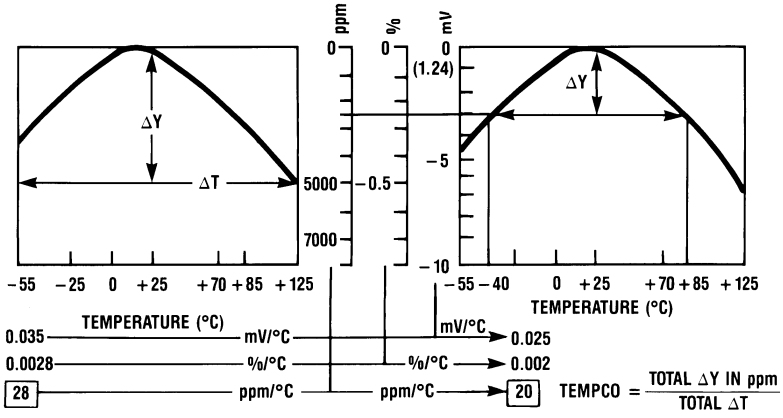


Figure 12.

Temperature Coefficient Typical LM185



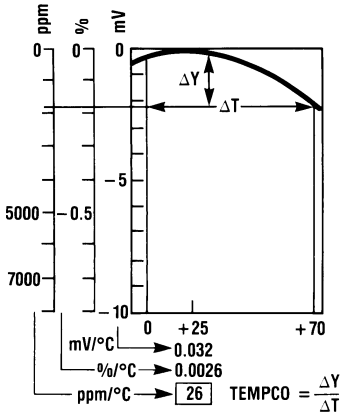


Figure 13.

TYPICAL APPLICATIONS

Precision 10V Reference

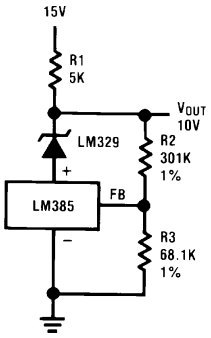


Figure 14.

Low AC Noise Reference

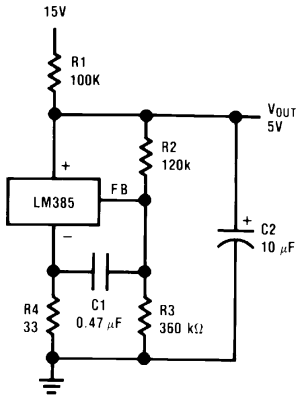


Figure 15.

25V Low Current Shunt Regulator

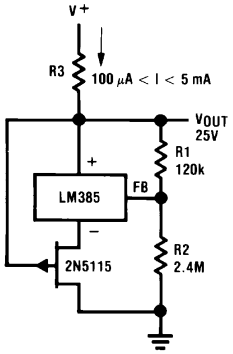


Figure 16.

200 mA Shunt Regulator

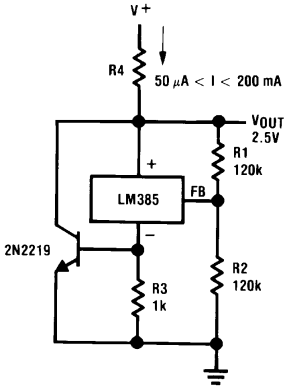


Figure 17.

Series-Shunt 20 mA Regulator

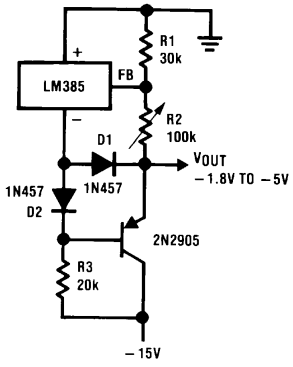


Figure 18.

High Efficiency Low Power Regulator

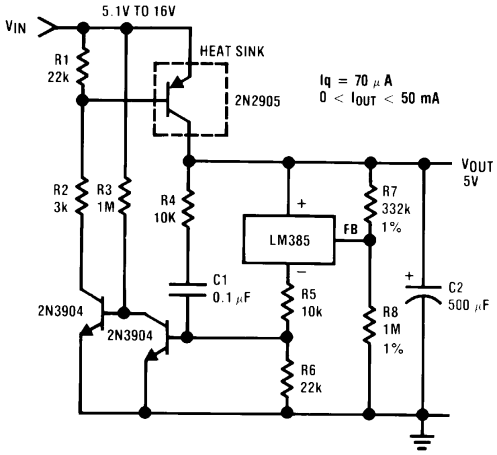


Figure 19.

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Voltage Level Detector

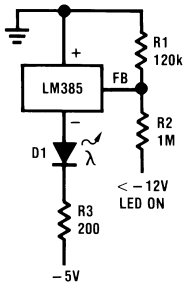

Figure 20.

Voltage Level Detector

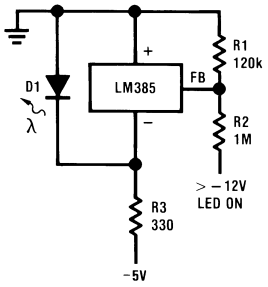

Figure 21.

Fast Positive Clamp
2.4V + ΔV_{D1}

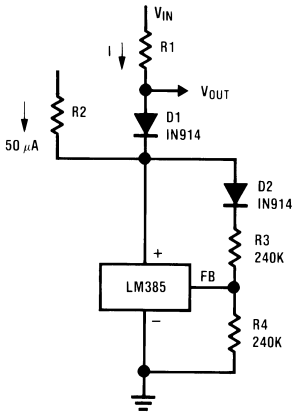

Figure 22.

Bidirectional Clamp
±2.4V

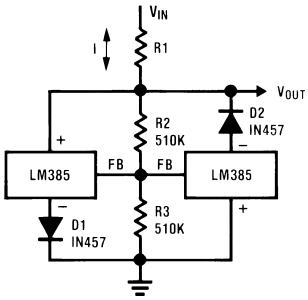

Figure 23.

Bidirectional Adjustable Clamp
±1.8V to ±2.4V

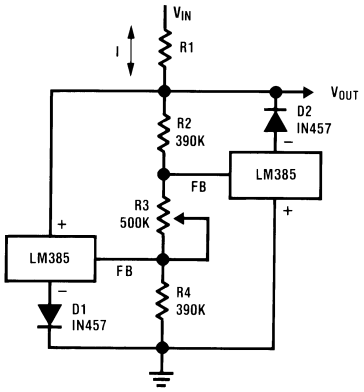

Figure 24.

Bidirectional Adjustable Clamp
±2.4V to ±6V

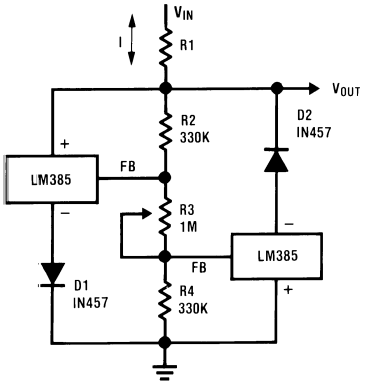

Figure 25.

*D1 can be any LED, V_F=1.5V to 2.2V at 3 mA. D1 may act as an indicator. D1 will be on if $I_{THRESHOLD}$ falls below the threshold current, except with I=O.

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Simple Floating Current Detector

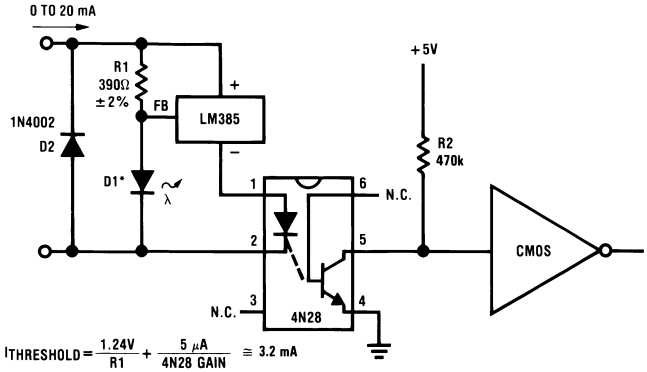

Figure 26.

Precision Floating Current Detector

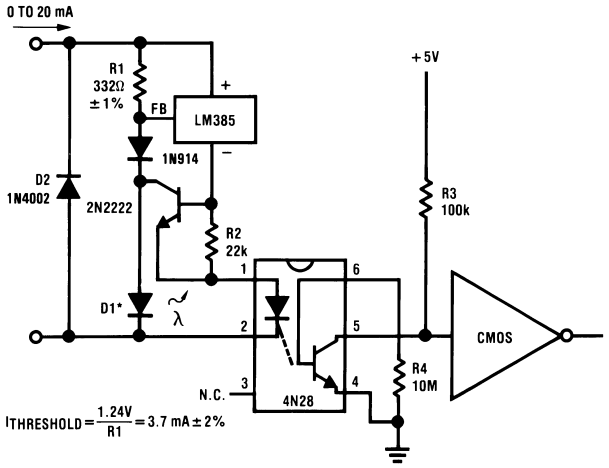

Figure 27.

Current Source

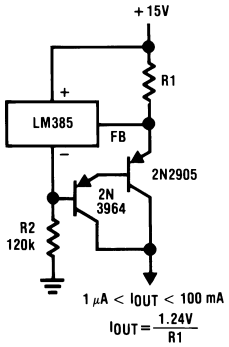

Figure 28.

Centigrade Thermometer, 10mV/°C

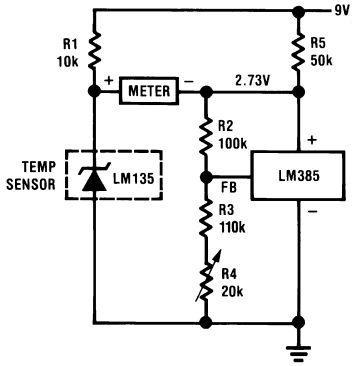

Figure 29.

Freezer Alarm

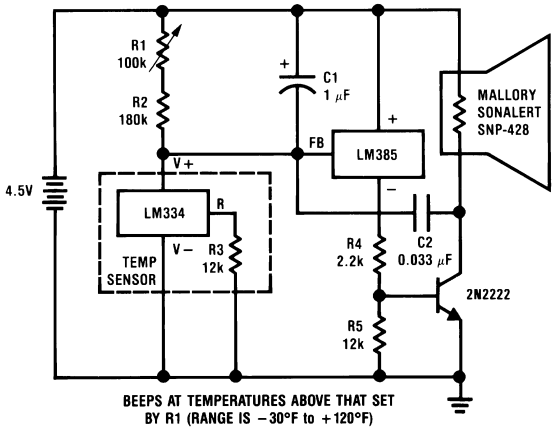

Figure 30.

1.2V Reference

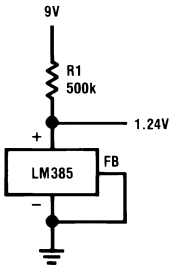

Figure 31.

$$V_{OUT} = 1.24\left(\frac{R3}{R2} + 1\right)$$

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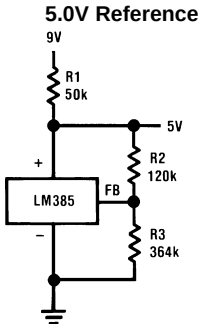

Figure 32.

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. MNLM185B-X Rev 0B0 and MNLM185BY-X Rev 0B0 will be archived.
04/06/06	B	Ordering Information Table, WG Connection Diagram, Absolute Maximum Ratings Section, Physical Dimensions Section	R. Malone	Added NSID, Connection Diagram, Physical Dimension Dwg, Thermal Resistance and Package Weight for NAC package. Revision A will be Archived.
06/12/08	C	LM185B and LM185BY Electrical Section	Larry McGee	Correct IC test, $V_R = V_{REF}$ condition, subgroup 1, 2, 3 moved limits to the maximum column. Revision B will be Archived.
03/27/13	D	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)
5962-9091402QYA	Active	Production	CFP (NAC) | 10	54 | TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM185BWG /883 Q 5962-90914 02QYA ACO 02QYA >T
LM185BWG/883	Active	Production	CFP (NAC) | 10	54 | TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM185BWG /883 Q 5962-90914 02QYA ACO 02QYA >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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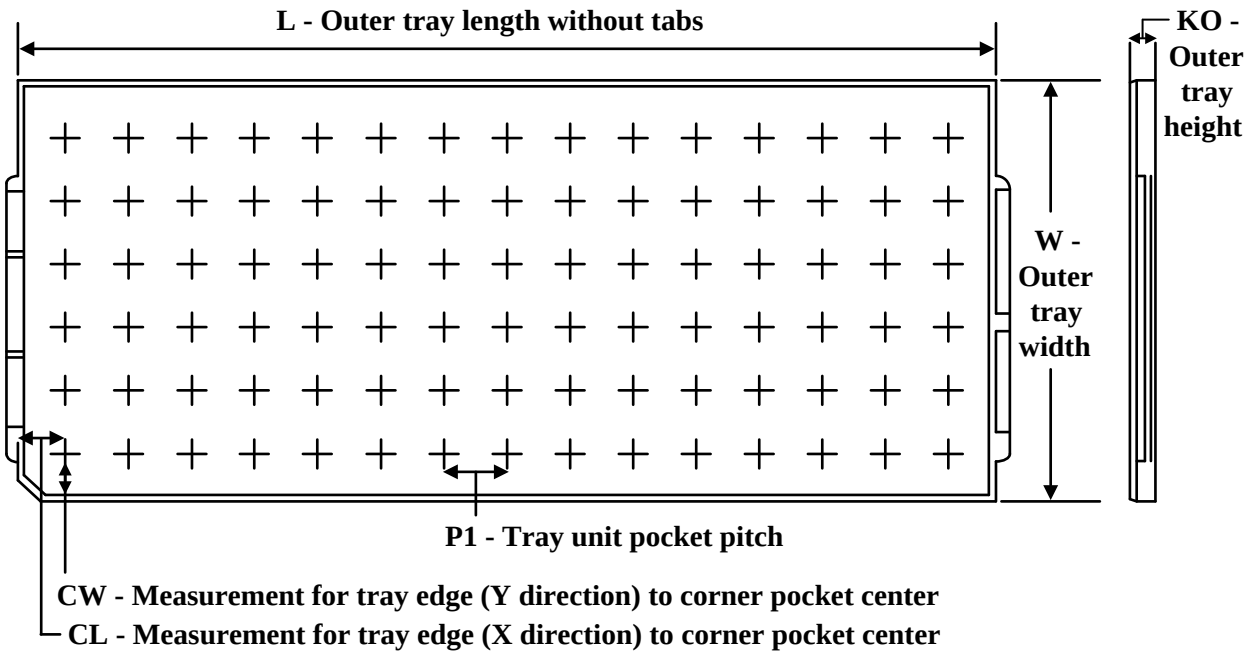
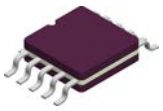
TRAY



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)
5962-9091402QYA	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08
LM185BWG/883	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08

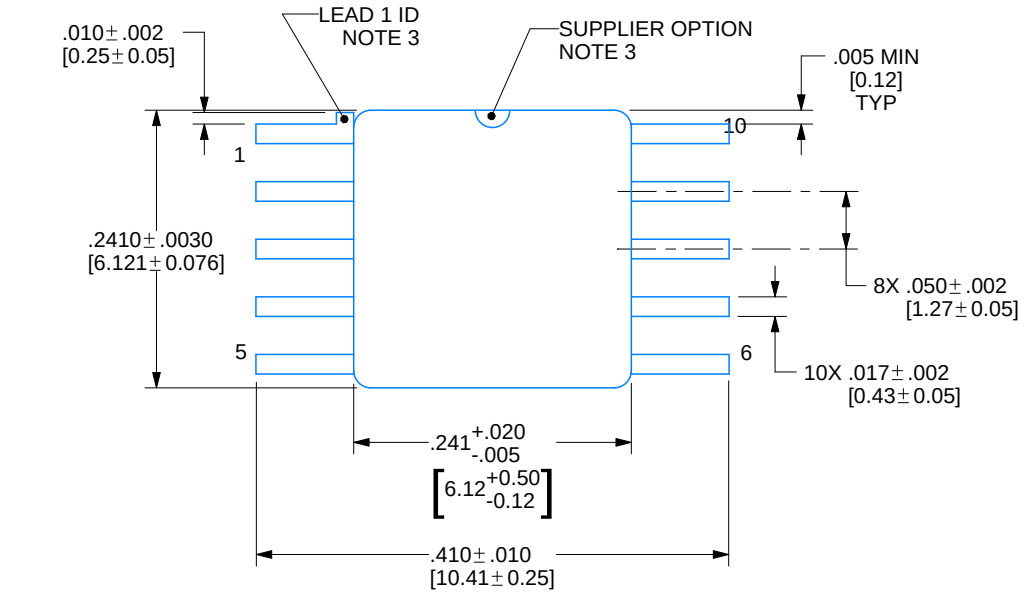


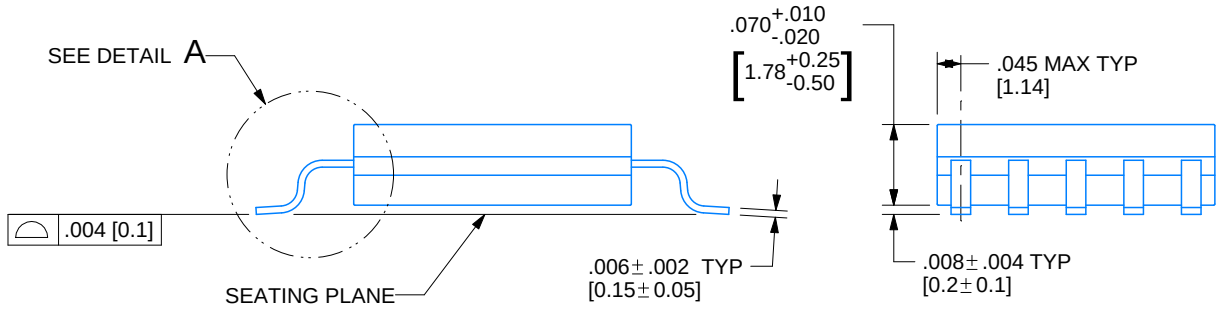
PACKAGE OUTLINE

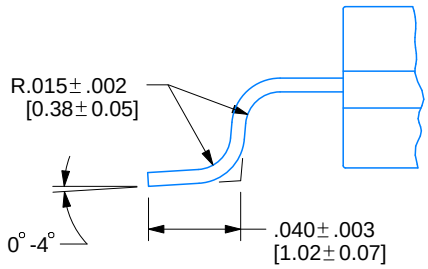
NAC0010A

CFP - 2.33mm max height

CERAMIC FLATPACK







DETAIL A
TYPICAL

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NOTES:

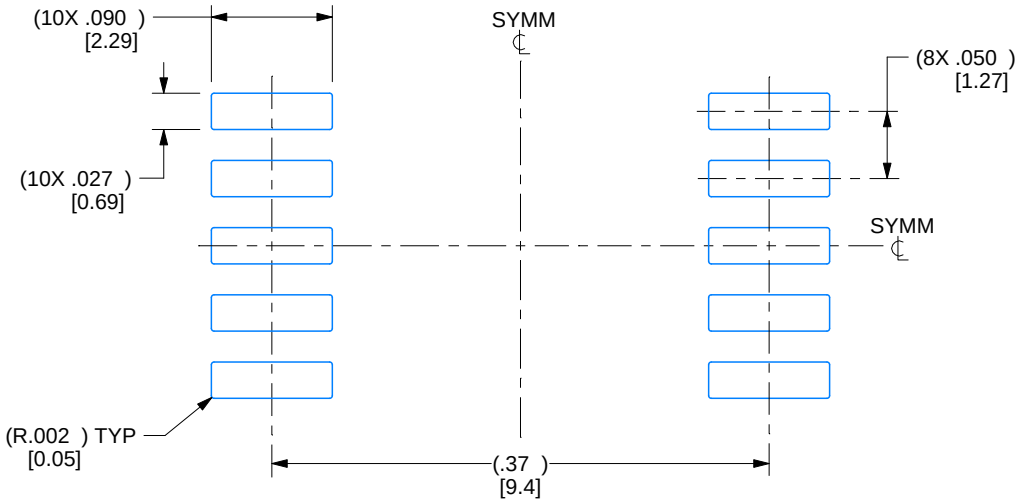
1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. For solder thickness and composition, see the "Lead Finish Composition/Thickness" link in the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

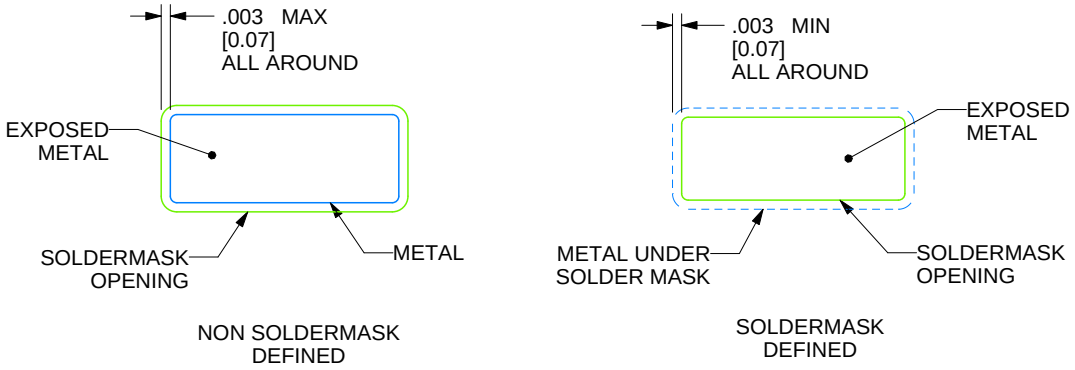
NAC0010A

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

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