

LM185QML Adjustable Micropower Voltage References

Check for Samples: [LM185QML](#)

FEATURES

- Adjustable from 1.24V to 5.30V
- Operating Current of 10 μ A to 20mA
- 1 Ω 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 10 μ A 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

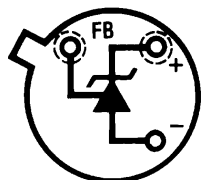


Figure 1. PFM Metal Can Package (Bottom View)
See Package Number NDV0003H

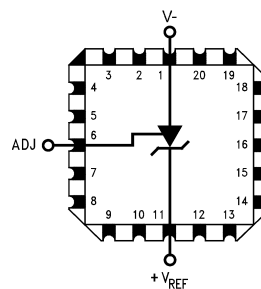


Figure 2. 20-Leadless Chip Carrier (Top View)
See Package Number NAJ0020A

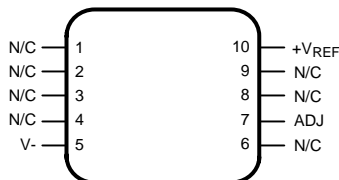


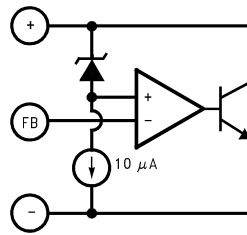
Figure 3. 10-Lead CLGA (Top View)
See Package Number NAC0010A



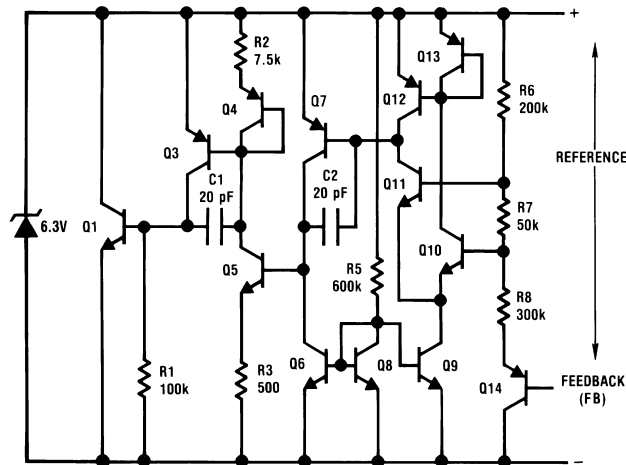
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Block Diagram



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.

Absolute Maximum Ratings⁽¹⁾

| | | | |
|--|-------------------|--|---------|
| Reverse Current | | 30mA | |
| Forward Current | | 10mA | |
| Operating Temperature Range | | -55°C ≤ T _A ≤ 125°C | |
| Storage Temperature | | -55°C ≤ T _A ≤ 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 |

LM185B Electrical Characteristics DC Parameters

| Symbol | Parameter | Conditions | Notes | Min | Max | Unit | Sub-groups |
|-----------------------------|--|---|--------------------|-------|-------|---------|------------|
| V_{Ref} | Reference Voltage | $I_R = 100\mu A$ | | 1.228 | 1.252 | V | 1 |
| | | | | 1.215 | 1.255 | V | 2, 3 |
| | | $I_R = 9\mu A$ | | 1.228 | 1.252 | V | 1 |
| | | $I_R = 10\mu A$ | | 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 |
| | | $V_R = 5.3V, I_R = 100\mu A$ | | 1.228 | 1.252 | V | 1 |
| | | | | 1.215 | 1.255 | V | 2, 3 |
| | | $V_R = 5.3V, I_R = 45\mu A$ | | 1.288 | 1.252 | V | 1 |
| | | $V_R = 5.3V, I_R = 50\mu A$ | | 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 | $9\mu A \leq I_R \leq 1mA$ | | | 1.0 | mV | 1 |
| | | $10\mu A \leq I_R \leq 1mA$ | | | 1.5 | mV | 2, 3 |
| | | $1mA \leq I_R \leq 20mA$ | | | 10 | mV | 1 |
| | | | | | 20 | mV | 2, 3 |
| | | $V_R = 5.3V, 45\mu A \leq I_R \leq 1mA$ | | | 1.0 | mV | 1 |
| | | $V_R = 5.3V, 50\mu A \leq I_R \leq 1mA$ | | | 1.5 | mV | 2, 3 |
| | | $V_R = 5.3V, 1mA \leq I_R \leq 20mA$ | | | 10 | mV | 1 |
| | | | 20 | mV | 2, 3 | | |
| $\Delta V_{Ref}/\Delta V_O$ | Reference Voltage Change with Output Voltage | $V_R = 5.3V, I_R = 100\mu A$ | | | 3.0 | mV | 1 |
| | | | | | 6.0 | mV | 2, 3 |
| I_F | Feedback Current | $I_R = 9\mu A$ | | | 20 | nA | 1 |
| | | | | | 25 | nA | 2, 3 |
| | | $I_R = 10\mu A$ | | | 20 | nA | 1 |
| | | | | | 25 | nA | 2, 3 |
| | | $V_R = 5.3V, I_R = 45\mu A$ | | | 20 | nA | 1 |
| | | $V_R = 5.3V, I_R = 50\mu A$ | | | 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.

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 | | |
| ΔV _{Ref} /ΔI _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})

Typical Performance Characteristics

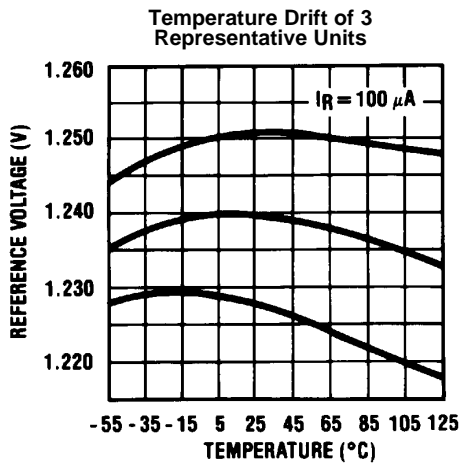


Figure 4.

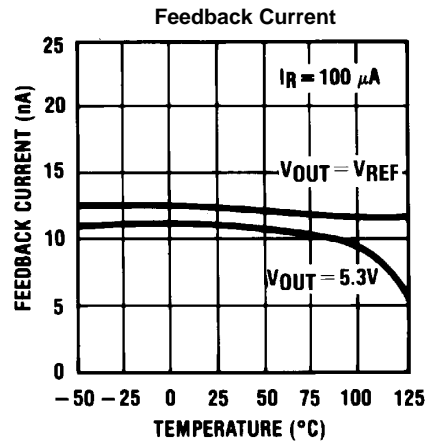


Figure 5.

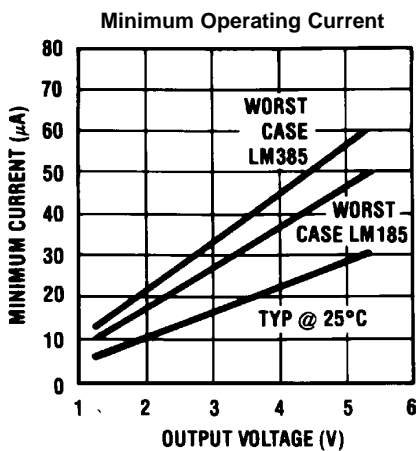


Figure 6.

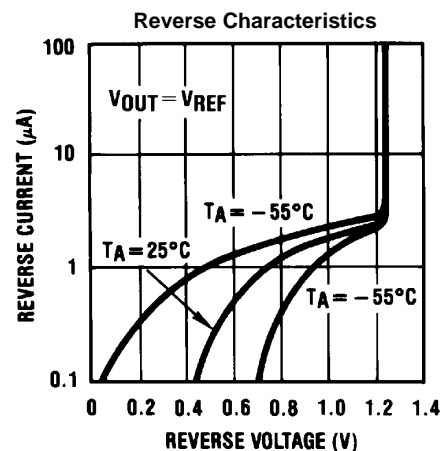


Figure 7.

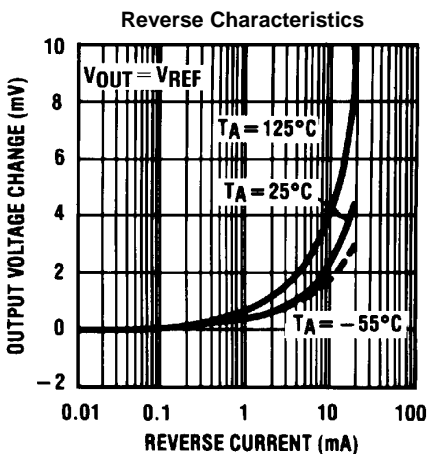


Figure 8.

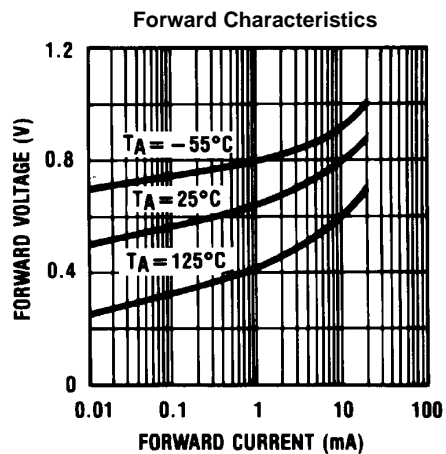


Figure 9.

Typical Performance Characteristics (continued)

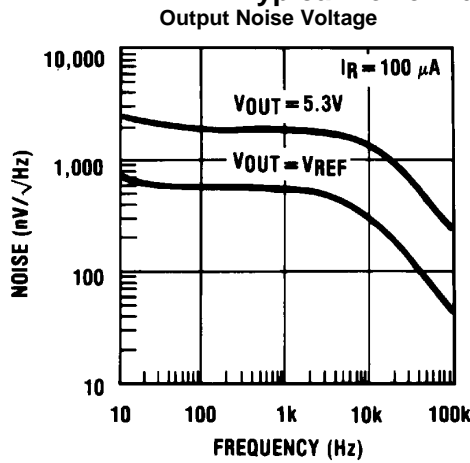


Figure 10.

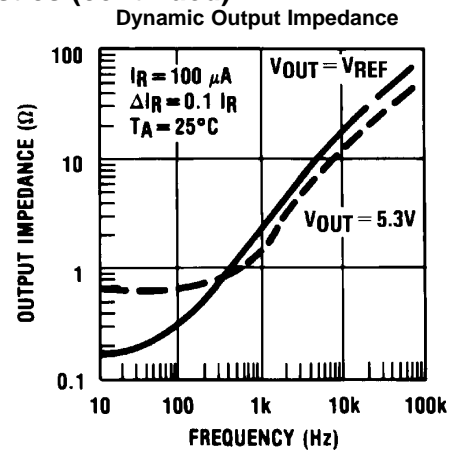


Figure 11.

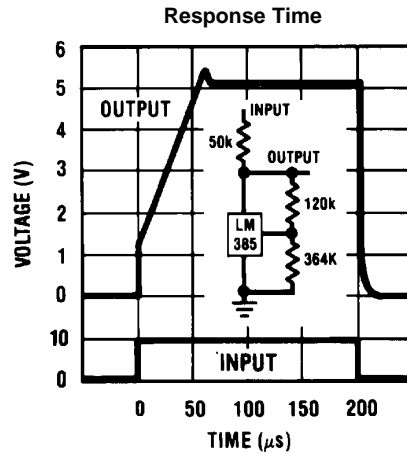


Figure 12.

Temperature Coefficient Typical LM185

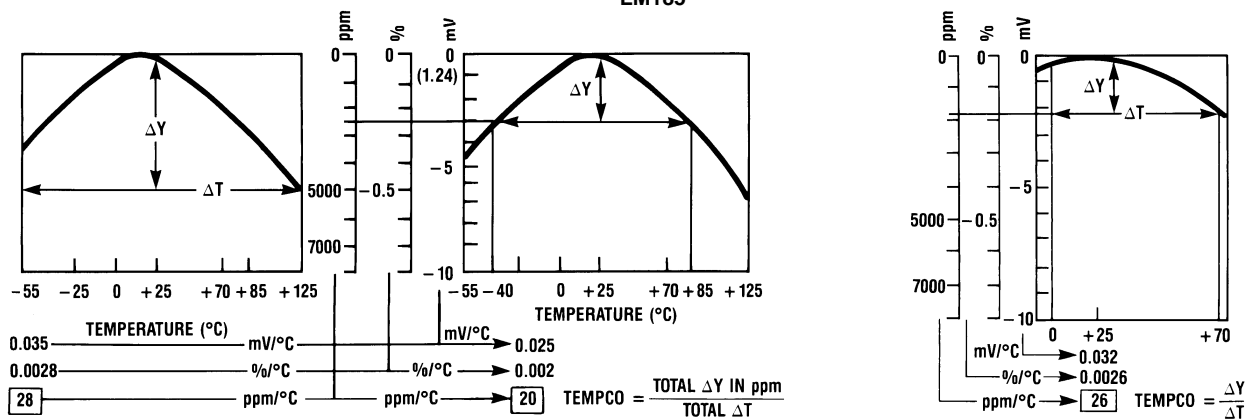


Figure 13.

TYPICAL APPLICATIONS

Precision 10V Reference

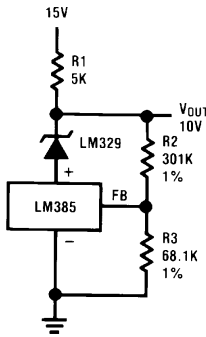


Figure 14.

Low AC Noise Reference

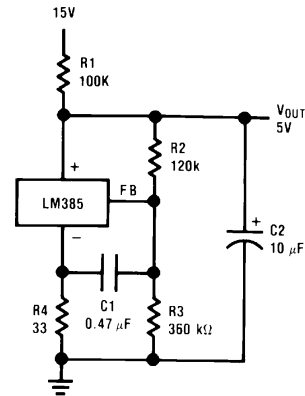


Figure 15.

25V Low Current Shunt Regulator

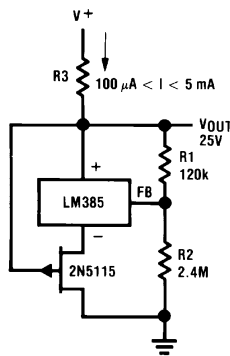


Figure 16.

200 mA Shunt Regulator

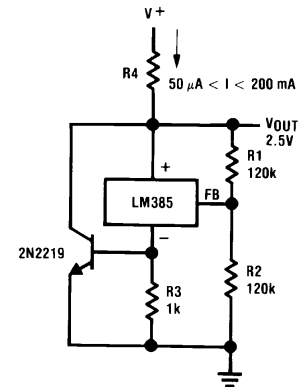


Figure 17.

Series-Shunt 20 mA Regulator

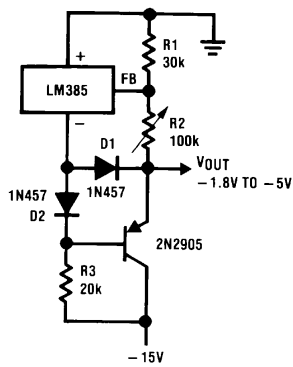


Figure 18.

High Efficiency Low Power Regulator

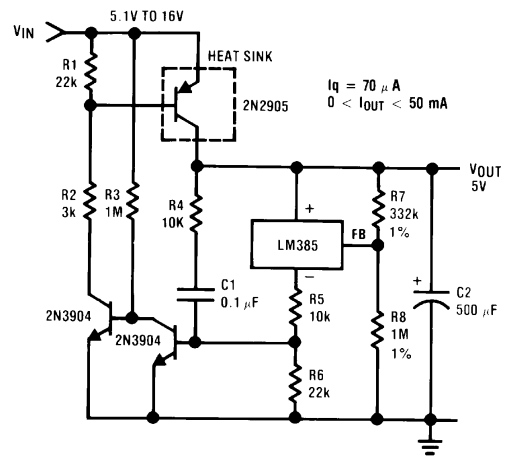


Figure 19.

Voltage Level Detector

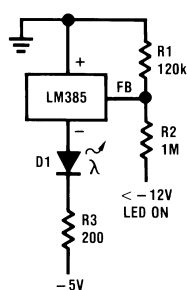


Figure 20.

Voltage Level Detector

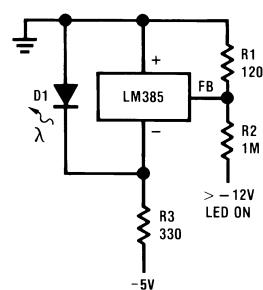


Figure 21.

Fast Positive Clamp
 $2.4V + \Delta V_{D1}$

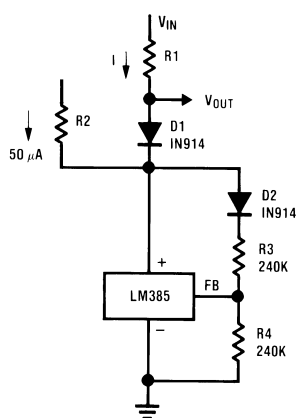


Figure 22.

Bidirectional Clamp
 $\pm 2.4V$

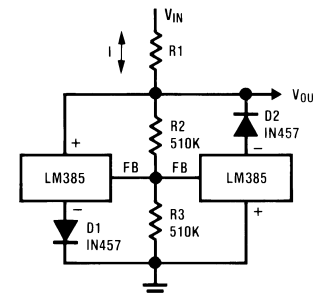


Figure 23.

Bidirectional Adjustable Clamp
 $\pm 1.8V$ to $\pm 2.4V$

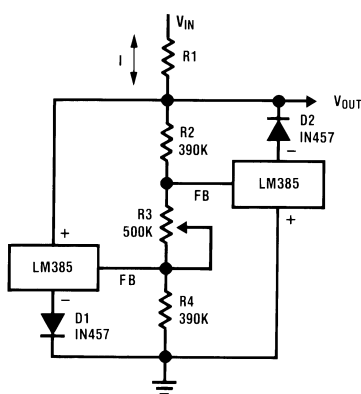


Figure 24.

Bidirectional Adjustable Clamp
 $\pm 2.4V$ to $\pm 6V$

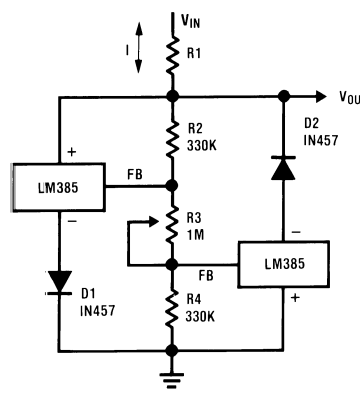


Figure 25.

*D1 can be any LED, $V_F=1.5V$ to $2.2V$ at $3mA$. D1 may act as an indicator. D1 will be on if $I_{THRESHOLD}$ falls below the threshold current, except with $I=0$.

Simple Floating Current Detector

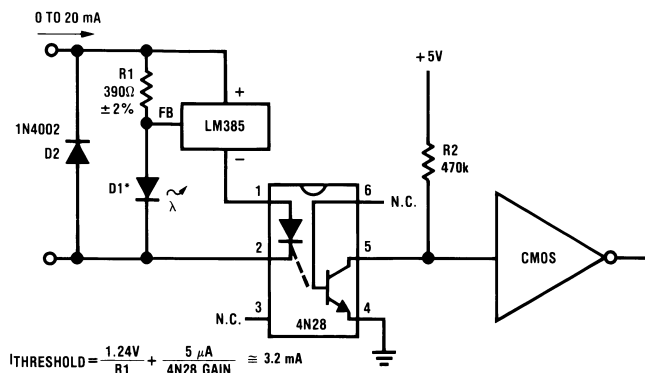


Figure 26.

Precision Floating Current Detector

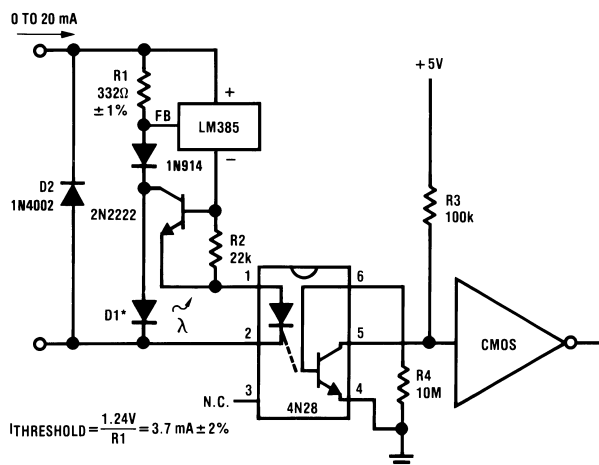


Figure 27.

Current Source

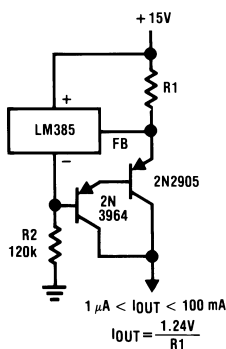


Figure 28.

Centigrade Thermometer, 10mV/°C

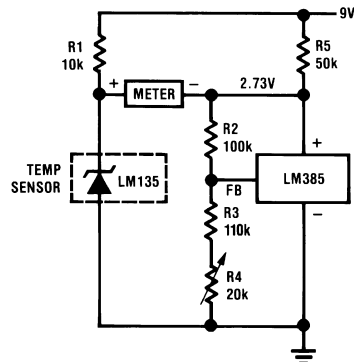


Figure 29.

Freezer Alarm

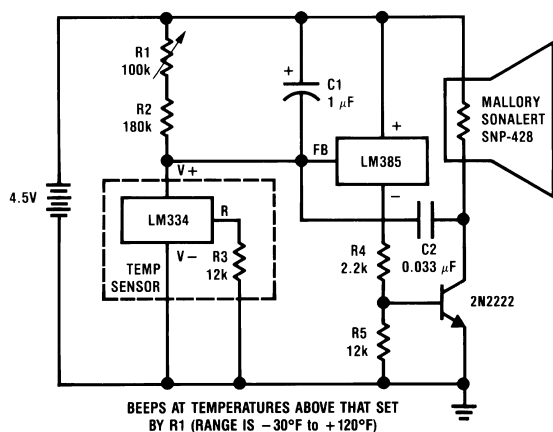


Figure 30.

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

1.2V Reference

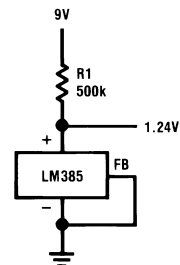


Figure 31.

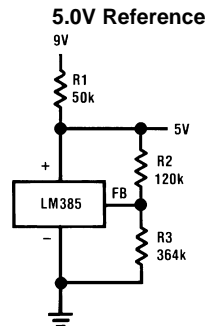




Figure 32.

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. |

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Top-Side Markings (4) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|------------------|----------------------|--------------|---|---|
| 5962-9091402QYA | ACTIVE | CFP | NAC | 10 | 54 | TBD | Call TI | Call TI | -55 to 125 | LM185BWG /883 Q 5962-90914 02QYA ACO 02QYA >T |  |
| LM185BWG/883 | ACTIVE | CFP | NAC | 10 | 54 | TBD | Call TI | Call TI | -55 to 125 | LM185BWG /883 Q 5962-90914 02QYA ACO 02QYA >T |  |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

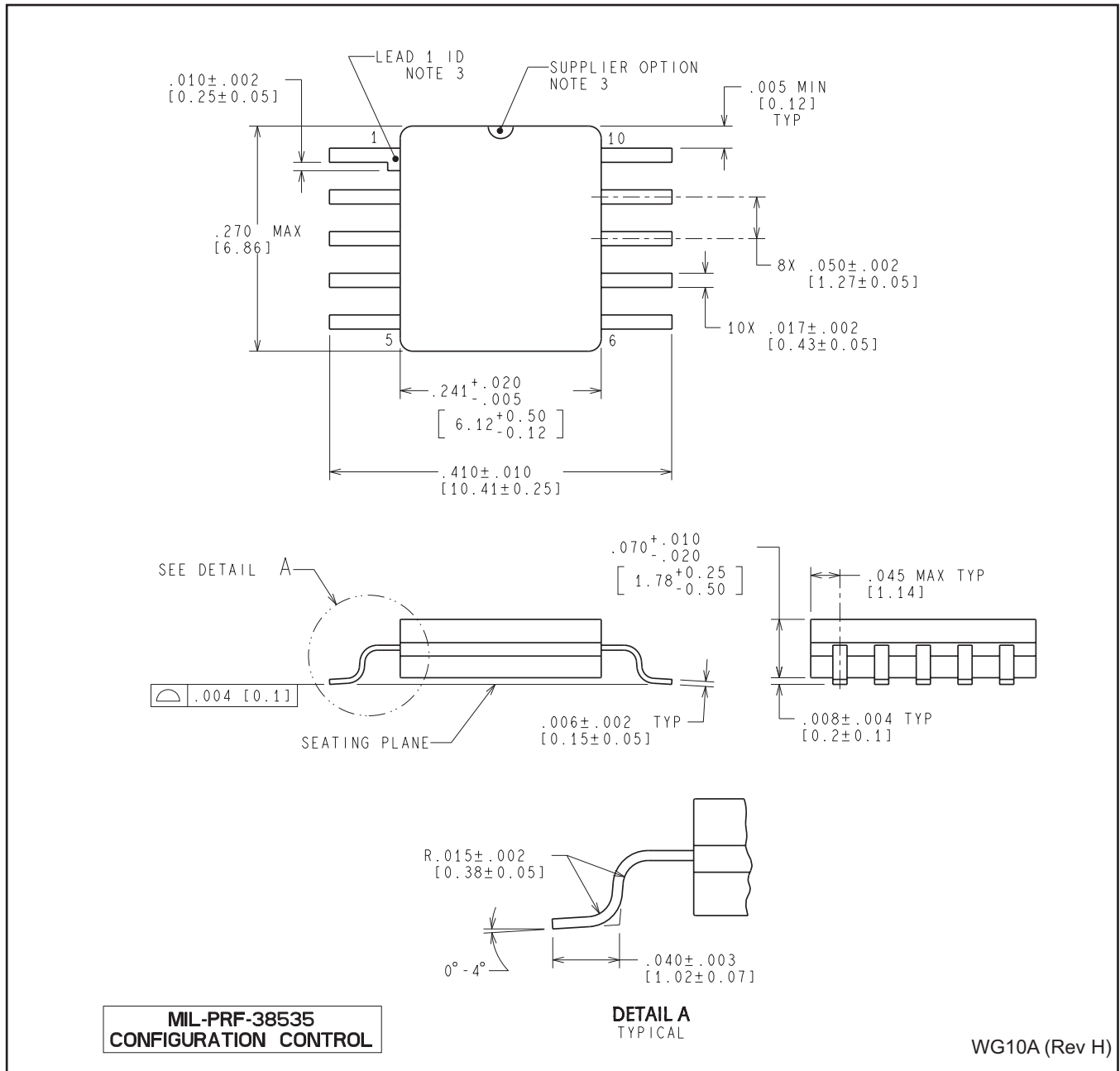
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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