

LM136-2.5-N, LM236-2.5-N, LM336-2.5-NV Reference Diode

 Check for Samples: [LM136-2.5-N](#)

FEATURES

- **Low Temperature Coefficient**
- **Wide Operating Current of 400 μ A to 10 mA**
- **0.2 Ω Dynamic Impedance**
- **\pm 1% Initial Tolerance Available**
- **Specified Temperature Stability**
- **Easily Trimmed for Minimum Temperature Drift**
- **Fast Turn-On**

DESCRIPTION

The LM136-2.5-N/LM236-2.5-N and LM336-2.5-N integrated circuits are precision 2.5V shunt regulator diodes. These monolithic IC voltage references operate as a low-temperature-coefficient 2.5V zener with 0.2 Ω dynamic impedance. A third terminal on the LM136-2.5-N allows the reference voltage and temperature coefficient to be trimmed easily.

The LM136-2.5-N series is useful as a precision 2.5V low voltage reference for digital voltmeters, power supplies or op amp circuitry. The 2.5V make it convenient to obtain a stable reference from 5V logic supplies. Further, since the LM136-2.5-N operates as a shunt regulator, it can be used as either a positive or negative voltage reference.

The LM136-2.5-N is rated for operation over -55°C to $+125^{\circ}\text{C}$ while the LM236-2.5-N is rated over a -25°C to $+85^{\circ}\text{C}$ temperature range.

The LM336-2.5-N is rated for operation over a 0°C to $+70^{\circ}\text{C}$ temperature range. See the connection diagrams for available packages.

Connection Diagram

TO-92 Plastic Package

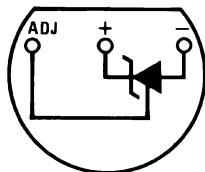


Figure 1. Bottom View
See Package Number LP

TO Metal Can Package

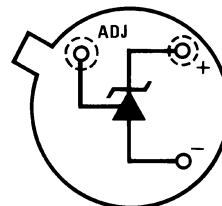


Figure 2. Bottom View
See Package Number NDV

SOIC Package

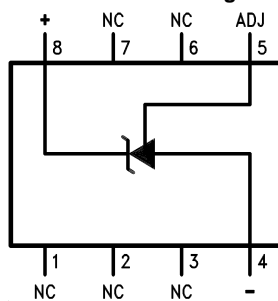


Figure 3. Top View
See Package Number D



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.

All trademarks are the property of their respective owners.

Typical Applications

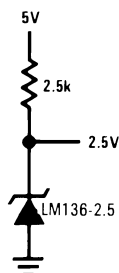
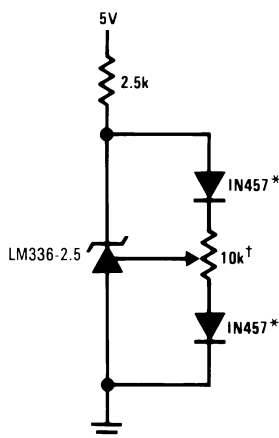


Figure 4. 2.5V Reference



†Adjust to 2.490V

*Any silicon signal diode

Figure 5. 2.5V Reference with Minimum Temperature Coefficient

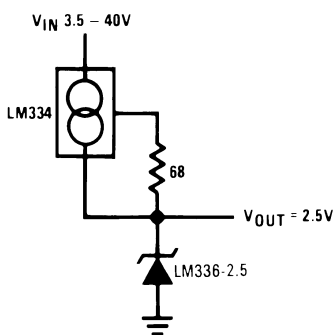


Figure 6. Wide Input Range Reference



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⁾⁽²⁾

| | | | |
|--|-------------------------|-----------------------|-------|
| Reverse Current | | 15 mA | |
| Forward Current | | 10 mA | |
| Storage Temperature | | -60°C to +150°C | |
| Operating Temperature Range ⁽³⁾ | LM136 | -55°C to +150°C | |
| | LM236 | -25°C to +85°C | |
| | LM336 | 0°C to +70°C | |
| Soldering Information | TO-92 Package (10 sec.) | 260°C | |
| | TO Package (10 sec.) | 300°C | |
| | SOIC Package | Vapor Phase (60 sec.) | 215°C |
| | | Infrared (15 sec.) | 220°C |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device beyond its specified operating conditions.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.
- (3) For elevated temperature operation, T_j max is:
 - LM136 150°C
 - LM236 125°C
 - LM336 100°C

| Thermal Resistance | TO-92 | TO | SOIC |
|-------------------------------------|-----------------------|---------|---------|
| θ_{ja} (Junction to Ambient) | 180°C/W (0.4" leads) | 440°C/W | 165°C/W |
| | 170°C/W (0.125" lead) | | |
| θ_{jc} (Junction to Case) | n/a | 80°C/W | n/a |

Electrical Characteristics ⁽¹⁾

| Parameter | Conditions | | LM136A-2.5-N/ LM236A-2.5-N LM136-2.5-N/ LM236-2.5-N | | | LM336B-2.5-N LM336-2.5-N | | | Units |
|---------------------------------------|--|---|--|-------|-------|-----------------------------|-------|----------|----------|
| | | | Min | Typ | Max | Min | Typ | Max | |
| Reverse Breakdown Voltage | $T_A=25^\circ\text{C}$, $I_R=1\text{ mA}$ | LM136, LM236, LM336 | 2.440 | 2.490 | 2.540 | 2.390 | 2.490 | 2.590 | V |
| | | LM136A, LM236A, LM336B | 2.465 | 2.490 | 2.515 | 2.440 | 2.490 | 2.540 | V |
| Reverse Breakdown Change With Current | $T_A=25^\circ\text{C}$, $400\ \mu\text{A}\leq I_R\leq 10\text{ mA}$ | | | 2.6 | 6 | | 2.6 | 10 | mV |
| Reverse Dynamic Impedance | $T_A=25^\circ\text{C}$, $I_R=1\text{ mA}$, $f = 100\text{ Hz}$ | | | 0.2 | 0.6 | | 0.2 | 1 | Ω |
| Temperature Stability ⁽²⁾ | V_R Adjusted to 2.490V $I_R=1\text{ mA}$ Figure 15 | $0^\circ\text{C}\leq T_A\leq 70^\circ\text{C}$ (LM336) | | | | | 1.8 | 6 | mV |
| | | $-25^\circ\text{C}\leq T_A\leq +85^\circ\text{C}$ (LM236H, LM236Z) | | 3.5 | 9 | | | | mV |
| | | $-25^\circ\text{C}\leq T_A\leq +85^\circ\text{C}$ (LM236M) | | 7.5 | 18 | | | | mV |
| | | $-55^\circ\text{C}\leq T_A\leq +125^\circ\text{C}$ (LM136) | | 12 | 18 | | | | mV |
| Reverse Breakdown Change With Current | $400\ \mu\text{A}\leq I_R\leq 10\text{ mA}$ | | 3 | 10 | | 3 | 12 | mV | |
| Reverse Dynamic Impedance | $I_R=1\text{ mA}$ | | 0.4 | 1 | | 0.4 | 1.4 | Ω | |
| Long Term Stability | $T_A=25^\circ\text{C}\pm 0.1^\circ\text{C}$, $I_R=1\text{ mA}$, $t = 1000\text{ hrs}$ | | 20 | | | 20 | | ppm | |

- (1) Unless otherwise specified, the LM136-2.5-N is specified from $-55^\circ\text{C}\leq T_A\leq +125^\circ\text{C}$, the LM236-2.5-N from $-25^\circ\text{C}\leq T_A\leq +85^\circ\text{C}$ and the LM336-2.5-N from $0^\circ\text{C}\leq T_A\leq +70^\circ\text{C}$.
- (2) Temperature stability for the LM336 and LM236 family is specified by design. Design limits are ensured (but not 100% production tested) over the indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels. Stability is defined as the maximum change in V_{ref} from 25°C to T_A (min) or T_A (max).

Typical Performance Characteristics

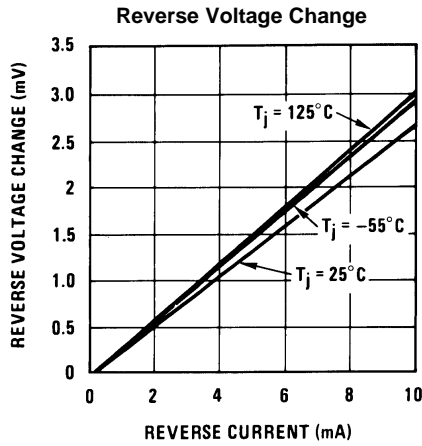


Figure 7.

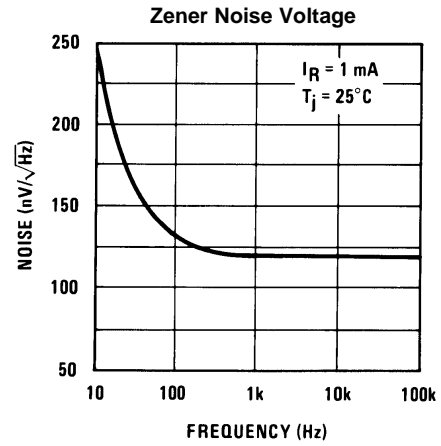


Figure 8.

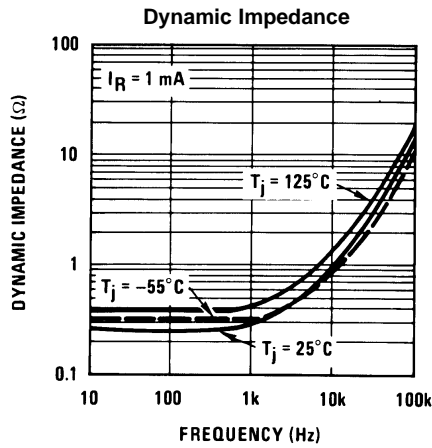


Figure 9.

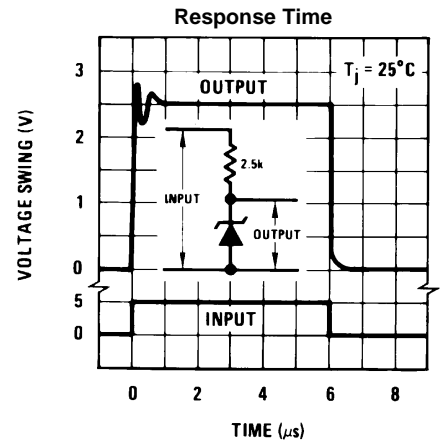


Figure 10.

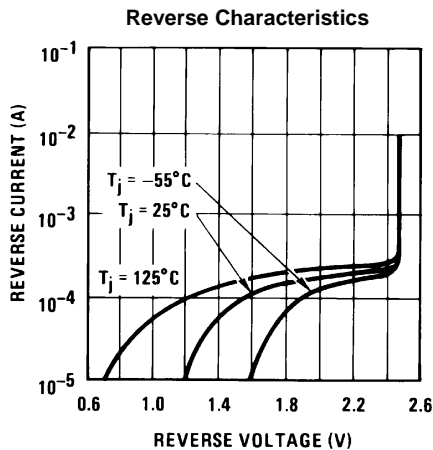


Figure 11.

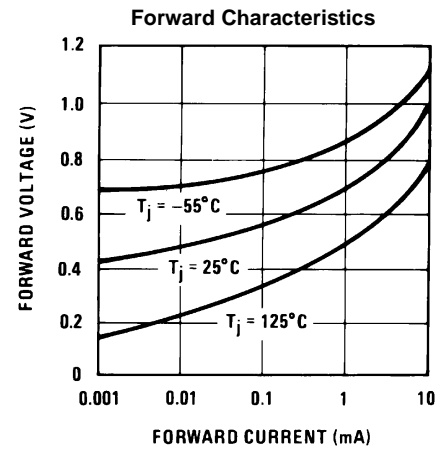
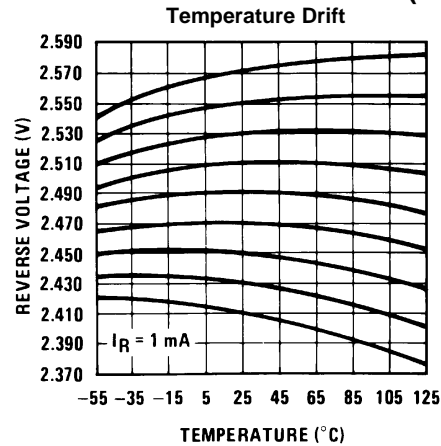


Figure 12.

Typical Performance Characteristics (continued)



APPLICATION HINTS

The LM136 series voltage references are much easier to use than ordinary zener diodes. Their low impedance and wide operating current range simplify biasing in almost any circuit. Further, either the breakdown voltage or the temperature coefficient can be adjusted to optimize circuit performance.

Figure 14 shows an LM136 with a 10k potentiometer for adjusting the reverse breakdown voltage. With the addition of R1 the breakdown voltage can be adjusted without affecting the temperature coefficient of the device. The adjustment range is usually sufficient to adjust for both the initial device tolerance and inaccuracies in buffer circuitry.

If minimum temperature coefficient is desired, two diodes can be added in series with the adjustment potentiometer as shown in Figure 15. When the device is adjusted to 2.490V the temperature coefficient is minimized. Almost any silicon signal diode can be used for this purpose such as a 1N914, 1N4148 or a 1N457. For proper temperature compensation the diodes should be in the same thermal environment as the LM136. It is usually sufficient to mount the diodes near the LM136 on the printed circuit board. The absolute resistance of R1 is not critical and any value from 2k to 20k will work.

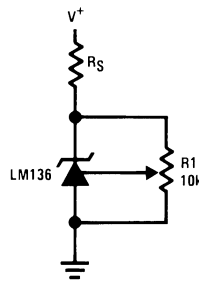


Figure 14. LM136 With Pot for Adjustment of Breakdown Voltage
(Trim Range = ± 120 mV typical)

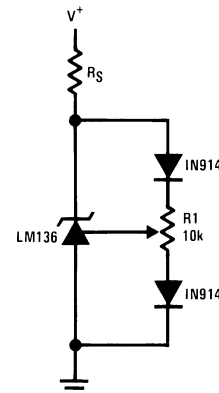
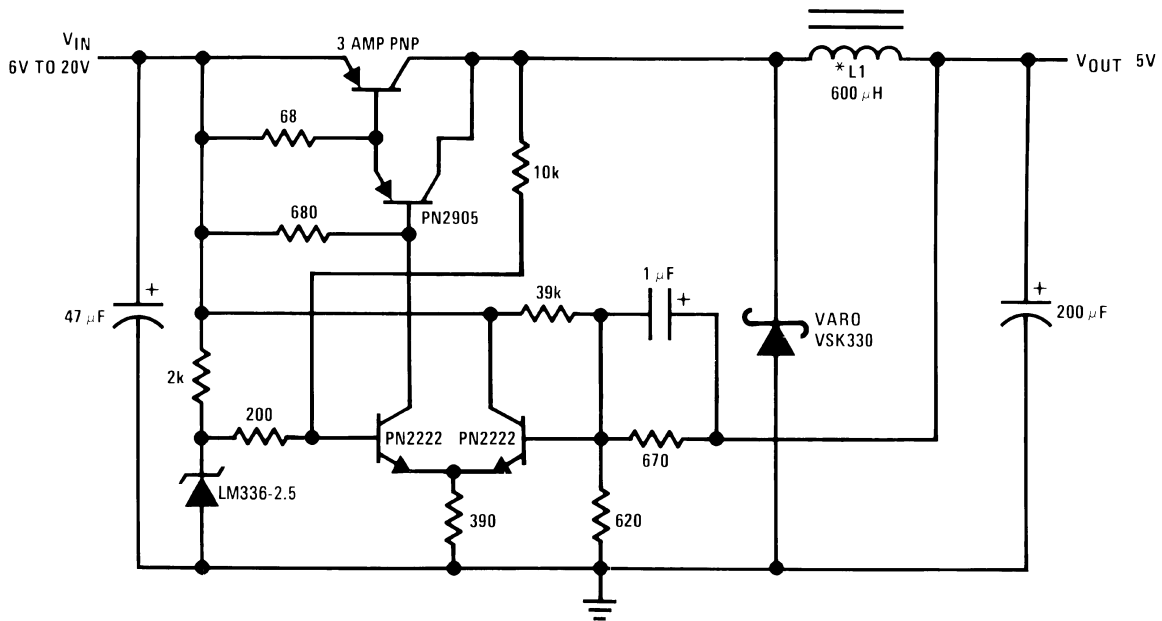
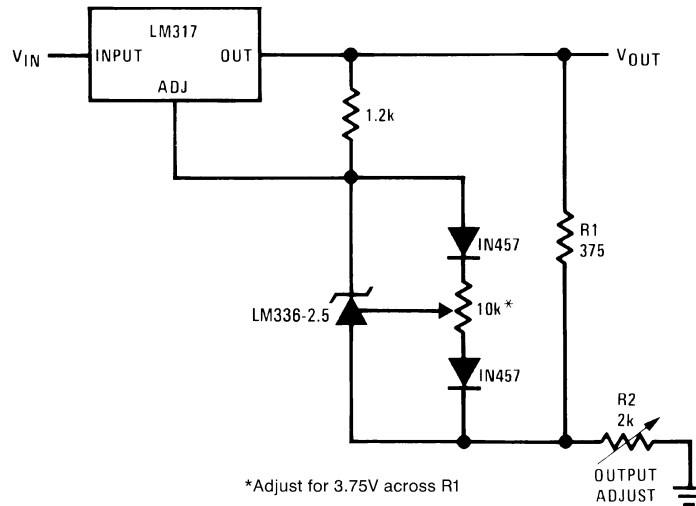


Figure 15. Temperature Coefficient Adjustment
(Trim Range = ± 70 mV typical)



[†]L1 60 turns #16 wire on Arnold Core A-254168-2
[†]Efficiency ≈ 80%

Figure 16. Low Cost 2 Amp Switching Regulator[†]



*Adjust for 3.75V across R1

Figure 17. Precision Power Regulator with Low Temperature Coefficient

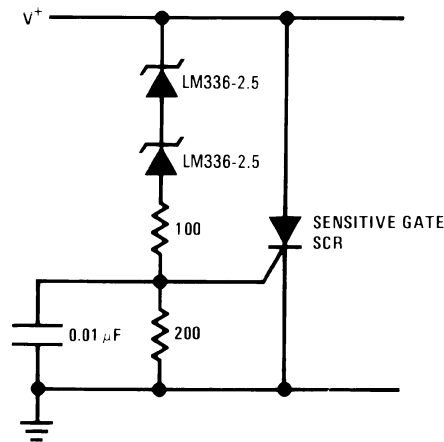
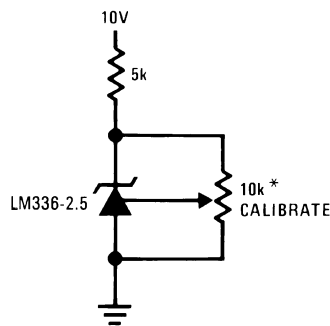


Figure 18. 5V Crowbar



*Does not affect temperature coefficient

Figure 19. Trimmed 2.5V Reference with Temperature Coefficient Independent of Breakdown Voltage

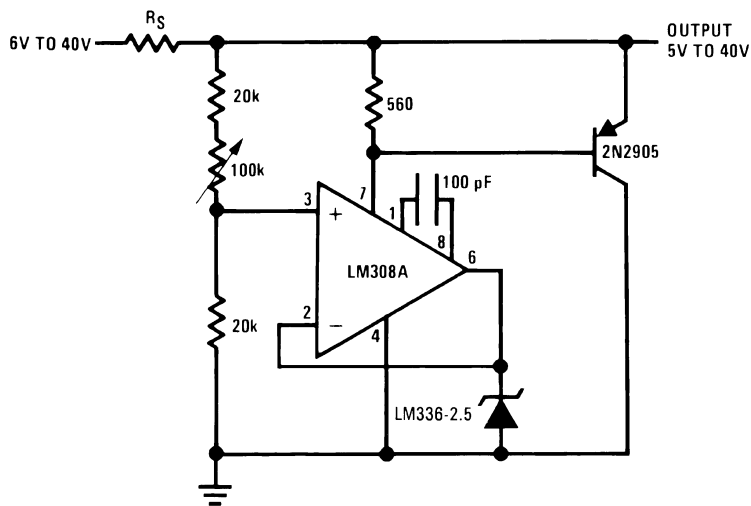


Figure 20. Adjustable Shunt Regulator

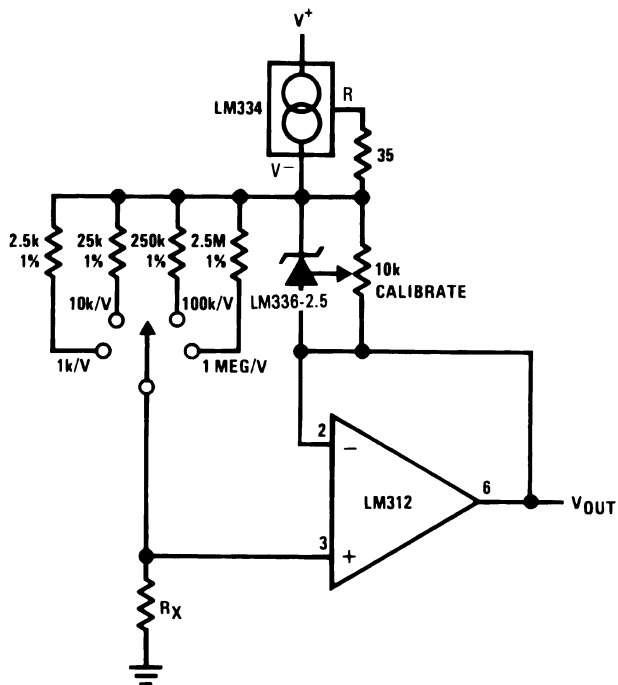


Figure 21. Linear Ohmmeter

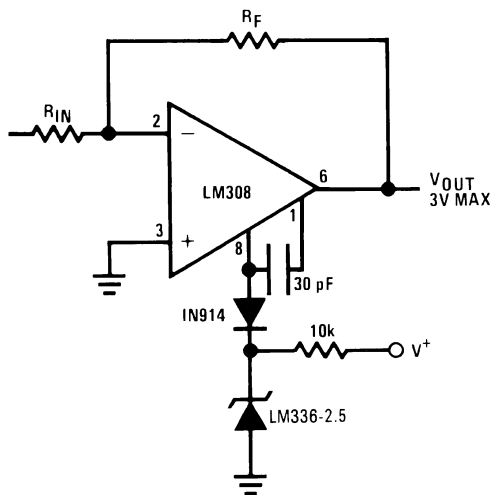


Figure 22. Op Amp with Output Clamped

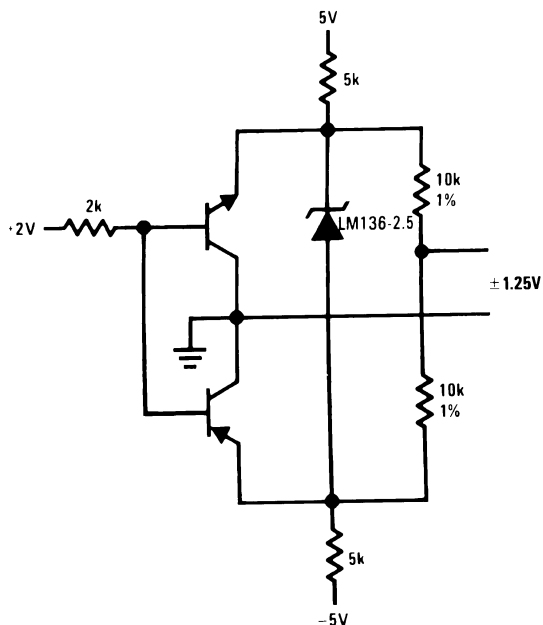


Figure 23. Bipolar Output Reference

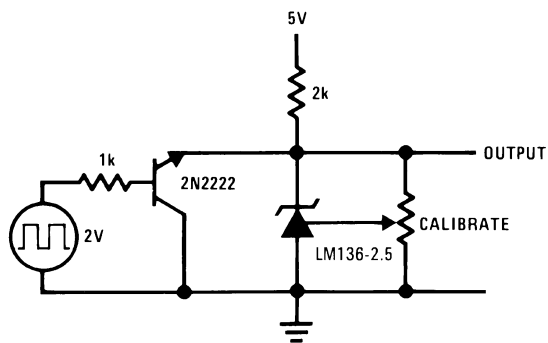


Figure 24. 2.5V Square Wave Calibrator

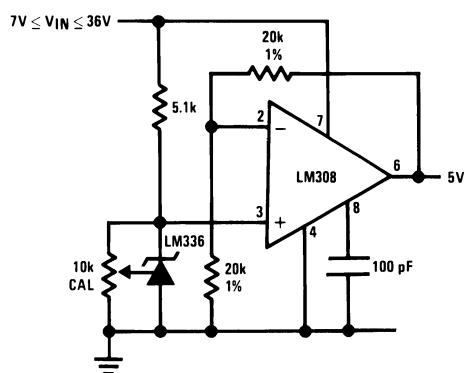


Figure 25. 5V Buffered Reference

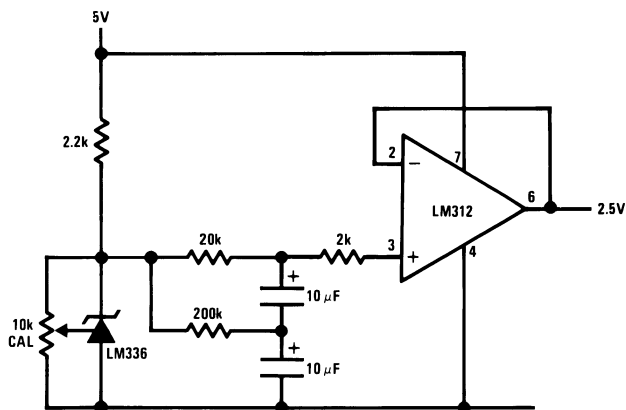
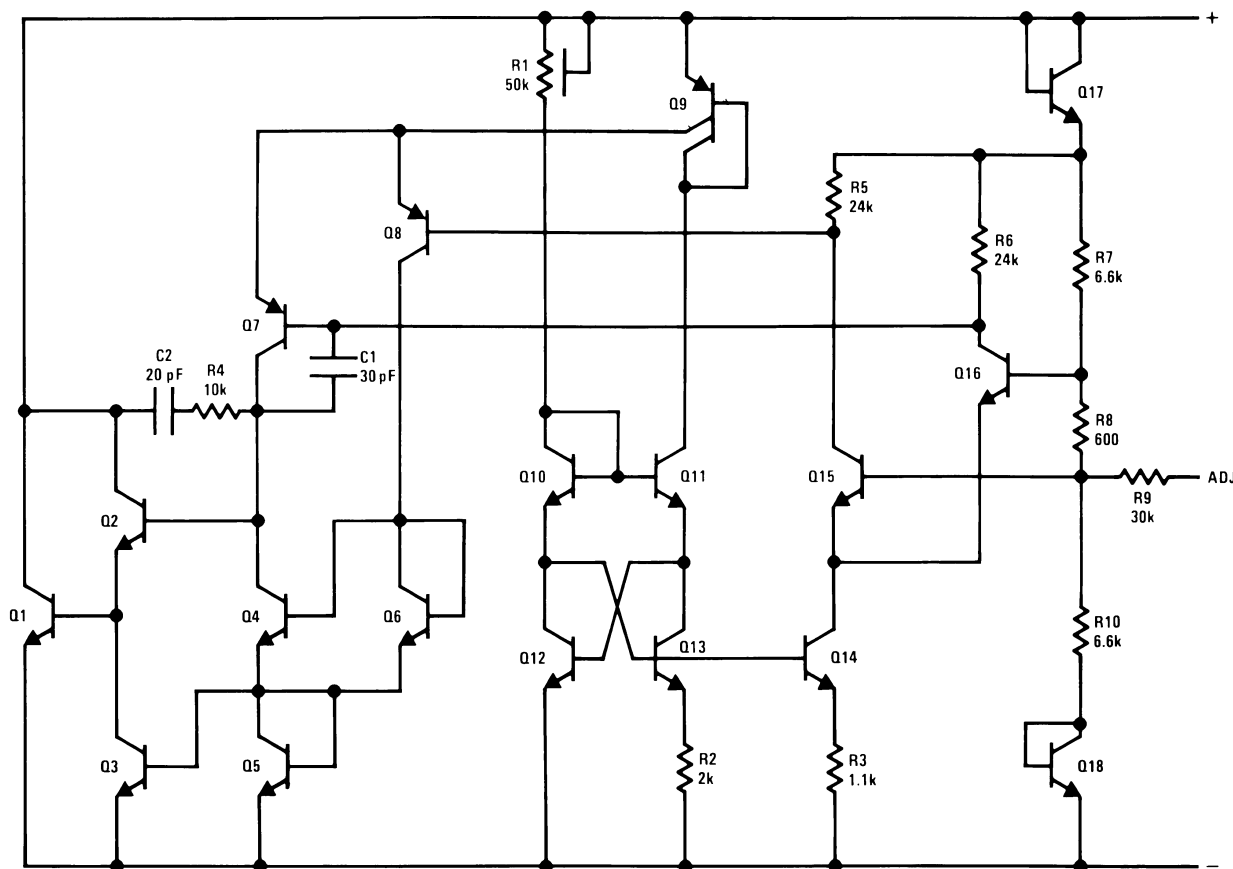


Figure 26. Low Noise Buffered Reference

Schematic Diagram



REVISION HISTORY

| Changes from Revision E (April 2013) to Revision F | Page |
|--|------|
| • Changed layout of National Data Sheet to TI format | 11 |

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 |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| LM136AH-2.5 | ACTIVE | TO | NDV | 3 | 1000 | TBD | Call TI | Call TI | -40 to 125 | LM136AH2.5 | Samples |
| LM136AH-2.5/NOPB | ACTIVE | TO | NDV | 3 | 1000 | Green (RoHS & no Sb/Br) | POST-PLATE | Level-1-NA-UNLIM | -40 to 125 | LM136AH2.5 | Samples |
| LM136H-2.5 | ACTIVE | TO | NDV | 3 | 1000 | TBD | Call TI | Call TI | -55 to 125 | LM136H2.5 | Samples |
| LM136H-2.5/NOPB | ACTIVE | TO | NDV | 3 | 1000 | Green (RoHS & no Sb/Br) | POST-PLATE | Level-1-NA-UNLIM | -55 to 125 | LM136H2.5 | Samples |
| LM236H-2.5 | ACTIVE | TO | NDV | 3 | 1000 | TBD | Call TI | Call TI | -25 to 85 | LM236H2.5 | Samples |
| LM236H-2.5/NOPB | ACTIVE | TO | NDV | 3 | 1000 | Green (RoHS & no Sb/Br) | POST-PLATE | Level-1-NA-UNLIM | -25 to 85 | LM236H2.5 | Samples |

(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.

OBSELETE: 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.

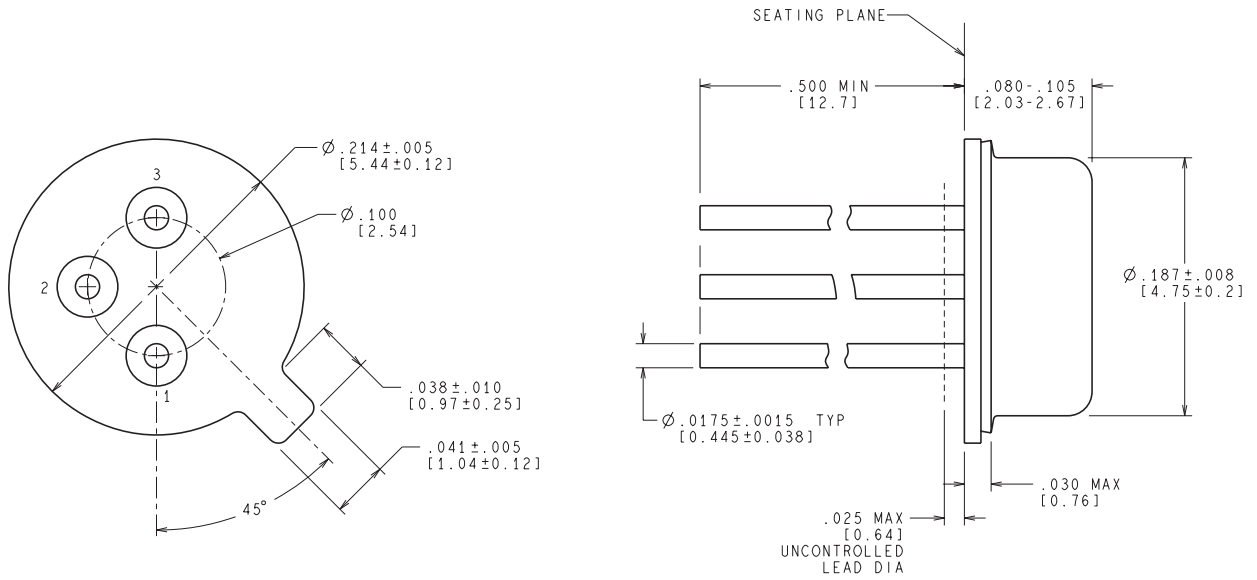
(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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.

NDV0003H



CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE IN MILLIMETERS

H03H (Rev F)

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

| | |
|------------------------------|--|
| Audio | www.ti.com/audio |
| Amplifiers | amplifier.ti.com |
| Data Converters | dataconverter.ti.com |
| DLP® Products | www.dlp.com |
| DSP | dsp.ti.com |
| Clocks and Timers | www.ti.com/clocks |
| Interface | interface.ti.com |
| Logic | logic.ti.com |
| Power Mgmt | power.ti.com |
| Microcontrollers | microcontroller.ti.com |
| RFID | www.ti-rfid.com |
| OMAP Applications Processors | www.ti.com/omap |
| Wireless Connectivity | www.ti.com/wirelessconnectivity |

Applications

| | |
|-------------------------------|--|
| Automotive and Transportation | www.ti.com/automotive |
| Communications and Telecom | www.ti.com/communications |
| Computers and Peripherals | www.ti.com/computers |
| Consumer Electronics | www.ti.com/consumer-apps |
| Energy and Lighting | www.ti.com/energy |
| Industrial | www.ti.com/industrial |
| Medical | www.ti.com/medical |
| Security | www.ti.com/security |
| Space, Avionics and Defense | www.ti.com/space-avionics-defense |
| Video and Imaging | www.ti.com/video |

TI E2E Community

e2e.ti.com