

National Semiconductor is now part of  
Texas Instruments.

Search <http://www.ti.com/> for the latest technical  
information and details on our current products and services.

# LM136A-2.5QML

## 2.5V Reference Diode

### General Description

The LM136A-2.5QML integrated circuit is a precision 2.5V shunt regulator diode. This monolithic IC voltage reference operates as a low-temperature-coefficient 2.5V zener with 0.2Ω dynamic impedance. A third terminal on the LM136A-2.5QML allows the reference voltage and temperature coefficient to be trimmed easily.

The LM136A-2.5QML 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 LM136A-2.5QML operates as a shunt regulator, it can be used as either a positive or negative voltage reference.

### Features

- Available with radiation guarantee
  - Total Ionizing Dose 100 krad(Si)
  - ELDRS Free 100 krad(Si)
- Low temperature coefficient
- Wide operating current of 400 μA to 10 mA
- Guaranteed temperature stability
- Easily trimmed for minimum temperature drift
- Fast turn-on
- 3-lead transistor package

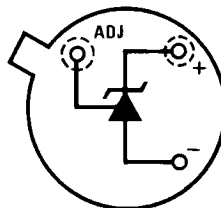
### Ordering Information

NS Part Number	SMD Part Number	NS Package Number	Package Description
LM136AH-2.5/883		H03H	T0-46, 3LD Metal Can
LM136AH-2.5RQV ( <i>Note 6</i> )	5962R0050101VXA 100 krad(Si)	H03H	T0-46, 3LD Metal Can
LM136AH-2.5RLQV ( <i>Note 7</i> ) <b>ELDRS Free</b>	5962R0050102VXA 100 krad(Si)	H03H	T0-46, 3LD Metal Can
LM136-2.5 MDE ( <i>Note 7</i> ) <b>ELDRS Free</b>	5962R0050102V9A 100 krad(Si)	( <i>Note 1</i> )	Bare Die
LM136-2.5 MDR ( <i>Note 6</i> )	5962R0050101V9A 100 krad(Si)	( <i>Note 1</i> )	Bare Die

Note 1: FOR ADDITIONAL DIE INFORMATION, PLEASE VISIT THE HI REL WEB SITE AT: [www.national.com/analog/space/level\\_die](http://www.national.com/analog/space/level_die)

### Connection Diagram

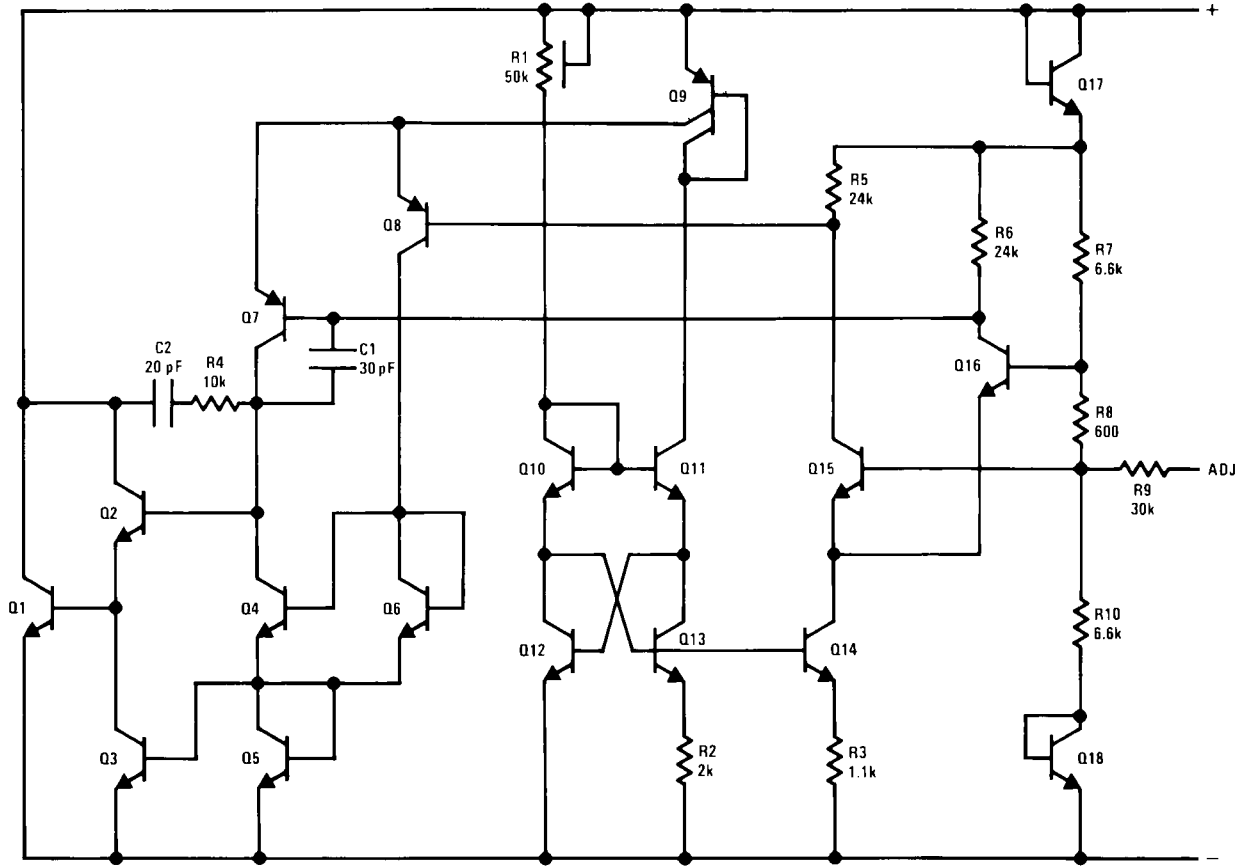
TO-46  
Metal Can Package



20139720

Bottom View  
See NS Package Number H03H

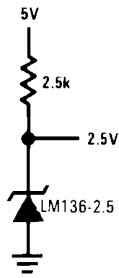
# Schematic Diagram



20139701

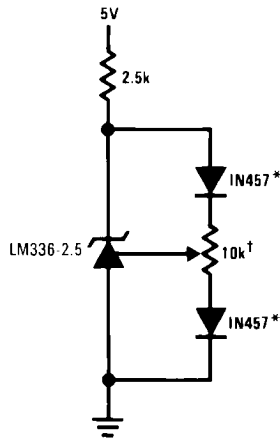
# Typical Applications

## 2.5V Reference



20139709

## 2.5V Reference with Minimum Temperature Coefficient

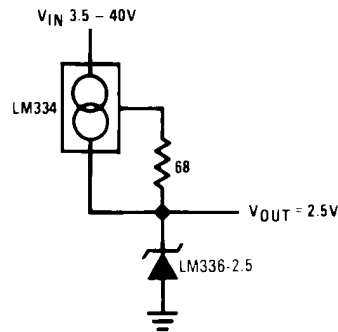


20139710

†Adjust to 2.490V

\*Any silicon signal diode

## Wide Input Range Reference



20139711

## Absolute Maximum Ratings *(Note 2)*

Reverse Current	15 mA
Forward Current	10 mA
Storage Temperature	$-60^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$
Operating Temperature Range <i>(Note 3)</i>	$-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$
Maximum Junction Temperature ( $T_J$ ) <i>(Note 3)</i>	$+150^{\circ}\text{C}$
Lead Temperature (Soldering 10 seconds)	$300^{\circ}\text{C}$
Thermal Resistance	
$\theta_{JA}$	
Still Air Flow	$354^{\circ}\text{C/W}$
500LF/Min Air Flow	$77^{\circ}\text{C/W}$
$\theta_{JC}$	$46^{\circ}\text{C/W}$
ESD Rating <i>(Note 4)</i>	$1,000\text{V}$

## Quality Conformance Inspection

Mil-Std-883, Method 5005 - Group A

Subgroup	Description	Temp $^{\circ}\text{C}$
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

## LM136A-2.5QML Electrical Characteristics

### DC Parameters

The following conditions apply, unless otherwise specified.  $I_R = 1\text{ mA}$

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
$I_{Adj}$	Adjust Current	$V_{Adj} = 0.7\text{V}$		-125	+125	$\mu\text{A}$	1, 2, 3
$\Delta V_Z$	Delta Zener Voltage	$0.4\text{mA} \leq I_Z \leq 10\text{ mA}$			6.0	mV	1
$V_Z$	Zener Voltage	$V_{Adj} = \text{Open}$		2.465	2.515	V	1
				2.44	2.54	V	2, 3
		$V_{Adj} = 0.7\text{V}$		2.39	2.49	V	1
				2.29	2.49	V	2, 3
$V_{Adj} = 1.9\text{V}$		2.49	2.69	V	1, 2, 3		
$Z_{RD}$	Reverse Dynamic Impedance		(Note 5)		0.6	$\Omega$	1
			(Note 5)		1.0	$\Omega$	2, 3
$V_{Stab}$	Temperature Stability	$V_Z = \text{Adjusted to } 2.490\text{V}$			18	mV	2, 3

### DC Drift Parameters

Delta calculations are performed on QMLV devices at Group B, Subgroup 5 only.

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
$V_Z$	Zener Voltage	$V_{Adj} = \text{Open}$		-10	+10	mV	1
		$V_{Adj} = 0.7\text{V}$		-10	+10	mV	1
		$V_{Adj} = 1.9\text{V}$		-10	+10	mV	1

**Note 2:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

**Note 3:** The maximum power dissipation must be derated at elevated temperatures and is dictated by  $T_{Jmax}$  (maximum junction temperature),  $\theta_{JA}$  (package junction to ambient thermal resistance), and  $T_A$  (ambient temperature). The maximum allowable power dissipation at any temperature is  $P_{Dmax} = (T_{Jmax} - T_A) / \theta_{JA}$  or the number given in the Absolute Maximum Ratings, whichever is lower.

**Note 4:** Human body model, 1.5K $\Omega$  in series with 100pF.

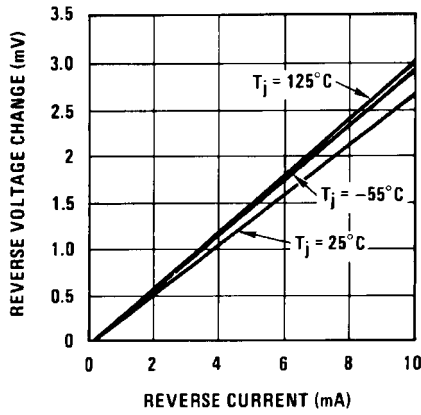
**Note 5:** Parameter tested go-no-go only.

**Note 6:** Pre and post irradiation limits are identical to those listed under DC electrical characteristics. These parts may be dose rate sensitive in a space environment and may demonstrate enhanced low dose rate effect. Radiation end point limits for the noted parameters are guaranteed only for the conditions as specified in Mil-Std-883, Method 1019.

**Note 7:** Low dose rate testing has been performed on a wafer-by-wafer basis, per test method 1019 condition D of MIL-STD-883, with no enhanced low dose rate sensitivity (ELDRS) effect.

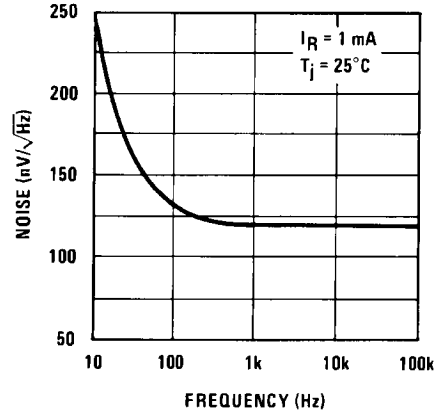
# Typical Performance Characteristics

Reverse Voltage Change



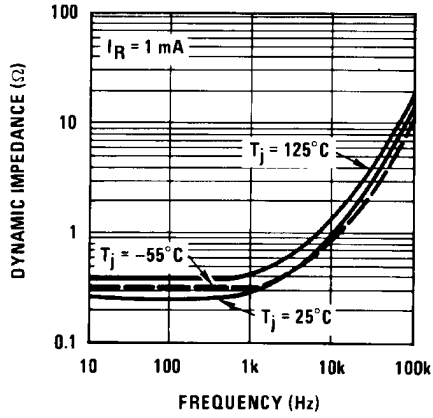
20139721

Zener Noise Voltage



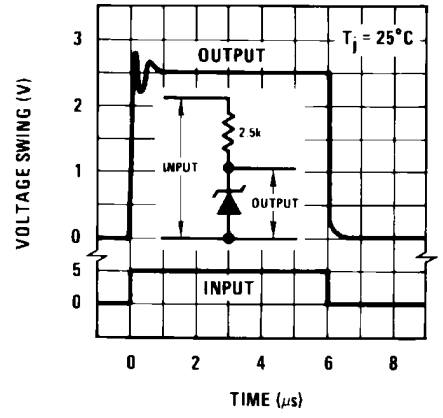
20139722

Dynamic Impedance



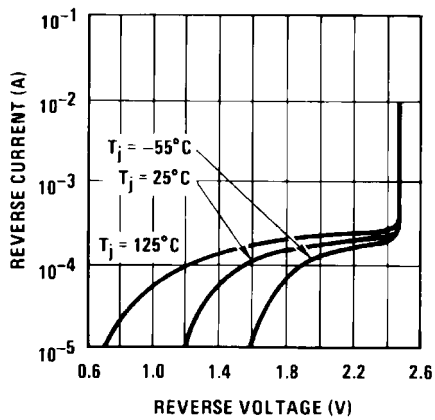
20139723

Response Time



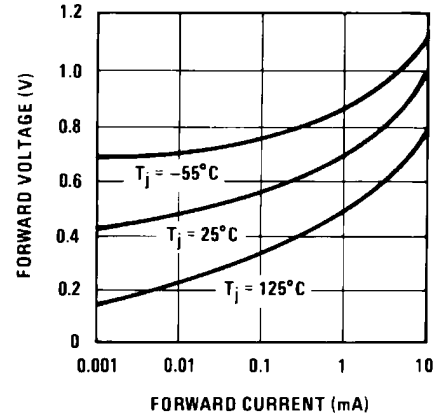
20139724

Reverse Characteristics

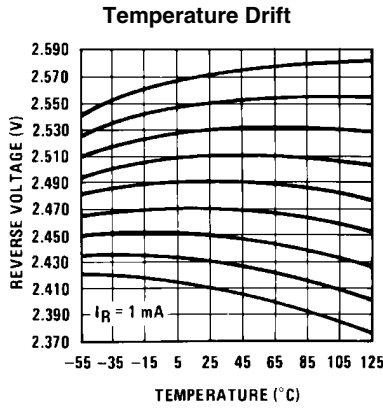


20139725

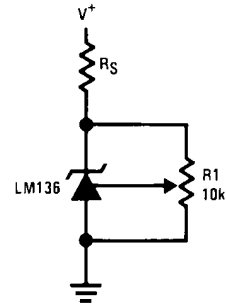
Forward Characteristics



20139726



20139727



20139728

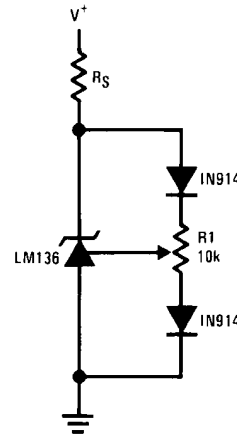
FIGURE 1. LM136 With Pot for Adjustment of Breakdown Voltage (Trim Range = ±120 mV typical)

### Application Hints

The LM136 voltage reference is much easier to use than ordinary zener diodes. It's 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 1 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.

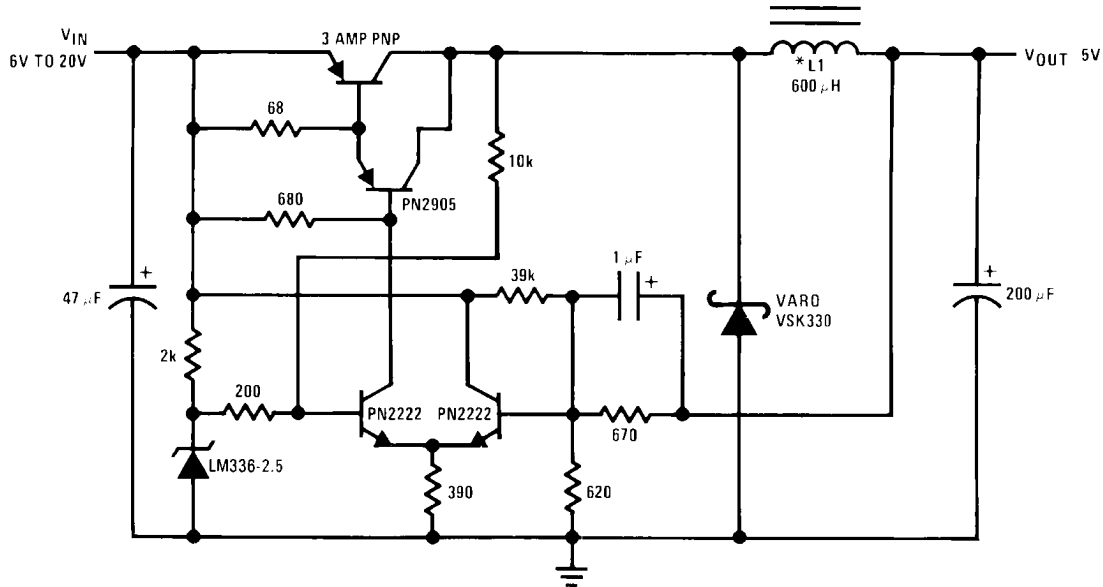
If minimum temperature coefficient is desired, two diodes can be added in series with the adjustment potentiometer as shown in Figure 2. When the device is adjusted to 2.490V the temperature coefficient is minimized. Almost any silicon signal diode can be used for this purpose such as a 1N914, 1N4148 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.



20139729

FIGURE 2. Temperature Coefficient Adjustment (Trim Range = ±70 mV typical)

### Low Cost 2 Amp Switching Regulator†



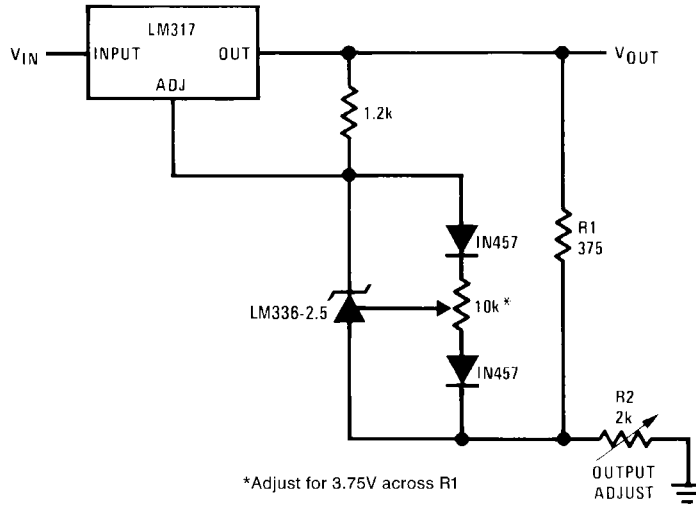
20139705

\*L1 60 turns #16 wire on Arnold Core A-254168-2

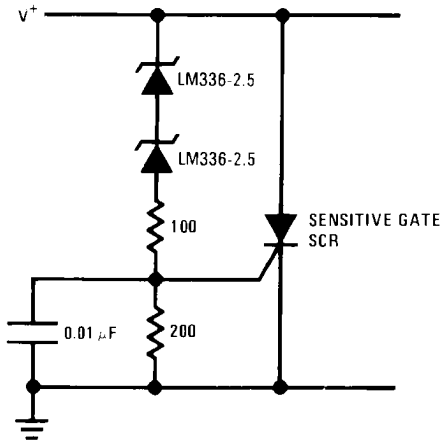
†Efficiency ≈ 80%



**Precision Power Regulator with Low Temperature Coefficient**

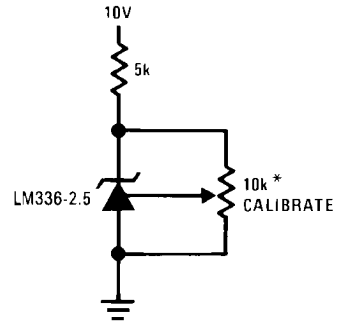


**5V Crowbar**



20139714

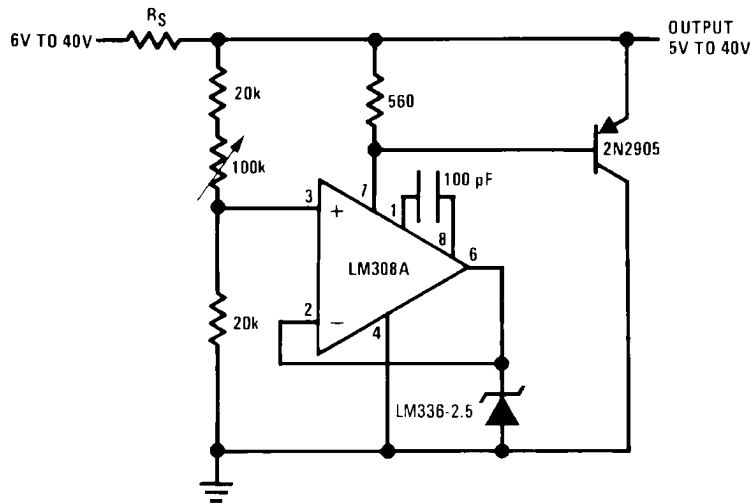
**Trimmed 2.5V Reference with Temperature Coefficient Independent of Breakdown Voltage**



\*Does not affect temperature coefficient

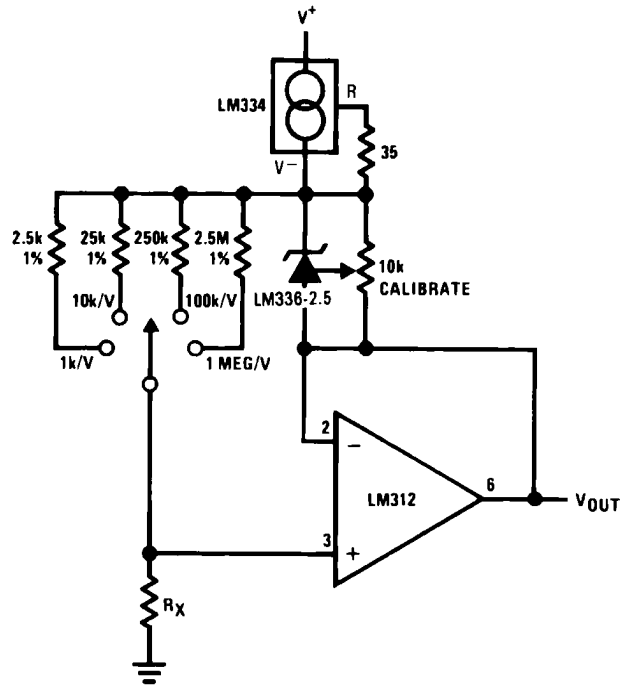
20139715

**Adjustable Shunt Regulator**



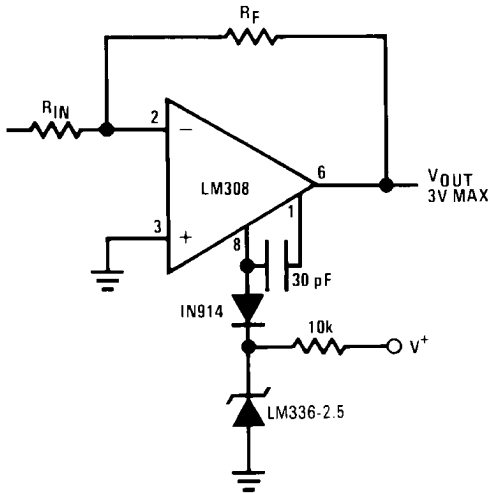
20139706

Linear Ohmmeter



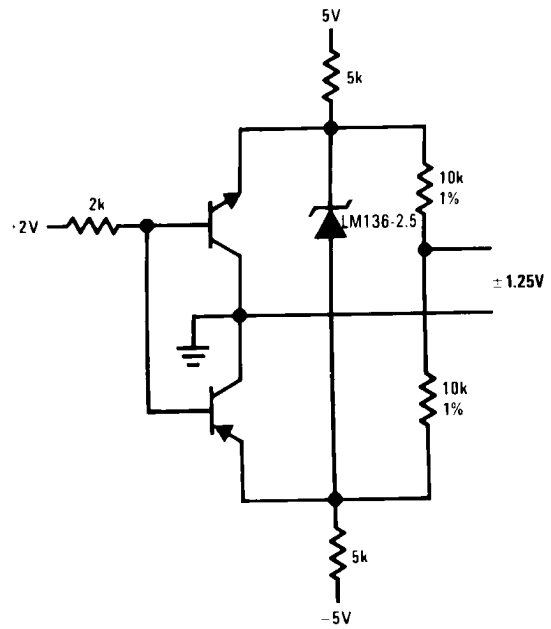
20139716

Op Amp with Output Clamped



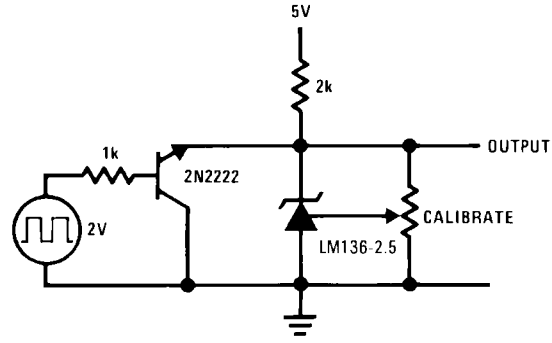
20139717

Bipolar Output Reference



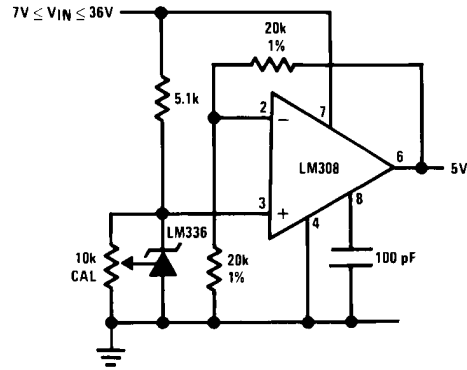
20139718

2.5V Square Wave Calibrator



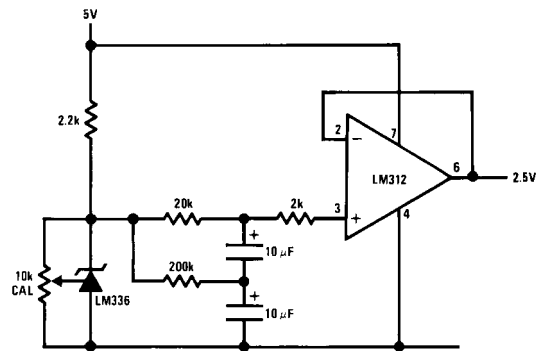
20139719

5V Buffered Reference



20139730

Low Noise Buffered Reference

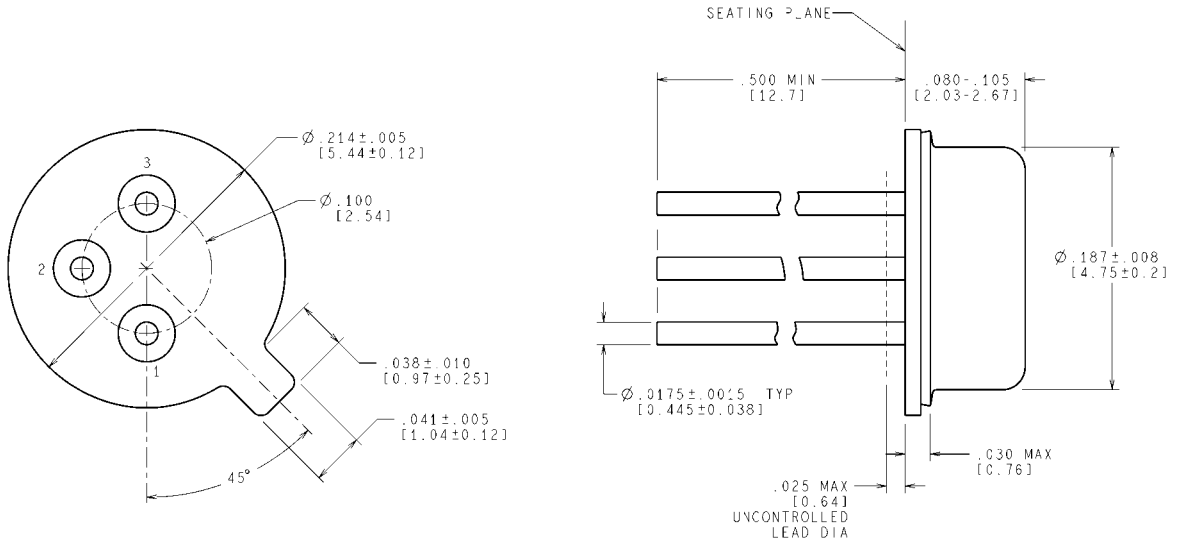


20139731

## Revision History

Date Released	Revision	Section	Changes
07/06/07	A	New Release, Corporate format	2 MDS datasheets converted into one corporate datasheet format. MNLM136-2.5-X Rev 0A0 and MNLM136A-2.5-X-RH. The ELDRS Part has also been added. Rev. 0E0 will be archived.
10/16/2010	B	Data Sheet Title, General Description, Order Information, Electrical Characteristics, Application Hints	Update with current device information and format. Removed all references to the LM136-2.5 Non "A" package NSID no longer offered. Added Die NSID's to data sheet. Revision A will be Archived.

**Physical Dimensions** inches (millimeters) unless otherwise noted



CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE IN MILLIMETERS

**NS Package Number H03H**

H03H (Rev F)



## Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:  
[www.national.com](http://www.national.com)

Products		Design Support	
Amplifiers	<a href="http://www.national.com/amplifiers">www.national.com/amplifiers</a>	WEBENCH® Tools	<a href="http://www.national.com/webench">www.national.com/webench</a>
Audio	<a href="http://www.national.com/audio">www.national.com/audio</a>	App Notes	<a href="http://www.national.com/appnotes">www.national.com/appnotes</a>
Clock and Timing	<a href="http://www.national.com/timing">www.national.com/timing</a>	Reference Designs	<a href="http://www.national.com/refdesigns">www.national.com/refdesigns</a>
Data Converters	<a href="http://www.national.com/adc">www.national.com/adc</a>	Samples	<a href="http://www.national.com/samples">www.national.com/samples</a>
Interface	<a href="http://www.national.com/interface">www.national.com/interface</a>	Eval Boards	<a href="http://www.national.com/evalboards">www.national.com/evalboards</a>
LVDS	<a href="http://www.national.com/lvds">www.national.com/lvds</a>	Packaging	<a href="http://www.national.com/packaging">www.national.com/packaging</a>
Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>	Feedback/Support	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Voltage References	<a href="http://www.national.com/vref">www.national.com/vref</a>	Design Made Easy	<a href="http://www.national.com/easy">www.national.com/easy</a>
PowerWise® Solutions	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>	Applications & Markets	<a href="http://www.national.com/solutions">www.national.com/solutions</a>
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
Temperature Sensors	<a href="http://www.national.com/tempensors">www.national.com/tempensors</a>	SolarMagic™	<a href="http://www.national.com/solarmagic">www.national.com/solarmagic</a>
PLL/VCO	<a href="http://www.national.com/wireless">www.national.com/wireless</a>	PowerWise® Design University	<a href="http://www.national.com/training">www.national.com/training</a>

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

#### LIFE SUPPORT POLICY

**NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION.** As used herein:

Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2010 National Semiconductor Corporation

For the most current product information visit us at [www.national.com](http://www.national.com)



**National Semiconductor**  
Americas Technical  
Support Center  
Email: [support@nsc.com](mailto:support@nsc.com)  
Tel: 1-800-272-9959

**National Semiconductor Europe**  
Technical Support Center  
Email: [europe.support@nsc.com](mailto:europe.support@nsc.com)

**National Semiconductor Asia**  
Pacific Technical Support Center  
Email: [ap.support@nsc.com](mailto:ap.support@nsc.com)

**National Semiconductor Japan**  
Technical Support Center  
Email: [jpn.feedback@nsc.com](mailto:jpn.feedback@nsc.com)