

## 5.0V Reference Diode

### General Description

The LM136A-5.0QML/LM136-5.0QML integrated circuits are precision 5.0V shunt regulator diodes. These monolithic IC voltage references operate as a low temperature coefficient 5.0V zener with 0.6Ω dynamic impedance. A third terminal on the LM136-5.0 allows the reference voltage and temperature coefficient to be trimmed easily.

The LM136-5.0 series is useful as a precision 5.0V low voltage reference for digital voltmeters, power supplies or op amp circuitry. The 5.0V makes it convenient to obtain a stable reference from low voltage supplies. Further, since the LM136-5.0 operates as a shunt regulator, it can be used as either a positive or negative voltage reference.

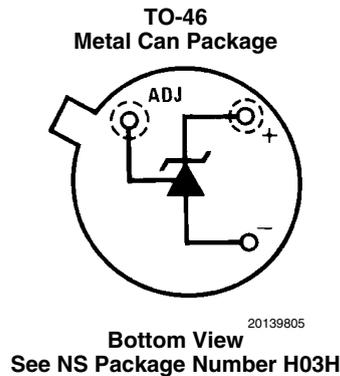
### Features

- Adjustable 4V to 6V
- Low temperature coefficient
- Wide operating current of 600 μA to 10 mA
- 0.6Ω dynamic impedance
- Guaranteed temperature stability
- Easily trimmed for minimum temperature drift
- Fast turn-on
- Three lead transistor package

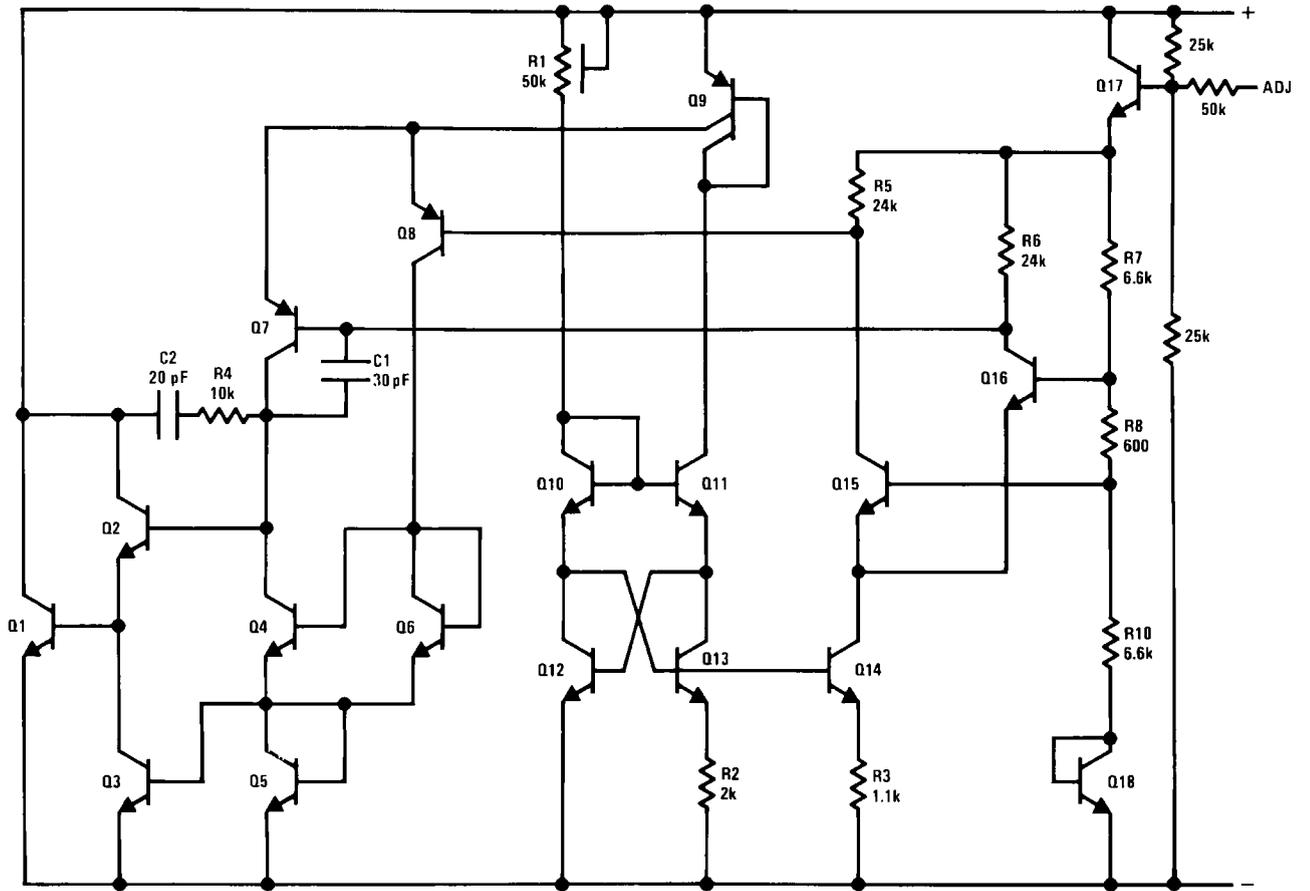
### Ordering Information

NS Part Number	SMD Part Number	NS Package Number	Package Description
LM136H-5.0/883		H03H	T0-46, 3LD Metal Can
LM136AH-5.0/883		H03H	T0-46, 3LD Metal Can
LM136AH-5.0-SMD	8418002XA	H03H	T0-46, 3LD Metal Can

### Connection Diagram



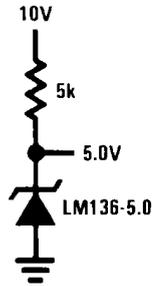
# Schematic Diagram



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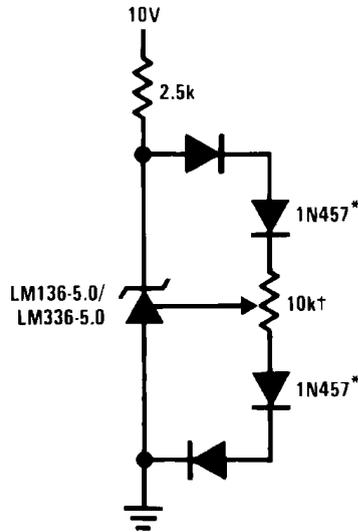
# Typical Applications

## 5.0V Reference



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## 5.0V Reference with Minimum Temperature Coefficient

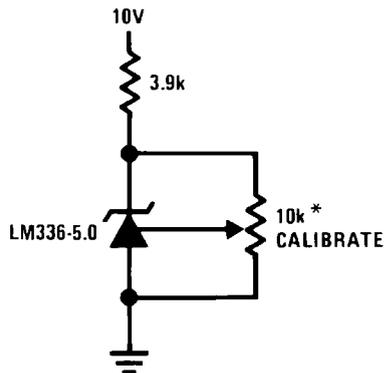


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† Adjust to 5.00V

\* Any silicon signal diode

## Trimmed 4V to 6V Reference with Temperature Coefficient Independent of Breakdown Voltage



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\* Does not affect temperature coefficient

## Absolute Maximum Ratings *(Note 1)*

Reverse Current	15mA
Forward Current	15mA
Storage Temperature	$-60^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$
Operating Temperature Range <i>(Note 2)</i>	$-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$
Soldering Information (10 Seconds)	300°C
Maximum Junction Temperature ( $T_{Jmax}$ )	150°C
Thermal Resistance	
$\theta_{JA}$	
Still Air Flow	354°C/W
500LF/Min Air Flow	77°C/W
$\theta_{JC}$	46°C/W
ESD Rating <i>(Note 3)</i>	1,000 V

## 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

## LM136-5.0 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
$V_R$	Reverse Breakdown Voltage	$V_{Adj} = 2.5V$		4.6	5.4	V	1
				4.8	5.6	V	2, 3
		$V_{Adj} = 1.5V$		5.4	6.6	V	1
				5.6	6.8	V	2, 3
		$V_{Adj} = 3.5V$		2.4	4.6	V	1
				2.8	4.8	V	2, 3
		$V_{Adj} = \text{Open}$		4.878	5.081	V	1
				4.83	5.13	V	2, 3
$I_{Adj}$	Adjust Current	$V_{Adj} = 2.5V$		-260	260	$\mu\text{A}$	1
		$V_{Adj} = 1.5V$		-260	260	$\mu\text{A}$	1
		$V_{Adj} = 3.5V$		-260	260	$\mu\text{A}$	1
$\Delta V_R$	Reverse Breakdown Change with Current	$0.6\text{mA} \leq I_R \leq 15 \text{ mA}$		-12	12	mV	1
				-20	20	mV	2, 3
$V_F$	Foward Voltage	$I_R = -10\text{mA}$		-1.5	-0.49	V	1
$V_{Stab}$	Temperature Stability	$V_R = \text{Adjusted to } 5V$			36	mV	2, 3
$Z_{RD}$	Reverse Dynamic Impedance		(Note 4)		1.6	$\Omega$	1, 2, 3

## LM136A-5.0 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
$V_R$	Reverse Breakdown Voltage	$V_{Adj} = 2.5V$		4.6	5.4	V	1
				4.8	5.6	V	2, 3
		$V_{Adj} = 1.5V$		5.4	6.6	V	1
				5.6	6.8	V	2, 3
		$V_{Adj} = 3.5V$		2.4	4.6	V	1
				2.8	4.8	V	2, 3
		$V_{Adj} = \text{Open}$		4.935	5.029	V	1
				4.88	5.08	V	2, 3
$I_{Adj}$	Adjust Current	$V_{Adj} = 2.5V$		-260	260	$\mu\text{A}$	1
		$V_{Adj} = 1.5V$		-260	260	$\mu\text{A}$	1
		$V_{Adj} = 3.5V$		-260	260	$\mu\text{A}$	1
$\Delta V_R$	Reverse Breakdown Change with Current	$0.6\text{mA} \leq I_R \leq 15 \text{ mA}$		-12	12	mV	1
				-20	20	mV	2, 3
$V_F$	Foward Voltage	$I_R = -10\text{mA}$		-1.5	-0.49	V	1
$V_{Stab}$	Temperature Stability	$V_R = \text{Adjusted to } 5V$			36	mV	2, 3
$Z_{RD}$	Reverse Dynamic Impedance		(Note 4)		1.6	$\Omega$	1, 2, 3

**Note 1:** 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.

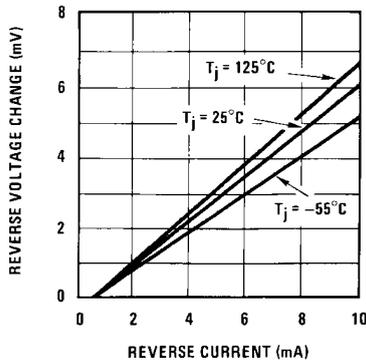
**Note 2:** The maximum power dissipation must be derated at elevated temperatures and is dictated by  $T_{Jmax}$  (maximum junction temperature),  $\theta_{JA}$  (package junction to ambient thermal resistance), and  $T_A$  (ambient temperature). The maximum allowable power dissipation at any temperature is  $P_{Dmax} = (T_{Jmax} - T_A) / \theta_{JA}$  or the number given in the Absolute Maximum Ratings, whichever is lower.

**Note 3:** Human body model, 100pF discharged through 1.5k $\Omega$

**Note 4:** Guaranteed, not tested.

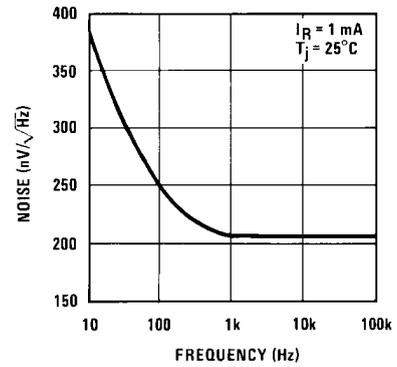
## Typical Performance Characteristics

**Reverse Voltage Change**



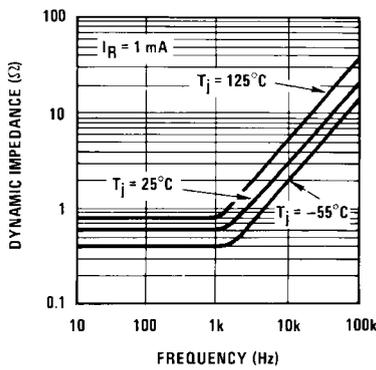
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**Zener Noise Voltage**



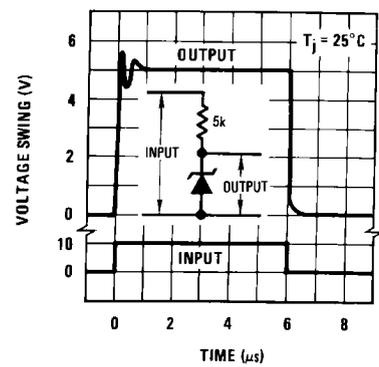
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**Dynamic Impedance**



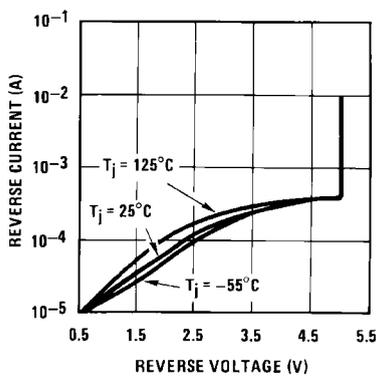
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**Response Time**



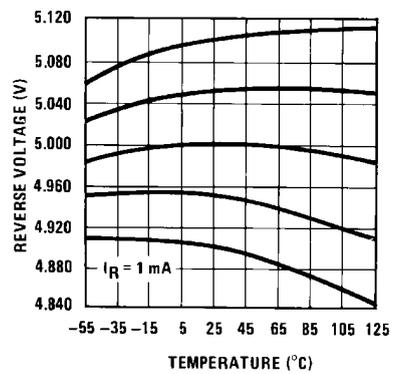
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**Reverse Characteristics**

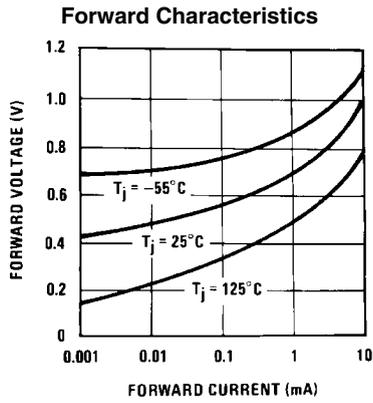


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**Temperature Drift**



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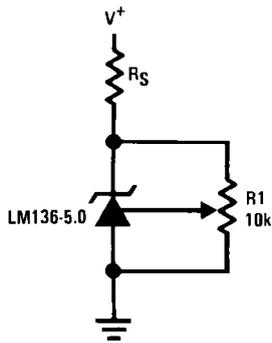
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## Application Hints

The LM136-5.0 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.

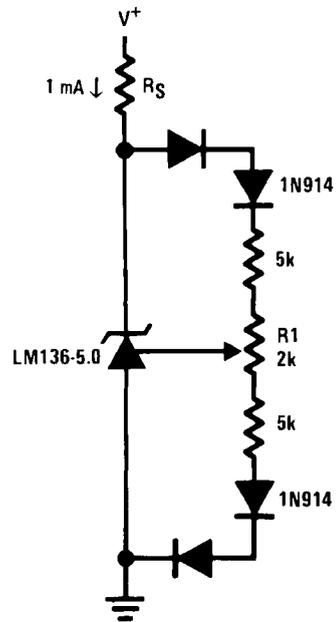
Figure 1 shows an LM136-5.0 with a 10k potentiometer for adjusting the reverse breakdown voltage. With the addition of R1 the breakdown voltage can be adjusted without affecting the temperature coefficient of the device. The adjustment range is usually sufficient to adjust for both the initial device tolerance and inaccuracies in buffer circuitry.

If minimum temperature coefficient is desired, four diodes can be added in series with the adjustment potentiometer as shown in Figure 2. When the device is adjusted to 5.00V 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 LM136-5.0. It is usually sufficient to mount the diodes near the LM136-5.0 on the printed circuit board. The absolute resistance of the network is not critical and any value from 2k to 20k will work. Because of the wide adjustment range, fixed resistors should be connected in series with the pot to make pot setting less critical.



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**FIGURE 1. LM136-5.0 with Pot for Adjustment of Breakdown Voltage (Trim Range =  $\pm 1.0\text{V}$  Typical)**

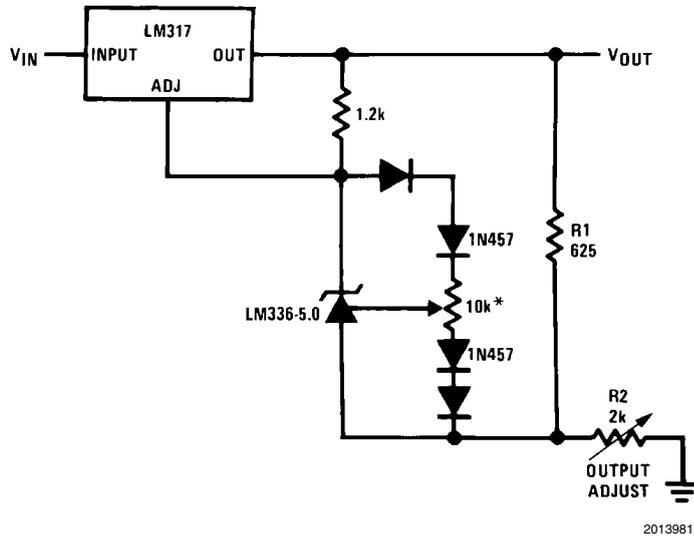


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**FIGURE 2. Temperature Coefficient Adjustment (Trim Range =  $\pm 0.5\text{V}$  Typical)**

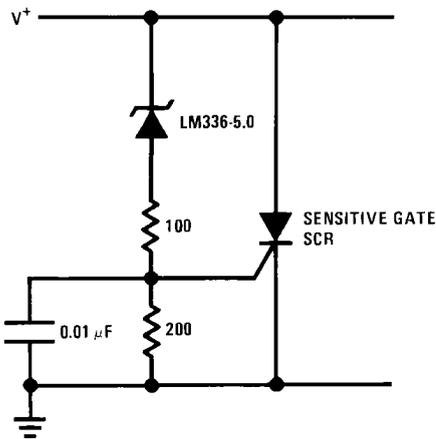
## Typical Applications

Precision Power Regulator with Low Temperature Coefficient

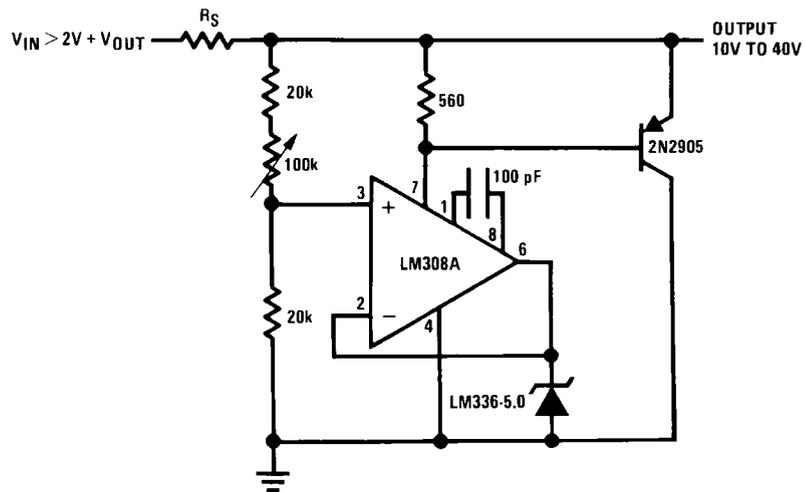


\* Adjust for 6.25V across R1

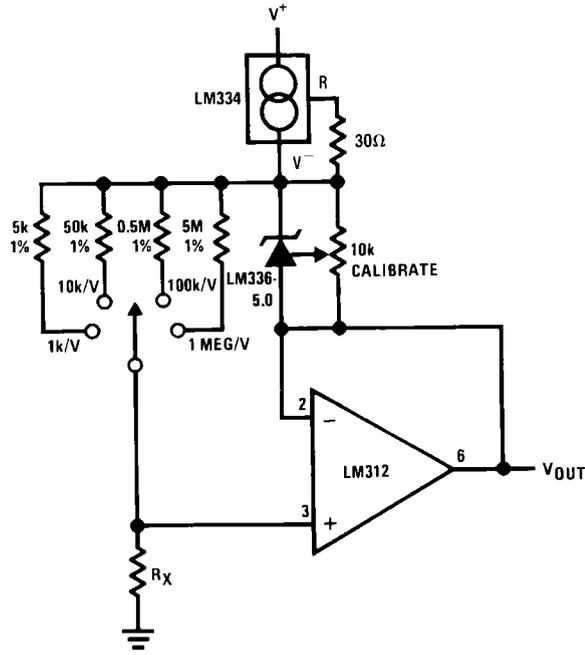
5V Crowbar



Adjustable Shunt Regulator

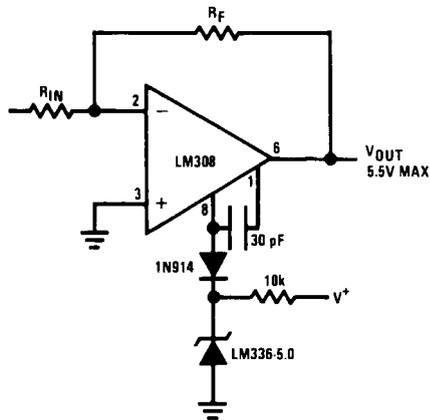


Linear Ohmmeter



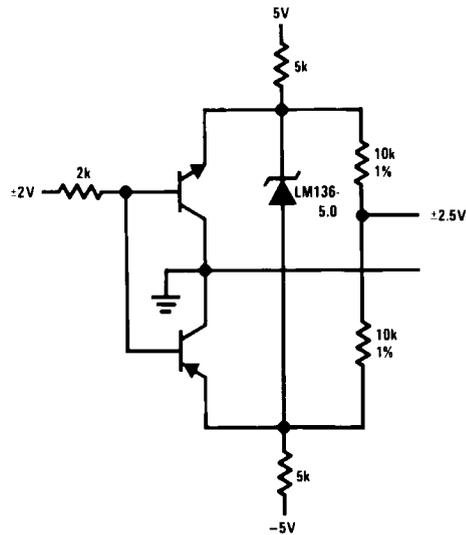
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Op Amp with Output Clamped



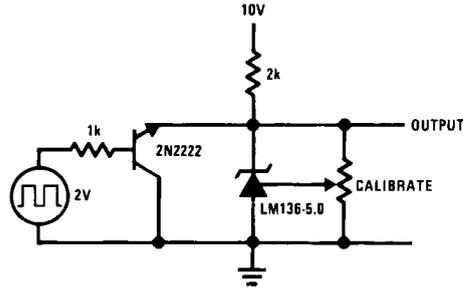
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Bipolar Output Reference



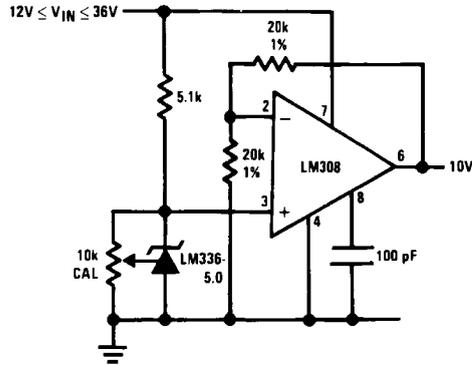
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5.0V Square Wave Calibrator



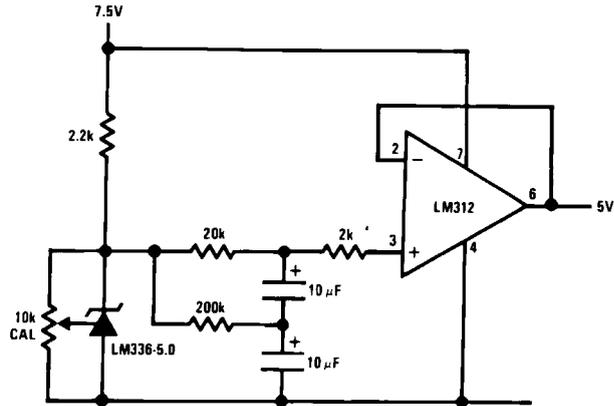
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10V Buffered Reference



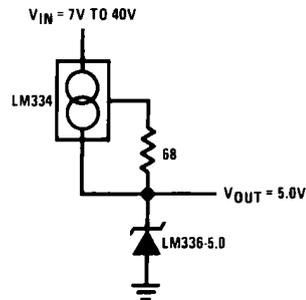
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Low Noise Buffered Reference



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Wide Input Range Reference

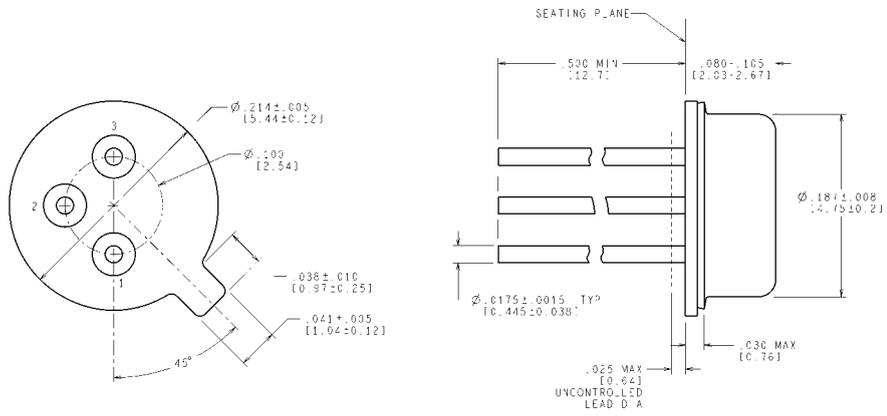


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## Revision History

Date Released	Revision	Section	Changes
04/10/08	A	New Release, Corporate format.	2 MDS datasheets were converted into one Corporate datasheet format. MNLM136A-5.0-X Rev 0B0 & LM136-5.0-X Rev 0A0 MDS Data Sheets will be archived.
10/26/2010	B	Data Sheet Title	Changed Title from LM136A-5.0/LM136-5.0QML to LM136A-5.0QML/LM136-5.0QML. Revision A will be Archived.

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



CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE IN MILLIMETERS

H03H (Rev F)

**TO-46 Metal Can Package (H)**  
**NS Package Number H03H**



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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>
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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>
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