June 2005



LM136-5.0/LM236-5.0/LM336-5.0 **5.0V Reference Diode General Description**

The LM136-5.0/LM236-5.0/LM336-5.0 integrated circuits are precision 5.0V shunt regulator diodes. These monolithic IC voltage references operate as a low temperature coefficient 5.0V zener with 0.6 Ω 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.

The LM136-5.0 is rated for operation over -55°C to +125°C while the LM236-5.0 is rated over a -25°C to +85°C temperature range. The LM336-5.0 is rated for operation over a 0°C to +70°C temperature range. See the connection diagrams for available packages. For applications requiring 2.5V see LM136-2.5.

Features

- Adjustable 4V to 6V
- Low temperature coefficient
- Wide operating current of 600 µA to 10 mA
- 0.6Ω dynamic impedance
- ± 1% initial tolerance available
- Guaranteed temperature stability
- Easily trimmed for minimum temperature drift
- Fast turn-on
- Three lead transistor package





Order Number LM336M-5.0 or LM336BM-5.0 See NS Package Number M08A



Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

15mA
10mA
-60°C to +150°C
–55°C to +150°C
–25°C to +85°C

LM336-5.0	0°C to +70°C
Soldering Information	
TO-92 Package (10 sec.)	260°C
TO-46 Package (10 sec.)	300°C
SO Package	
Vapor Phase (60 sec.)	215°C
Infrared (15 sec.)	220°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" (appendix D) for other methods of soldering surface mount devices.

Electrical Characteristics

(Note 3)

		LM1364	-5.0/LM2	236A-5.0	LN	I336B-5	.0	
Parameter	Conditions	LM136	LM136-5.0/LM236-5.0 LM336-5.0		LM336-5.0		Units	
		Min	Тур	Max	Min	Тур	Max	
Reverse Breakdown Voltage	T _A =25°C, I _R =1 mA							
	LM136-5.0/LM236-5.0/LM336-5.0	4.9	5.00	5.1	4.8	5.00	5.2	V
	LM136A-5.0/LM236A-5.0, LM336B-5.0	4.95	5.00	5.05	4.90	5.00	5.1	V
Reverse Breakdown Change	T _A =25°C,		6	12		6	20	mV
With Current	600 μA≤l _R ≤10 mA							
Reverse Dynamic Impedance	T _A =25°C, I _R =1 mA, f = 100 Hz		0.6	1.2		0.6	2	Ω
Temperature Stability	V _R Adjusted 5.00V							
(Note 4)	I _R =1 mA, (<i>Figure 2</i>)							
	0°C≤T _A ≤70°C (LM336-5.0)					4	12	mV
	–25°C≤T _A ≤+85°C (LM236-5.0)		7	18				mV
	–55°C≤T _A ≤+125°C (LM136-5.0)		20	36				mV
Reverse Breakdown Change	600 μA≤l _R ≤10 mA		6	17		6	24	mV
With Current								
Adjustment Range	Circuit of Figure 1		±1			±1		V
Reverse Dynamic Impedance	I _R = 1 mA		0.8	1.6		0.8	2.5	Ω
Long Term Stability	$T_{A}=25^{\circ}C\pm0.1^{\circ}C$, $I_{B}=1$ mA, t = 1000 hrs		20			20		ppm

Note 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.

Note 2: For elevated temperature operation, T_j max is:

LM136 150°C LM236 125°C LM336 100°C

Thermal Resistance	TO-92	TO-46	SO-8
θ_{ja} (Junction to Ambient)	180°C/W (0.4" Leads)	440°C/W	165°C/W
	170°C/W (0.125"		
	Leads)		
θ_{ia} (Junction to Case)	N/A	80°C/W	N/A

Note 3: Unless otherwise specified, the LM136-5.0 is specified from $-55^{\circ}C \le T_A \le +125^{\circ}C$, the LM236-5.0 from $-25^{\circ}C \le T_A \le +85^{\circ}C$ and the LM336-5.0 from $0^{\circ}C \le T_A \le +70^{\circ}C$.

Note 4: Temperature stability for the LM336 and LM236 family is guaranteed by design. Design limits are guaranteed (but not 100% percent 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 charge in V_{REF} from 25°C to $T_{\text{A}}(\text{min})$ or $T_{\text{A}}(\text{max})$.



Typical Performance Characteristics Reverse Voltage Change Zener Noise Voltage 400 8 I_R = 1 mA T_i = 25°C REVERSE VOLTAGE CHANGE (mV) T_j = 125°C 350 6 NOISE (nV/\Hz) = 25°C 300 4 250 T_j = -55°C 2 200 0 150 0 2 4 6 8 10 100k 10 100 1k 10k REVERSE CURRENT (mA) FREQUENCY (Hz) 00571617 00571618 **Dynamic Impedance Response Time** 100 Tj = 25°C 6 I_B = 1 mA OUTPUT DYNAMIC IMPEDANCE (2) T_i = 125°C VOLTAGE SWING (V) 4 10 2 T_j = 25°C OUTPUT 1 -55°(0 10 INPUT 0 0.1 100k 0 2 10 100 1k 10k 4 6 FREQUENCY (Hz) TIME (µs) 00571619 00571620 **Reverse Characteristics Temperature Drift** 10-1 5.120 5.080 (F) 10⁻² 10⁻³ 10⁻³ 10⁻⁴ (A) 5.040 5.000 5.000 4.960 4.920 10-2 10-3 T_i = 125°C = 25°C Ti 4.880 $I_B = 1 mA$ -55°C 4.840 10-5 -55-35-15 5 25 45 65 85 105 125 0.5 1.5 2.5 3.5 4.5 5.5 TEMPERATURE (°C) REVERSE VOLTAGE (V) 00571622 00571621

Typical Performance Characteristics (Continued)





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.









Typical Applications





* Adjust for 6.25V across R1







LM136-5.0/LM236-5.0/LM336-5.0

Typical Applications (Continued)



Op Amp with Output Clamped



00571624

Typical Applications (Continued)



Typical Applications (Continued)

Low Noise Buffered Reference



00571628

Wide Input Range Reference



LM136-5.0/LM236-5.0/LM336-5.0





