

LM136A-2.5QML 2.5V Reference Diode

Check for Samples: [LM136A-2.5QML](#), [LM136A-2.5QML-SP](#)

FEATURES

- **Available with Radiation Specification**
 - **Total Ionizing Dose 100 krad(Si)**
 - **ELDRS Free 100 krad(Si)**
- **Low Temperature Coefficient**
- **Wide Operating Current of 400 μ A to 10 mA**
- **Specified Temperature Stability**
- **Easily Trimmed for Minimum Temperature Drift**
- **Fast Turn-on**
- **3–Lead Transistor Package**

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 0.2 Ω 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.

Connection Diagram

Bottom View

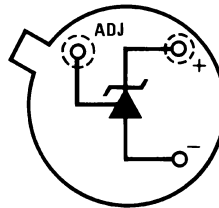


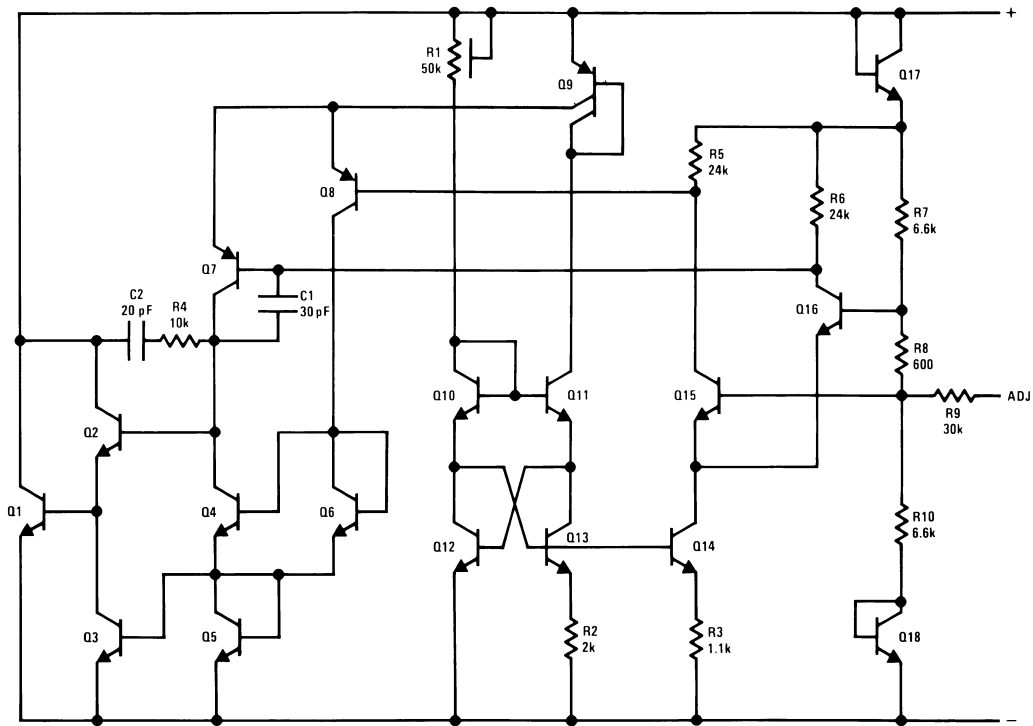
Figure 1. TO Package
See Package Number NDV0003H



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.

Schematic Diagram



Typical Applications

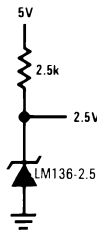
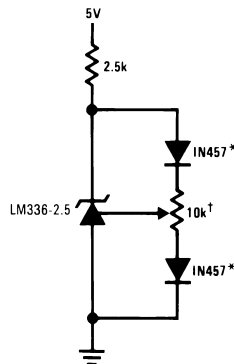


Figure 2. 2.5V Reference



†Adjust to 2.490V
 *Any silicon signal diode

Figure 3. 2.5V Reference with Minimum Temperature Coefficient

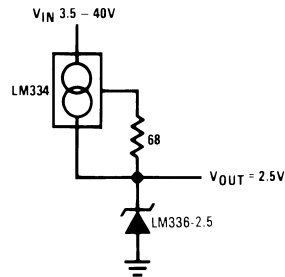


Figure 4. Wide Input Range Reference



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⁾

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 ⁽²⁾			$-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$
Maximum Junction Temperature (T_J) ⁽²⁾			+150°C
Lead Temperature (Soldering 10 seconds)			300°C
Thermal Resistance	θ_{JA}	Still Air Flow	354°C/W
		500LF/Min Air Flow	77°C/W
	θ_{JC}		46°C/W
ESD Rating ⁽³⁾			1,000V

- (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 ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
- (2) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), θ_{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.
- (3) Human body model, 1.5K Ω in series with 100pF.

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

LM136A-2.5QML Electrical Characteristics DC Parameters⁽¹⁾⁽²⁾

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

Parameter		Test Conditions	Notes	Min	Max	Unit	Sub-groups
I_{Adj}	Adjust Current	$V_{Adj} = 0.7\text{V}$		-125	+125	μA	1, 2, 3
ΔV_Z	Delta Zener Voltage	$0.4\text{mA} \leq I_Z \leq 10\text{mA}$			6.0	mV	1
					10	mV	2, 3
V_Z	Zener Voltage	$V_{Adj} = \text{Open}$		2.46 5	2.51 5	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		See ⁽³⁾		0.6	Ω	1
			See ⁽³⁾		1.0	Ω	2, 3
V_{Stab}	Temperature Stability	$V_Z = \text{Adjusted to } 2.490\text{V}$			18	mV	2, 3

- (1) 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 specified only for the conditions as specified in Mil-Std-883, Method 1019.
- (2) 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.
- (3) Parameter tested go-no-go only.

LM136A-2.5QML Electrical Characteristics DC Drift Parameters⁽¹⁾⁽²⁾

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

Parameter		Test 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

- (1) 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 specified only for the conditions as specified in Mil-Std-883, Method 1019.
- (2) 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

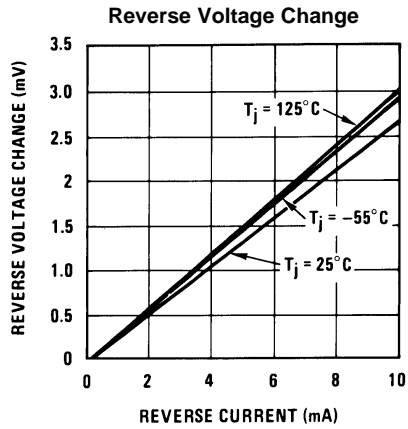


Figure 5.

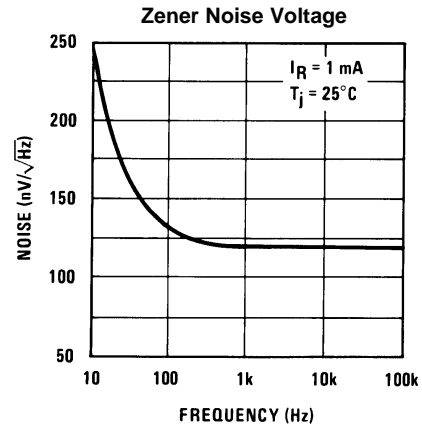


Figure 6.

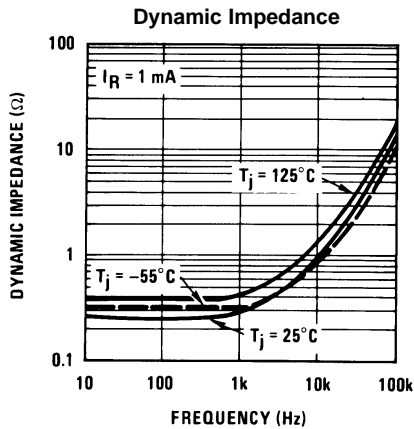


Figure 7.

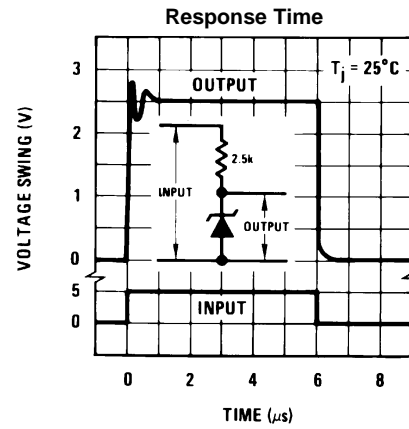


Figure 8.

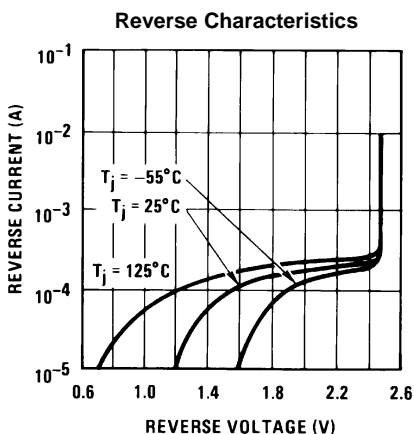


Figure 9.

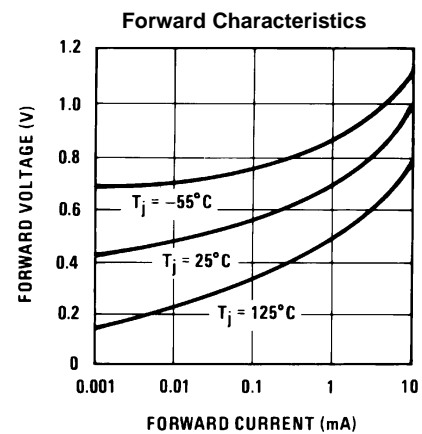


Figure 10.

Typical Performance Characteristics (continued)

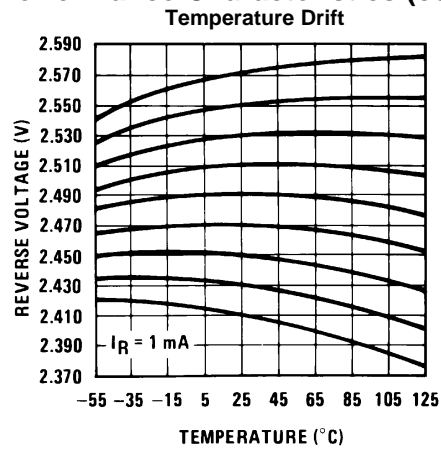


Figure 11.

APPLICATION HINTS

The LM136 voltage reference is much easier to use than ordinary zener diodes. Its 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 12 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 13. 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.

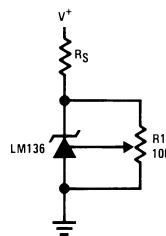


Figure 12. LM136 With Pot for Adjustment of Breakdown Voltage
(Trim Range = ± 120 mV typical)

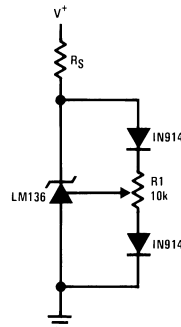
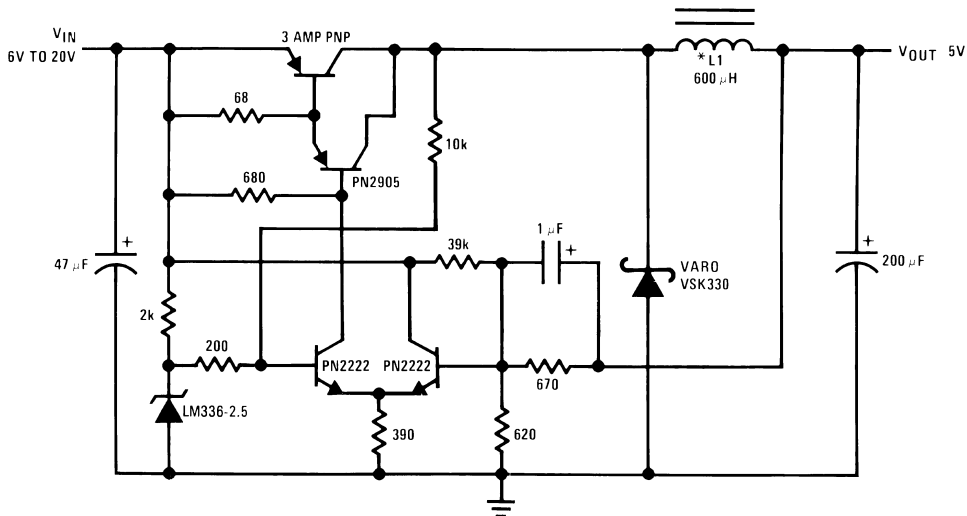


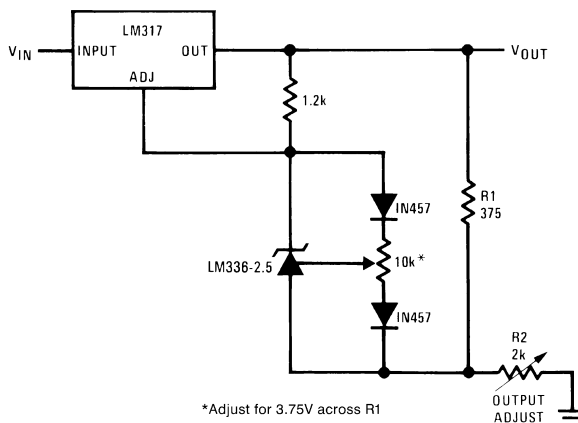
Figure 13. Temperature Coefficient Adjustment
(Trim Range = ± 70 mV typical)



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

†Efficiency ≈ 80%

Figure 14. Low Cost 2 Amp Switching Regulator†



*Adjust for 3.75V across R1

Figure 15. Precision Power Regulator with Low Temperature Coefficient

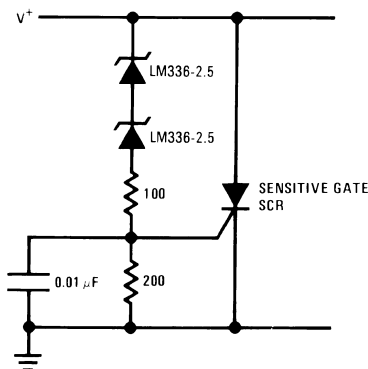
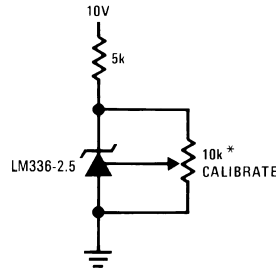


Figure 16. 5V Crowbar



*Does not affect temperature coefficient

Figure 17. Trimmed 2.5V Reference with Temperature Coefficient Independent of Breakdown Voltage

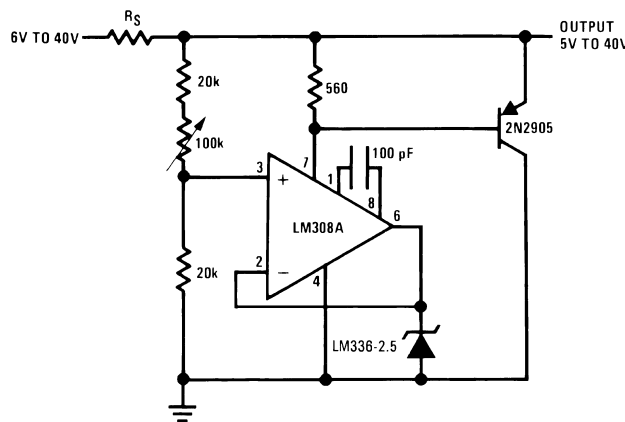


Figure 18. Adjustable Shunt Regulator

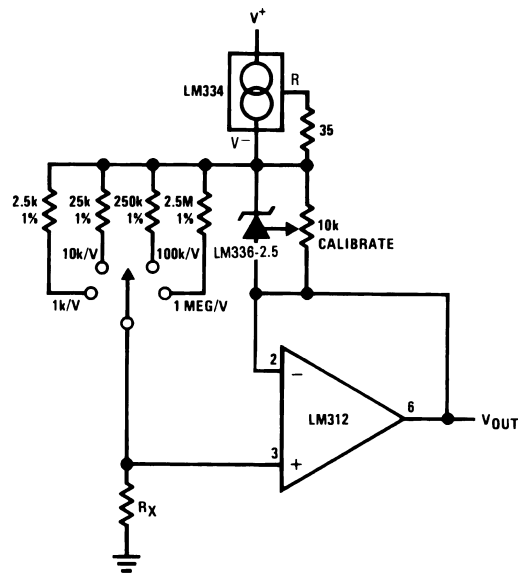


Figure 19. Linear Ohmmeter

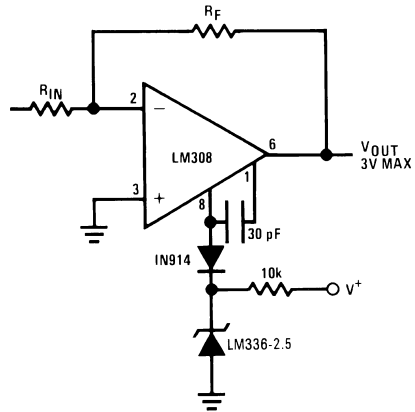


Figure 20. Op Amp with Output Clamped

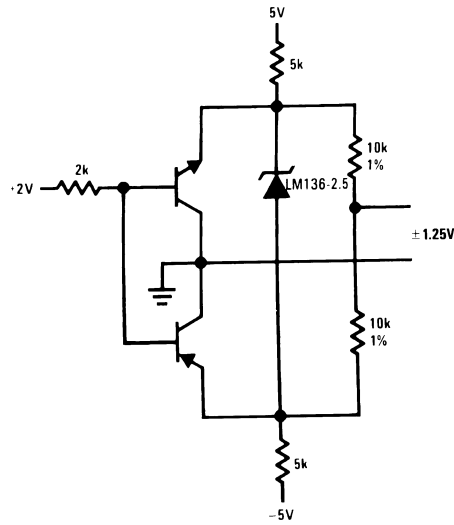


Figure 21. Bipolar Output Reference

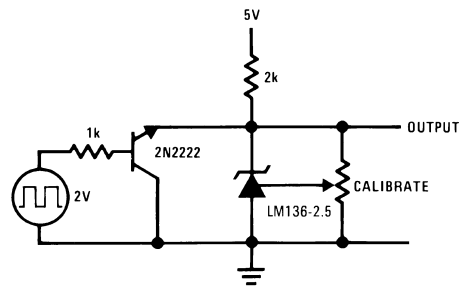


Figure 22. 2.5V Square Wave Calibrator

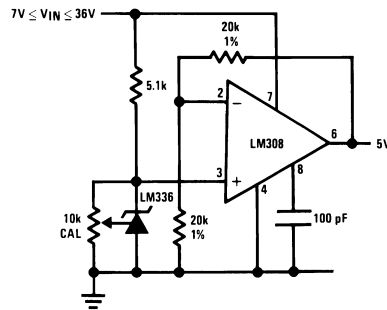


Figure 23. 5V Buffered Reference

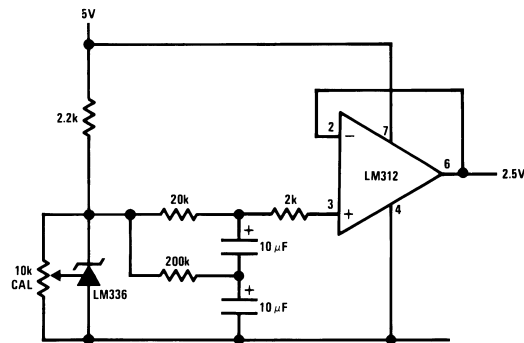


Figure 24. Low Noise Buffered Reference

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.

Changes from Revision D (April 2013) to Revision E
Page

- Changed layout of National Data Sheet to TI format [12](#)

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962R0050101V9A	ACTIVE	DIESALE	Y	0	40	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
5962R0050101VXA	ACTIVE	TO	NDV	3	20	TBD	Call TI	Call TI	-55 to 125	R0050101VXA Q	Samples
5962R0050102V9A	ACTIVE	DIESALE	Y	0	40	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
5962R0050102VXA	ACTIVE	TO	NDV	3	20	TBD	Call TI	Call TI	-55 to 125	R0050102VXA Q	Samples
LM136-2.5 MDE	ACTIVE	DIESALE	Y	0	40	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
LM136-2.5 MDR	ACTIVE	DIESALE	Y	0	40	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
LM136AH-2.5/883	ACTIVE	TO	NDV	3	20	TBD	Call TI	Call TI	-55 to 125	LM136A-2.5 Q	Samples
LM136AH-2.5RLQV	ACTIVE	TO	NDV	3	20	TBD	Call TI	Call TI	-55 to 125	R0050102VXA Q	Samples
LM136AH-2.5RQV	ACTIVE	TO	NDV	3	20	TBD	Call TI	Call TI	-55 to 125	R0050101VXA Q	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.

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) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.
- (5) Multiple Device Markings will be inside parentheses. Only one Device 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 Device Marking for that device.
- (6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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.

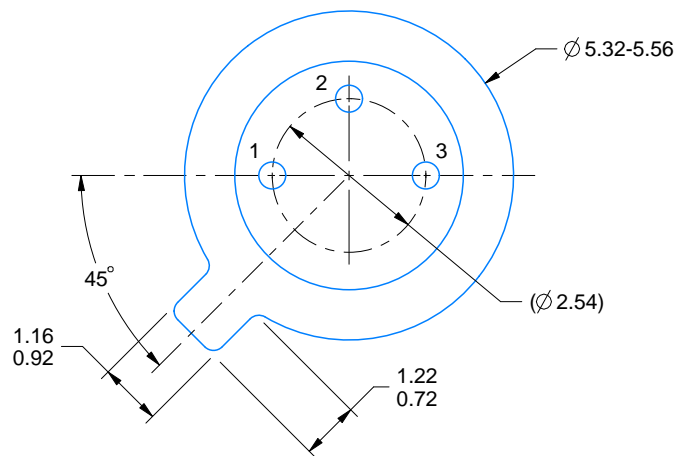
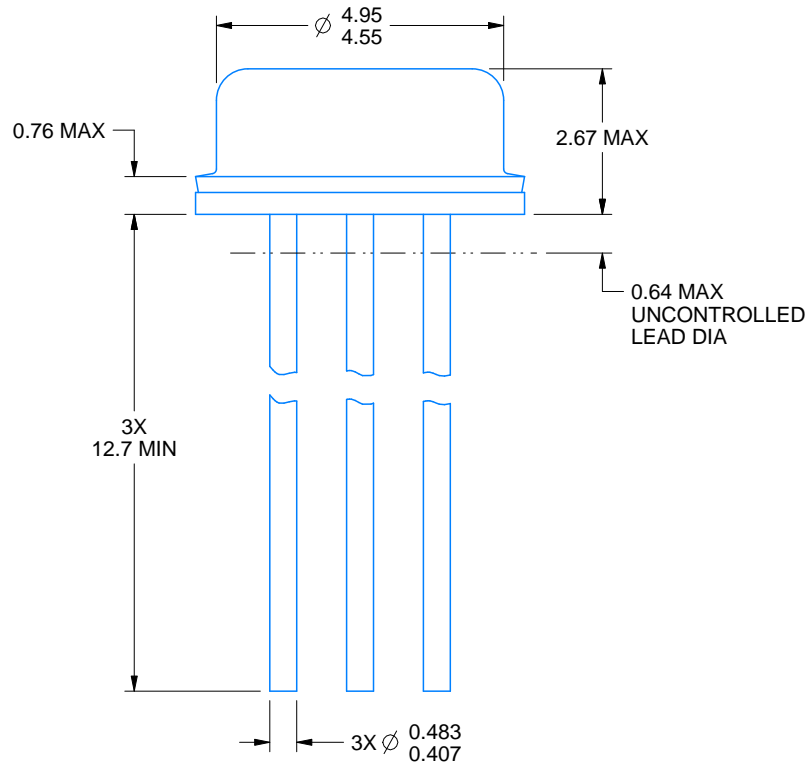
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF LM136A-2.5QML, LM136A-2.5QML-SP :

- Military: [LM136A-2.5QML](#)
- Space: [LM136A-2.5QML-SP](#)

NOTE: Qualified Version Definitions:

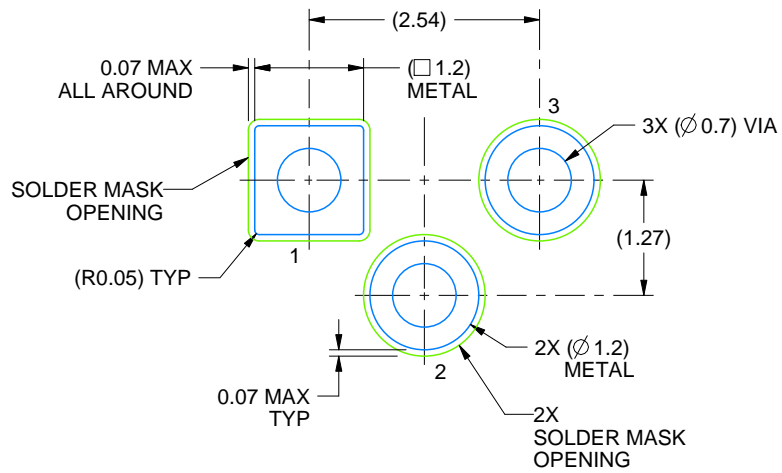
- Military - QML certified for Military and Defense Applications
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application



4219876/A 01/2017

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-46.



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE:12X

IMPORTANT NOTICE FOR TI DESIGN INFORMATION AND RESOURCES

Texas Instruments Incorporated ("TI") technical, application or other design advice, services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using any particular TI Resource in any way, you (individually or, if you are acting on behalf of a company, your company) agree to use it solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources.

You understand and agree that you remain responsible for using your independent analysis, evaluation and judgment in designing your applications and that you have full and exclusive responsibility to assure the safety of your applications and compliance of your applications (and of all TI products used in or for your applications) with all applicable regulations, laws and other applicable requirements. You represent that, with respect to your applications, you have all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. You agree that prior to using or distributing any applications that include TI products, you will thoroughly test such applications and the functionality of such TI products as used in such applications. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

You are authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources 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.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING TI RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY YOU AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

You agree to fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of your non-compliance with the terms and provisions of this Notice.

This Notice applies to TI Resources. Additional terms apply to the use and purchase of certain types of materials, TI products and services. These include; without limitation, TI's standard terms for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>), [evaluation modules](#), and [samples](http://www.ti.com/sc/docs/sampterm.htm) (<http://www.ti.com/sc/docs/sampterm.htm>).

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2017, Texas Instruments Incorporated