

## 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  $\mu$ 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 $\Omega$  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

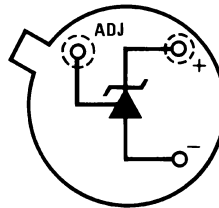


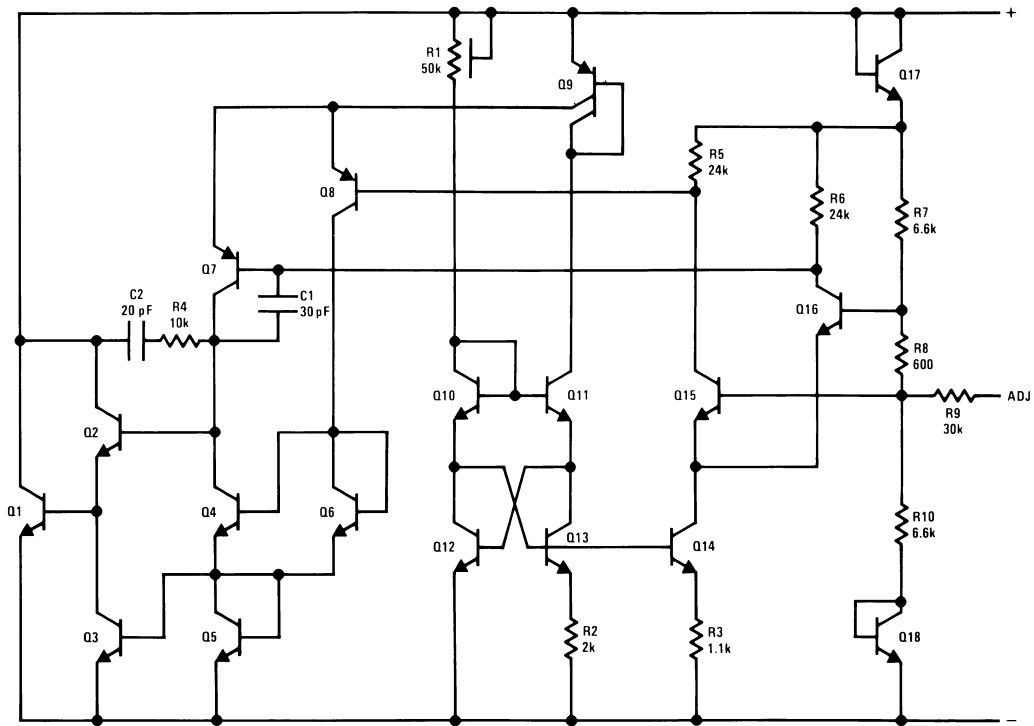
Figure 1. TO Package  
See Package Number NDV0003H



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Schematic Diagram



Typical Applications

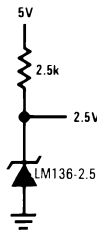
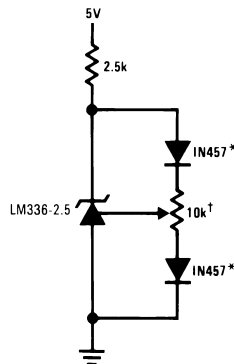
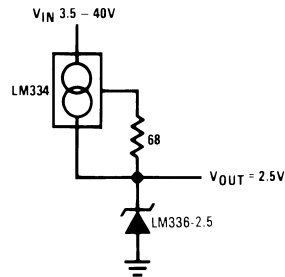


Figure 2. 2.5V Reference



†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<sup>(1)</sup>**

|   |               |                    |  |
|---|---------------|--------------------|--|
| 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 <sup>(2)</sup>            |               |                    | $-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ |
| Maximum Junction Temperature ( $T_J$ ) <sup>(2)</sup> |               |                    | +150°C   |
| Lead Temperature (Soldering 10 seconds)               |               |                    | 300°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 <sup>(3)</sup>                             |               |                    | 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),  $\theta_{JA}$  (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.
- (3) Human body model, 1.5K $\Omega$  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<sup>(1)(2)</sup>**

 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      | $\mu\text{A}$ | 1, 2, 3    |
| $\Delta V_Z$            | Delta Zener Voltage       | $0.4\text{mA} \leq I_Z \leq 10\text{mA}$  |                    |           | 6.0       | mV            | 1          |
|                         |                           |   |                    |           | 10        | mV            | 2, 3       |
| $V_Z$                   | Zener Voltage             | $V_{Adj} = \text{Open}$                   |                    | 2.46<br>5 | 2.51<br>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 <sup>(3)</sup> |           | 0.6       | $\Omega$      | 1          |
|                         |                           |   | See <sup>(3)</sup> |           | 1.0       | $\Omega$      | 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<sup>(1)(2)</sup>**

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

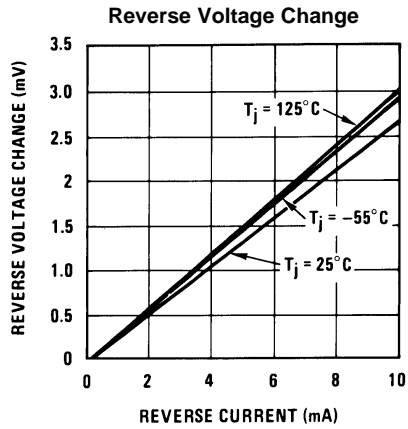


Figure 5.

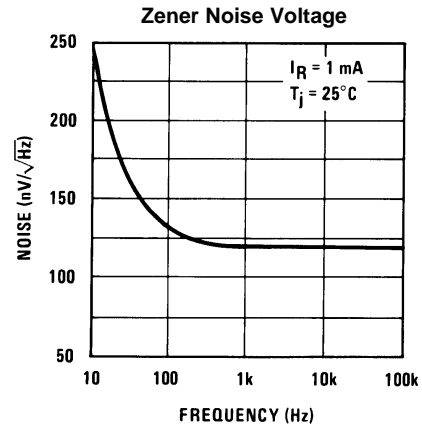


Figure 6.

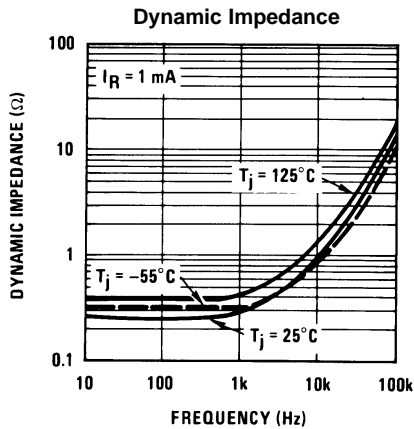


Figure 7.

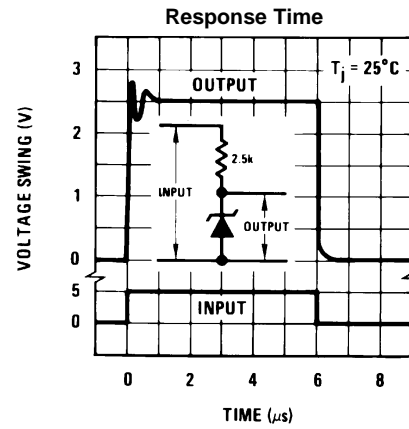


Figure 8.

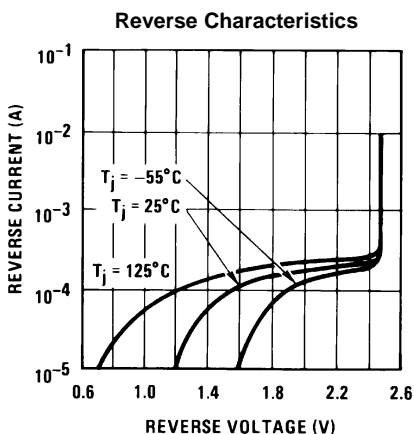


Figure 9.

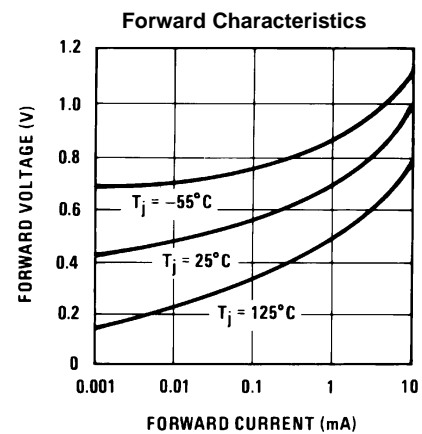


Figure 10.

Typical Performance Characteristics (continued)

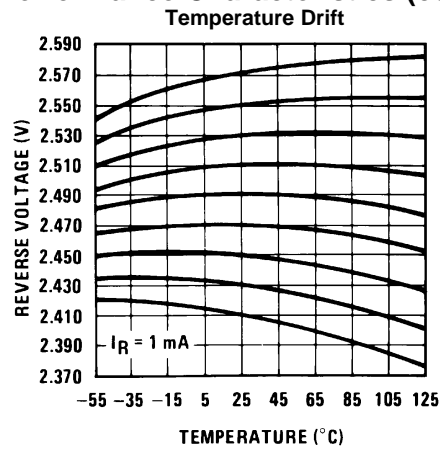


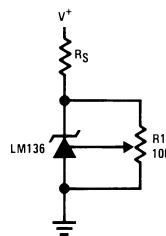
Figure 11.

## APPLICATION HINTS

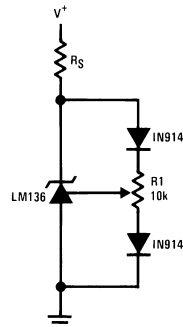
The LM136 voltage reference is much easier to use than ordinary zener diodes. Its low impedance and wide operating current range simplify biasing in almost any circuit. Further, either the breakdown voltage or the temperature coefficient can be adjusted to optimize circuit performance.

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.

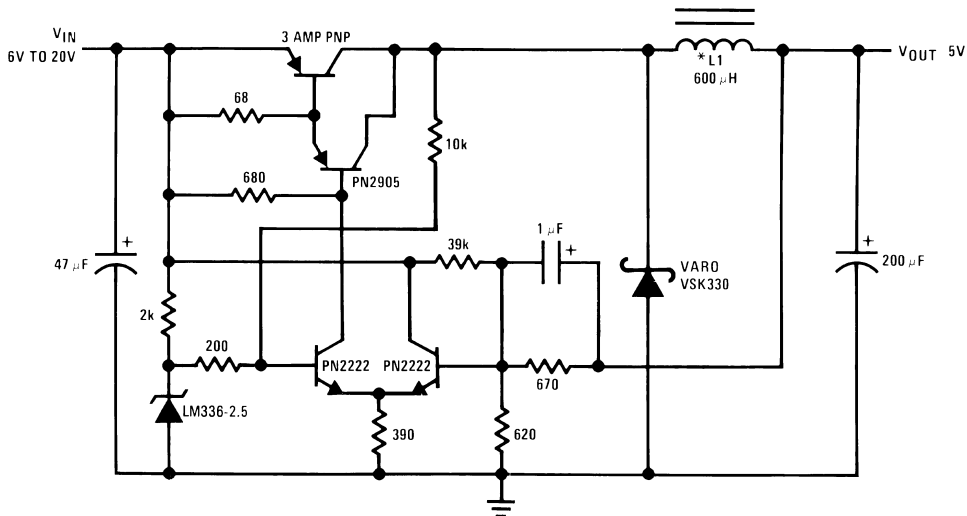


**Figure 12. LM136 With Pot for Adjustment of Breakdown Voltage**  
(Trim Range =  $\pm 120$  mV typical)



**Figure 13. Temperature Coefficient Adjustment**  
(Trim Range =  $\pm 70$  mV typical)





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

†Efficiency ≈ 80%

Figure 14. Low Cost 2 Amp Switching Regulator†

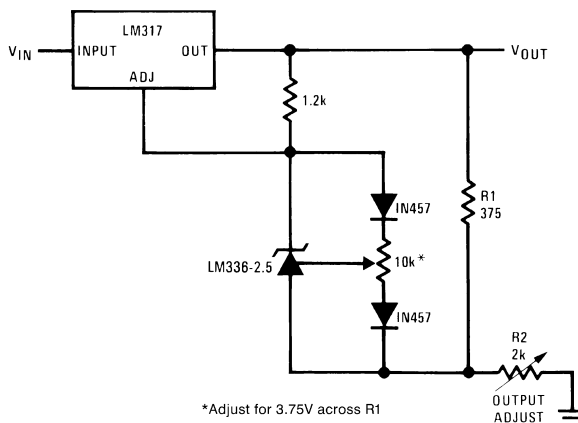


Figure 15. Precision Power Regulator with Low Temperature Coefficient

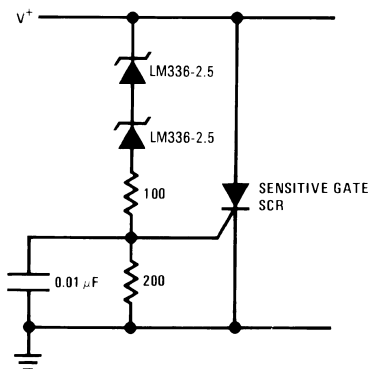
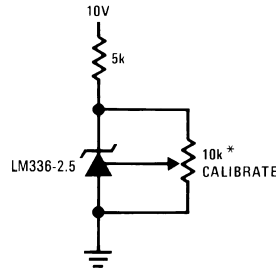


Figure 16. 5V Crowbar



\*Does not affect temperature coefficient

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

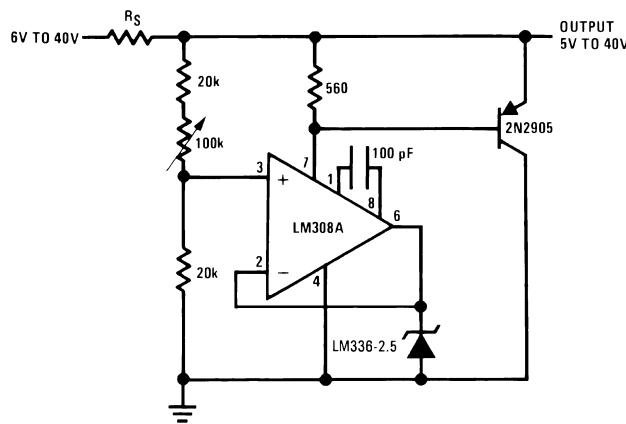


Figure 18. Adjustable Shunt Regulator

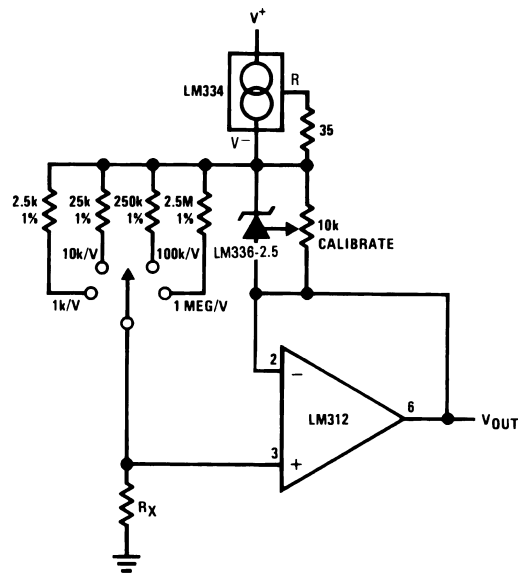


Figure 19. Linear Ohmmeter

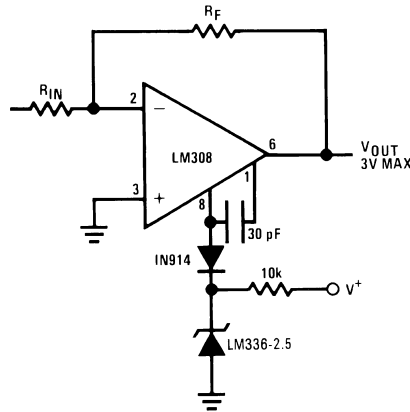


Figure 20. Op Amp with Output Clamped

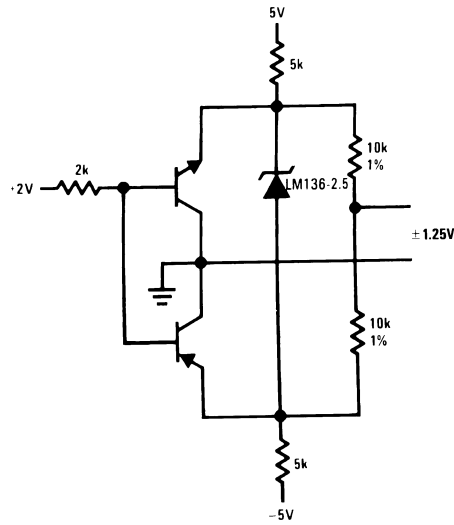


Figure 21. Bipolar Output Reference

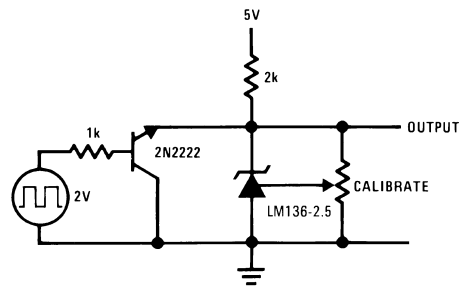


Figure 22. 2.5V Square Wave Calibrator

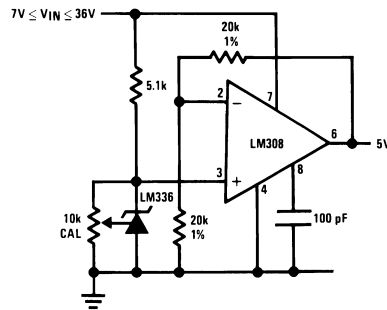


Figure 23. 5V Buffered Reference

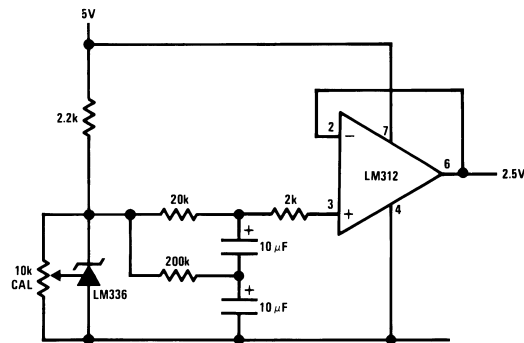


Figure 24. Low Noise Buffered Reference

### 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<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)      | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|----------------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| 5962R0050101V9A  | ACTIVE        | DIESALE      | Y               | 0    | 40          | RoHS & Green         | Call TI                              | Level-1-NA-UNLIM     | -55 to 125   |                         | <a href="#">Samples</a> |
| 5962R0050101VXA  | ACTIVE        | TO           | NDV             | 3    | 20          | Non-RoHS & Non-Green | Call TI                              | Call TI              | -55 to 125   | R0050101VXA Q           | <a href="#">Samples</a> |
| 5962R0050102V9A  | ACTIVE        | DIESALE      | Y               | 0    | 40          | RoHS & Green         | Call TI                              | Level-1-NA-UNLIM     | -55 to 125   |                         | <a href="#">Samples</a> |
| 5962R0050102VXA  | ACTIVE        | TO           | NDV             | 3    | 20          | Non-RoHS & Non-Green | Call TI                              | Call TI              | -55 to 125   | R0050102VXA Q           | <a href="#">Samples</a> |
| LM136-2.5 MD8    | ACTIVE        | DIESALE      | Y               | 0    | 400         | RoHS & Green         | Call TI                              | Level-1-NA-UNLIM     | -55 to 125   |                         | <a href="#">Samples</a> |
| LM136-2.5 MDE    | ACTIVE        | DIESALE      | Y               | 0    | 40          | RoHS & Green         | Call TI                              | Level-1-NA-UNLIM     | -55 to 125   |                         | <a href="#">Samples</a> |
| LM136-2.5 MDR    | ACTIVE        | DIESALE      | Y               | 0    | 40          | RoHS & Green         | Call TI                              | Level-1-NA-UNLIM     | -55 to 125   |                         | <a href="#">Samples</a> |
| LM136AH-2.5/883  | ACTIVE        | TO           | NDV             | 3    | 20          | Non-RoHS & Non-Green | Call TI                              | Call TI              | -55 to 125   | LM136A-2.5 Q            | <a href="#">Samples</a> |
| LM136AH-2.5RLQV  | ACTIVE        | TO           | NDV             | 3    | 20          | Non-RoHS & Green     | Call TI                              | Level-1-NA-UNLIM     | -55 to 125   | R0050102VXA Q           | <a href="#">Samples</a> |
| LM136AH-2.5RQV   | ACTIVE        | TO           | NDV             | 3    | 20          | Non-RoHS & Green     | Call TI                              | Level-1-NA-UNLIM     | -55 to 125   | R0050101VXA Q           | <a href="#">Samples</a> |

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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 finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**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

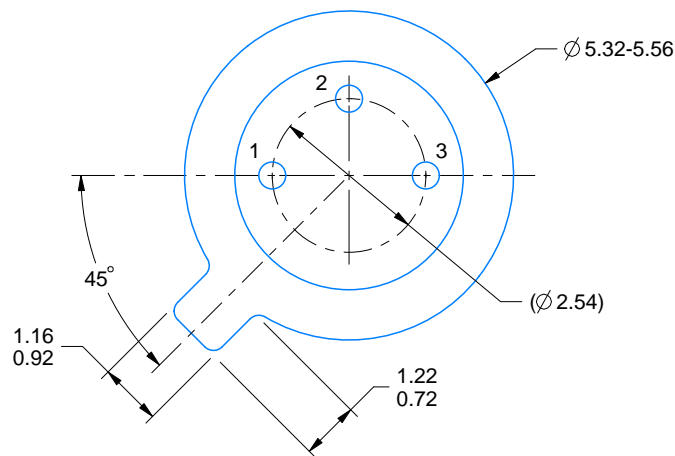
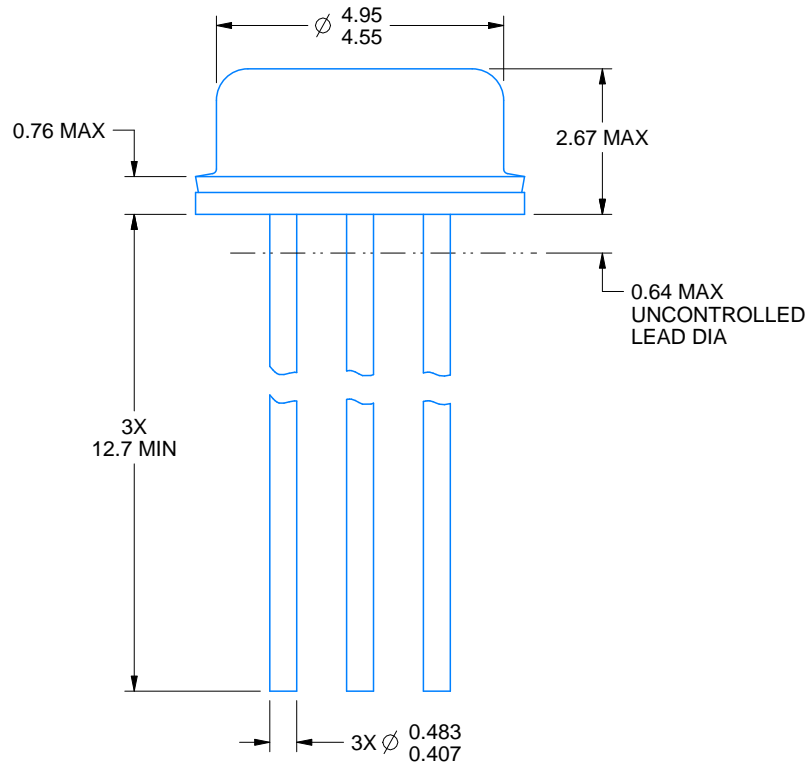
**TRAY**


Chamfer on Tray corner indicates Pin 1 orientation of packed units.

\*All dimensions are nominal

| Device          | Package Name | Package Type | Pins | SPQ | Unit array matrix | Max temperature (°C) | L (mm) | W (mm) | K0 (µm) | P1 (mm) | CL (mm) | CW (mm) |
|-----------------|--------------|--------------|------|-----|-------------------|----------------------|--------|--------|---------|---------|---------|---------|
| 5962R0050101VXA | NDV          | TO-CAN       | 3    | 20  | 2 X 10            | 150                  | 126.49 | 61.98  | 10922   | 11.43   | 11.81   | 19.2    |
| 5962R0050102VXA | NDV          | TO-CAN       | 3    | 20  | 2 X 10            | 150                  | 126.49 | 61.98  | 10922   | 11.43   | 11.81   | 19.2    |
| LM136AH-2.5/883 | NDV          | TO-CAN       | 3    | 20  | 2 X 10            | 150                  | 126.49 | 61.98  | 10922   | 11.43   | 11.81   | 19.2    |
| LM136AH-2.5RLQV | NDV          | TO-CAN       | 3    | 20  | 2 X 10            | 150                  | 126.49 | 61.98  | 10922   | 11.43   | 11.81   | 19.2    |
| LM136AH-2.5RQV  | NDV          | TO-CAN       | 3    | 20  | 2 X 10            | 150                  | 126.49 | 61.98  | 10922   | 11.43   | 11.81   | 19.2    |

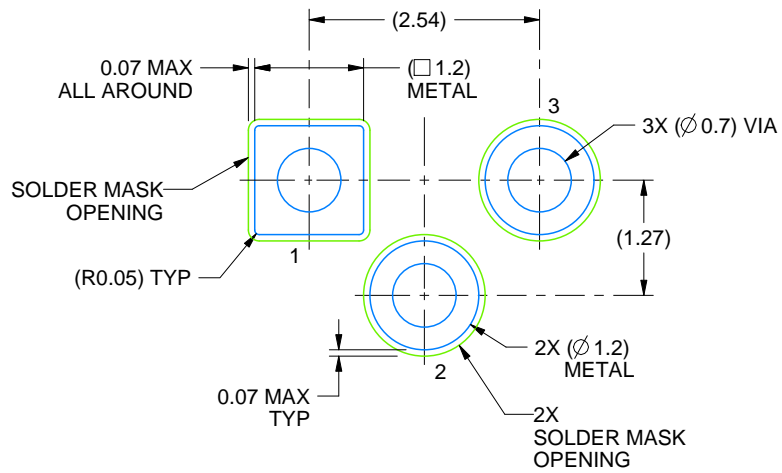




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NOTES:

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

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