THE DATASHEET OF

LM136H-5.0

LM136-5.0, LM236-5.0, LM336-5.0 5.0V Reference Diode

Check for Samples: LM136-5.0, LM236-5.0, LM336-5.0

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**
- **Specified Temperature Stability**
- **Easily Trimmed for Minimum Temperature Drift**
- **Fast Turn-on**
- **Three Lead Transistor Package**

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 0.6Ω 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.

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.

Connection Diagrams

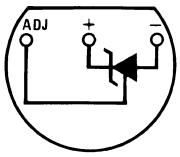


Figure 1. TO-92 Plastic Package (Bottom View)

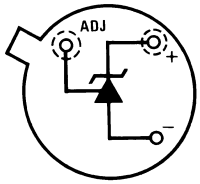


Figure 2. TO Metal Can Package (Bottom View)

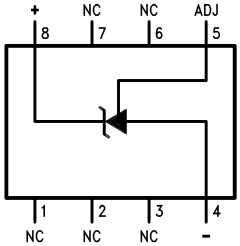


Figure 3. SOIC Package

Typical Applications

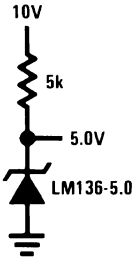
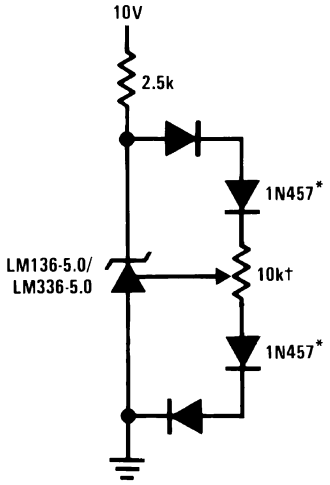
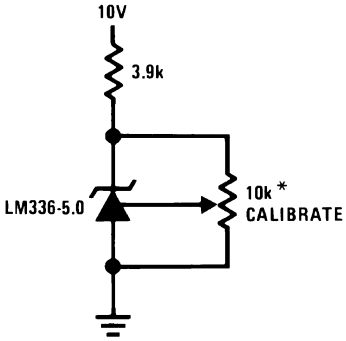


Figure 4. 5.0V Reference



† Adjust to 5.00V
* Any silicon signal diode

Figure 5. 5.0V Reference with Minimum Temperature Coefficient



* Does not affect temperature coefficient

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

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 to +150	°C
Operating Temperature Range (2)		
LM136-5.0	−55 to +150	°C
LM236-5.0	−25 to +85	°C
LM336-5.0	0 to +70	°C
Soldering Information		
TO-92 Package (10 sec.)	260	°C
TO Package (10 sec.)	300	°C
SOIC Package		
Vapor Phase (60 sec.)	215	°C
Infrared (15 sec.)	220	°C

(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.
(2) For elevated temperature operation, T_j max see THERMAL CHARACTERISTICS

THERMAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

	LM136	**150°C**	
	LM236	**125°C**	
	LM336	**100°C**	
Thermal Resistance	**TO-92**	**TO**	**SOIC-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_{ja} (Junction to Case)	N/A	80°C/W	N/A

ELECTRICAL CHARACTERISTICS

		LM136A-5.0/LM236A-5.0			**LM336B-5.0**			
Parameter	**Conditions**	**LM136-5.0/LM236-5.0**			**LM336-5.0**			**Units**
		Min	**Typ**	**Max**	**Min**	**Typ**	**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≤I_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 (2)	V_R Adjusted 5.00V							
	I_R=1 mA, (Figure 15)							
	0°C≤T_A≤70°C (LM336-5.0)					4	12	mV

(1) Unless otherwise specified, the LM136-5.0 is specified from −55°C≤T_A≤+125°C, the LM236-5.0 from −25°C≤T_A≤+85°C and the LM336-5.0 from 0°C≤T_A≤+70°C.
(2) Temperature stability for the LM336 and LM236 family is specified by design. Design limits are specified (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_A(min) or T_A(max).

ELECTRICAL CHARACTERISTICS (continued)

(1)

		LM136A-5.0/LM236A-5.0			LM336B-5.0			
Parameter	**Conditions**	**LM136-5.0/LM236-5.0**			**LM336-5.0**			**Units**
		Min	**Typ**	**Max**	**Min**	**Typ**	**Max**	
	−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 With Current	600 µA≤I_R≤10 mA		6	17		6	24	mV
Adjustment Range	Circuit of Figure 14		±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°C±0.1°C, I_R=1 mA, t = 1000 hrs		20			20		ppm

TYPICAL PERFORMANCE CHARACTERISTICS

Reverse Voltage Change

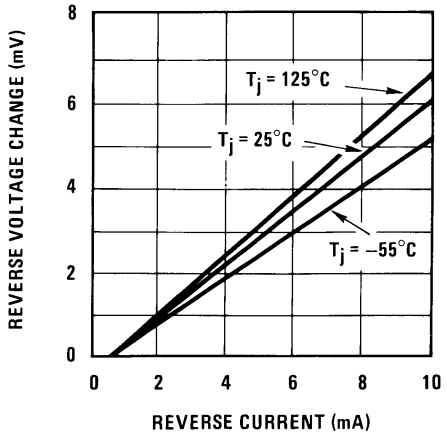


Figure 7.

Zener Noise Voltage

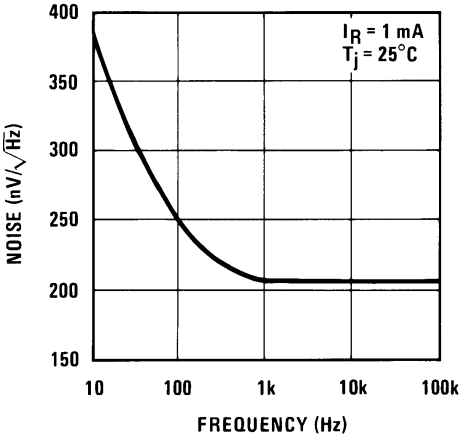


Figure 8.

Dynamic Impedance

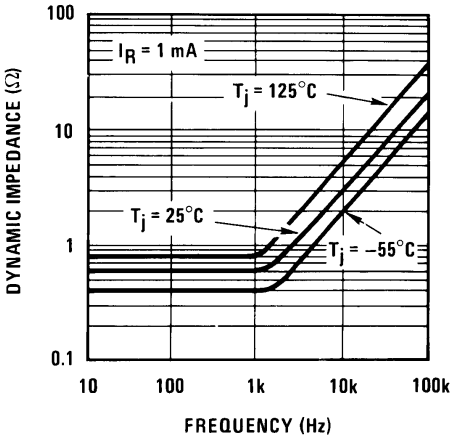


Figure 9.

Response Time

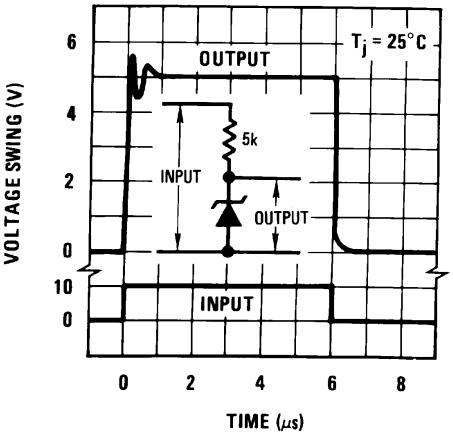


Figure 10.

Reverse Characteristics

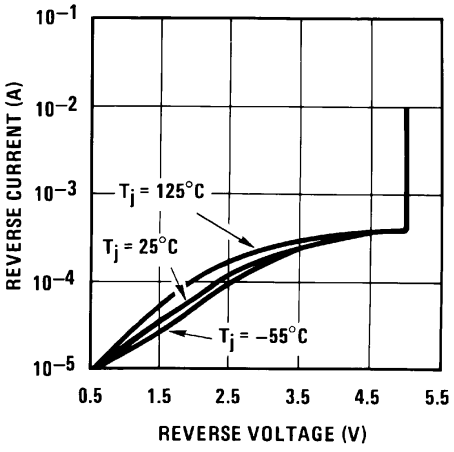


Figure 11.

Temperature Drift

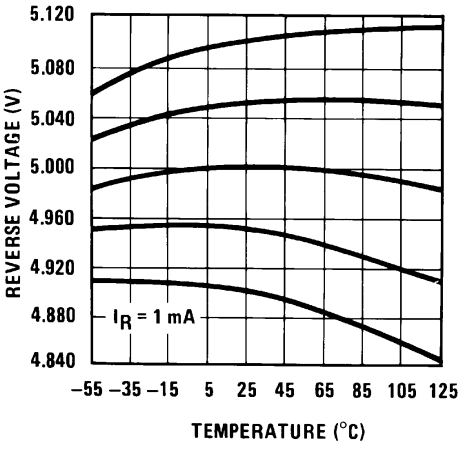


Figure 12.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Forward Characteristics

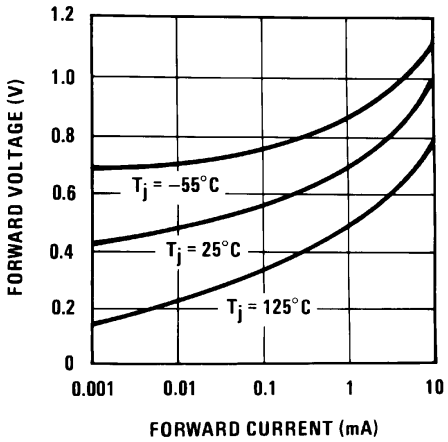


Figure 13.

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 14 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 15. 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.

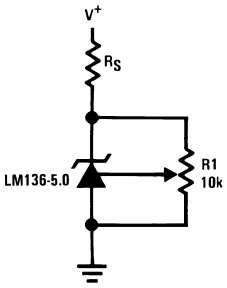


Figure 14. LM136-5.0 with Pot for Adjustment of Breakdown Voltage (Trim Range = ±1.0V Typical)

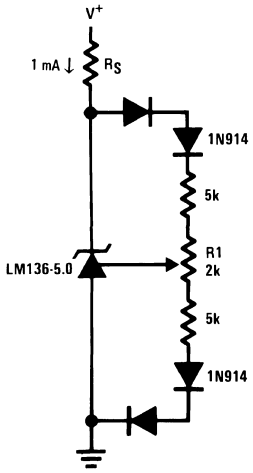
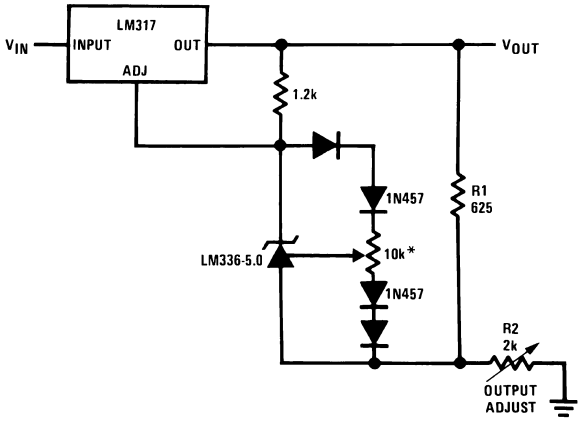


Figure 15. Temperature Coefficient Adjustment (Trim Range = ±0.5V Typical)

Typical Applications



* Adjust for 6.25V across R1

Figure 16. Precision Power Regulator with Low Temperature Coefficient

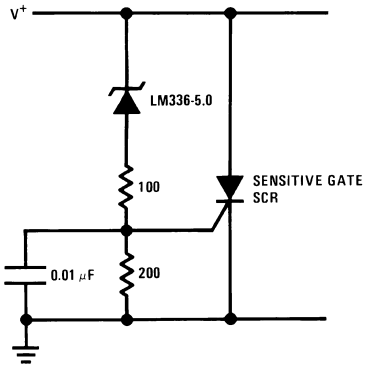


Figure 17. 5V Crowbar

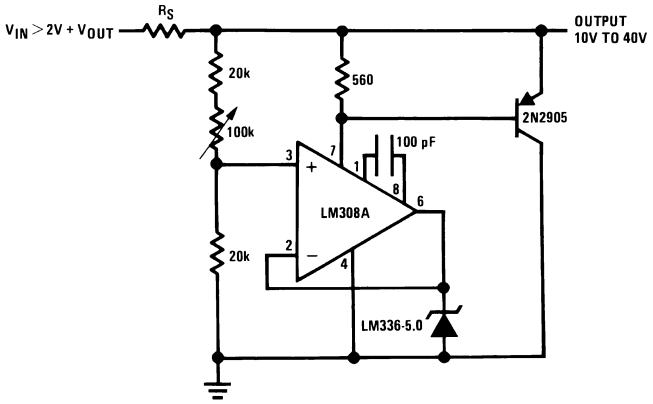


Figure 18. Adjustable Shunt Regulator

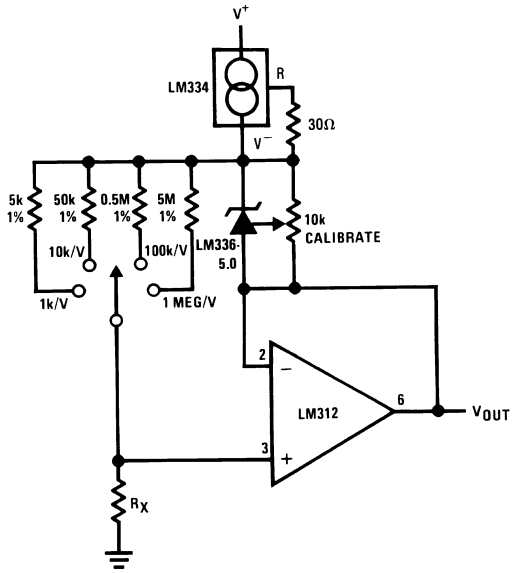


Figure 19. Linear Ohmmeter

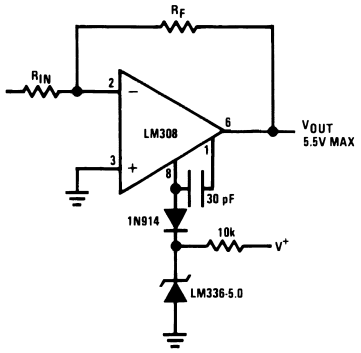


Figure 20. Op Amp with Output Clamped

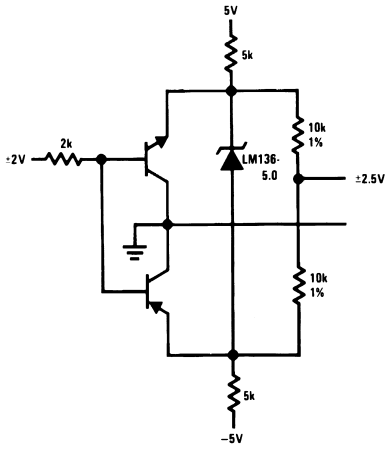


Figure 21. Bipolar Output Reference

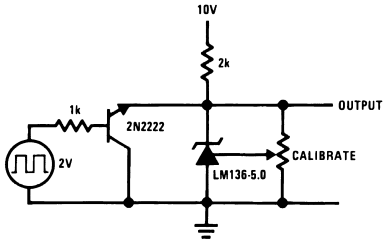


Figure 22. 5.0V Square Wave Calibrator

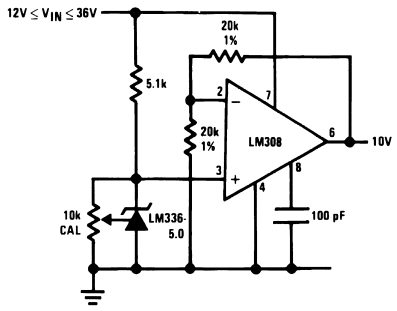


Figure 23. 10V Buffered Reference

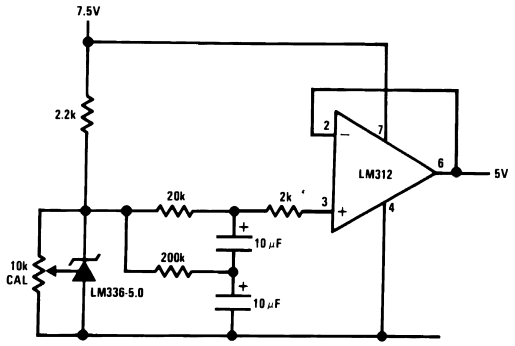


Figure 24. Low Noise Buffered Reference

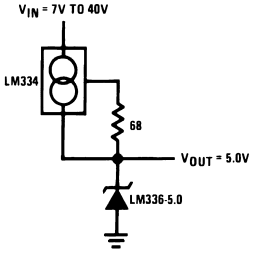
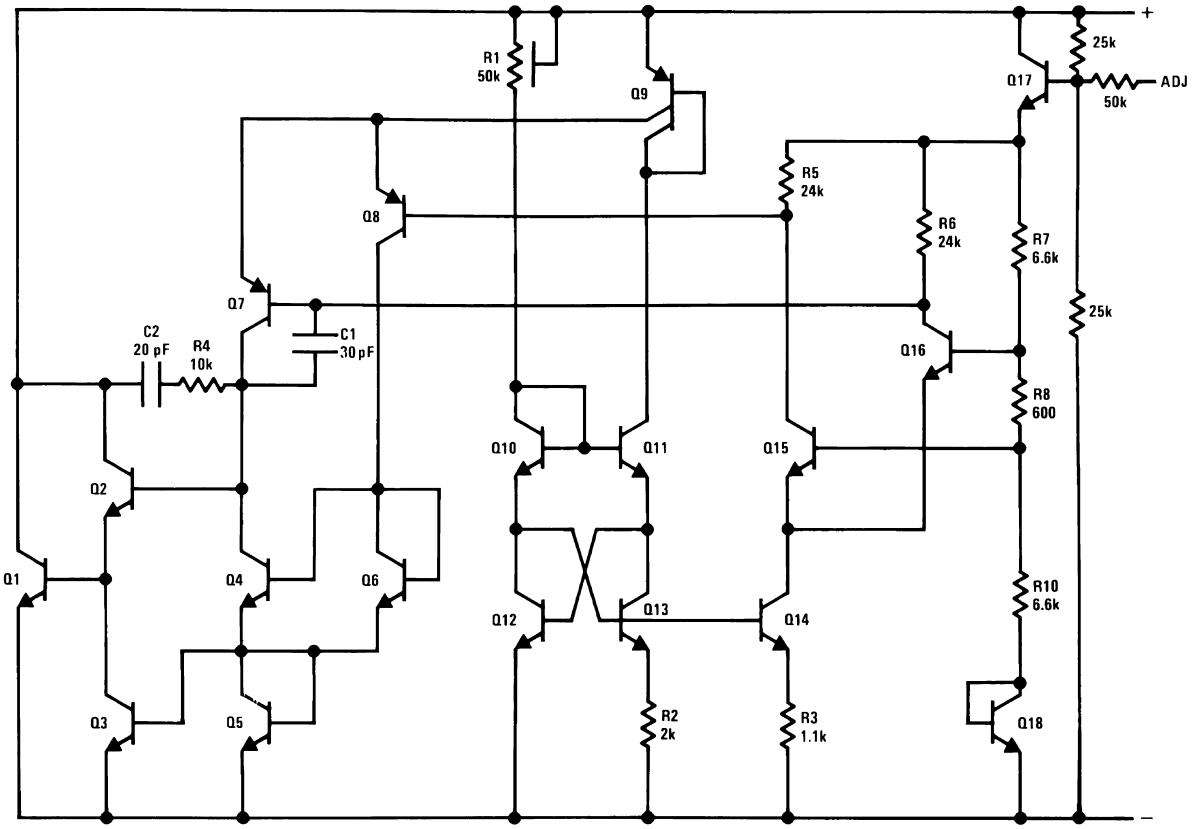


Figure 25. Wide Input Range Reference

Schematic Diagram



REVISION HISTORY

Changes from Revision C (March 2013) to Revision D	Page
• Changed layout of National Data Sheet to TI format	9

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
LM136AH-5.0	ACTIVE	TO	NDV	3	1000	TBD	Call TI	Call TI	-40 to 125	(LM136AH5.0 ~ LM136AH5.0)	Samples
LM136AH-5.0/NOPB	ACTIVE	TO	NDV	3	1000	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-40 to 125	(LM136AH5.0 ~ LM136AH5.0)	Samples
LM136H-5.0	ACTIVE	TO	NDV	3	1000	TBD	Call TI	Call TI	-55 to 125	(LM136H5.0 ~ LM136H5.0)	Samples
LM136H-5.0/NOPB	ACTIVE	TO	NDV	3	1000	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM136H5.0 ~ LM136H5.0)	Samples
LM236AH-5.0/NOPB	ACTIVE	TO	NDV	3	1000	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM236AH5.0 ~ LM236AH5.0)	Samples
LM236H-5.0	ACTIVE	TO	NDV	3	1000	TBD	Call TI	Call TI	-25 to 85	(LM236H5.0 ~ LM236H5.0)	Samples
LM236H-5.0/NOPB	ACTIVE	TO	NDV	3	1000	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-25 to 85	(LM236H5.0 ~ LM236H5.0)	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.

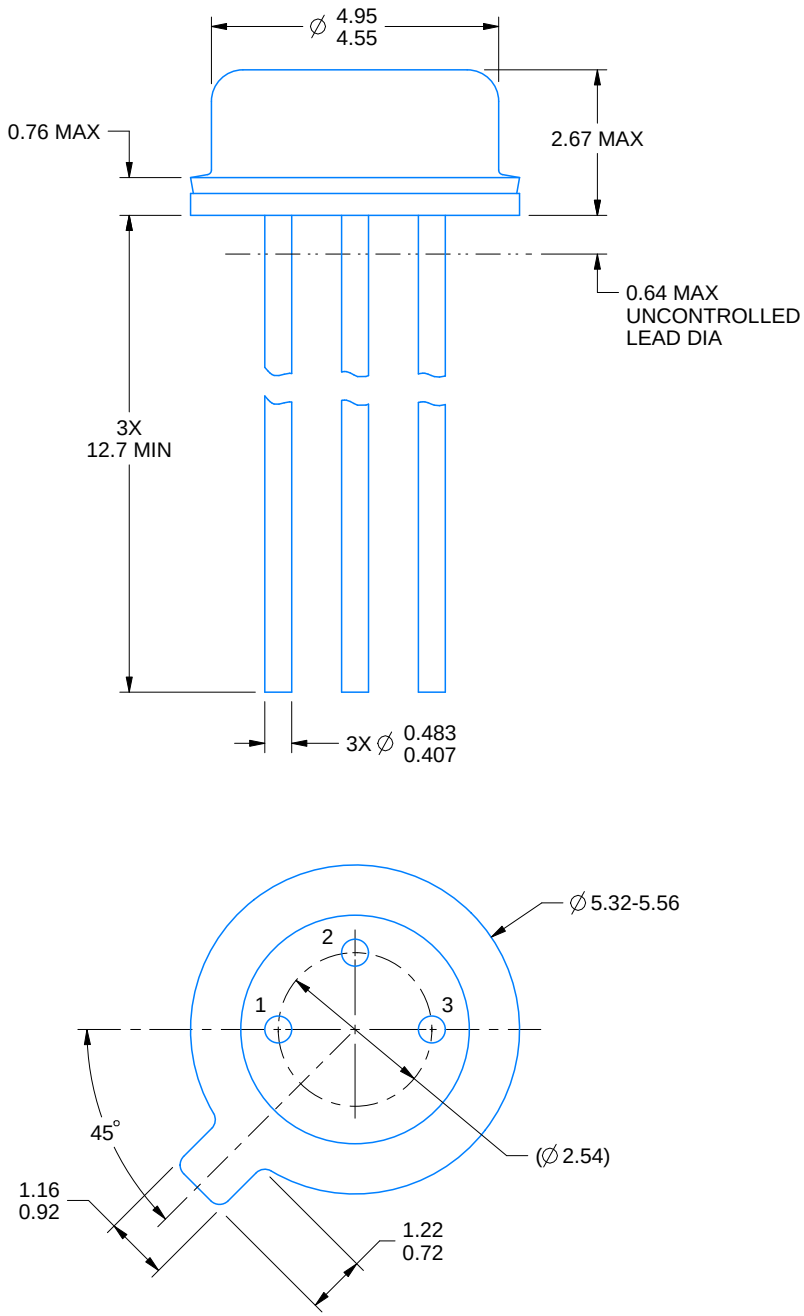
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

PACKAGE OUTLINE

NDV0003H

TO-CAN - 2.67 mm max height

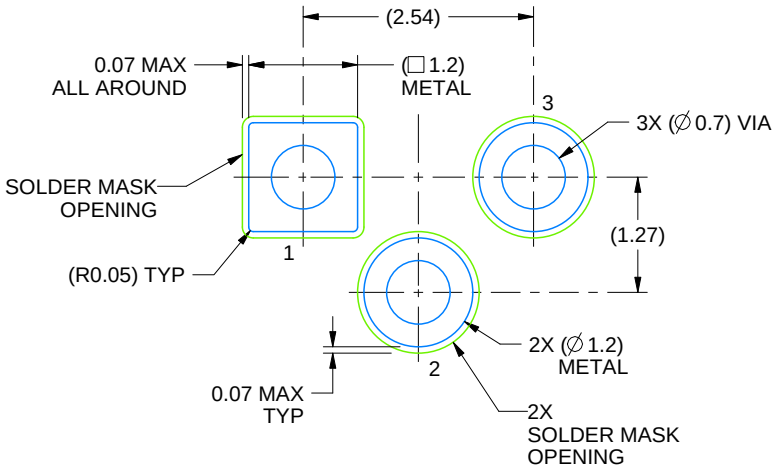
TO-46



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

4219876/A 01/2017

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