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

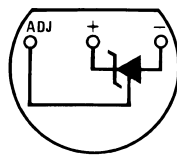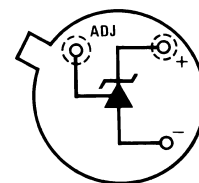**Figure 1. TO-92 Plastic Package (Bottom View)**

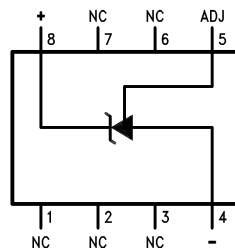**Figure 2. TO Metal Can Package (Bottom View)**

Figure 3. SOIC Package

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.
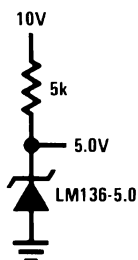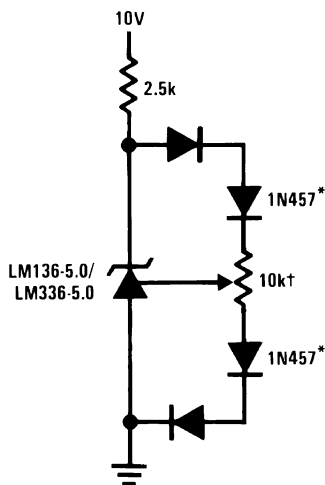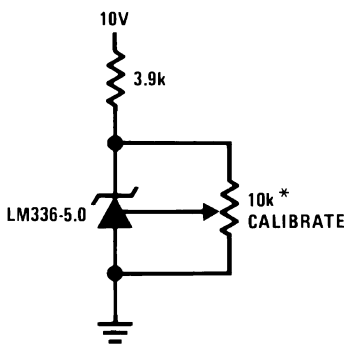
Typical Applications

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

Product Folder Links: *LM136-5.0 LM236-5.0 LM336-5.0*

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

Parameter	Conditions	LM136A-5.0/LM236A-5.0			LM336B-5.0			Units
		LM136-5.0/LM236-5.0			LM336-5.0			
		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 With Current	T_A=25°C, 600 µA≤I_R≤10 mA		6	12		6	20	mV
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).

Product Folder Links: LM136-5.0 LM236-5.0 LM336-5.0

ELECTRICAL CHARACTERISTICS (continued)

(1)

| Parameter | Conditions | LM136A-5.0/LM236A-5.0 | | | LM336B-5.0 | | | Units |
| | | LM136-5.0/LM236-5.0 | | | LM336-5.0 | | | |
		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
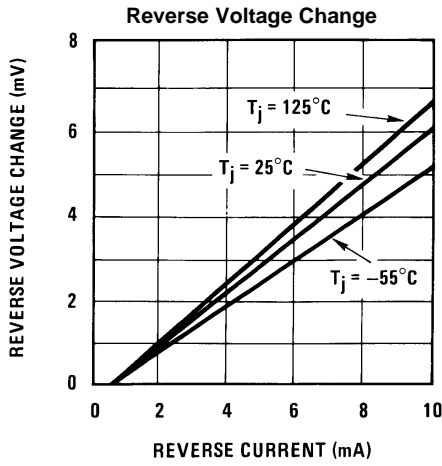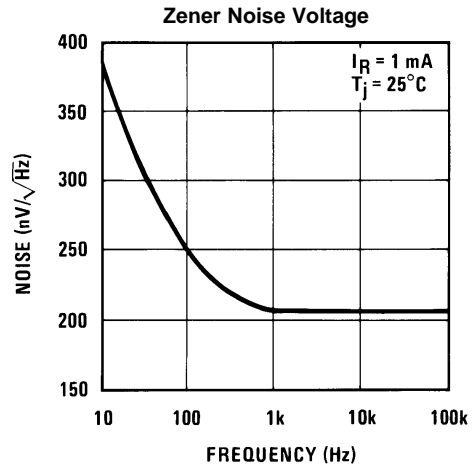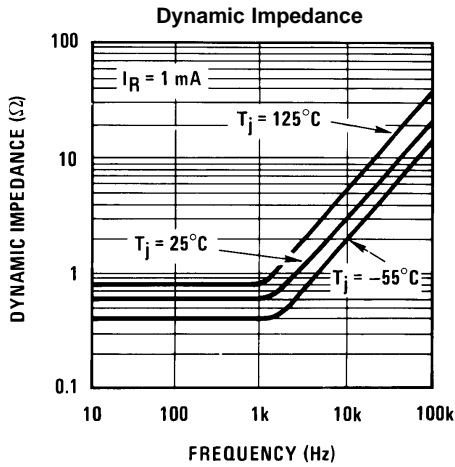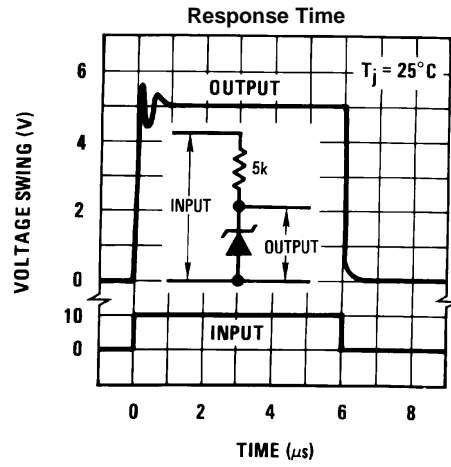
Product Folder Links: *LM136-5.0 LM236-5.0 LM336-5.0*

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.

Product Folder Links: *LM136-5.0 LM236-5.0 LM336-5.0*

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Forward Characteristics

Figure 13.

Product Folder Links: *LM136-5.0 LM236-5.0 LM336-5.0*
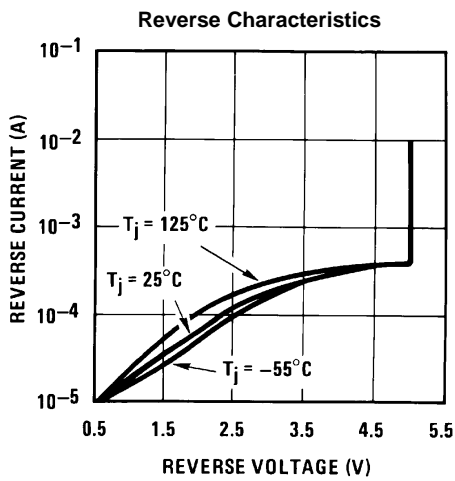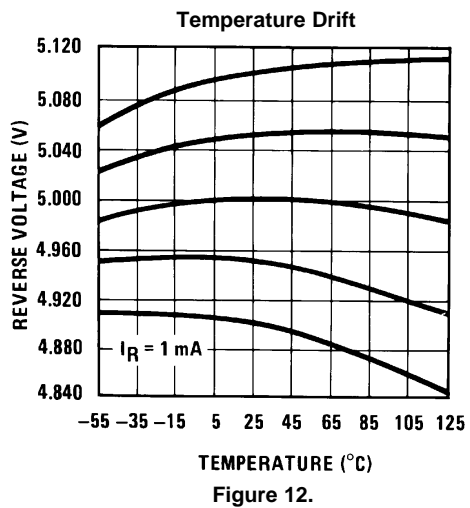
APPLICATION HINTS

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.

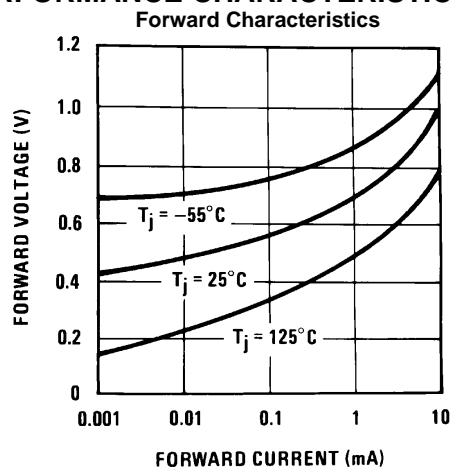If minimum temperature coefficient is desired, four diodes can be added in series with the adjustment potentiometer as shown in Figure 15. When the device is adjusted to 5.00V the temperature coefficient is minimized. Almost any silicon signal diode can be used for this purpose such as a 1N914, 1N4148 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.
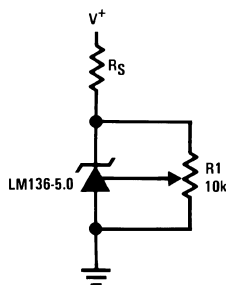
Figure 14. LM136-5.0 with Pot for Adjustment of Breakdown Voltage (Trim Range = ±1.0V Typical)
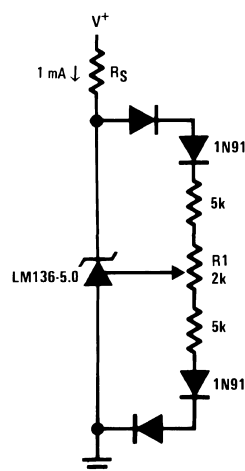
Figure 15. Temperature Coefficient Adjustment (Trim Range = ±0.5V Typical)

Typical Applications
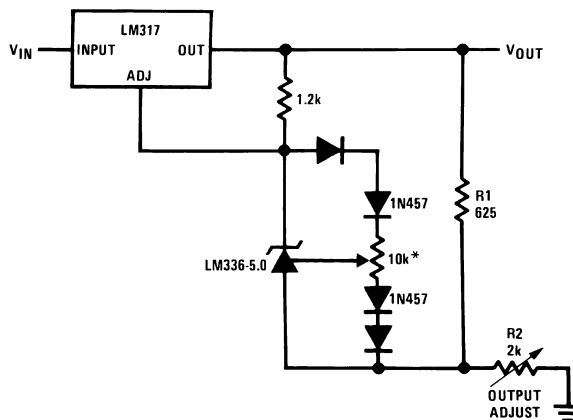
* Adjust for 6.25V across R1

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

Product Folder Links: *LM136-5.0 LM236-5.0 LM336-5.0*

Figure 23. 10V Buffered Reference
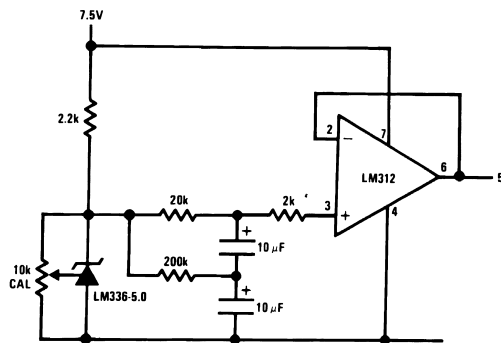
Figure 24. Low Noise Buffered Reference
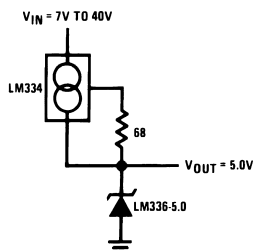
Figure 25. Wide Input Range Reference

Schematic Diagram

REVISION HISTORY

Product Folder Links: *LM136-5.0 LM236-5.0 LM336-5.0*

PACKAGING INFORMATION

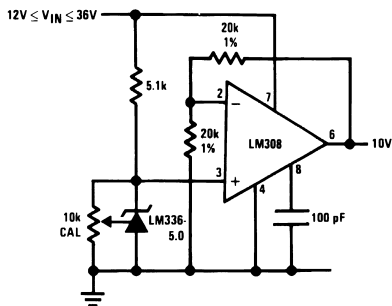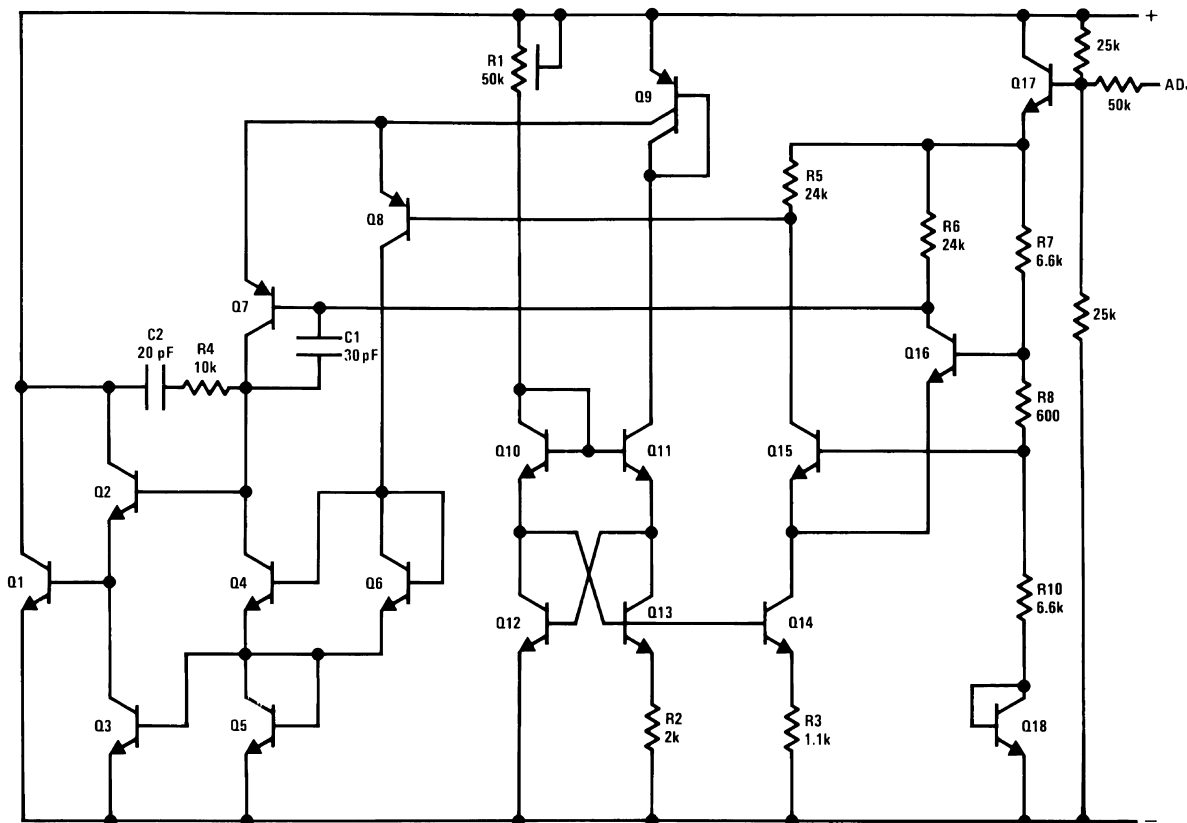| Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM136-5.0-MW8	ACTIVE	WAFERSALE	YS	0	1	RoHS & Green	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
LM136AH-5.0	ACTIVE	TO	NDV	3	1000	Non-RoHS & Non-Green	Call TI	Call TI	-40 to 125	(LM136AH5.0, LM136AH5.0)	Samples
LM136AH-5.0/NOPB	ACTIVE	TO	NDV	3	1000	RoHS & Green	Call TI	Level-1-NA-UNLIM	-40 to 125	(LM136AH5.0, LM136AH5.0)	Samples
LM136H-5.0	ACTIVE	TO	NDV	3	1000	Non-RoHS & Non-Green	Call TI	Call TI	-55 to 125	(LM136H5.0, LM136H5.0)	Samples
LM136H-5.0/NOPB	ACTIVE	TO	NDV	3	1000	RoHS & Green	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM136H5.0, LM136H5.0)	Samples
LM236AH-5.0/NOPB	ACTIVE	TO	NDV	3	1000	RoHS & Green	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM236AH5.0, LM236AH5.0)	Samples
LM236H-5.0	ACTIVE	TO	NDV	3	1000	Non-RoHS & Non-Green	Call TI	Call TI	-25 to 85	(LM236H5.0, LM236H5.0)	Samples
LM236H-5.0/NOPB	ACTIVE	TO	NDV	3	1000	RoHS & Green	Call TI	Level-1-NA-UNLIM	-25 to 85	(LM236H5.0, LM236H5.0)	Samples
LM336-5 MWC	ACTIVE	WAFERSALE	YS	0	1	RoHS & Green	Call TI	Level-1-NA-UNLIM	-40 to 85		Samples
LM336BM-5.0/NOPB	ACTIVE	SOIC	D	8	95	RoHS & Green	SN	Level-1-260C-UNLIM	0 to 70	LM336 BM5.0	Samples
LM336BMX-5.0/NOPB	ACTIVE	SOIC	D	8	2500	RoHS & Green	SN	Level-1-260C-UNLIM	0 to 70	LM336 BM5.0	Samples
LM336BZ-5.0/NOPB	ACTIVE	TO-92	LP	3	1800	RoHS & Green	Call TI	N / A for Pkg Type	0 to 70	LM336 BZ5.0	Samples
LM336M-5.0	NRND	SOIC	D	8	95	Non-RoHS & Green	Call TI	Level-1-235C-UNLIM	0 to 70	LM336 M5.0	
LM336M-5.0/NOPB	ACTIVE	SOIC	D	8	95	RoHS & Green	SN	Level-1-260C-UNLIM	0 to 70	LM336 M5.0	Samples
LM336MX-5.0/NOPB	ACTIVE	SOIC	D	8	2500	RoHS & Green	SN	Level-1-260C-UNLIM	0 to 70	LM336 M5.0	Samples
LM336Z-5.0/NOPB	ACTIVE	TO-92	LP	3	1800	RoHS & Green	Call TI	N / A for Pkg Type	0 to 70	LM336 Z-5.0	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] **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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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.

PACKAGE MATERIALS INFORMATION

TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSIONS

A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM336BMX-5.0/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM336MX-5.0/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

PACKAGE MATERIALS INFORMATION

TAPE AND REEL BOX DIMENSIONS

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM336BMX-5.0/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM336MX-5.0/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

![Texas Instruments logo] **PACKAGE MATERIALS INFORMATION**

TUBE

T - Tube height

L - Tube length

W - Tube width

B - Alignment groove width

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LM336BM-5.0/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM336M-5.0	D	SOIC	8	95	495	8	4064	3.05
LM336M-5.0	D	SOIC	8	95	495	8	4064	3.05
LM336M-5.0/NOPB	D	SOIC	8	95	495	8	4064	3.05

.228-.244 TYP
[5.80-6.19]

PIN 1 ID AREA

6X .050
[1.27]

2X .150
[3.81]

.189-.197
[4.81-5.00]
NOTE 3

.150-.157
[3.81-3.98]
NOTE 4

8X .012-.020
[0.31-0.51]

⊕ .010 [0.25] Ⓜ C A B

SEATING PLANE

⌒ .004 [0.1] C

4X (0°-15°)

.069 MAX
[1.75]

SEE DETAIL A

4X (0°-15°)

.005-.010 TYP
[0.13-0.25]

.010
[0.25]

0°-8°

.016-.050
[0.41-1.27]

(.041)
[1.04]

.004-.010
[0.11-0.25]

DETAIL A
TYPICAL

4214825/C   02/2019

NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches.
   Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not
   exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

8X (.061)
[1.55]

1

8X (.024)
[0.6]

6X (.050)
[1.27]

4

SYMM
₵

SEE
DETAILS

8

SYMM
₵

(R.002) TYP
[0.05]

5

(.213)
[5.4]

LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X

METAL

SOLDER MASK
OPENING

EXPOSED
METAL

.0028 MAX
[0.07]
ALL AROUND

**NON SOLDER MASK
DEFINED**

SOLDER MASK
OPENING

METAL UNDER
SOLDER MASK

EXPOSED
METAL

.0028 MIN
[0.07]
ALL AROUND

**SOLDER MASK
DEFINED**

SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

8X (.061)
[1.55]

1

8X (.024)
[0.6]

SYMM
¢

8

SYMM
¢

(R.002) TYP
[0.05]

6X (.050)
[1.27]

4

5

(.213)
[5.4]

SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate
   design recommendations.
9. Board assembly site may have different recommendations for stencil design.

Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

TEXAS
INSTRUMENTS

5.21
4.44

EJECTOR PIN
OPTIONAL

5.34
4.32

(1.5) TYP

SEATING
PLANE

(2.54)
NOTE 3

(0.51) TYP

6X
0.076 MAX

2X
4 MAX

SEATING
PLANE

3X
12.7 MIN

2X
2.6 ± 0.2

3X 0.55
0.38

3X 0.43
0.35

FORMED LEAD OPTION
OTHER DIMENSIONS IDENTICAL
TO STRAIGHT LEAD OPTION

STRAIGHT LEAD OPTION

2X 1.27 ± 0.13

3X 2.67
2.03

4.19
3.17

3   2   1

3.43 MIN
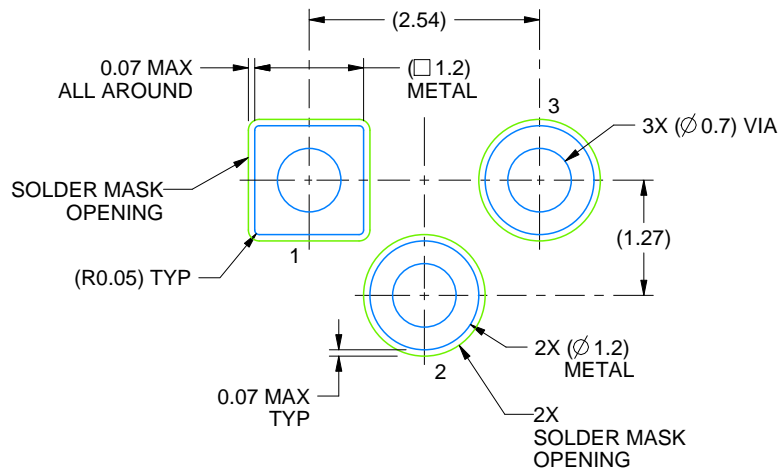
4215214/B   04/2017

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. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping method:
   a. Straight lead option available in bulk pack only.
   b. Formed lead option available in tape and reel or ammo pack.
   c. Specific products can be offered in limited combinations of shipping medium and lead options.
   d. Consult product folder for more information on available options.

**TEXAS
INSTRUMENTS**
www.ti.com

FULL R
TYP

0.05 MAX
ALL AROUND
TYP

(1.07)

METAL
TYP

3X (∅ 0.85) HOLE

2X
METAL

(1.5)

2X (1.5)

2X
SOLDER MASK
OPENING

(R0.05) TYP

1

2

3

SOLDER MASK
OPENING

(1.27)

2X (1.07)

(2.54)

LAND PATTERN EXAMPLE
STRAIGHT LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X

0.05 MAX
ALL AROUND
TYP

(□ 1.4)

2X (∅ 1.4)
METAL

3X (∅ 0.9) HOLE

METAL

(R0.05) TYP

1

2

3

2X
SOLDER MASK
OPENING

SOLDER MASK
OPENING

(2.6)

(5.2)

LAND PATTERN EXAMPLE
FORMED LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X

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FOR FORMED LEAD OPTION PACKAGE

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⌀ 4.95
4.55

0.76 MAX

2.67 MAX

0.64 MAX
UNCONTROLLED
LEAD DIA

3X
12.7 MIN

3X ⌀ 0.483
0.407

⌀ 5.32-5.56

2

1

3

45°

(⌀ 2.54)

1.16
0.92

1.22
0.72
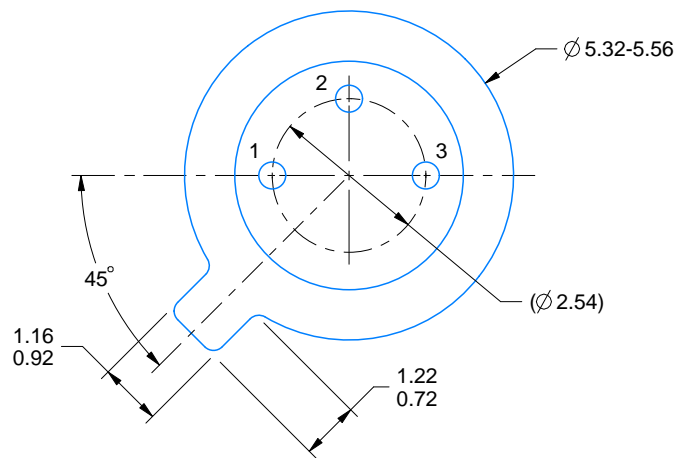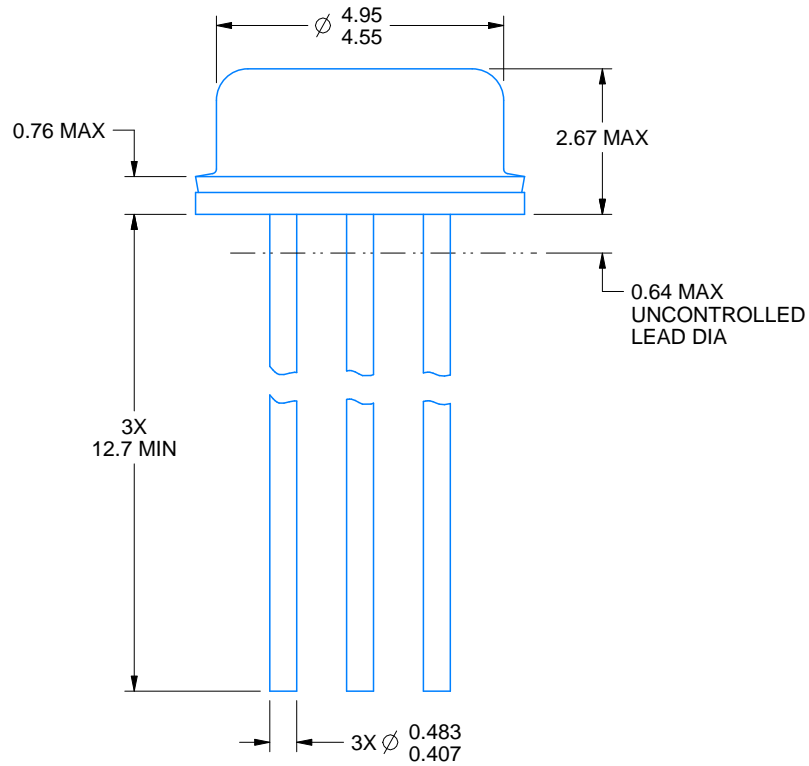
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NOTES:

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.

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(2.54)

0.07 MAX
ALL AROUND

(□ 1.2)
METAL

3

3X (∅ 0.7) VIA

SOLDER MASK
OPENING

(1.27)

(R0.05) TYP

1

2X (∅ 1.2)
METAL

0.07 MAX
TYP

2

2X
SOLDER MASK
OPENING

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

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