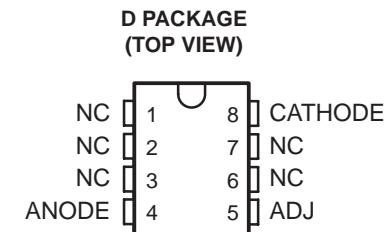


- Low Temperature Coefficient
- Wide Operating Current . . . 400  $\mu$ A to 10 mA
- 0.27- $\Omega$  Dynamic Impedance
- $\pm 1\%$  Tolerance Available
- Specified Temperature Stability
- Easily Trimmed for Minimum Temperature Drift
- Fast Turnon



NC – No internal connection

**LM336-2.5, LM336B-2.5 . . . LP PACKAGE  
(TOP VIEW)**



### description/ordering information

The LM236-2.5, LM336-2.5, and LM336B-2.5 integrated circuits are precision 2.5-V shunt regulator diodes. These reference circuits operate as low-temperature-coefficient 2.5-V Zener diodes with a 0.2- $\Omega$  dynamic impedance. A third terminal provided on the circuit allows the reference voltage and temperature coefficient to be trimmed easily.

The series is useful as precision 2.5-V low-voltage references ( $V_Z$ ) for digital voltmeters, power supplies, or operational-amplifier circuitry. The 2.5-V voltage reference makes it convenient to obtain a stable reference from 5-V logic supplies. Devices in this series operate as shunt regulators, and can be used as either positive or negative voltage references.

The LM236-2.5 is characterized for operation from  $-25^\circ\text{C}$  to  $85^\circ\text{C}$ . The LM336-2.5 and LM336B-2.5 are characterized for operation from  $0^\circ\text{C}$  to  $70^\circ\text{C}$ .

### ORDERING INFORMATION

| TA  | PACKAGE†            |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---------------------|--------------|-----------------------|------------------|
| $0^\circ\text{C}$ to $70^\circ\text{C}$   | SOIC (D)            | Tube of 75   | LM336D-2-5            | 336-25           |
|   |                     | Reel of 2500 | LM336DR-2-5           |                  |
|   |                     | Tube of 75   | LM336BD-2-5           | 336B25           |
|   |                     | Reel of 2500 | LM336BDR-2-5          |                  |
|   | TO-226 / TO-92 (LP) | Bulk of 1000 | LM336LP-2-5           | 336-25           |
|   |                     | Reel of 2000 | LM336LPR-2-5          |                  |
|   |                     | Bulk of 1000 | LM336BLP-2-5          | 336B25           |
|   |                     | Reel of 2000 | LM336BLPR-2-5         |                  |
| $-25^\circ\text{C}$ to $85^\circ\text{C}$ | SOIC (D)            | Tube of 75   | LM236D-2-5            | 236-25           |
|   |                     | Reel of 2500 | LM236DR-2-5           |                  |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/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.

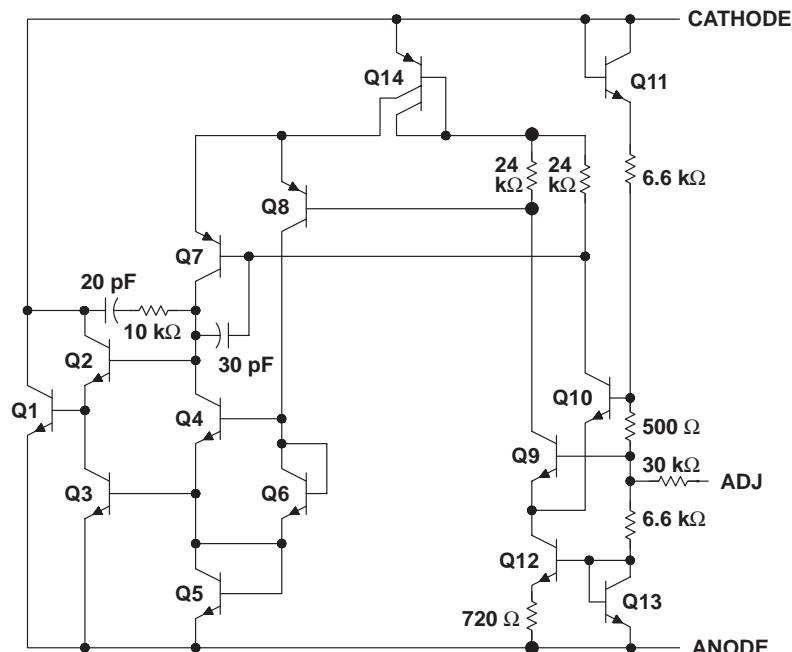
# LM236-2.5, LM336-2.5, LM336B-2.5 2.5-V INTEGRATED REFERENCE CIRCUITS

SLVS063E – NOVEMBER 1988 – REVISED OCTOBER 2003

## symbol



## schematic diagram



NOTE A: All component values are nominal.

## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

|   |                |
|---|----------------|
| Reverse current, $I_R$ .....  | 20 mA          |
| Forward current, $I_F$ .....  | 10 mA          |
| Package thermal impedance, $\theta_{JA}$ (see Notes 1 and 2): D package ..... | 97°C/W         |
| LP package .....  | 140°C/W        |
| Operating virtual junction temperature, $T_J$ .....                           | 150°C          |
| Storage temperature range, $T_{stg}$ .....                                    | -65°C to 150°C |

<sup>†</sup> Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. Maximum power dissipation is a function of  $T_J(\max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\max) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can impact reliability.  
2. The package thermal impedance is calculated in accordance with JEDEC 51-7.

## recommended operating conditions

|                                      |                       | MIN | MAX | UNIT |
|--------------------------------------|-----------------------|-----|-----|------|
| $T_A$ Operating free-air temperature | LM236-2.5             | -25 | 85  | °C   |
|                                      | LM336-2.5, LM336B-2.5 | 0   | 70  |      |

**LM236-2.5, LM336-2.5, LM336B-2.5  
2.5-V INTEGRATED REFERENCE CIRCUITS**

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**electrical characteristics at specified free-air temperature (unless otherwise noted)**

| PARAMETER   | TEST CONDITIONS   | TA <sup>†</sup> | LM236-2.5 |      |      | LM336-2.5 |      |      | UNIT    |
|---|---|-----------------|-----------|------|------|-----------|------|------|---------|
|   |   |                 | MIN       | TYP  | MAX  | MIN       | TYP  | MAX  |         |
| V <sub>Z</sub><br>Reference voltage                                 | I <sub>Z</sub> = 1 mA                                     | 25°C            | 2.44      | 2.49 | 2.54 | 2.39      | 2.49 | 2.59 | V       |
|   |   |                 |           |      |      | 2.44      | 2.49 | 2.54 |         |
| ΔV <sub>Z(ΔT)</sub><br>Change in reference voltage with temperature | V <sub>Z</sub> adjusted to 2.490 V, I <sub>Z</sub> = 1 mA | Full range      |           | 3.5  | 9    |           | 1.8  | 6    | mV      |
| ΔV <sub>Z(ΔI)</sub><br>Change in reference voltage with current     | I <sub>Z</sub> = 400 μA to 10 mA                          | 25°C            |           | 2.6  | 6    |           | 2.6  | 10   | mV      |
|   |   | Full range      |           | 3    | 10   |           | 3    | 12   |         |
| ΔV <sub>Z(Δt)</sub><br>Long-term change in reference voltage        | I <sub>Z</sub> = 1 mA                                     | 25°C            |           | 20   |      |           | 20   |      | ppm/khr |
| z <sub>Z</sub><br>Reference impedance                               | I <sub>Z</sub> = 1 mA, f = 1 kHz                          | 25°C            |           | 0.2  | 0.6  |           | 0.2  | 1    | W       |
|   |   | Full range      |           | 0.4  | 1    |           | 0.4  | 1.4  |         |

<sup>†</sup> Full range is -25°C to 85°C for the LM236-2.5 and 0°C to 70°C for the LM336-2.5 and LM336B-2.5.

# LM236-2.5, LM336-2.5, LM336B-2.5 2.5-V INTEGRATED REFERENCE CIRCUITS

SLVS063E – NOVEMBER 1988 – REVISED OCTOBER 2003

## TYPICAL CHARACTERISTICS

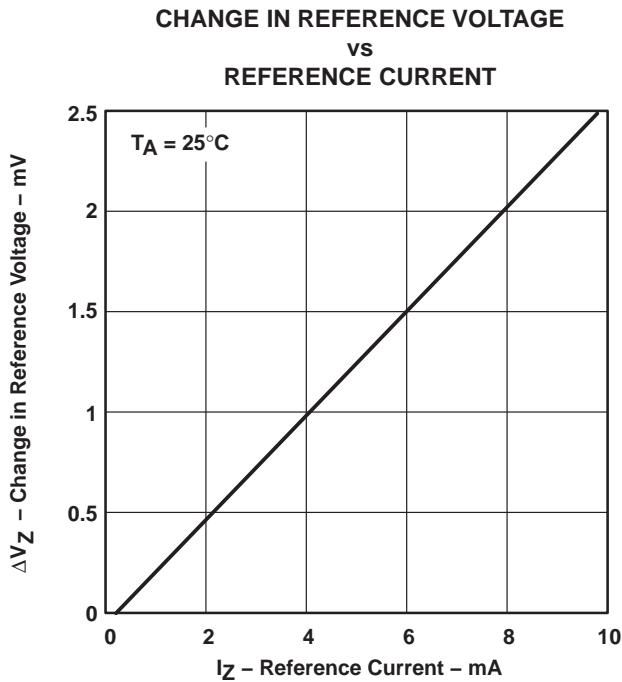


Figure 1

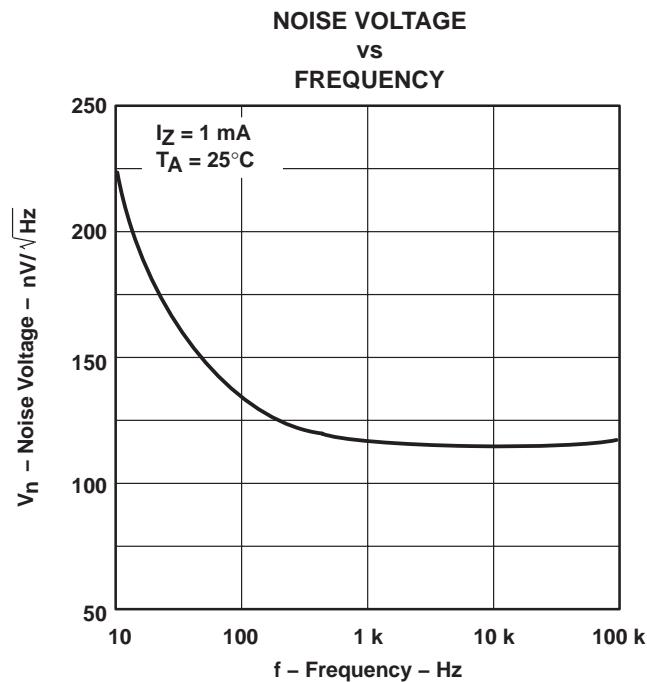


Figure 2

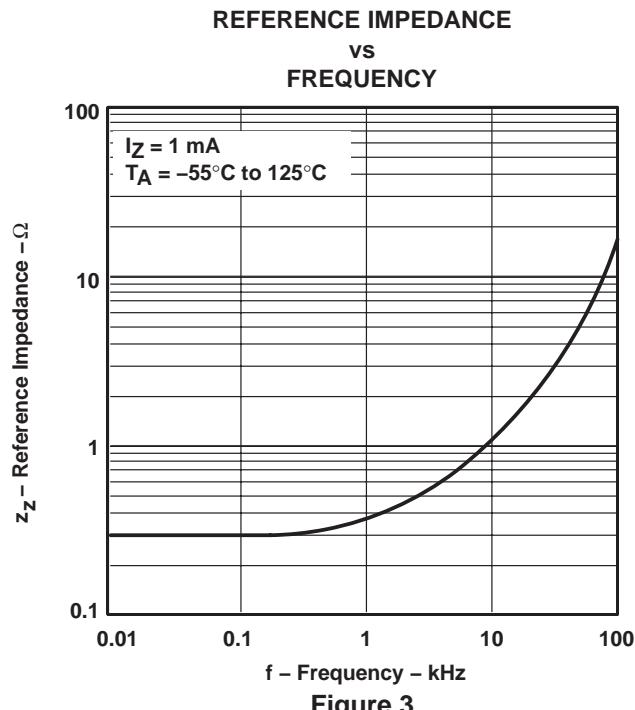
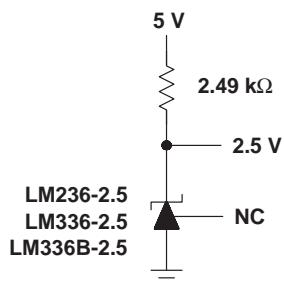
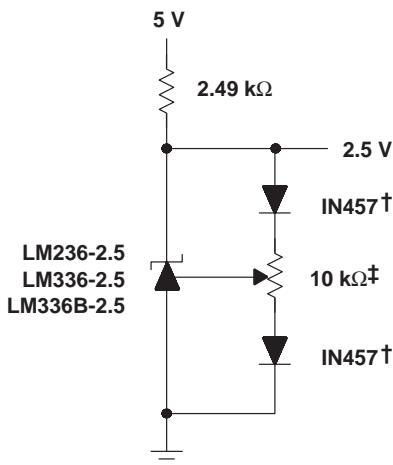


Figure 3

## APPLICATION INFORMATION



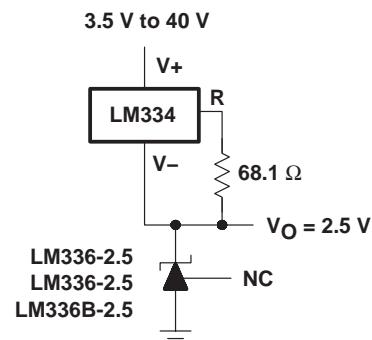
**Figure 4. 2.5-V Reference**



† Any silicon signal diode

‡ Adjust to 2.49 V

**Figure 5. 2.5-V Reference  
With Minimum Temperature Coefficient**



**Figure 6. Wide-Input-Range Reference**

**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 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|---------|
| LM236D-2-5       | ACTIVE        | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -25 to 85    | 236-25                  | Samples |
| LM236DR-2-5      | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -25 to 85    | 236-25                  | Samples |
| LM336-2.5 MDC    | ACTIVE        | DIESALE      | Y               | 0    | 400         | RoHS & Green    | Call TI                              | Level-1-NA-UNLIM     | -40 to 85    |                         | Samples |
| LM336BD-2-5      | ACTIVE        | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 336B25                  | Samples |
| LM336BDR-2-5     | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 336B25                  | Samples |
| LM336BLP-2-5     | ACTIVE        | TO-92        | LP              | 3    | 1000        | RoHS & Green    | SN                                   | N / A for Pkg Type   | 0 to 70      | 336B25                  | Samples |
| LM336BLPR-2-5    | ACTIVE        | TO-92        | LP              | 3    | 2000        | RoHS & Green    | SN                                   | N / A for Pkg Type   | 0 to 70      | 336B25                  | Samples |
| LM336D-2-5       | ACTIVE        | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 336-25                  | Samples |
| LM336DR-2-5      | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 336-25                  | Samples |
| LM336LP-2-5      | ACTIVE        | TO-92        | LP              | 3    | 1000        | RoHS & Green    | SN                                   | N / A for Pkg Type   | 0 to 70      | 336-25                  | Samples |
| LM336LPR-2-5     | ACTIVE        | TO-92        | LP              | 3    | 2000        | RoHS & Green    | SN                                   | N / A for Pkg Type   | 0 to 70      | 336-25                  | 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.

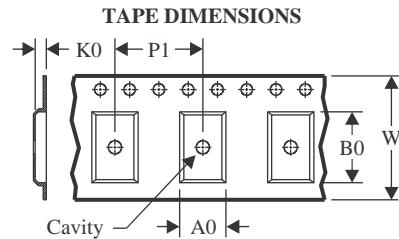
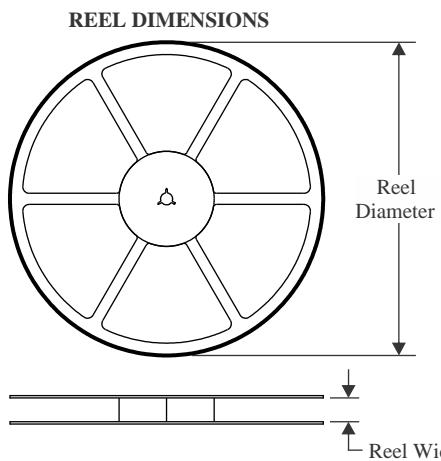
**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

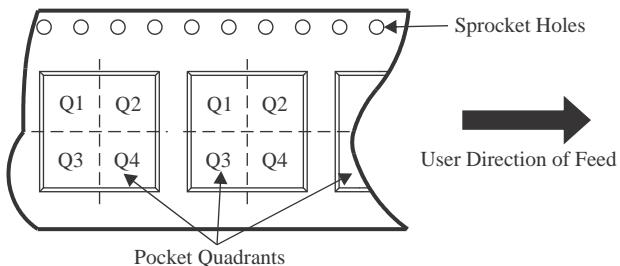
- (4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.
- (5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If 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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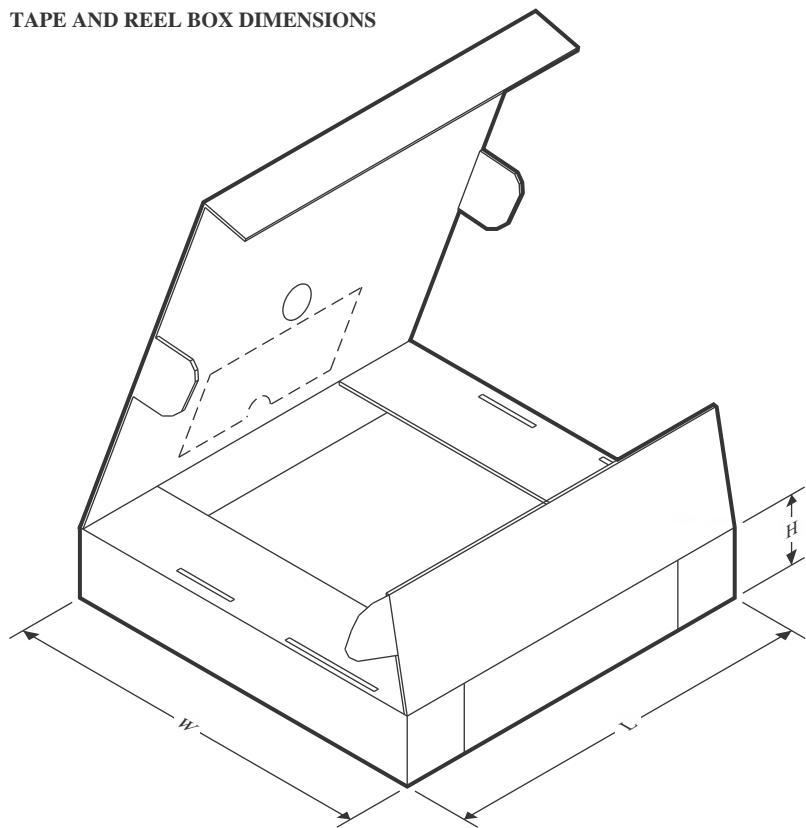
**TAPE AND REEL INFORMATION**

|    |   |
|----|---|
| 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**

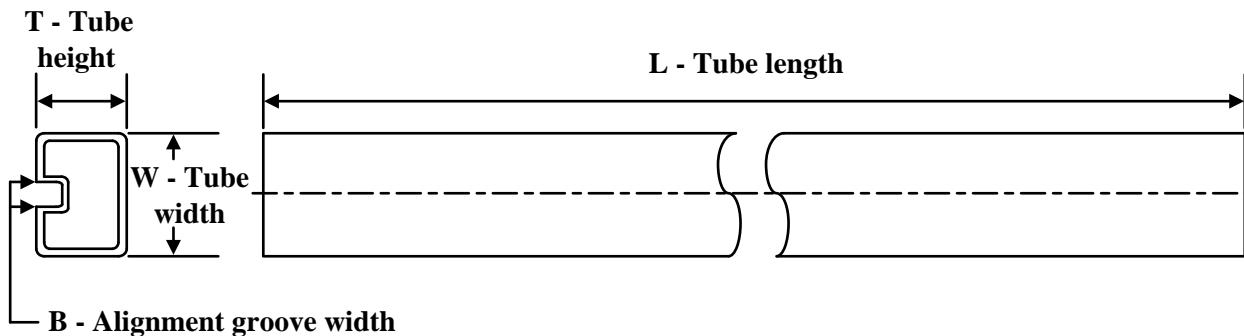
\*All dimensions are nominal

| 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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM236DR-2-5  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM336BDR-2-5 | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM336DR-2-5  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

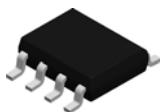
| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM236DR-2-5  | SOIC         | D               | 8    | 2500 | 353.0       | 353.0      | 32.0        |
| LM336BDR-2-5 | SOIC         | D               | 8    | 2500 | 353.0       | 353.0      | 32.0        |
| LM336DR-2-5  | SOIC         | D               | 8    | 2500 | 353.0       | 353.0      | 32.0        |

**TUBE**


\*All dimensions are nominal

| Device      | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T ( $\mu$ m) | B (mm) |
|-------------|--------------|--------------|------|-----|--------|--------|--------------|--------|
| LM236D-2-5  | D            | SOIC         | 8    | 75  | 507    | 8      | 3940         | 4.32   |
| LM336BD-2-5 | D            | SOIC         | 8    | 75  | 507    | 8      | 3940         | 4.32   |
| LM336D-2-5  | D            | SOIC         | 8    | 75  | 507    | 8      | 3940         | 4.32   |

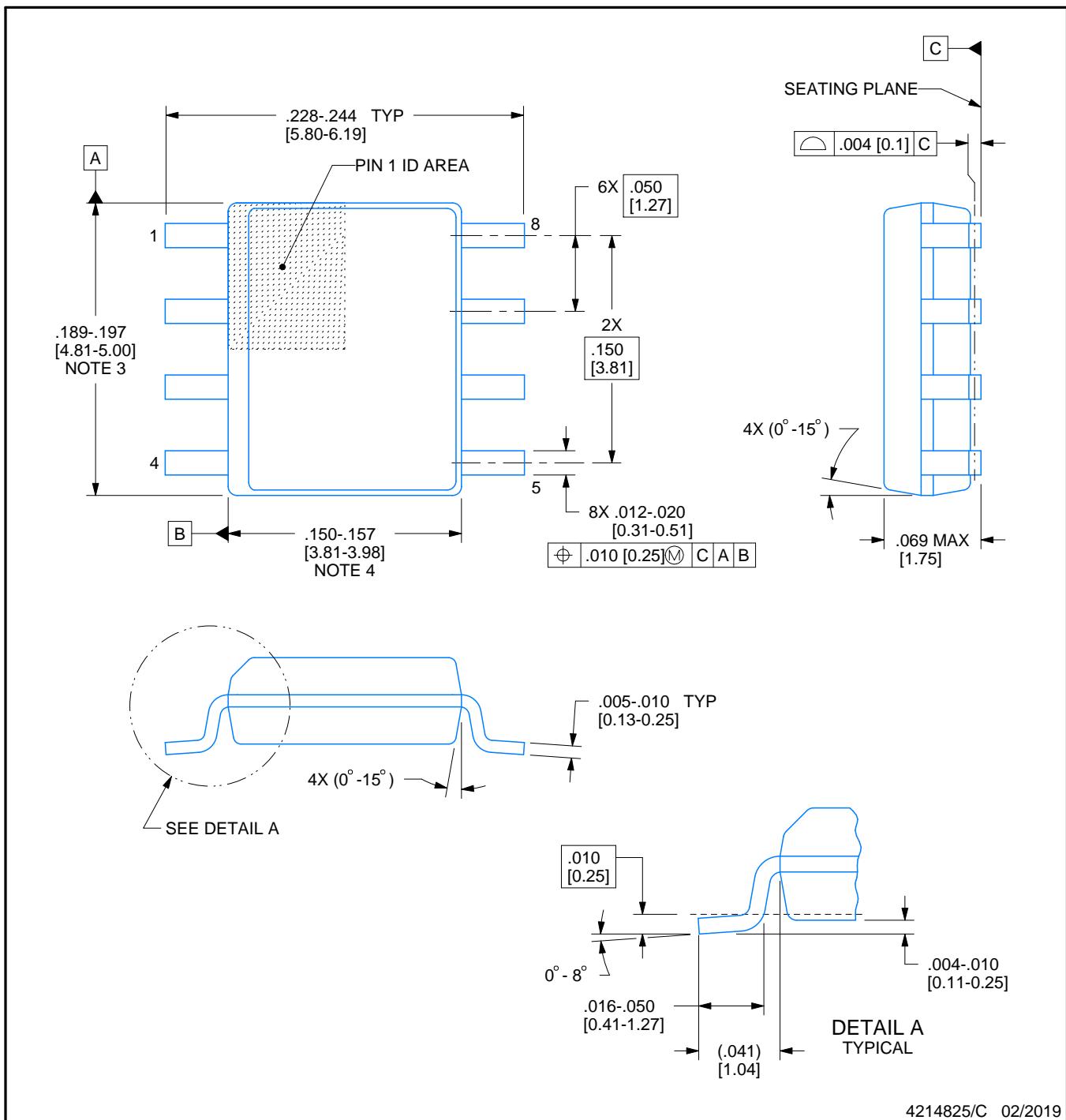
D0008A



# PACKAGE OUTLINE

## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

### NOTES:

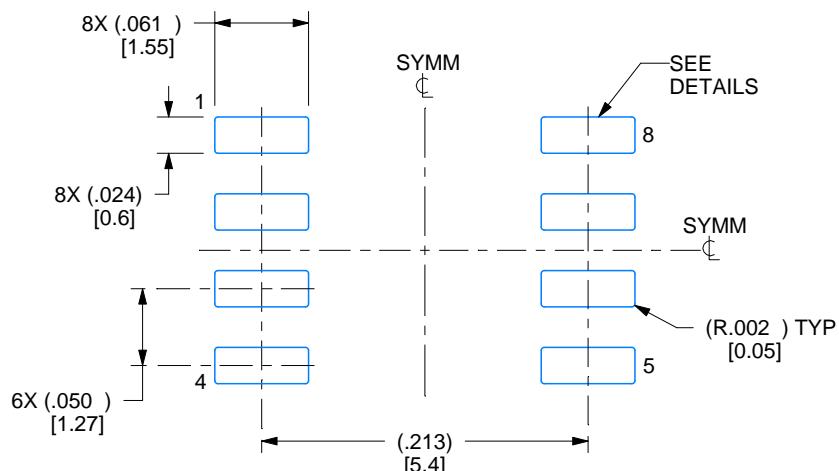
- Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate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

# EXAMPLE BOARD LAYOUT

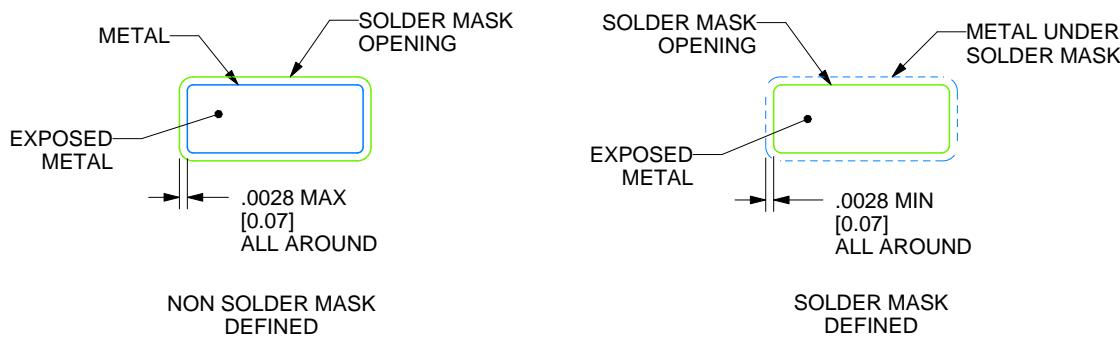
D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

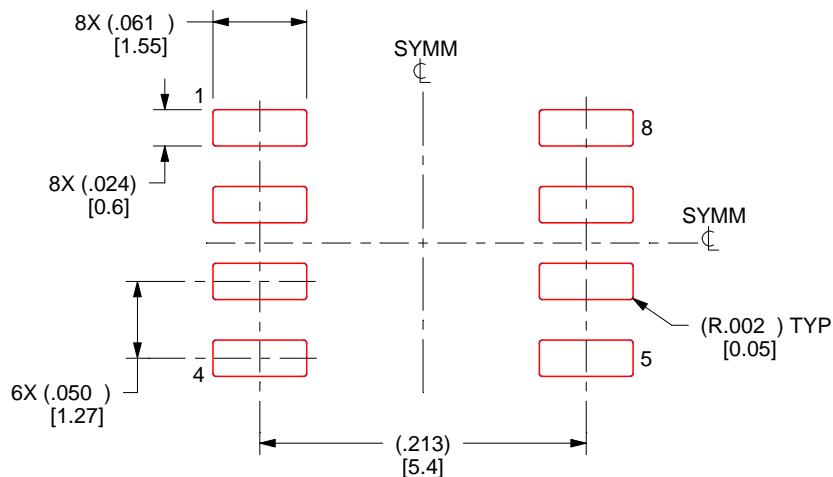
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



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.

# GENERIC PACKAGE VIEW

**LP 3**

**TO-92 - 5.34 mm max height**

TRANSISTOR OUTLINE



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

4040001-2/F

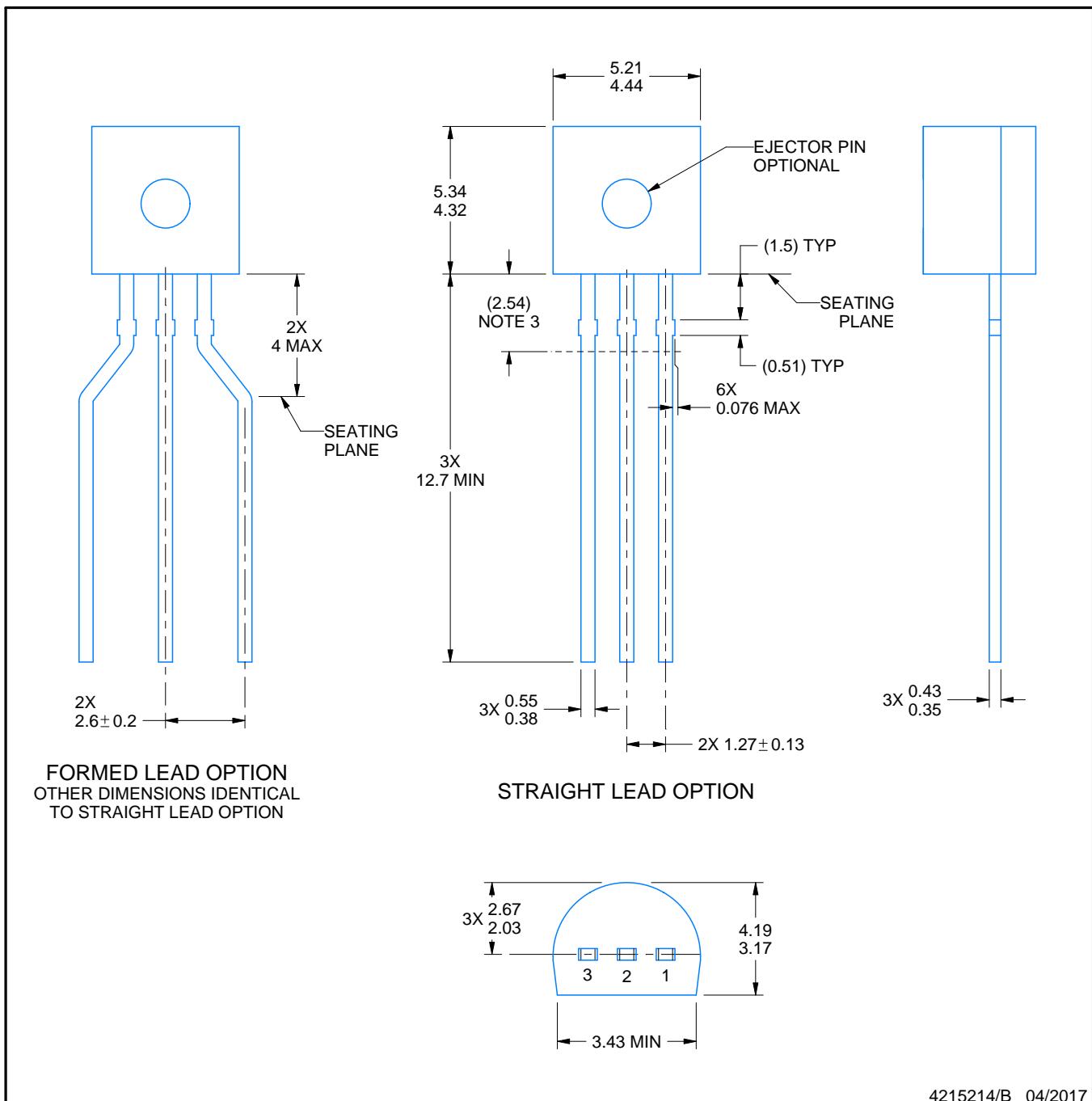
# PACKAGE OUTLINE

LP0003A



TO-92 - 5.34 mm max height

TO-92



4215214/B 04/2017

## NOTES:

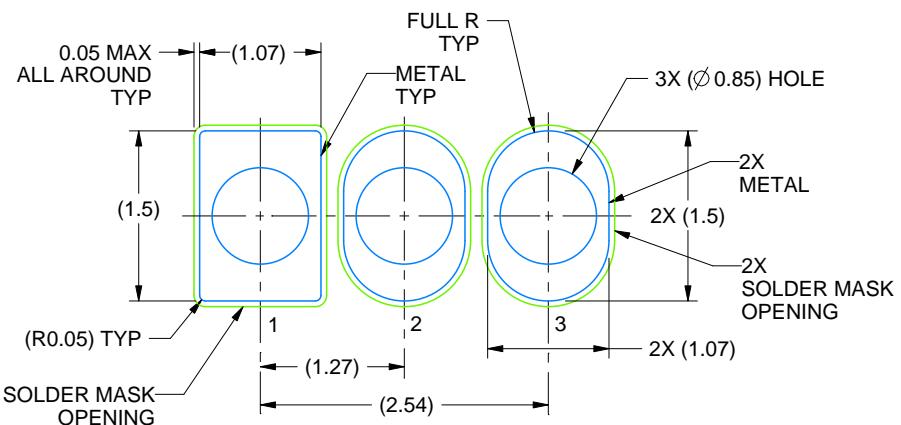
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping 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.

# EXAMPLE BOARD LAYOUT

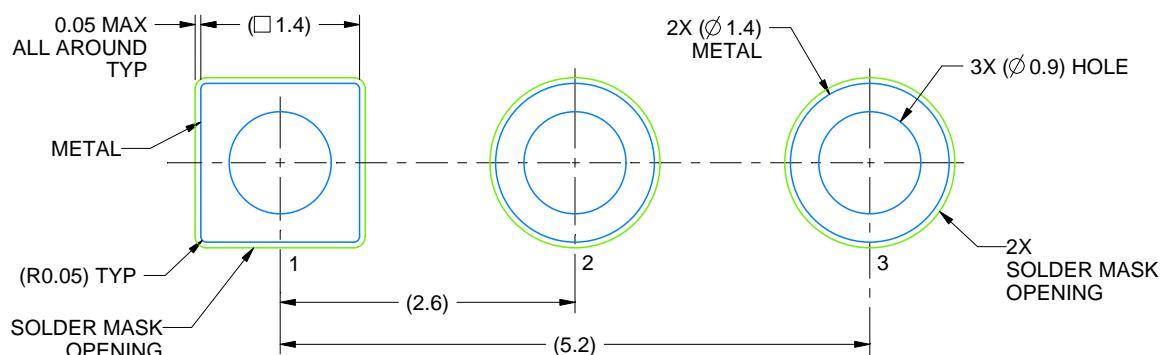
LP0003A

TO-92 - 5.34 mm max height

TO-92



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



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

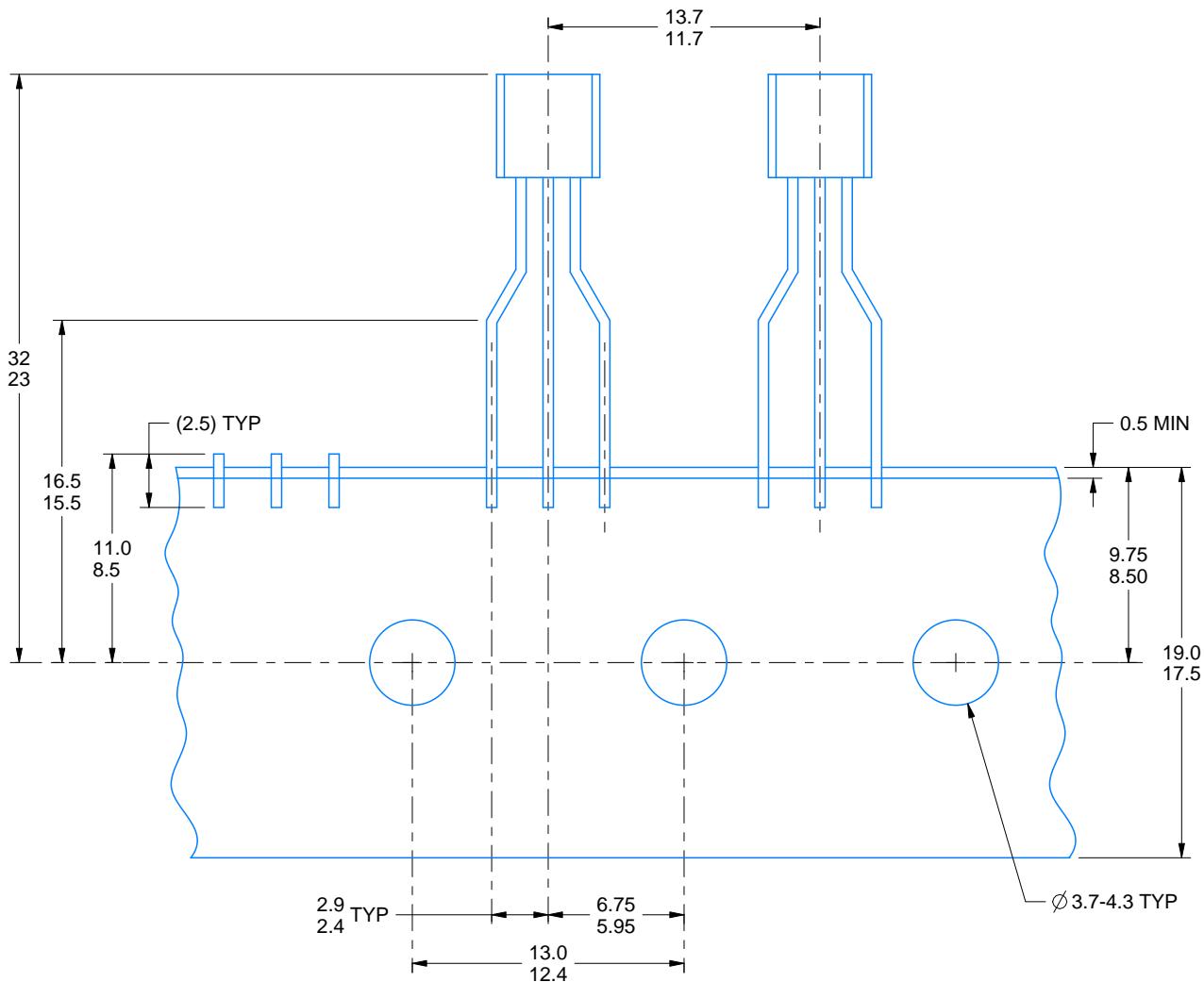
4215214/B 04/2017

## **TAPE SPECIFICATIONS**

LP0003A

## **TO-92 - 5.34 mm max height**

TO-92



## FOR FORMED LEAD OPTION PACKAGE

4215214/B 04/2017

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