

## LM129/LM329 Precision Reference

### General Description

The LM129 and LM329 family are precision multi-current temperature-compensated 6.9V zener references with dynamic impedances a factor of 10 to 100 less than discrete diodes. Constructed in a single silicon chip, the LM129 uses active circuitry to buffer the internal zener allowing the device to operate over a 0.5 mA to 15 mA range with virtually no change in performance. The LM129 and LM329 are available with selected temperature coefficients of 0.001, 0.002, 0.005 and 0.01%/°C. These references also have excellent long term stability and low noise.

A new subsurface breakdown zener used in the LM129 gives lower noise and better long-term stability than conventional IC zeners. Further the zener and temperature compensating transistor are made by a planar process so they are immune to problems that plague ordinary zeners. For example, there is virtually no voltage shift in zener voltage due to temperature cycling and the device is insensitive to stress on the leads.

The LM129 can be used in place of conventional zeners with improved performance. The low dynamic impedance simplifies biasing and the wide operating current allows the replacement of many zener types.

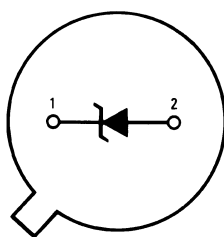
The LM129 is packaged in a 2-lead TO-46 package and is rated for operation over a -55°C to +125°C temperature range. The LM329 for operation over 0°C to 70°C is available in both a hermetic TO-46 package and a TO-92 epoxy package.

### Features

- 0.6 mA to 15 mA operating current
- 0.6Ω dynamic impedance at any current
- Available with temperature coefficients of 0.001%/°C
- 7μV wideband noise
- 5% initial tolerance
- 0.002% long term stability
- Low cost
- Subsurface zener

### Connection Diagrams

**Metal Can Package (TO-46)**



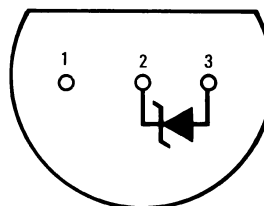
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Pin 2 is electrically connected to case

#### Bottom View

**Order Number LM129AH, LM129AH/883, LM129BH,  
LM129BH/883, LM129CH, LM329AH, LM329BH,  
LM329CH or LM329DH  
See NS Package H02A**

**Plastic Package (TO-92)**



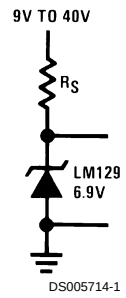
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#### Bottom View

**Order Number LM329BZ,  
LM329CZ or LM329DZ  
See NS Package Z03A**

## Typical Applications

### Simple Reference



**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

(Note 3)

|                           |       |
|---------------------------|-------|
| Reverse Breakdown Current | 30 mA |
| Forward Current           | 2 mA  |

## Operating Temperature Range

|       |                 |
|-------|-----------------|
| LM129 | -55°C to +125°C |
| LM329 | 0°C to +70°C    |

## Storage Temperature Range

-55°C to +150°C

## Soldering Information

|                        |       |
|------------------------|-------|
| TO-92 package: 10 sec. | 260°C |
| TO-46 package: 10 sec. | 300°C |

**Electrical Characteristics** (Note 2)

| Parameter                                                                               | Conditions                                                                        | LM129A, B, C |               |                | LM329A, B, C, D |                     |                       | Units                                |
|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------|---------------|----------------|-----------------|---------------------|-----------------------|--------------------------------------|
|                                                                                         |                                                                                   | Min          | Typ           | Max            | Min             | Typ                 | Max                   |                                      |
| Reverse Breakdown Voltage                                                               | $T_A = 25^\circ\text{C}$ ,<br>$0.6\text{ mA} \leq I_R \leq 15\text{ mA}$          | 6.7          | 6.9           | 7.2            | 6.6             | 6.9                 | 7.25                  | V                                    |
| Reverse Breakdown Change with Current (Note 4)                                          | $T_A = 25^\circ\text{C}$ ,<br>$0.6\text{ mA} \leq I_R \leq 15\text{ mA}$          |              | 9             | 14             |                 | 9                   | 20                    | mV                                   |
| Reverse Dynamic Impedance (Note 4)                                                      | $T_A = 25^\circ\text{C}$ , $I_R = 1\text{ mA}$                                    |              | 0.6           | 1              |                 | 0.8                 | 2                     | $\Omega$                             |
| RMS Noise                                                                               | $T_A = 25^\circ\text{C}$ ,<br>$10\text{ Hz} \leq F \leq 10\text{ kHz}$            |              | 7             | 20             |                 | 7                   | 100                   | $\mu\text{V}$                        |
| Long Term Stability (1000 hours)                                                        | $T_A = 45^\circ\text{C} \pm 0.1^\circ\text{C}$ ,<br>$I_R = 1\text{ mA} \pm 0.3\%$ |              | 20            |                |                 | 20                  |                       | ppm                                  |
| Temperature Coefficient<br>LM129A, LM329A<br>LM129B, LM329B<br>LM129C, LM329C<br>LM329D | $I_R = 1\text{ mA}$                                                               |              | 6<br>15<br>30 | 10<br>20<br>50 |                 | 6<br>15<br>30<br>50 | 10<br>20<br>50<br>100 | ppm/°C<br>ppm/°C<br>ppm/°C<br>ppm/°C |
| Change In Reverse Breakdown Temperature Coefficient                                     | $1\text{ mA} \leq I_R \leq 15\text{ mA}$                                          |              | 1             |                |                 | 1                   |                       | ppm/°C                               |
| Reverse Breakdown Change with Current                                                   | $1\text{ mA} \leq I_R \leq 15\text{ mA}$                                          |              | 12            |                |                 | 12                  |                       | mV                                   |
| Reverse Dynamic Impedance                                                               | $1\text{ mA} \leq I_R \leq 15\text{ mA}$                                          |              | 0.8           |                |                 | 1                   |                       | $\Omega$                             |

**Note 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 guarantee specific performance limits.

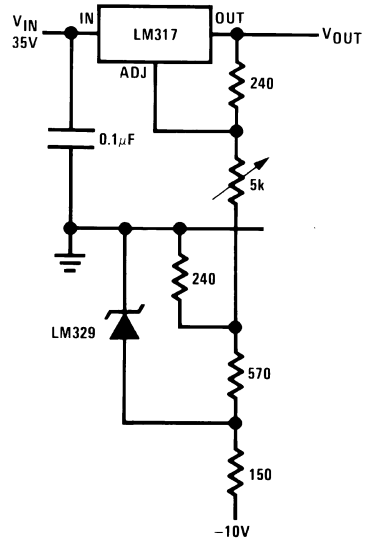
**Note 2:** These specifications apply for  $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  for the LM129 and  $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$  for the LM329 unless otherwise specified. The maximum junction temperature for an LM129 is  $150^\circ\text{C}$  and LM329 is  $100^\circ\text{C}$ . For operating at elevated temperature, devices in TO-46 package must be derated based on a thermal resistance of  $440^\circ\text{C/W}$  junction to ambient or  $80^\circ\text{C/W}$  junction to case. For the TO-92 package, the derating is based on  $180^\circ\text{C/W}$  junction to ambient with 0.4" leads from a PC board and  $160^\circ\text{C/W}$  junction to ambient with 0.125" lead length to a PC board.

**Note 3:** Refer to RETS129H for LM129 family military specifications.

**Note 4:** These changes are tested on a pulsed basis with a low duty-cycle. For changes versus temperature, compute in terms of tempco.

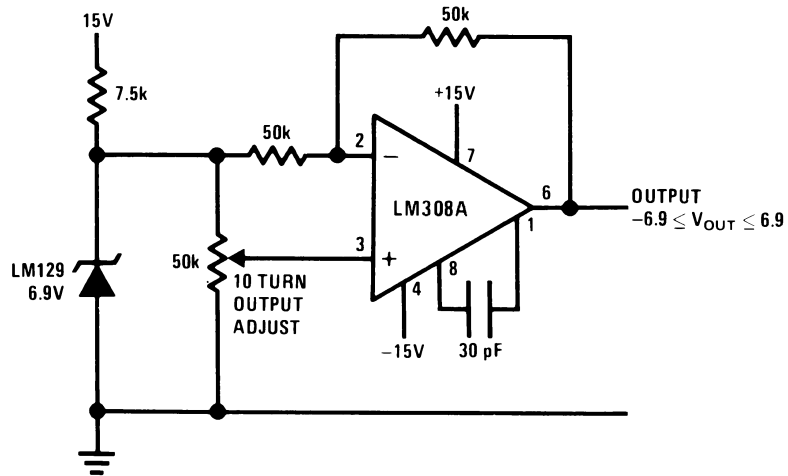
## Typical Applications

### Low Cost 0–25V Regulator



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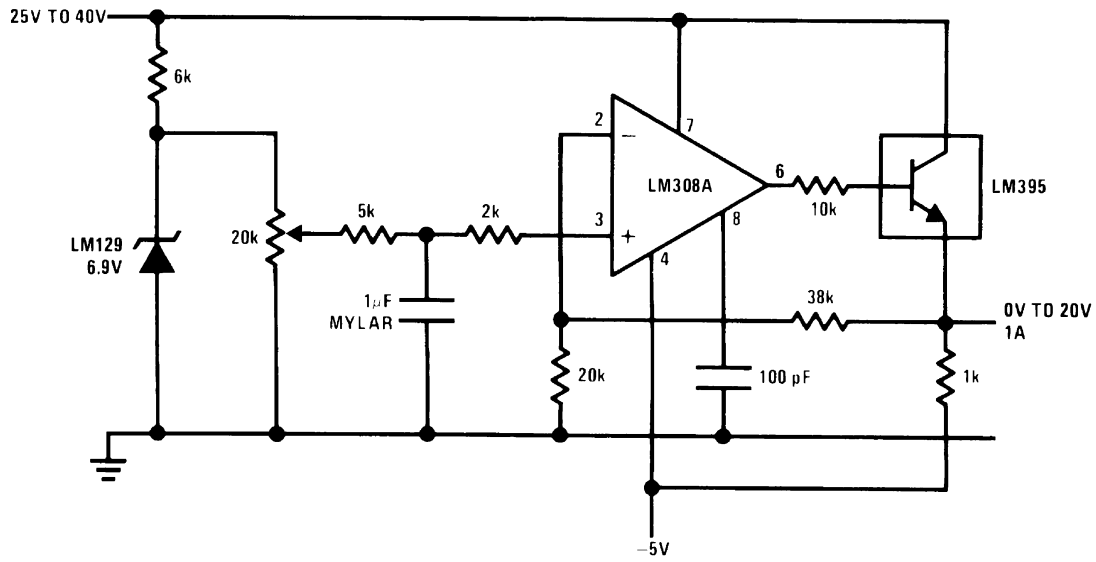
### Adjustable Bipolar Output Reference



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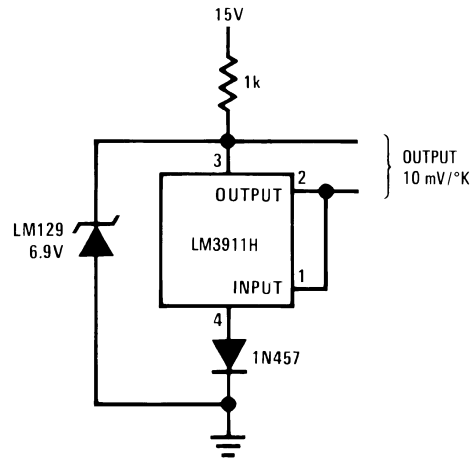
# Typical Applications (Continued)

## 0V to 20V Power Reference



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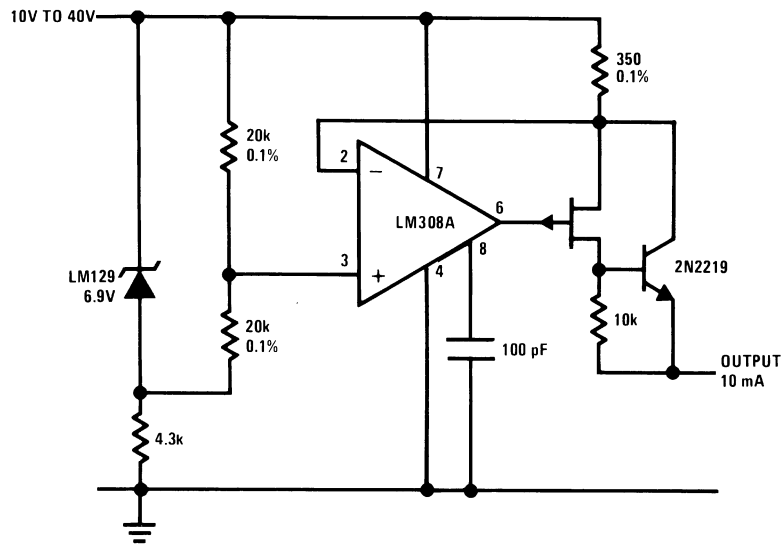
## External Reference for Temperature Transducer



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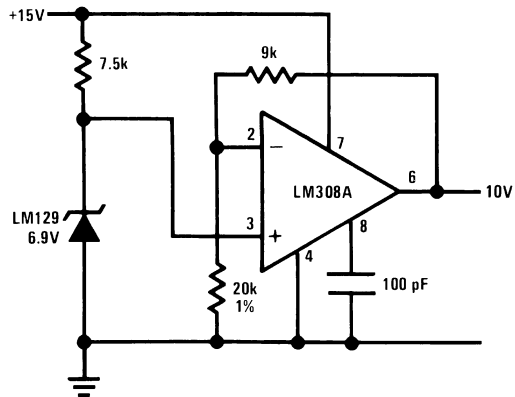
## Typical Applications (Continued)

### Positive Current Source



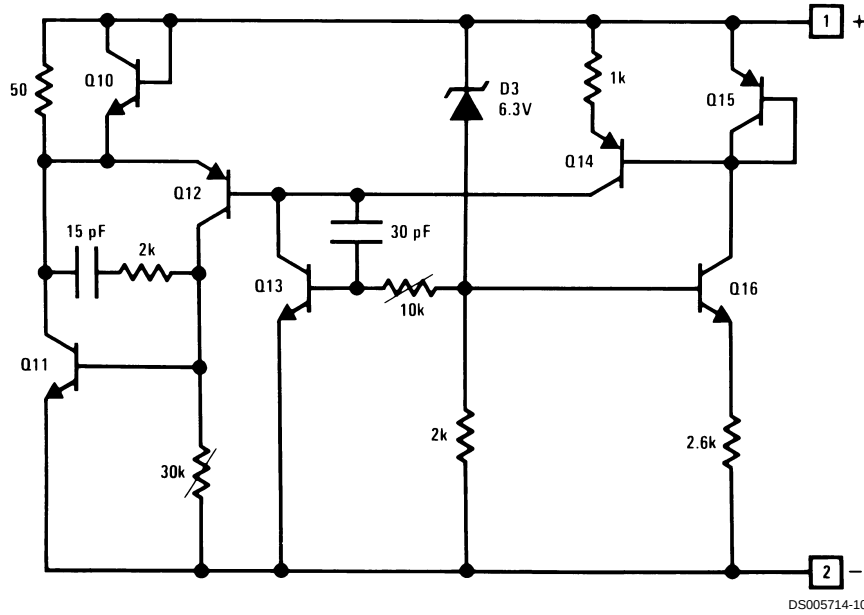
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### Buffered Reference with Single Supply



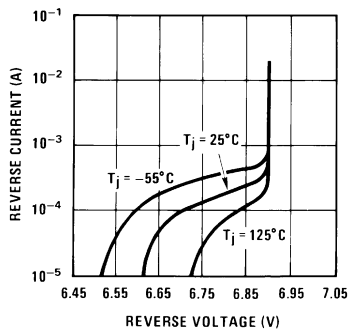
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## Schematic Diagram



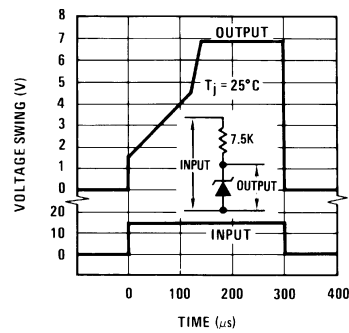
## Typical Performance Characteristics

### Reverse Characteristics



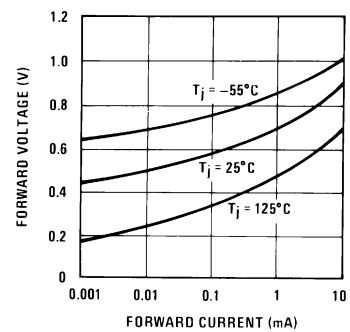
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### Response Time



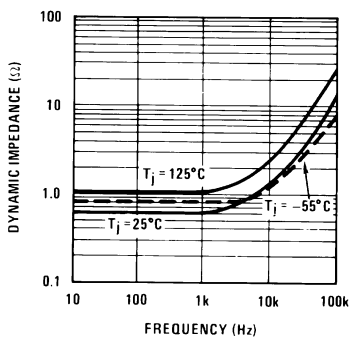
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### Forward Characteristics



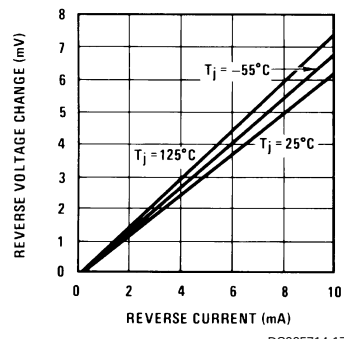
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### Dynamic Impedance



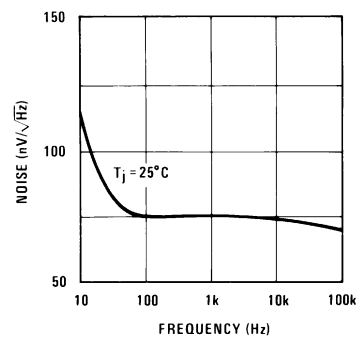
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### Reverse Voltage Change



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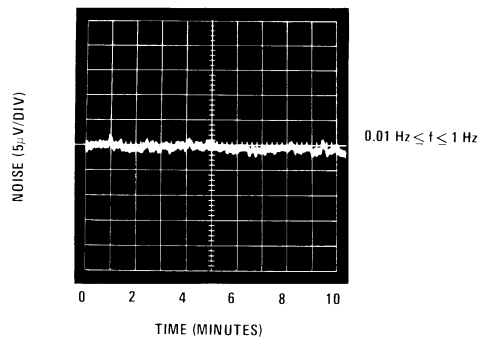
### Zener Noise Voltage



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## Typical Performance Characteristics (Continued)

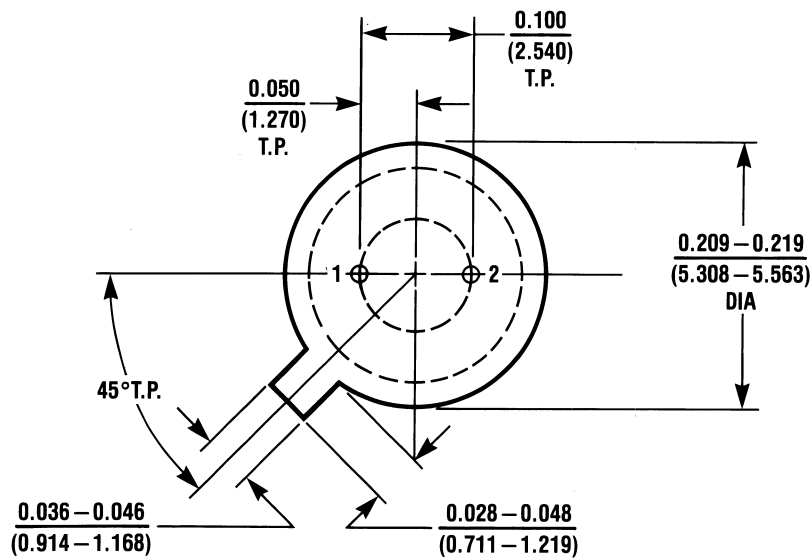
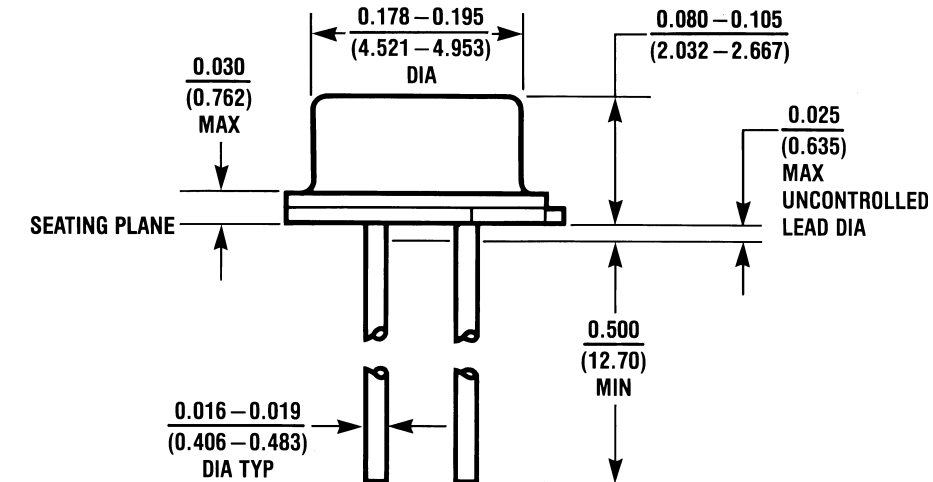
### Low Frequency Noise Voltage



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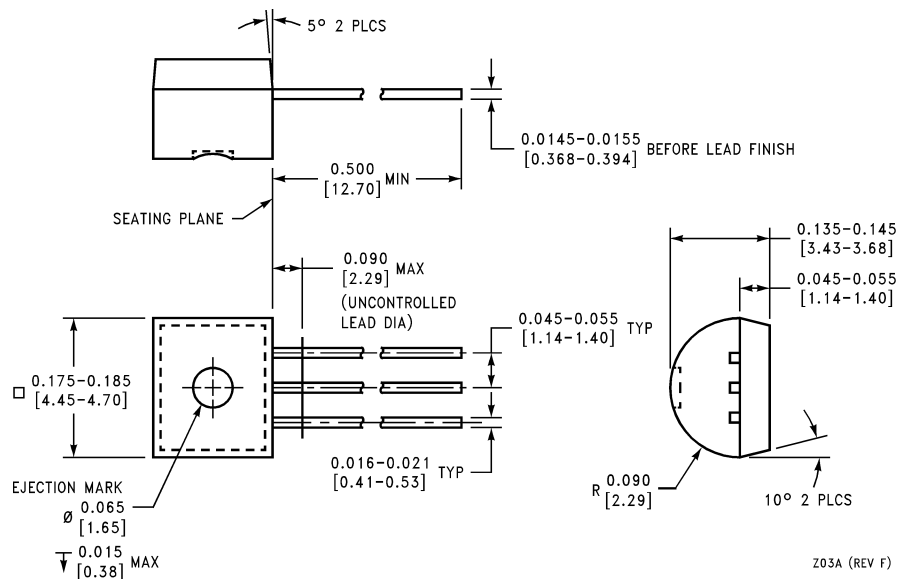
# Physical Dimensions inches (millimeters) unless otherwise noted



H02A (REV C)

**Metal Can Package**  
 Order Number LM129AH, LM129AH/883, LM129BH, LM129BH/883,  
 LM129CH, LM329AH, LM329BH, LM329CH, or LM329DH  
**NS Package H02A**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



**Plastic Package**  
**Order Number LM329BZ, LM329CZ, or LM329DZ**  
**NS Package Z03A**

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