

## FEATURES

- 6.95V Shunt Reference
- Guaranteed 0.5ppm/°C Temperature Coefficient
- Guaranteed 1Ω Maximum Dynamic Impedance
- Guaranteed 20μV<sub>RMS</sub> Maximum Noise
- Guaranteed Initial Tolerance of 2%
- Wide Operating Current Range
- Available in 4-Lead TO-46 Metal Can

## APPLICATIONS

- Precision Voltage Reference for Multimeters
- Calibration Equipment Voltage Standards
- Laboratory Measurement Equipment
- Industrial Monitor/Control Instruments
- High Accuracy Data Converters

## DESCRIPTION

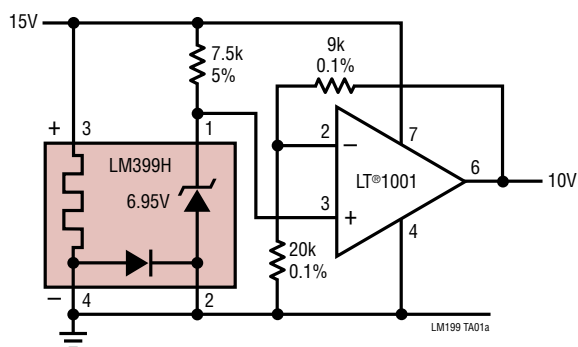
The **LM199/LM399** precision shunt reference features excellent temperature stability over a wide range of voltage, temperature and operating current conditions. A stabilizing heater is incorporated with the active Zener on a monolithic substrate which nearly eliminates changes in voltage with temperature. The subsurface Zener operates over a current range of 0.5mA to 10mA, and offers minimal noise and excellent long-term stability.

Ideal applications for the LM199/LM399 include digital voltmeters, precision calibration equipment, current sources and a variety of other precision low cost references. A 10V buffered reference application is shown below.

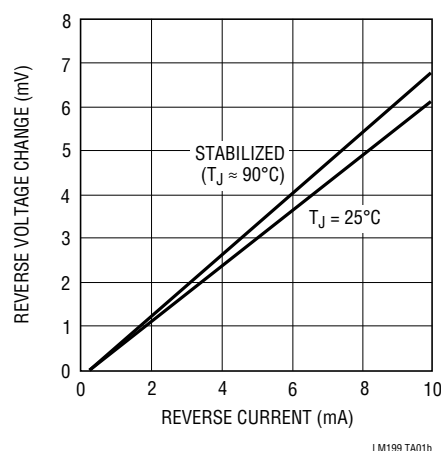
LT, LT, LTC, LTM, Linear Technology and the Linear logo are registered trademarks of Linear Technology Corporation. All other trademarks are the property of their respective owners.

## TYPICAL APPLICATION

10V Buffered Reference



Reverse Voltage Change



# LM199/LM399

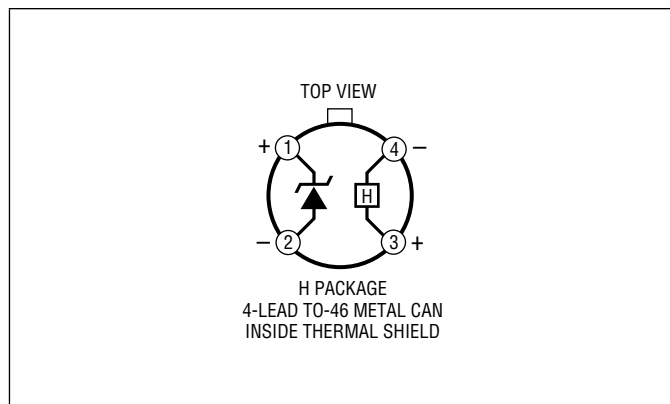
## LM199A/LM399A

### ABSOLUTE MAXIMUM RATINGS

(Note 1)

|                                                         |                |
|---------------------------------------------------------|----------------|
| Temperature Stabilizer .....                            | 40V            |
| Reverse Breakdown Current.....                          | 20mA           |
| Forward Current.....                                    | 1mA            |
| Reference to Substrate Voltage, $V_{RS}$ (Note 2) ..... | -0.1V          |
| Operating Temperature Range                             |                |
| LM199/LM199A (OBSOLETE) .....                           | -55°C to 125°C |
| LM399/LM399A .....                                      | 0°C to 70°C    |
| Storage Temperature Range                               |                |
| LM199/LM199A (OBSOLETE) .....                           | -65°C to 150°C |
| LM399/LM399A .....                                      | -65°C to 150°C |
| Lead Temperature (Soldering, 10 sec).....               | 300°C          |

### PIN CONFIGURATION



### ORDER INFORMATION

| LEAD FREE FINISH        | TAPE AND REEL    | PART MARKING | PACKAGE DESCRIPTION    | TEMPERATURE RANGE |
|-------------------------|------------------|--------------|------------------------|-------------------|
| LM399H                  | LM399H#TRPBF     | LM399H       | 4-Lead TO-46 Metal Can | 0°C to 70°C       |
| LM399AH                 | LM399AH#TRPBF    | LM399AH      | 4-Lead TO-46 Metal Can | 0°C to 70°C       |
| <b>OBSOLETE PACKAGE</b> |                  |              |                        |                   |
| LM199H                  | LM199H#TRPBF     |              | 4-Lead TO-46 Metal Can | -55°C to 125°C    |
| LM199AH                 | LM199AH#TRPBF    |              | 4-Lead TO-46 Metal Can | -55°C to 125°C    |
| LM199AH-20              | LM199AH-20#TRPBF |              | 4-Lead TO-46 Metal Can | -55°C to 125°C    |
| LM399AH-20              | LM399AH-20#TRPBF |              | 4-Lead TO-46 Metal Can | 0°C to 70°C       |
| LM399AH-50              | LM399AH-50#TRPBF |              | 4-Lead TO-46 Metal Can | 0°C to 70°C       |

Consult LTC Marketing for parts specified with wider operating temperature ranges.

Consult LTC Marketing for information on nonstandard lead based finish parts.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

For more information on tape and reel specifications, go to: <http://www.linear.com/tapeand reel/>

### ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ . (Note 3)

| SYMBOL                                  | PARAMETER                                     | CONDITIONS                                                                                                                                                   |   | LM199/LM199A |          |           | LM399/LM399A |      |     | UNITS                      |
|-----------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--------------|----------|-----------|--------------|------|-----|----------------------------|
|                                         |                                               |                                                                                                                                                              |   | MIN          | TYP      | MAX       | MIN          | TYP  | MAX |                            |
| $V_Z$                                   | Reverse Breakdown Voltage                     | $0.5\text{mA} \leq I_R \leq 10\text{mA}$                                                                                                                     | ● | 6.8          | 6.95     | 7.1       | 6.75         | 6.95 | 7.3 | V                          |
| $\Delta V_Z$                            | Reverse Breakdown Voltage Change with Current | $0.5\text{mA} \leq I_R \leq 10\text{mA}$                                                                                                                     | ● |              | 6        | 9         |              | 6    | 12  | mV                         |
| $r_Z$                                   | Reverse Dynamic Impedance                     | $I_R = 1\text{mA}$ (Note 6) ( $10\text{Hz} \leq f \leq 100\text{Hz}$ )                                                                                       | ● |              | 0.5      | 1         |              | 0.5  | 1.5 | $\Omega$                   |
| $\frac{\Delta V_Z}{\Delta \text{Temp}}$ | Temperature Coefficient LM199/LM399           | $-55^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$<br>$85^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$<br>$0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ |   |              | 0.3<br>5 | 1<br>15   |              | 0.3  | 2   | ppm/°C<br>ppm/°C<br>ppm/°C |
|                                         | LM199A/LM399A                                 | $-55^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$<br>$85^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$<br>$0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ |   |              | 0.2<br>5 | 0.5<br>10 |              | 0.3  | 1   | ppm/°C<br>ppm/°C<br>ppm/°C |
| $e_n$                                   | RMS Noise                                     | $10\text{Hz} \leq f \leq 10\text{kHz}$                                                                                                                       | ● |              | 7        | 20        |              | 7    | 50  | $\mu\text{V}$              |

199399fc

## ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ . (Note 3)

| SYMBOL                                  | PARAMETER                             | CONDITIONS                                                                                               | LM199/LM199A |           |          | LM399/LM399A |     |          | UNITS                   |
|-----------------------------------------|---------------------------------------|----------------------------------------------------------------------------------------------------------|--------------|-----------|----------|--------------|-----|----------|-------------------------|
|                                         |                                       |                                                                                                          | MIN          | TYP       | MAX      | MIN          | TYP | MAX      |                         |
| $\frac{\Delta V_Z}{\Delta \text{Time}}$ | Long-Term Stability                   | Stabilized, $22^\circ\text{C} \leq T_A \leq 28^\circ\text{C}$ , 1000 Hours, $I_R = 1\text{mA} \pm 0.1\%$ |              | 8         | (Note 4) |              | 8   | (Note 4) | ppm/ $\sqrt{\text{kH}}$ |
| $I_H$                                   | Temperature Stabilizer Supply Current | $T_A = 25^\circ\text{C}$ , Still Air, $V_H = 30\text{V}$<br>$T_A = -55^\circ\text{C}$ (Note 5)           |              | 8.5<br>22 | 14<br>28 |              | 8.5 | 15       | mA                      |
| $V_H$                                   | Temperature Stabilizer Supply Voltage | ●                                                                                                        | 9            |           | 40       | 9            |     | 40       | V                       |
|                                         | Warm-Up Time to $\pm 0.05\% V_Z$      | $V_H = 30\text{V}$                                                                                       |              | 3         |          |              | 3   |          | Seconds                 |
|                                         | Initial Turn-On Current               | $9\text{V} \leq V_H \leq 40\text{V}$ (Note 5)                                                            |              | 140       | 200      |              | 140 | 200      | mA                      |

**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

**Note 2:** The substrate is electrically connected to the negative terminal of the temperature stabilizer. The voltage that can be applied to either terminal of the reference is 40V more positive or 0.1V more negative than the substrate.

**Note 3:** These specifications apply for 30V applied to the temperature stabilizer and  $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$  for the LM199; and  $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$  for the LM399.

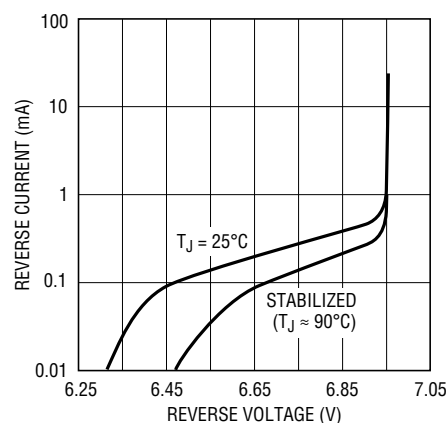
**Note 4:** Devices with maximum guaranteed long-term stability of 20ppm/ $\sqrt{\text{kH}}$  are available. Drift decreases with time.

**Note 5:** This initial current can be reduced by adding an appropriate resistor and capacitor to the heater circuit. See the Typical Performance Characteristics graphs to determine values.

**Note 6:** Guaranteed by "Reverse Breakdown Change with Current."

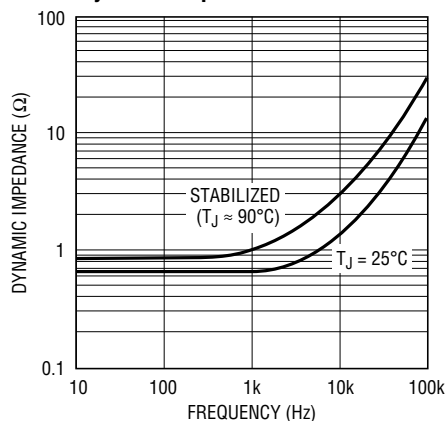
## TYPICAL PERFORMANCE CHARACTERISTICS

Reverse Characteristics



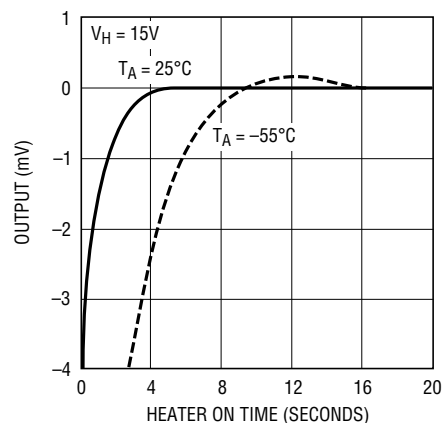
LM199 G01

Dynamic Impedance



LM199 G02

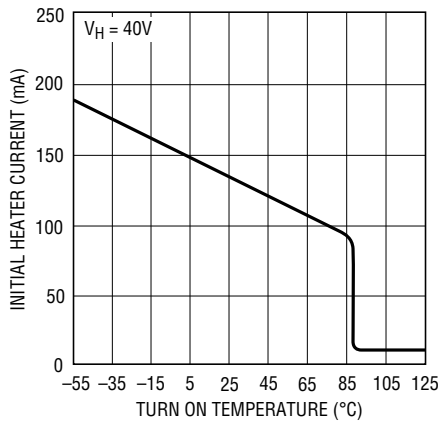
Stabilization Time



LM199 G03

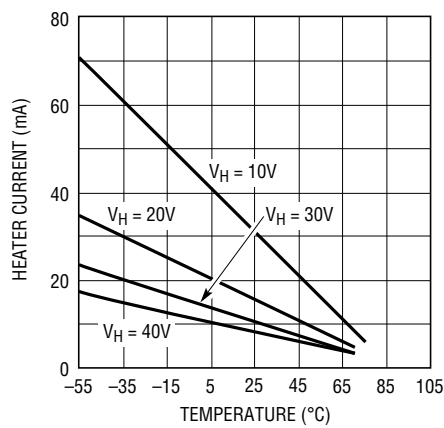
## TYPICAL PERFORMANCE CHARACTERISTICS

Initial Heater Current



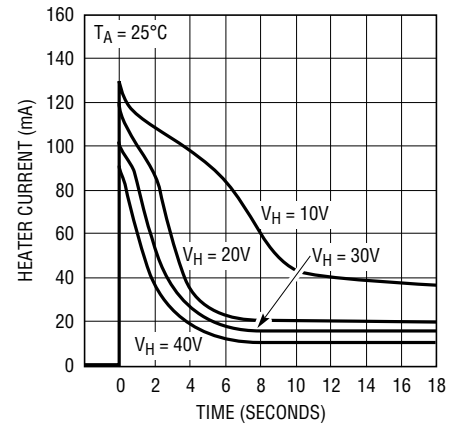
LM199 G04

Heater Current



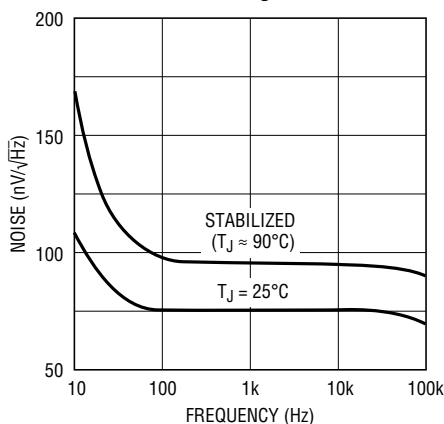
LM199 G05

Heater Current



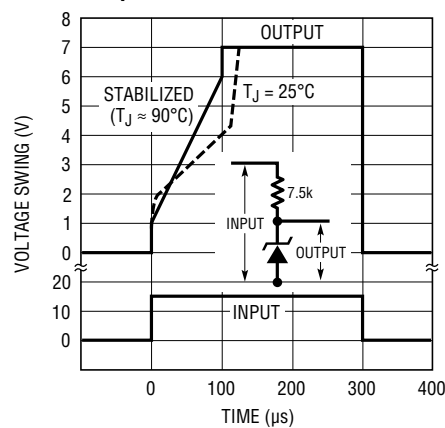
LM199 G06

Zener Noise Voltage



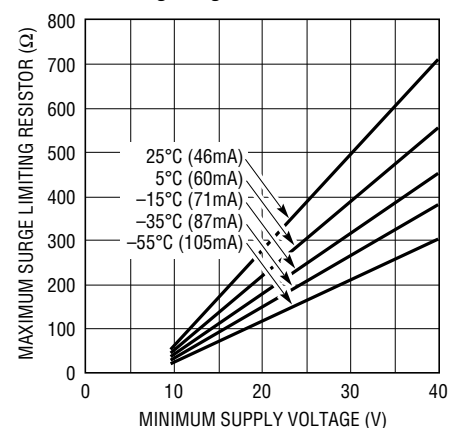
LM199 G07

Response Time



LM199 G08

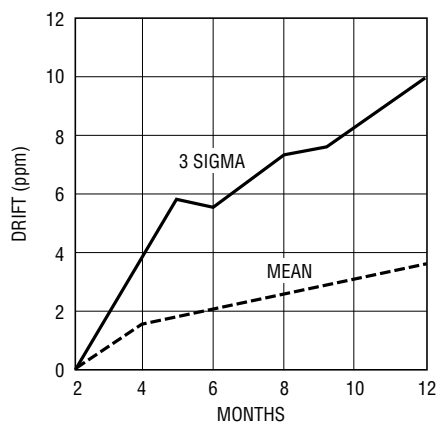
Limiting Surge Current



HEATER MUST BE BYPASSED WITH A  $2\mu F$  OR LARGER TANTALUM CAPACITOR IF RESISTORS ARE USED

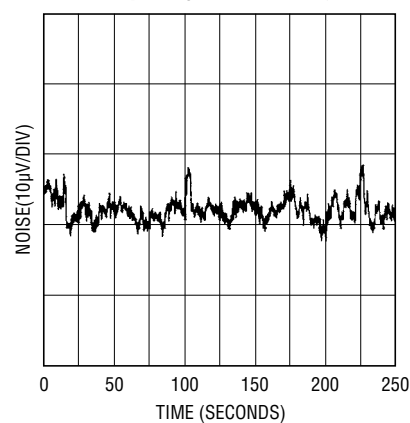
LM199 G09

Long-Term Reference Performance, 44 Units Tested



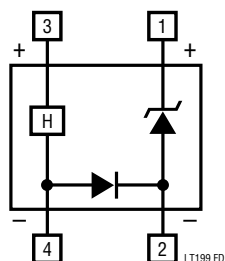
LM199 G10

Low Frequency Noise Voltage



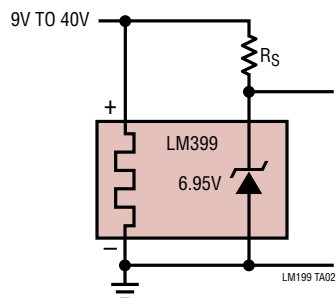
LM199 G11

## FUNCTIONAL BLOCK DIAGRAM

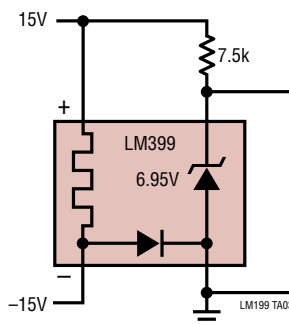


## TYPICAL APPLICATIONS

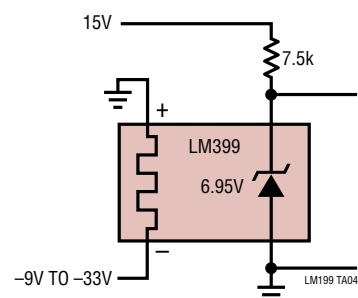
Single Supply Operation



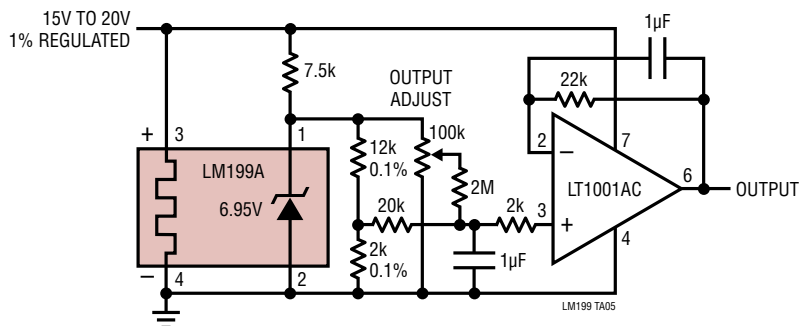
Split Supply Operation



Negative Heater Supply with Positive Reference

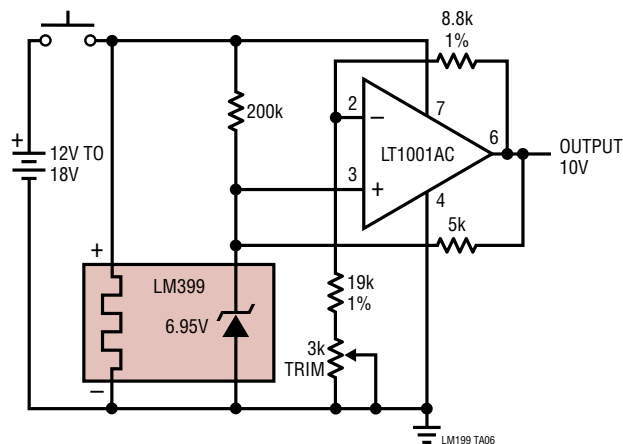


Standard Cell Replacement



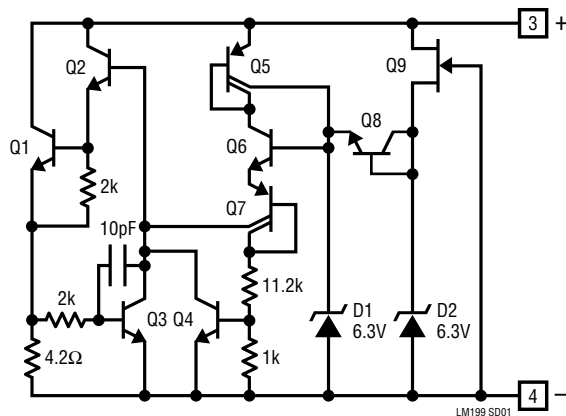
TYPICAL APPLICATIONS

Portable Calibrator

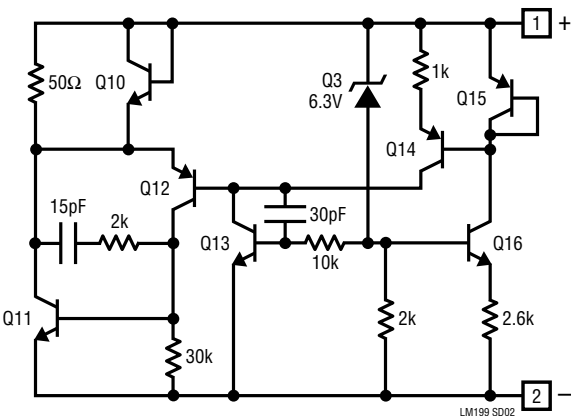


SCHEMATIC DIAGRAMS

Temperature Stabilizer



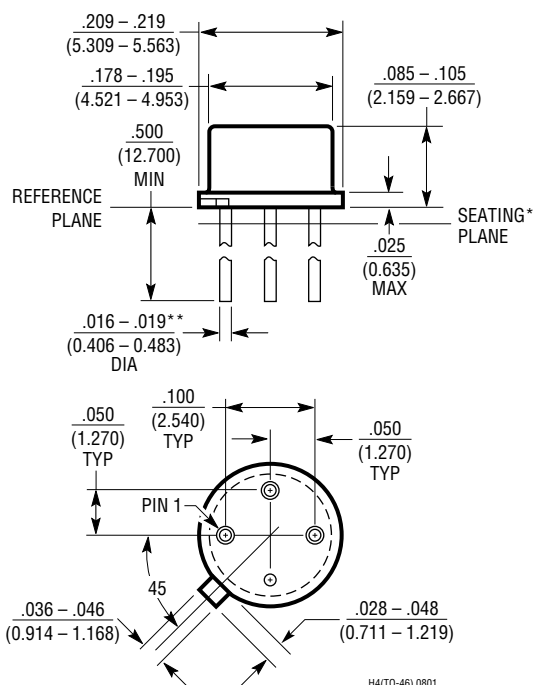
Reference



## PACKAGE DESCRIPTION

Please refer to <http://www.linear.com/designtools/packaging/> for the most recent package drawings.

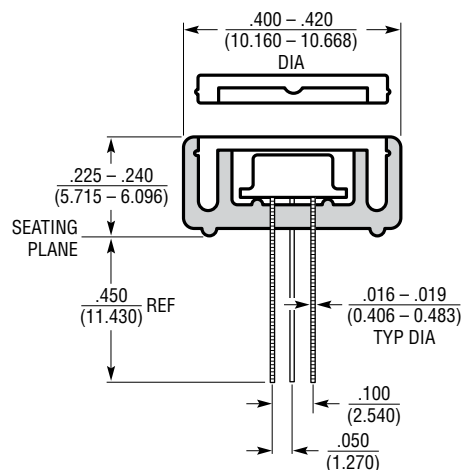
**H Package**  
**4-Lead TO-46 Metal Can**  
(Reference LTC DWG # 05-08-1341)



\* LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE AND .050" BELOW THE REFERENCE PLANE

\*\* FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS  $\frac{.016 - .024}{(0.406 - 0.610)}$

**Thermal Shield\* for TO-46, H Package**



\*THERMAL SHIELD MATERIAL IS VALOX

## REVISION HISTORY (Revision history begins at Rev C)

| REV | DATE  | DESCRIPTION                         | PAGE NUMBER |
|-----|-------|-------------------------------------|-------------|
| C   | 12/14 | Package/Order Information updated   | 2           |
|     |       | Thermal shield dimensions corrected | 7           |

# LM199/LM399

## LM199A/LM399A

---

### RELATED PARTS

| PART NUMBER                        | DESCRIPTION                                        | COMMENTS                                 |
|------------------------------------|----------------------------------------------------|------------------------------------------|
| <a href="#">LT<sup>®</sup>1021</a> | Precision References for Series or Shunt Operation | Industry Standard Pinout, -40°C to 125°C |
| <a href="#">LT1389</a>             | 1.25V, 2.5V, 4V and 5V Nanopower Shunt Reference   | 800nA, 0.05% Accuracy, 10ppm/°C Drift    |
| <a href="#">LT1634</a>             | 1.25 and 2.5V Micropower Shunt Reference           | 0.05%, 10ppm/°C, 10μA Current            |
| <a href="#">LTZ1000</a>            | 7V Ultra Precision, Stable Shunt Reference         | 0.05ppm/°C, 1.2mV <sub>P-P</sub> Noise   |

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А