

## 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

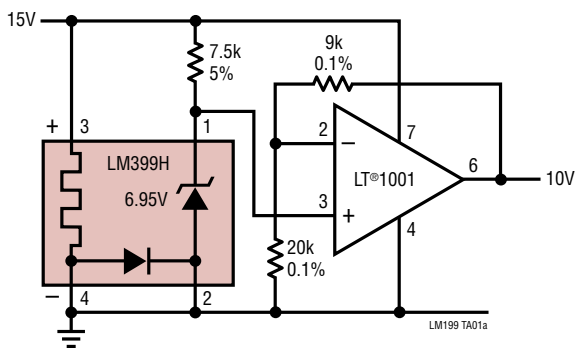
The **LM199/LM399** precision shunt reference features excellent temperature stability over a wide range of voltage, temperature and operating current conditions. A stabilizing heater is incorporated with the active Zener on a monolithic substrate which nearly eliminates changes in voltage with temperature. 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.

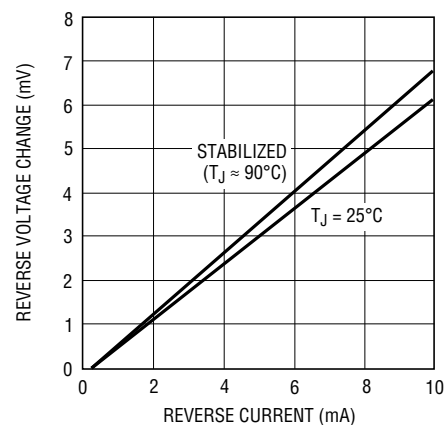
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## TYPICAL APPLICATION

10V Buffered Reference



Reverse Voltage Change



# LM199/LM399

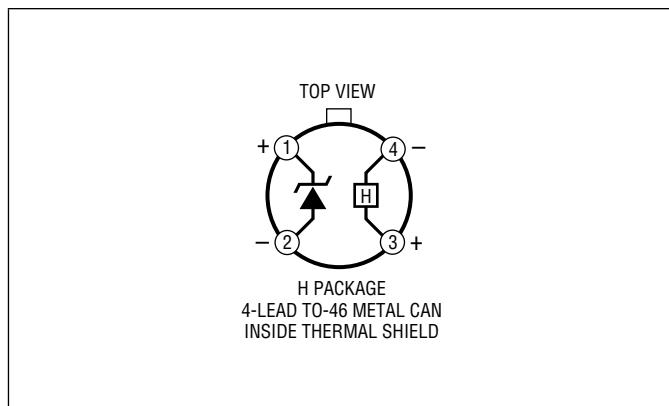
# LM199A/LM399A

## 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
OBSOLETE PACKAGE				
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/tapeandreel/>

## 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	$-55^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$			0.3	1				ppm/°C
		$85^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$			5	15				ppm/°C
	LM199A/LM399A	$-55^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$			0.2	0.5				ppm/°C
		$85^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$			5	10				ppm/°C
		$0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$					0.3	2		ppm/°C
$e_n$	RMS Noise	$10\text{Hz} \leq f \leq 10\text{kHz}$	●		7	20		7	50	$\mu\text{V}$

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**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, $V_H = 30\text{V}$ $T_A = -55^\circ\text{C}$ (Note 5)		8.5 22	14 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.

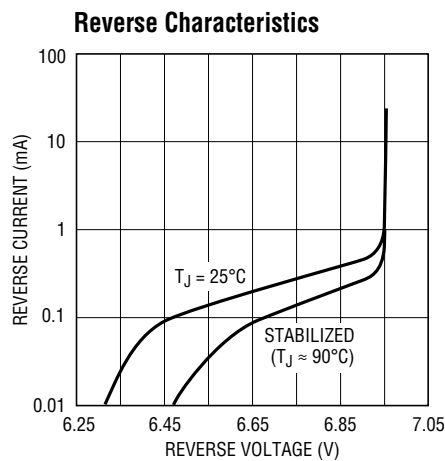
**Note 3:** These specifications apply for 30V applied to the temperature stabilizer and  $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$  for the LM199; and  $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$  for the LM399.

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

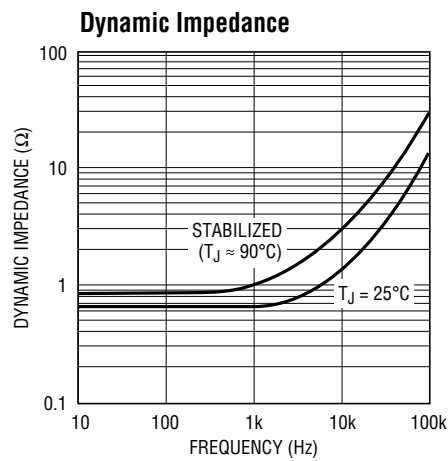
**Note 5:** This initial current can be reduced by adding an appropriate resistor and capacitor to the heater circuit. See the Typical Performance Characteristics graphs to determine values.

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

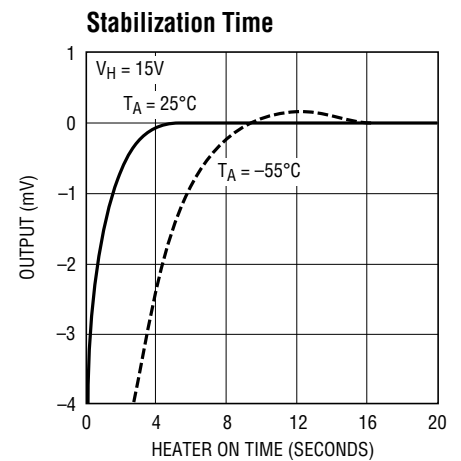
**TYPICAL PERFORMANCE CHARACTERISTICS**



LM199 G01

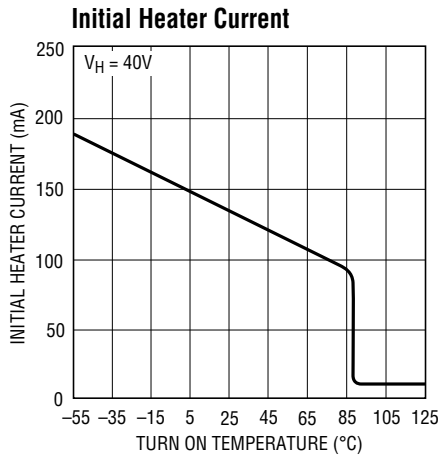


LM199 G02

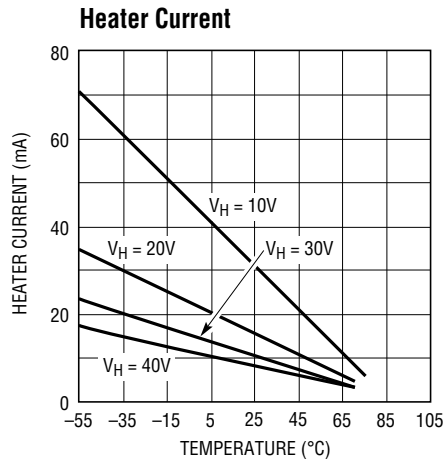


LM199 G03

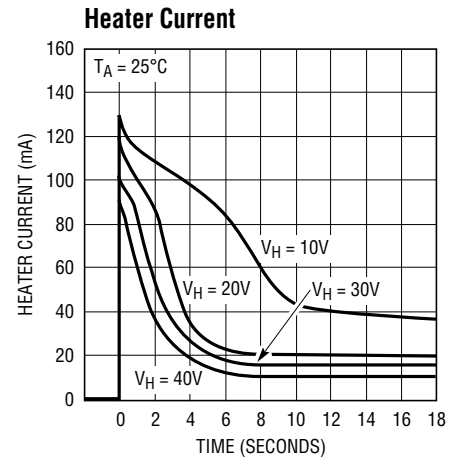
## TYPICAL PERFORMANCE CHARACTERISTICS



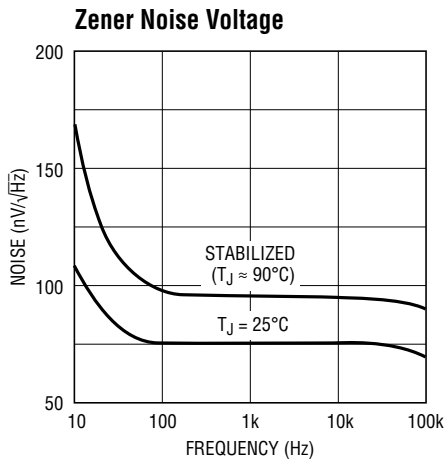
LM199 G04



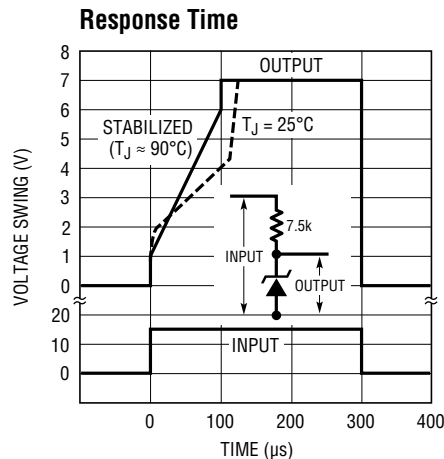
LM199 G05



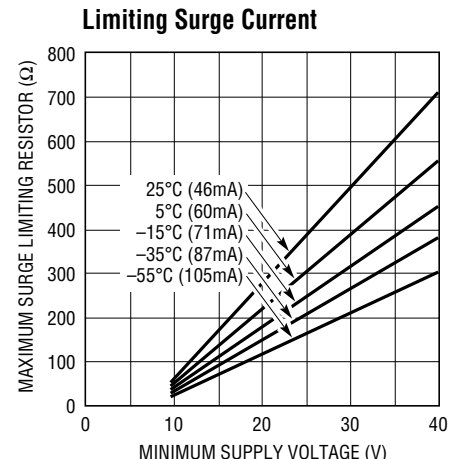
LM199 G06



LM199 G07

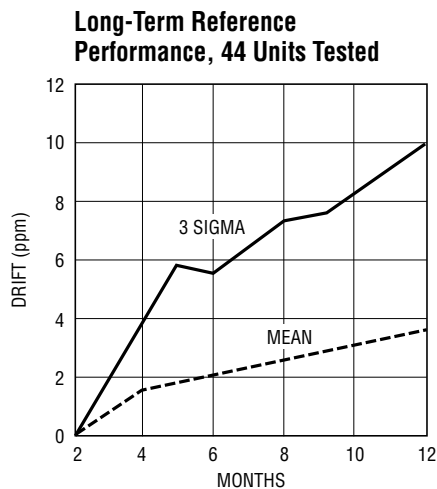


LM199 G08

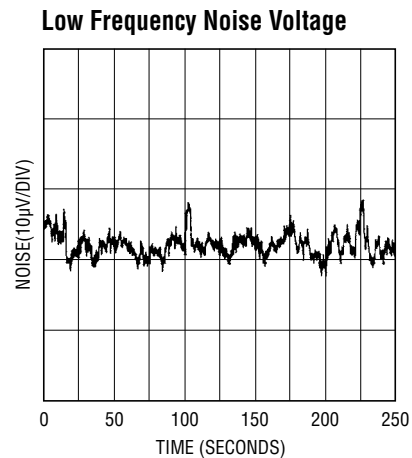


HEATER MUST BE BYPASSED WITH A 2μF OR LARGER TANTALUM CAPACITOR IF RESISTORS ARE USED

LM199 G09

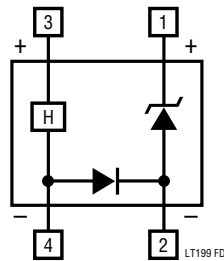


LM199 G10



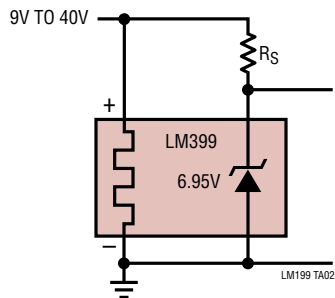
LM199 G11

## FUNCTIONAL BLOCK DIAGRAM

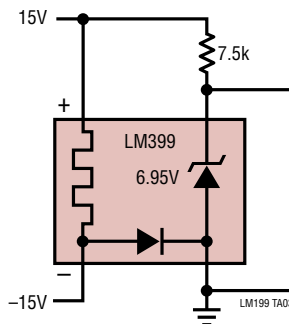


## TYPICAL APPLICATIONS

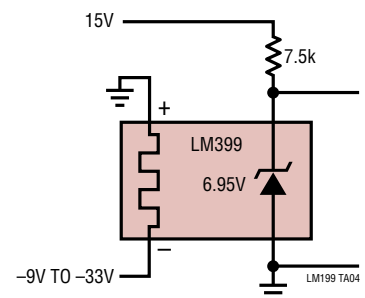
Single Supply Operation



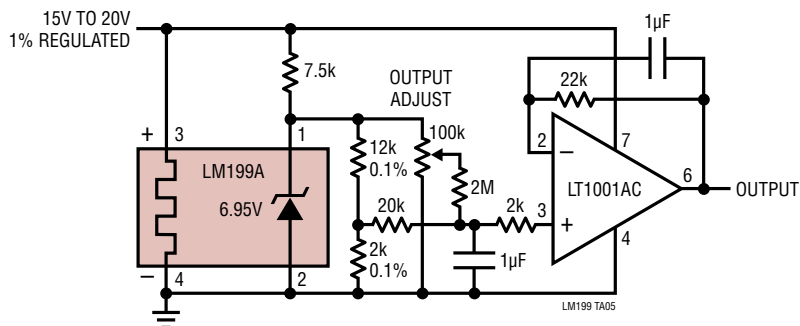
Split Supply Operation



Negative Heater Supply with Positive Reference

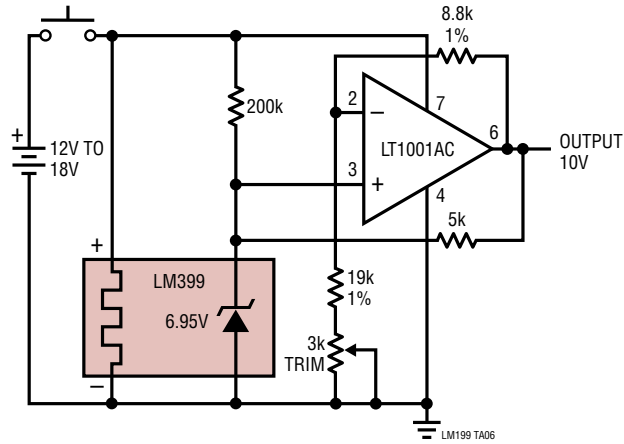


Standard Cell Replacement



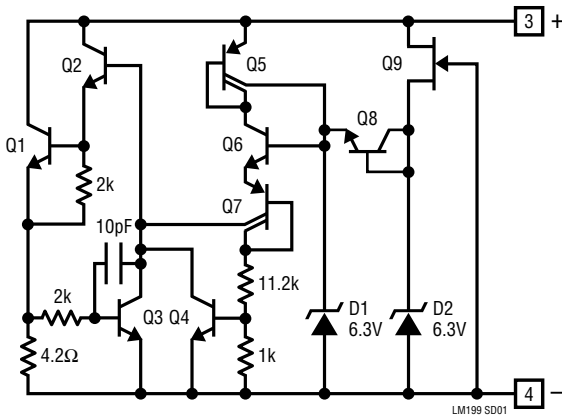
## TYPICAL APPLICATIONS

Portable Calibrator

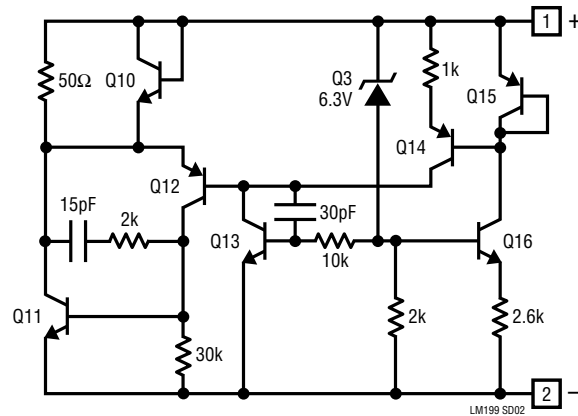


## SCHEMATIC DIAGRAMS

Temperature Stabilizer



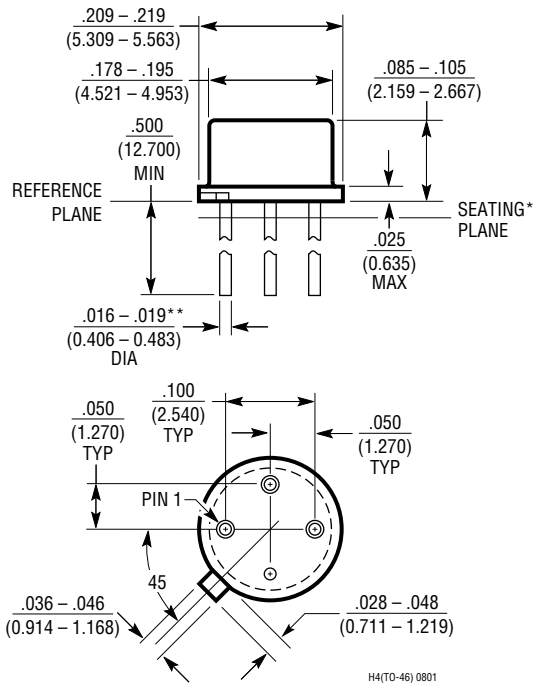
Reference



## PACKAGE DESCRIPTION

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

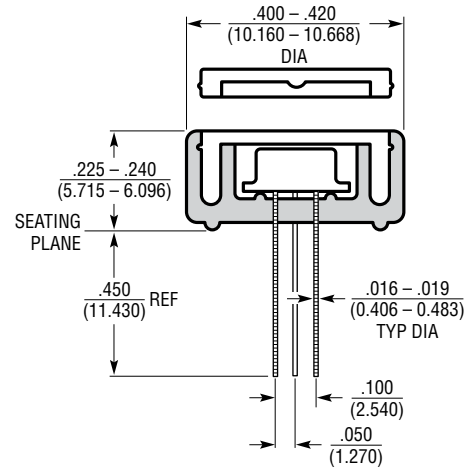
**H Package**  
**4-Lead TO-46 Metal Can**  
(Reference LTC DWG # 05-08-1341)



\*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

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### 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