

FEATURES

- 6.95V Shunt Reference
- Guaranteed 0.5ppm/°C Temperature Coefficient
- Guaranteed 1Ω Maximum Dynamic Impedance
- Guaranteed 20μV_{RMS} 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

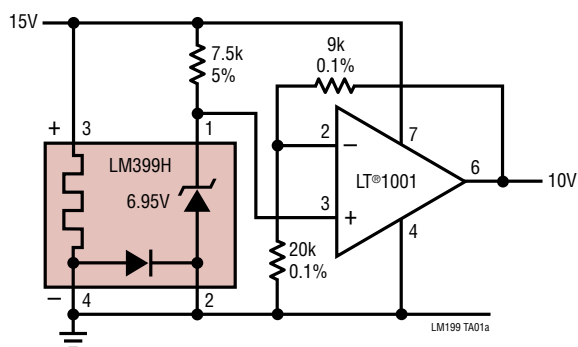
The **LM199/LM399** precision shunt reference features excellent temperature stability over a wide range of voltage, temperature and operating current conditions. A stabilizing heater is incorporated with the active Zener on a monolithic substrate which nearly eliminates changes in voltage with temperature.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

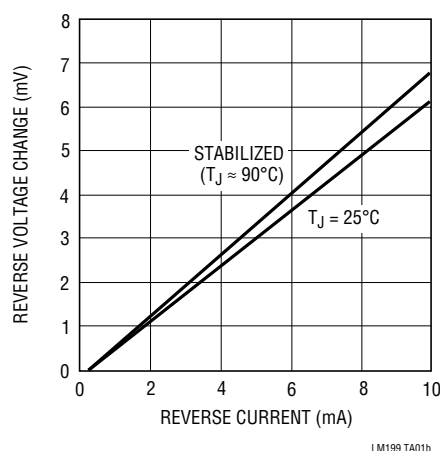
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TYPICAL APPLICATION

10V Buffered Reference



Reverse Voltage Change



LM199/LM399

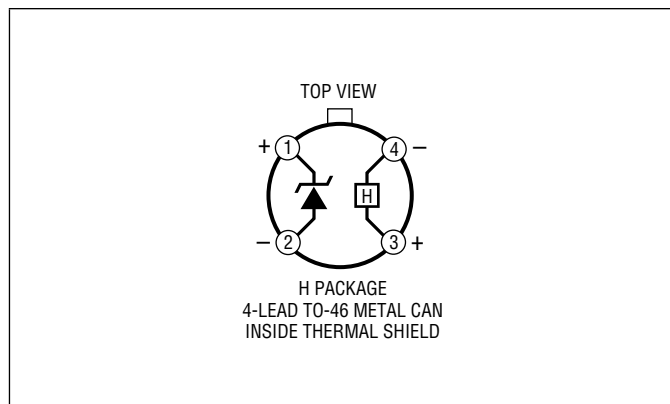
LM199A/LM399A

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
ΔV_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	Ω
$\frac{\Delta V_Z}{\Delta \text{Temp}}$	Temperature Coefficient LM199/LM399	$-55^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$ $85^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$			0.3 5	1 15		0.3	2	ppm/°C ppm/°C ppm/°C
	LM199A/LM399A	$-55^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$ $85^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$			0.2 5	0.5 10		0.3	1	ppm/°C ppm/°C ppm/°C
e_n	RMS Noise	$10\text{Hz} \leq f \leq 10\text{kHz}$	●		7	20		7	50	μV

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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.

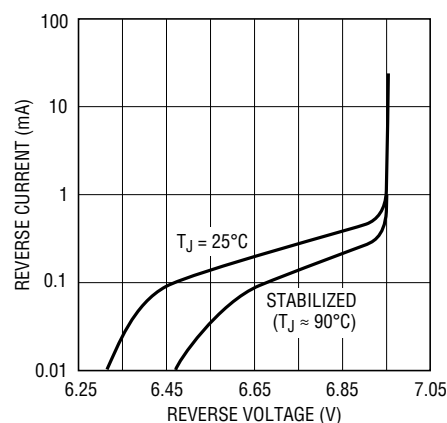
Note 4: Devices with maximum guaranteed long-term stability of 20ppm/ $\sqrt{\text{kH}}$ are available. Drift decreases with time.

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."

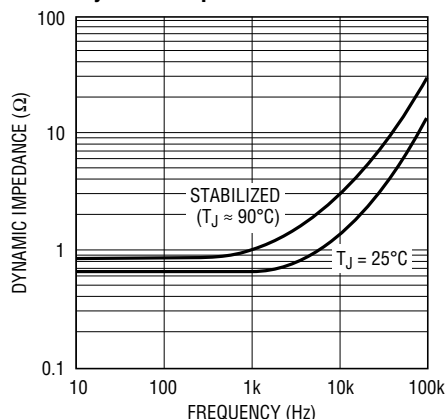
TYPICAL PERFORMANCE CHARACTERISTICS

Reverse Characteristics



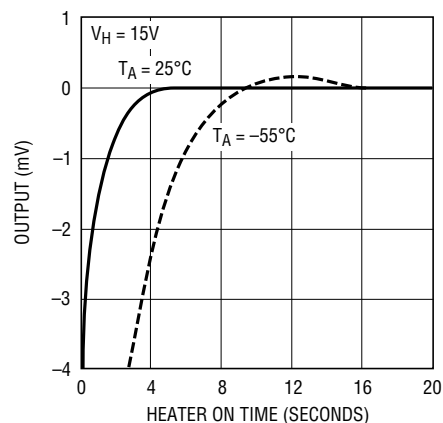
LM199 G01

Dynamic Impedance



LM199 G02

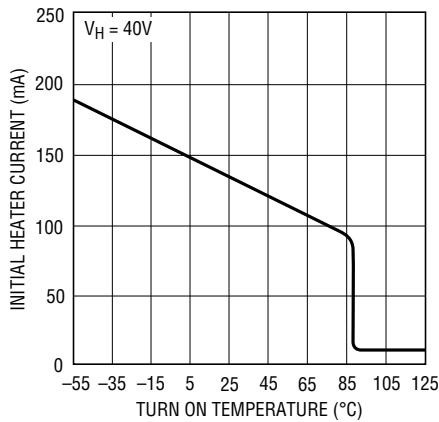
Stabilization Time



LM199 G03

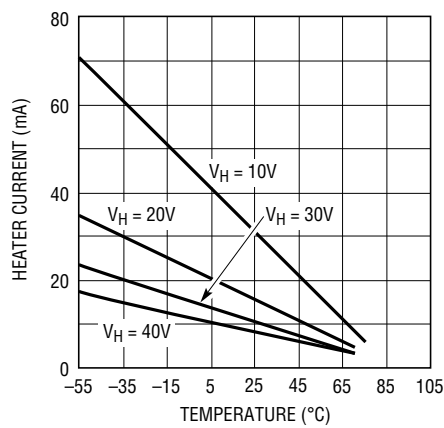
TYPICAL PERFORMANCE CHARACTERISTICS

Initial Heater Current



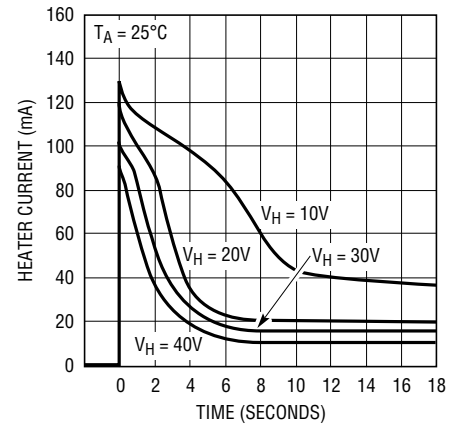
LM199 G04

Heater Current



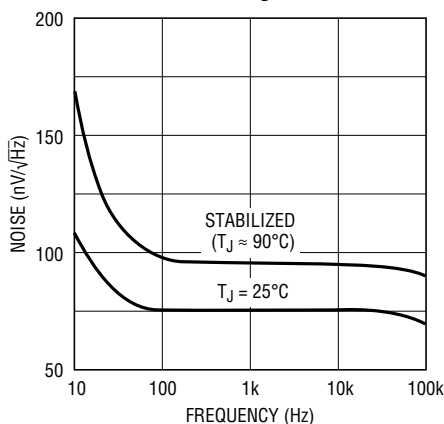
LM199 G05

Heater Current



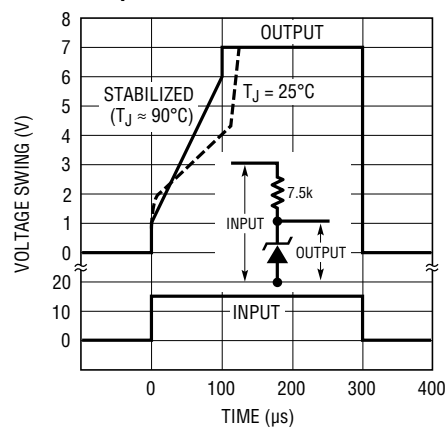
LM199 G06

Zener Noise Voltage



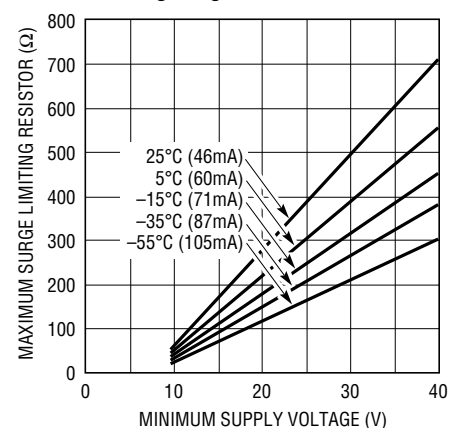
LM199 G07

Response Time



LM199 G08

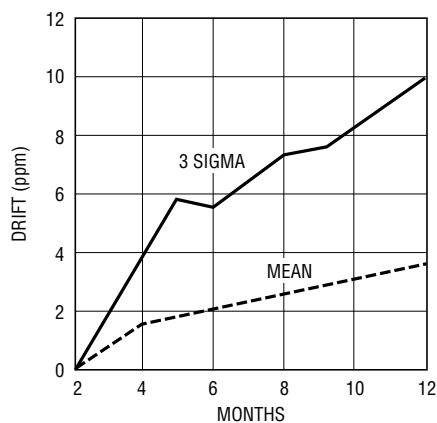
Limiting Surge Current



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

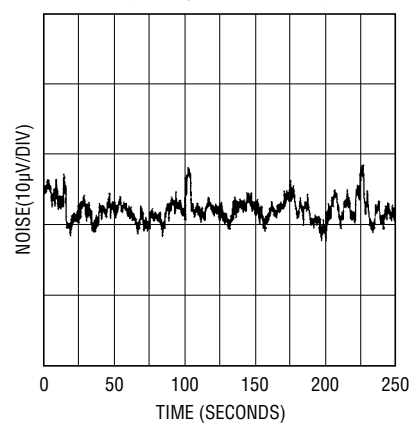
LM199 G09

Long-Term Reference Performance, 44 Units Tested



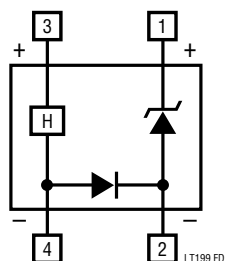
LM199 G10

Low Frequency Noise Voltage



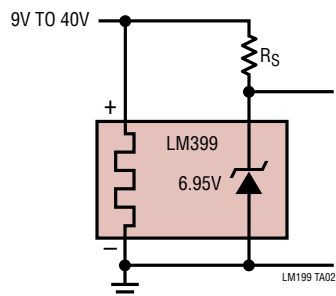
LM199 G11

FUNCTIONAL BLOCK DIAGRAM

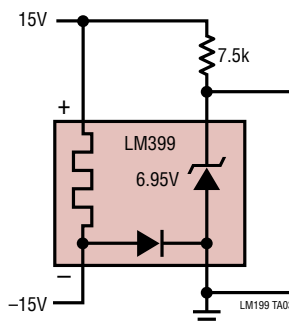


TYPICAL APPLICATIONS

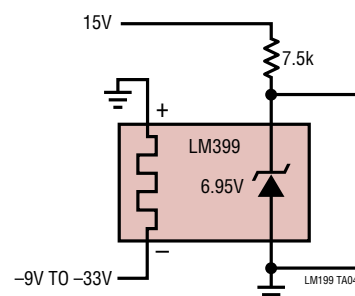
Single Supply Operation



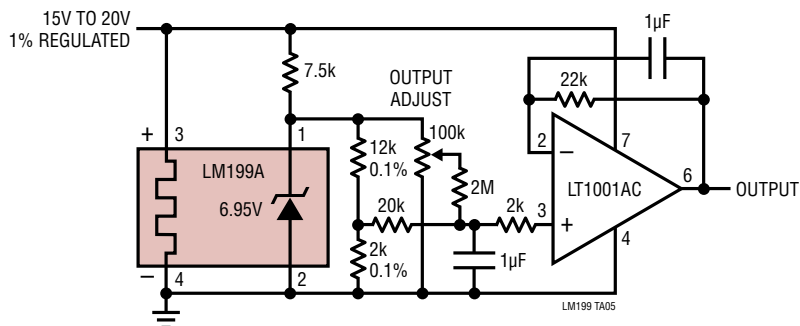
Split Supply Operation



Negative Heater Supply with Positive Reference



Standard Cell Replacement



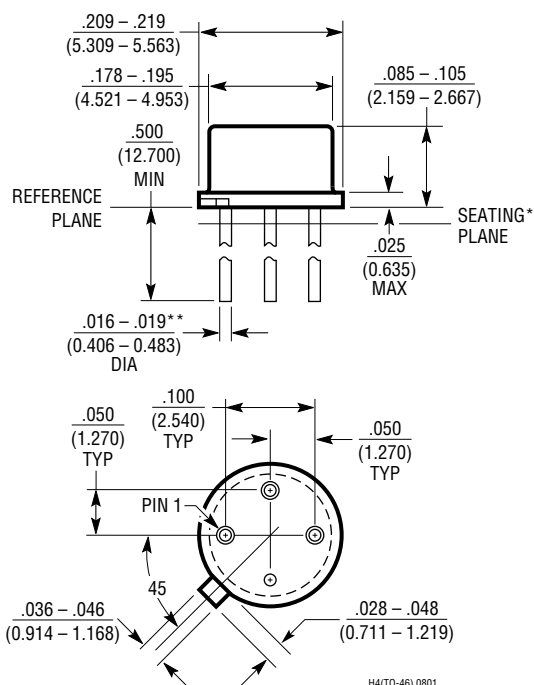
The diagram shows a precision 10V reference circuit. A 12V to 18V supply is connected to the circuit. The LM399 is configured as a precision centrabuck, with its output set to 6.95V. This output is connected to the non-inverting input (pin 3) of the LT1001AC. The inverting input (pin 2) is connected to the 6.95V output through a 200k resistor. The output of the LT1001AC (pin 6) is connected to the 6.95V output through an 8.8k 1% resistor. The output of the LT1001AC is also connected to the 6.95V output through a 5k resistor. The output of the LT1001AC is labeled 'OUTPUT 10V'. A 19k 1% resistor and a 3k TRIM potentiometer are connected between the output of the LT1001AC and the 6.95V output. The LM399 is labeled 'LM399 6.95V'.

The circuit diagram shows the internal components of the LM199 SDO2 oscillator. It includes several transistors labeled Q10 through Q16, a diode Q3 with a forward voltage of 6.3V, and various passive components: resistors of 50Ω, 1k, 2k, 2.6k, 30k, and 10k; capacitors of 15pF and 30pF. The circuit is powered by a 5V supply at pin 1 and ground at pin 2.

PACKAGE DESCRIPTION

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

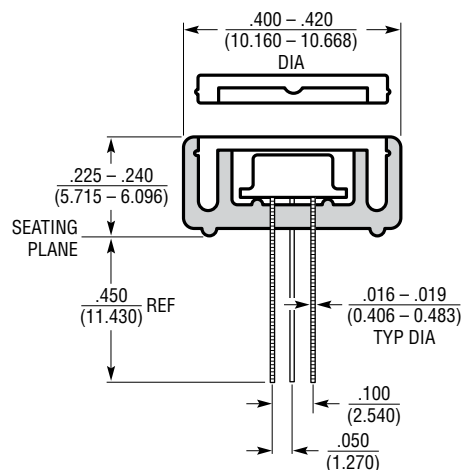
H Package
4-Lead TO-46 Metal Can
(Reference LTC DWG # 05-08-1341)



*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
LT®1021	Precision References for Series or Shunt Operation	Industry Standard Pinout, -40°C to 125°C
LT1389	1.25V, 2.5V, 4V and 5V Nanopower Shunt Reference	800nA, 0.05% Accuracy, 10ppm/°C Drift
LT1634	1.25 and 2.5V Micropower Shunt Reference	0.05%, 10ppm/°C, 10µA Current
LTZ1000	7V Ultra Precision, Stable Shunt Reference	0.05ppm/°C, 1.2mV _{P-P} Noise