Precision Reference

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

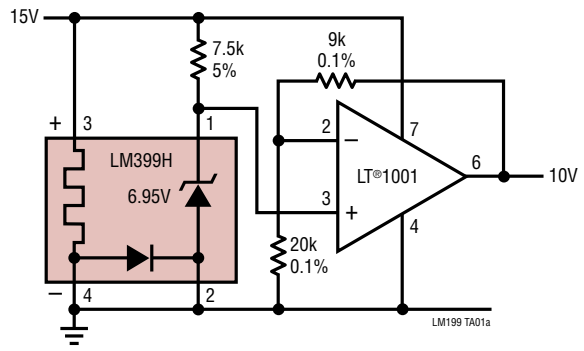
The LM199/LM399 precision shunt reference features excellent temperature stability over a wide range of voltage, temperature and operating current conditions. A stabilizing heater is incorporated with the active Zener on a monolithic substrate which nearly eliminates changes in voltage with temperature.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

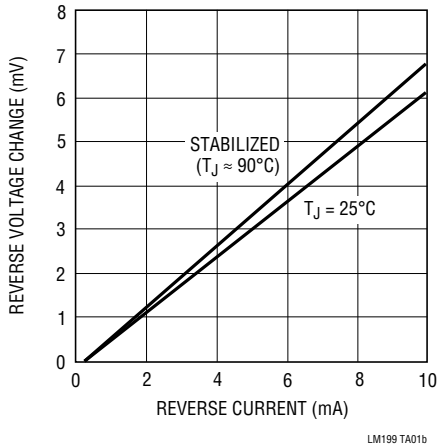
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TYPICAL APPLICATION

10V Buffered Reference



Reverse Voltage Change

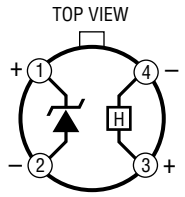


ABSOLUTE MAXIMUM RATINGS

(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



H PACKAGE
4-LEAD TO-46 METAL CAN
INSIDE THERMAL SHIELD

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°C. (Note 3)

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

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. (Note 3)

SYMBOL	PARAMETER	CONDITIONS		LM199/LM199A MIN	LM199/LM199A TYP	LM199/LM199A MAX	LM399/LM399A MIN	LM399/LM399A TYP	LM399/LM399A MAX	UNITS
$\frac{\Delta V_Z}{\Delta Time}$	Long-Term Stability	Stabilized, 22°C ≤ T_A ≤ 28°C, 1000 Hours, I_R = 1mA ±0.1%			8	(Note 4)		8	(Note 4)	ppm/$\sqrt{kH}$
I_H	Temperature Stabilizer Supply Current	T_A = 25°C, Still Air, V_H = 30V T_A = –55°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 ±0.05% V_Z	V_H = 30V			3			3		Seconds
	Initial Turn-On Current	9V ≤ V_H ≤ 40V (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°C ≤ T_A ≤ 125°C for the LM199; and 0°C ≤ T_A ≤ 70°C for the LM399.

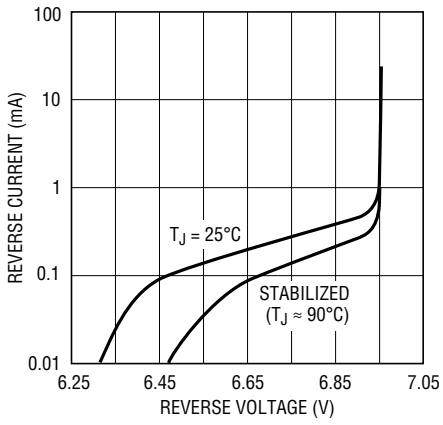
Note 4: Devices with maximum guaranteed long-term stability of 20ppm/$\sqrt{kH}$ are available. Drift decreases with time.

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.

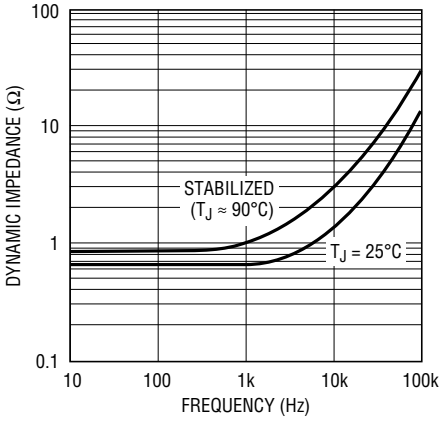
Note 6: Guaranteed by "Reverse Breakdown Change with Current."

TYPICAL PERFORMANCE CHARACTERISTICS

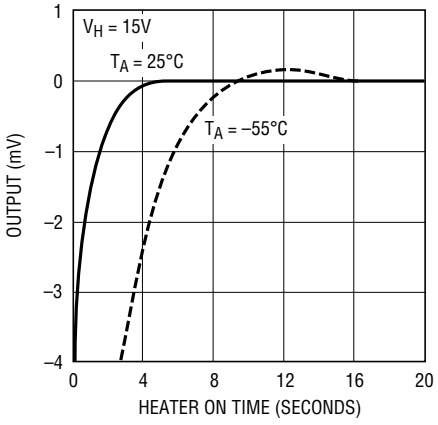
Reverse Characteristics



Dynamic Impedance

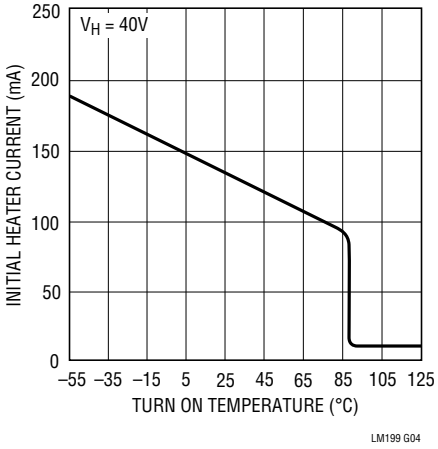


Stabilization Time



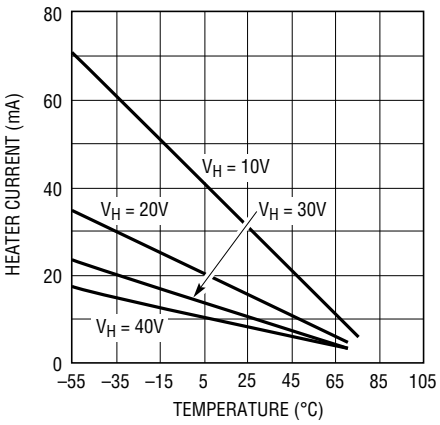
TYPICAL PERFORMANCE CHARACTERISTICS

Initial Heater Current



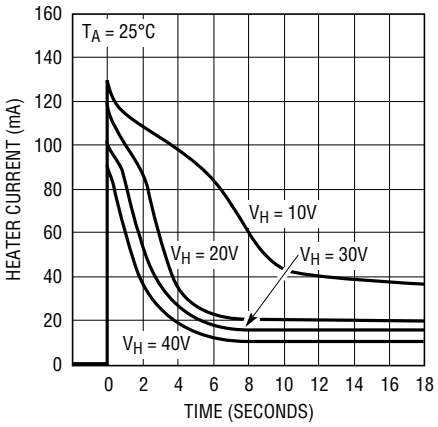
LM199 G04

Heater Current



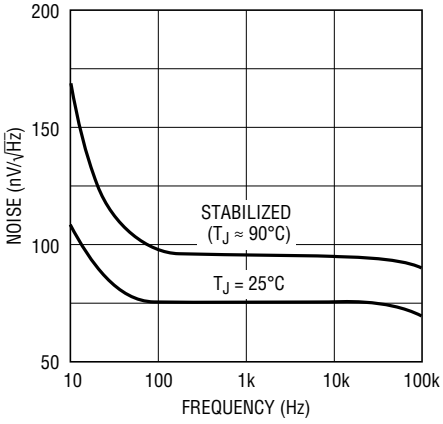
LM199 G05

Heater Current



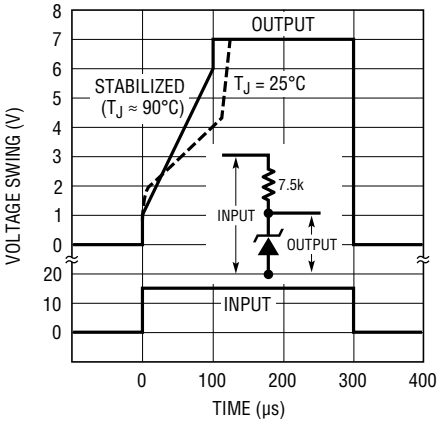
LM199 G06

Zener Noise Voltage



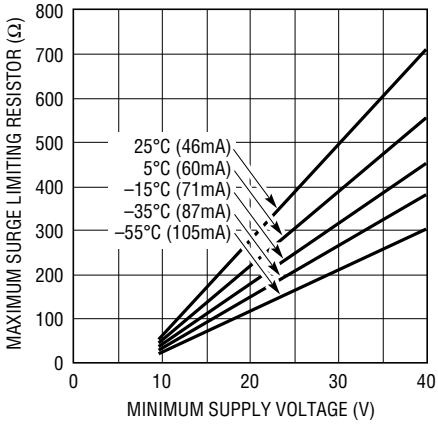
LM199 G07

Response Time



LM199 G08

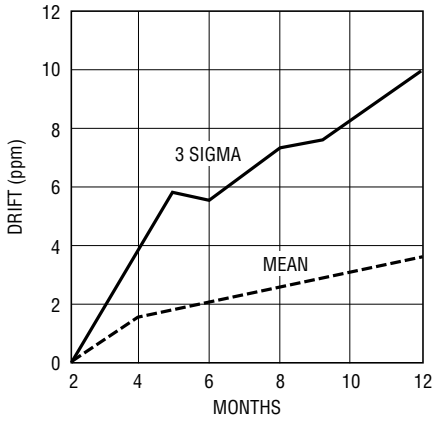
Limiting Surge Current



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

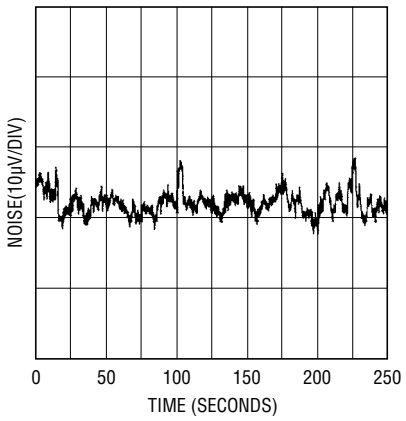
LM199 G09

Long-Term Reference Performance, 44 Units Tested



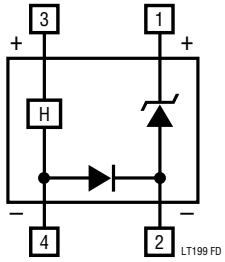
LM199 G10

Low Frequency Noise Voltage



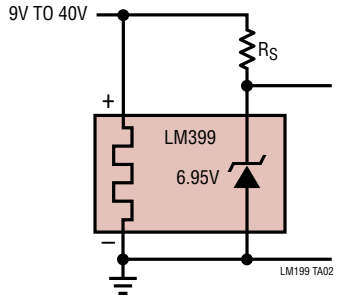
LM199 G11

FUNCTIONAL BLOCK DIAGRAM

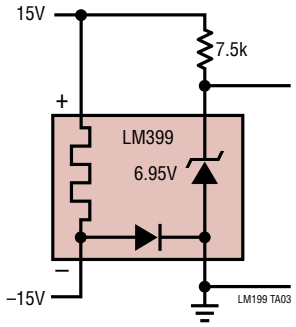


TYPICAL APPLICATIONS

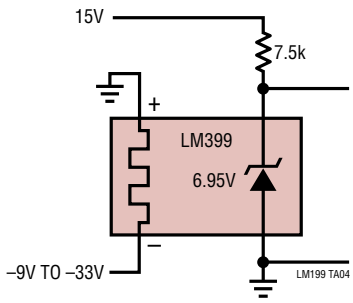
Single Supply Operation



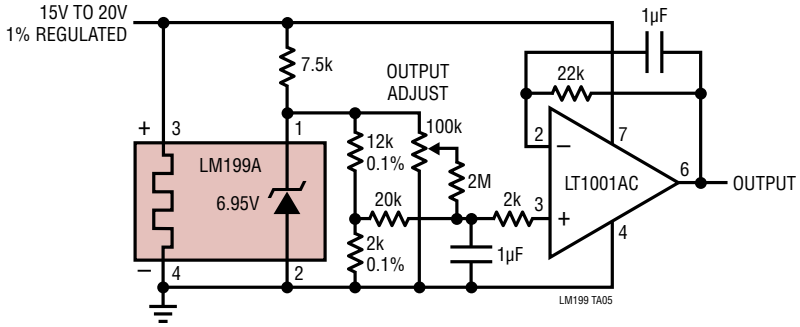
Split Supply Operation



Negative Heater Supply with Positive Reference

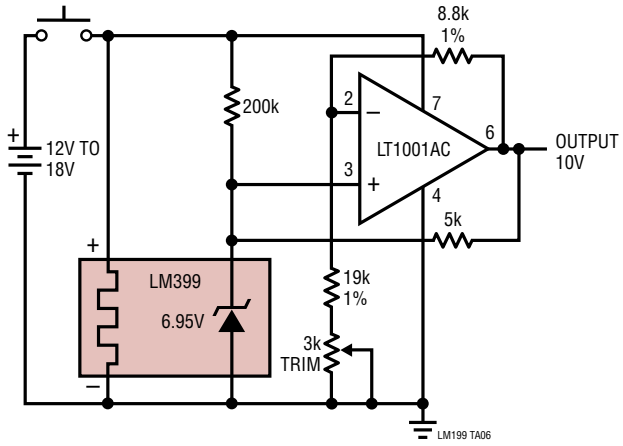


Standard Cell Replacement



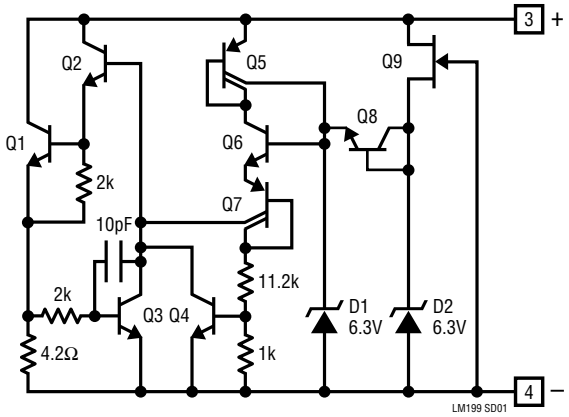
TYPICAL APPLICATIONS

Portable Calibrator

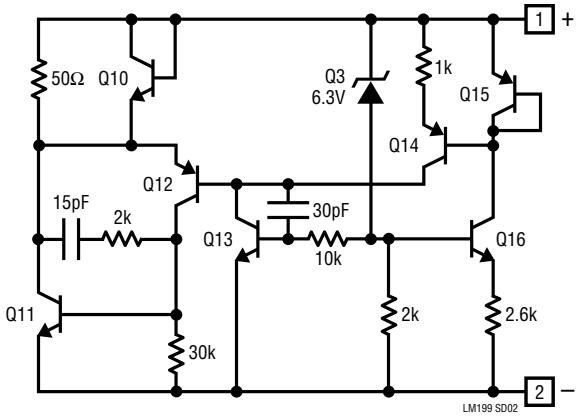


SCHEMATIC DIAGRAMS

Temperature Stabilizer



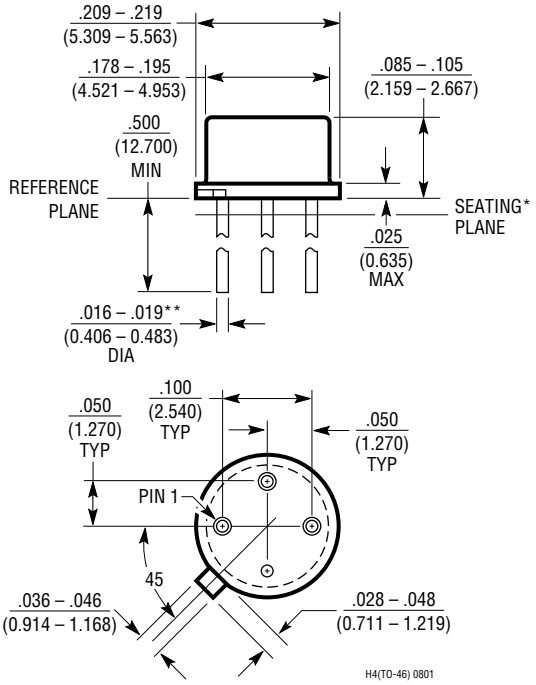
Reference



PACKAGE DESCRIPTION

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

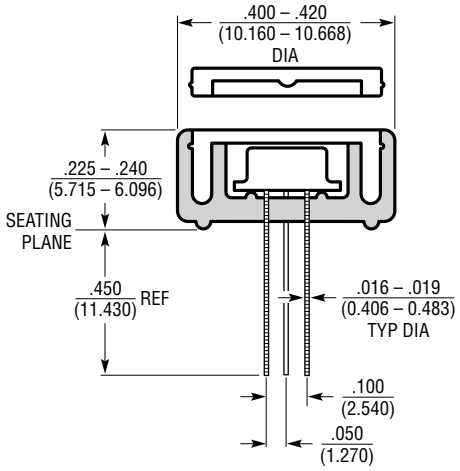
H Package
4-Lead TO-46 Metal Can
(Reference LTC DWG # 05-08-1341)



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

**FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS .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

Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.

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

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