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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All other trademarks are the property of their respective owners.

TYPICAL APPLICATION

10V Buffered Reference

LM199 TA01a

Reverse Voltage Change

LM199 TA01b
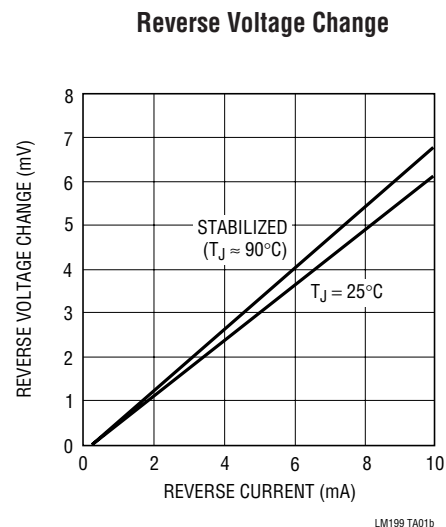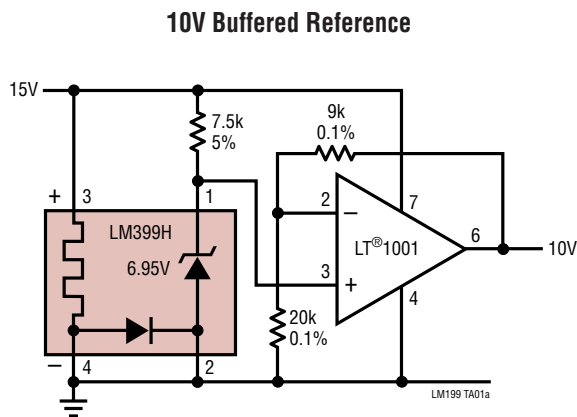
ABSOLUTE MAXIMUM RATINGS

(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

PACKAGE/ORDER INFORMATION

TOP VIEW

+ ① ④ –

H

– ② ③ +

H PACKAGE
4-LEAD TO-46 METAL CAN
INSIDE THERMAL SHIELD
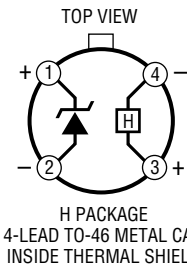
ORDER PART NUMBER	
LM399H LM399AH	LM199H LM199AH LM199AH-20 LM399AH-20 LM399AH-50 **OBSOLETE**

Order Options Tape and Reel: Add #TR
Lead Free: Add #PBF   Lead Free Tape and Reel: Add #TRPBF
Lead Free Part Marking: http://www.linear.com/leadfree/

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

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			LM399/LM399A			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reverse Breakdown Voltage	$0.5mA \le I_R \le 10mA$	●	6.8	6.95	7.1	6.75	6.95	7.3	V
ΔV_Z	Reverse Breakdown Voltage Change with Current	$0.5mA \le I_R \le 10mA$	●		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	$-55°C \le T_A \le 85°C$ $85°C \le T_A \le 125°C$ $0°C \le T_A \le 70°C$			0.3 5	1 15		 0.3	 2	ppm/°C ppm/°C ppm/°C
	LM199A/LM399A	$-55°C \le T_A \le 85°C$ $85°C \le T_A \le 125°C$ $0°C \le T_A \le 70°C$			0.2 5	0.5 10		 0.3	 1	ppm/°C ppm/°C ppm/°C
e_n	RMS Noise	$10Hz \le f \le 10kHz$	●		7	20		7	50	μV
$\frac{\Delta V_Z}{\Delta Time}$	Long-Term Stability	Stabilized, $22°C \le T_A \le 28°C$, 1000 Hours, I_R = 1mA ±0.1%			8	(Note 4)		8	(Note 4)	ppm/√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	$9V \le V_H \le 40V$ (Note 5)			140	200		140	200	mA

LM199399fb

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LINEAR
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ELECTRICAL CHARACTERISTICS

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

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 $-55°C \leq T_A \leq 125°C$ for the LM199; and $0°C \leq T_A \leq 70°C$ 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

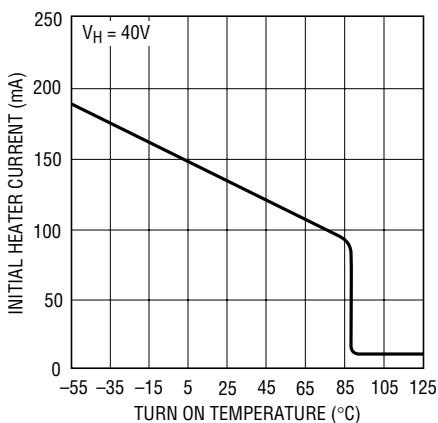### Reverse Characteristics
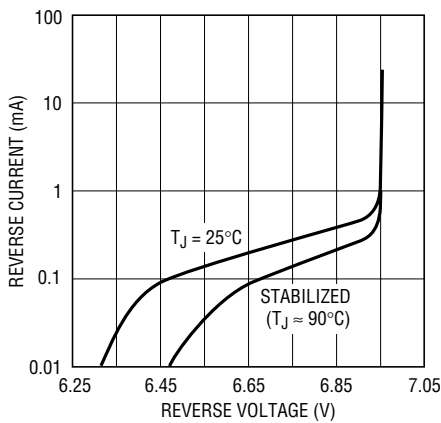
LM199 G01

Dynamic Impedance
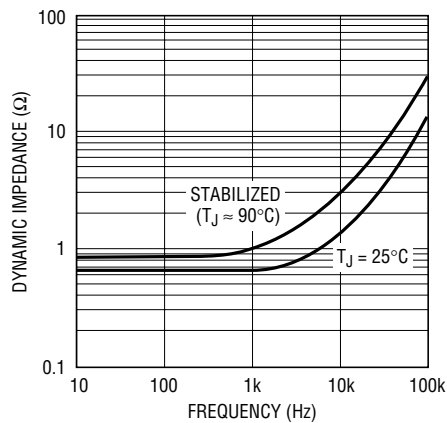
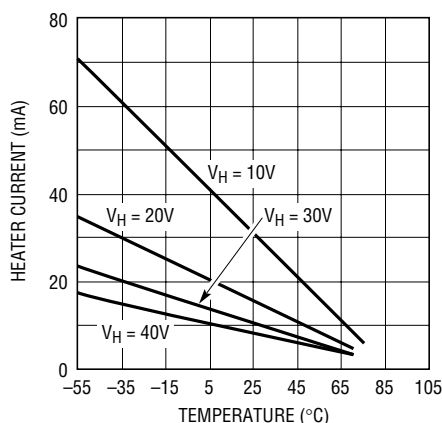LM199 G02

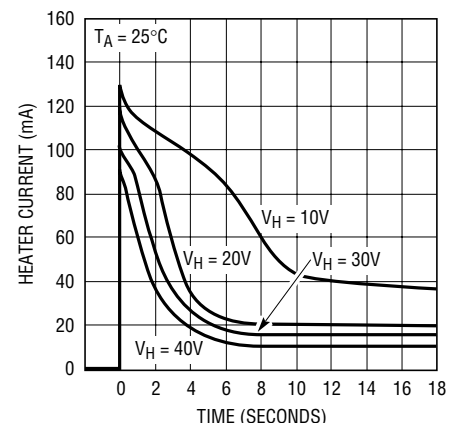### Stabilization Time
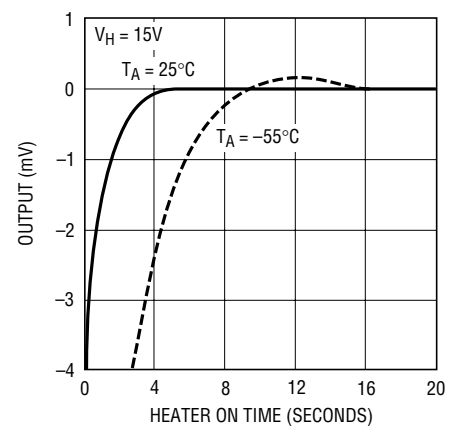
LM199 G03

Initial Heater Current

LM199 G04

Heater Current
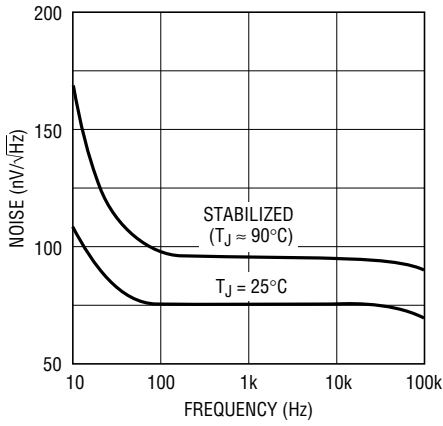

LM199 G05

Heater Current

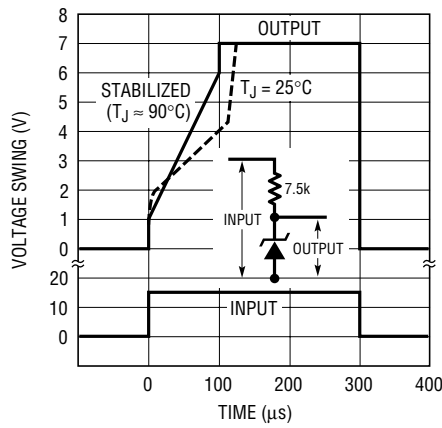LM199 G06

LM199399fb

TYPICAL PERFORMANCE CHARACTERISTICS
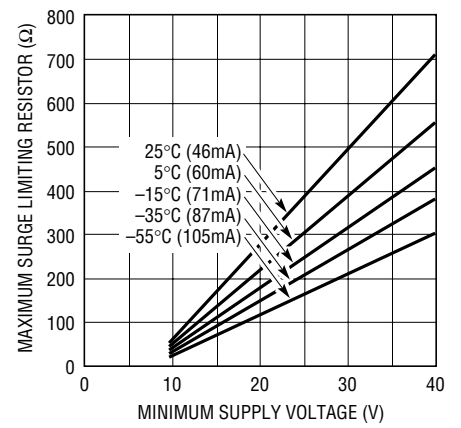
Zener Noise Voltage

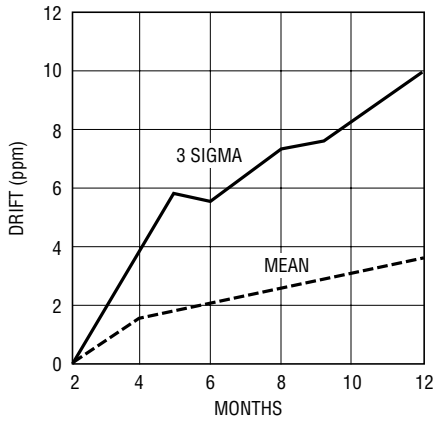LM199 G07

Response Time

LM199 G08

Limiting Surge Current

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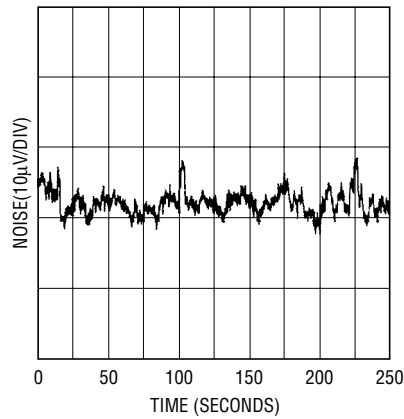TANTALUM CAPACITOR IF RESISTORS ARE USED

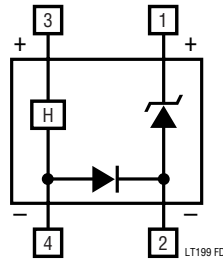LM199 G09

**Long-Term Reference
Performance, 44 Units Tested**
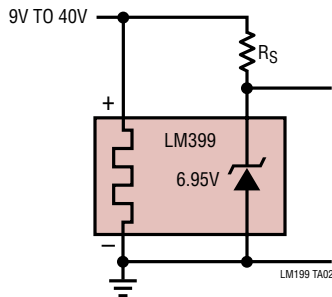

LM199 G10

Low Frequency Noise Voltage

LM199 G11

LM199399fb

LINEAR
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FUNCTIONAL BLOCK DIAGRAM

LT199 FD

TYPICAL APPLICATIONS

Single Supply Operation

9V TO 40V

R_S

LM399
6.95V

LM199 TA02

Split Supply Operation

15V

7.5k

LM399
6.95V

−15V

LM199 TA03
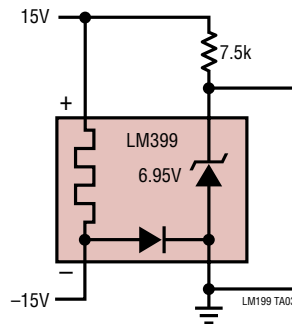
Negative Heater Supply with Positive Reference

15V

7.5k

LM399
6.95V

−9V TO −33V

LM199 TA04
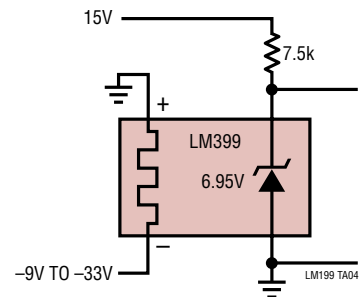
Standard Cell Replacement

15V TO 20V
1% REGULATED

7.5k

OUTPUT
ADJUST

1µF

22k

LM199A
6.95V

12k
0.1%

100k

2M

2k

LT1001AC

OUTPUT

20k

2k
0.1%

1µF

LM199 TA05
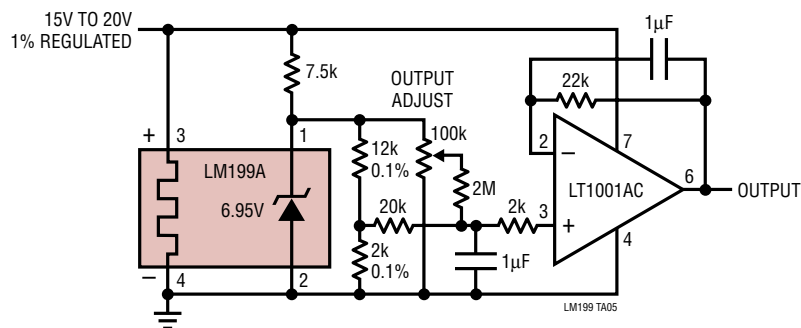
TYPICAL APPLICATIONS

Portable Calibrator

LM199 TA06
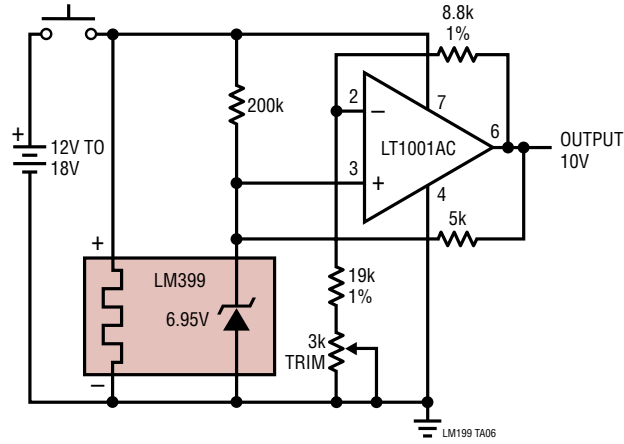
SCHEMATIC DIAGRAMS

Temperature Stabilizer

LM199 SD01

Reference

LM199 SD02

LM199399fb

LINEAR TECHNOLOGY
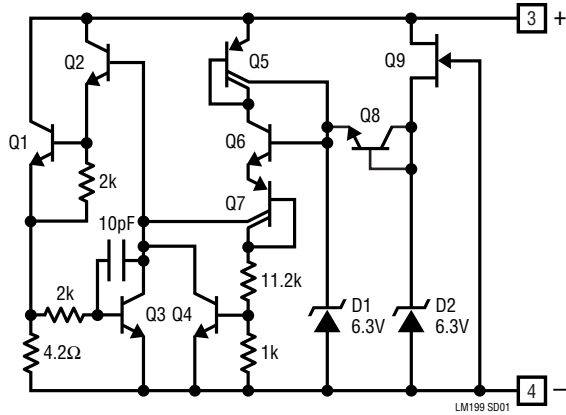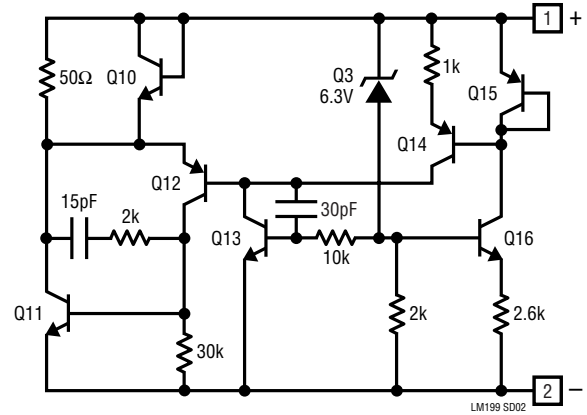
PACKAGE DESCRIPTION

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

Thermal Shield* for TO-46, H Package

.209 – .219
(5.309 – 5.563)

.178 – .195
(4.521 – 4.953)

.085 – .105
(2.159 – 2.667)

.500
(12.700)
MIN

REFERENCE
PLANE

SEATING*
PLANE

.025
(0.635)
MAX

.016 – .019**
(0.406 – 0.483)
DIA

.050
(1.270)
TYP

.100
(2.540)
TYP

.050
(1.270)
TYP

PIN 1

45°

.036 – .046
(0.914 – 1.168)

.028 – .048
(0.711 – 1.219)

H4(TO-46) 0801
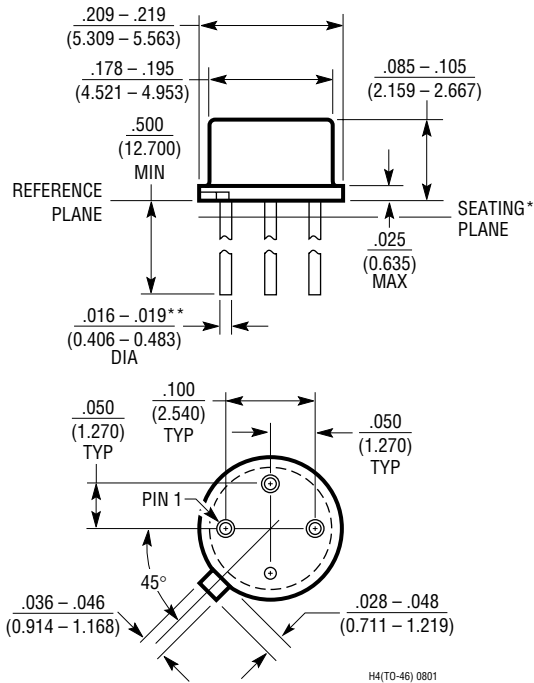
*LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE
AND .050" BELOW THE REFERENCE PLANE

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

.399 – .409
(10.135 – 10.389)
DIA

.244 – .234
(5.690 – 5.943)

SEATING
PLANE

.400
(10.160)

.016 – .019
(0.406 – 0.483)
TYP DIA

.100
(2.540)

.050
(1.270)

* THERMAL SHIELD MATERIAL IS VALOX™.
VALOX IS A TRADEMARK OF GENERAL ELECTRIC

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1021	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