

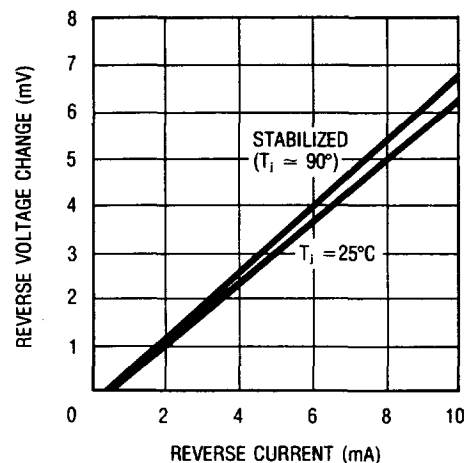
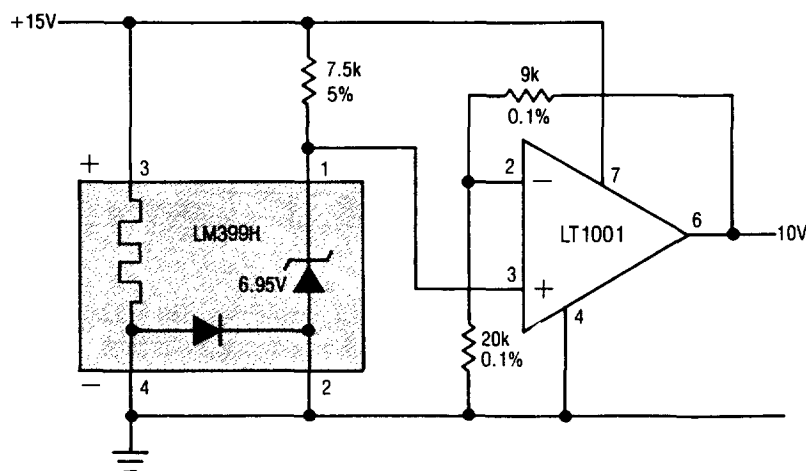
DESCRIPTION

- The LM199/399 precision 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 LM199/399 include digital voltmeters, precision calibration equipment, current sources and a variety of other precision low cost references. A 10 volt buffered reference application is shown below.

- Precision voltage reference for multimeters
- Calibration equipment voltage standards
- Laboratory measurement equipment
- Industrial monitor/control instruments
- High accuracy data converters

Reverse Voltage Change



ABSOLUTE MAXIMUM RATINGS

Temperature Stabilizer	40V
Reverse Breakdown Current	20mA
Forward Current	1mA
Reference to Substrate Voltage $V_{(RS)}$, (Note 1).	-0.1V
Operating Temperature Range	
LM199/199A	-55°C to 125°C
LM399/399A	0°C to 70°C
Storage Temperature Range	
LM199/199A	-65°C to 150°C
LM399/399A	-65°C to 150°C
Lead Temperature (Soldering, 10 sec.)	300°C

PACKAGE/ORDER INFORMATION

TOP VIEW

H PKG.
TO-46 METAL CAN INSIDE THERMAL SHIELD

ORDER PART NO.

LM199H, LM199AH
LM399H, LM399AH
LM199AH-20, LM399AH-50

FUNCTIONAL BLOCK DIAGRAM

ELECTRICAL CHARACTERISTICS (See Note 2)

SYMBOL	PARAMETER	CONDITIONS		LM199/199A			LM399/399A			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 5) ($10 \leq f \leq 100\text{Hz}$)	●		0.5	1		0.5	1.5	Ω
$\frac{\Delta V_Z}{\Delta \text{Temp}}$	Temperature Coefficient LM199/LM399	-55°C $\leq T_A \leq$ 85°C +85°C $\leq T_A \leq$ 125°C 0°C $\leq T_A \leq$ 70°C			0.3 5	1 15		0.3 2		ppm/°C ppm/°C ppm/°C
	LM199A/LM399A	-55°C $\leq T_A \leq$ 85°C +85°C $\leq T_A \leq$ 125°C 0°C $\leq T_A \leq$ 70°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
$\frac{\Delta V_Z}{\Delta \text{Time}}$	Long Term Stability	Stabilized, 22°C $\leq T_A \leq$ 28°C 1000 Hours, $I_R = 1\text{mA} \pm 0.1\%$			8	Note 3		8	Note 3	ppm/ $\sqrt{\text{kHz}}$
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 4)			8.5 22	14 28		8.5	15	mA
V_H	Temperature Stabilizer Supply Voltage		●	9		40	9		40	V
	Warm-up Time to $\pm 0.05\% V_Z$	$V_H = 30\text{V}$, $T_A = 25^\circ\text{C}$			3			3		Seconds
	Initial Turn-on Current	$9\text{V} \leq V_H \leq 40\text{V}$, $T_A = 25^\circ\text{C}$, (See Note 4)			140	200		140	200	mA

The ● denotes the specifications which apply over full operating temperature range.

Note 1: 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 2: 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.

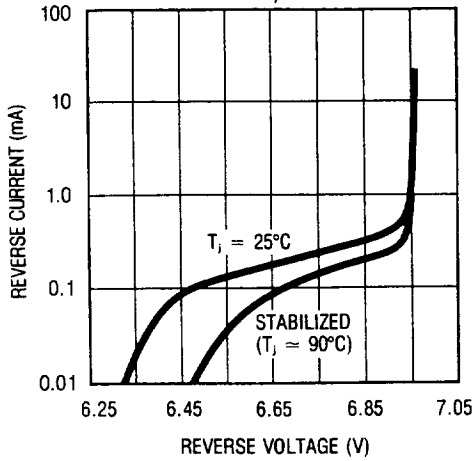
Note 3: Devices with maximum guaranteed long term stability of 20 ppm/ $\sqrt{\text{kHz}}$ are available. Drift decreases with time.

Note 4: This initial current can be reduced by adding an appropriate resistor and capacitor to the heater circuit. See the performance characteristic graphs to determine values.

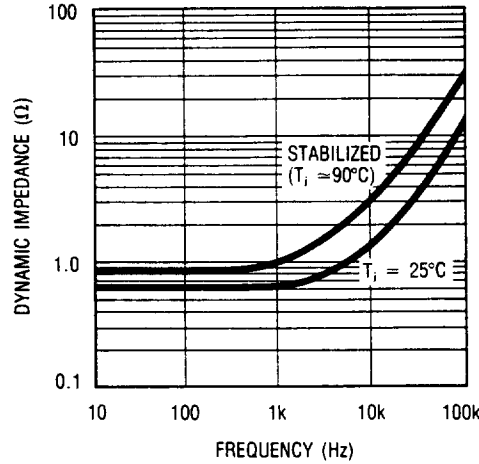
Note 5: Guaranteed by "Reverse Breakdown Change with Current."

TYPICAL PERFORMANCE CHARACTERISTICS

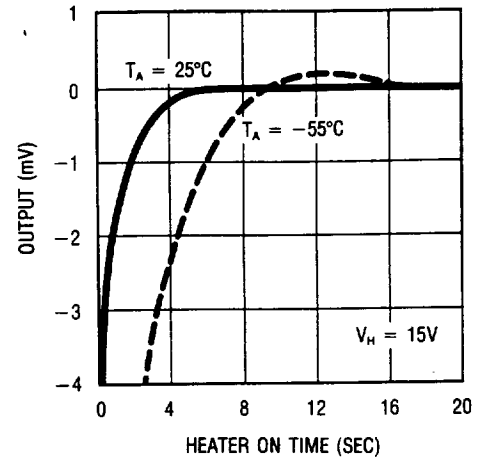
Reverse Characteristics



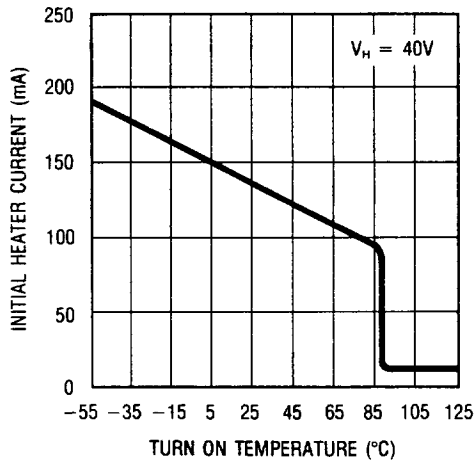
Dynamic Impedance



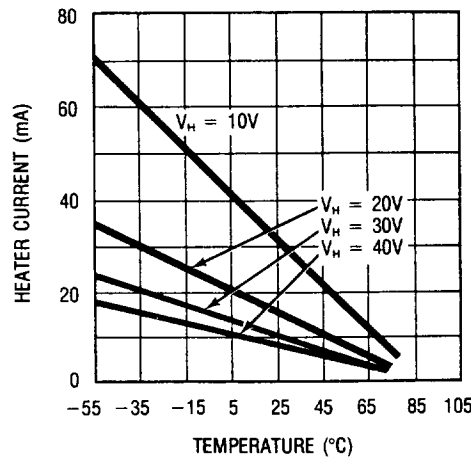
Stabilization Time



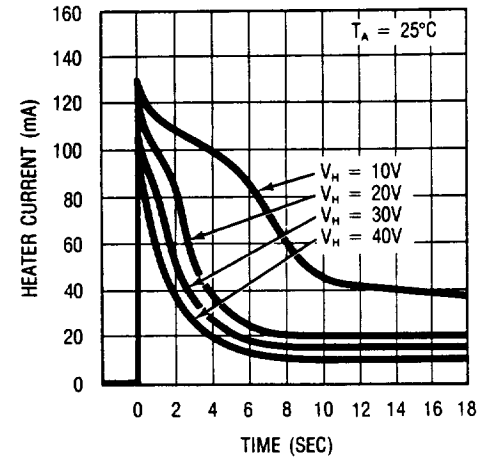
Initial Heater Current



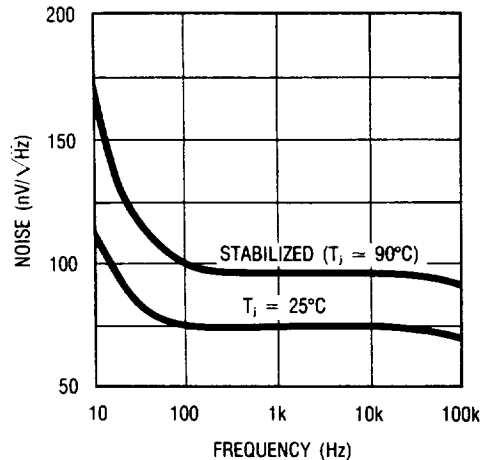
Heater Current



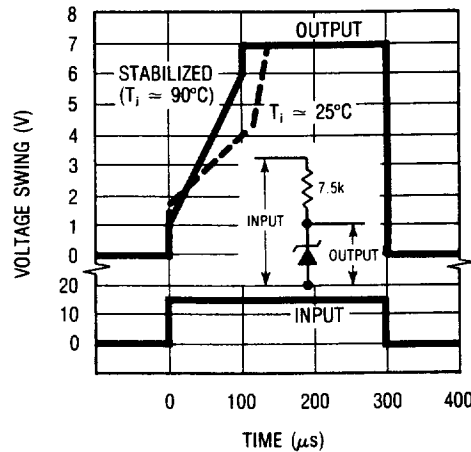
Heater Current



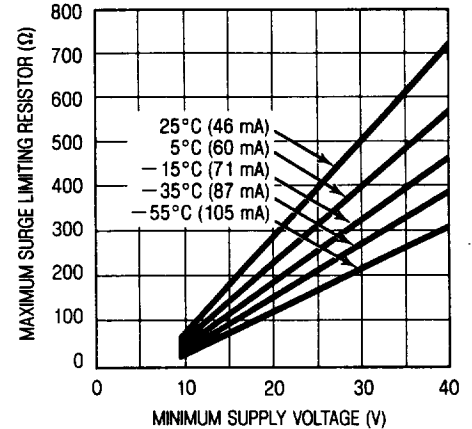
Zener Noise Voltage



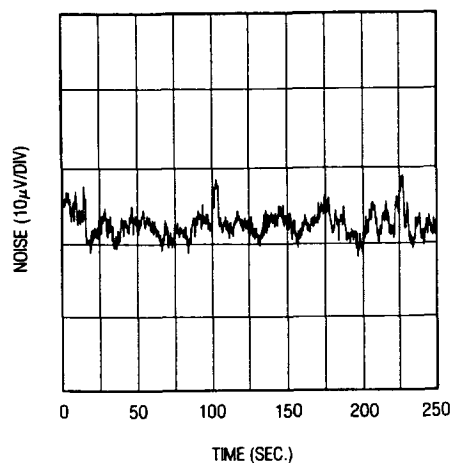
Response Time



Limiting Surge Current



*Heater must be bypassed with a 2 μ F or larger tantalum capacitor if resistors are used.



TYPICAL APPLICATIONS

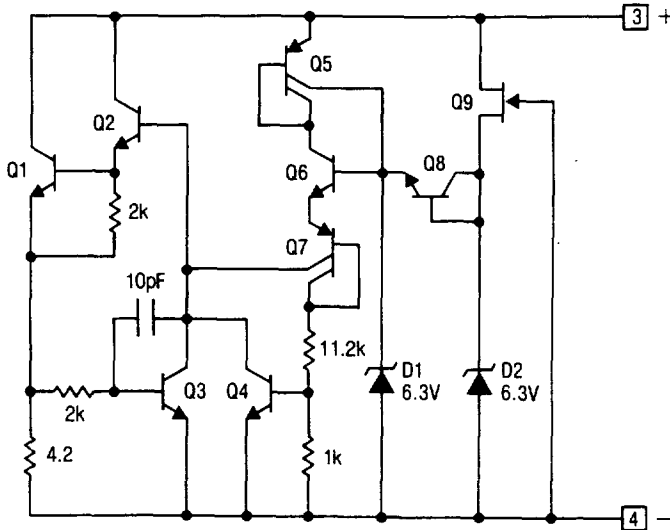
The diagram shows the internal circuit of an LM399 precision centimeter voltmeter. It features a 9V to 40V input terminal connected to a resistor R_S . The other end of R_S is connected to the non-inverting input of the LM399 chip. The LM399 chip has a 6.95V reference voltage indicated on its symbol. The chip is also connected to ground.

The circuit diagram shows an LM399 integrated circuit used as a precision centimeter voltmeter. The positive input (+) is connected to a +15V supply through a 7.5k resistor. The negative input (-) is connected to a -15V supply. Inside the IC, there are two LEDs labeled "6.95V". A reference voltage source is also shown.

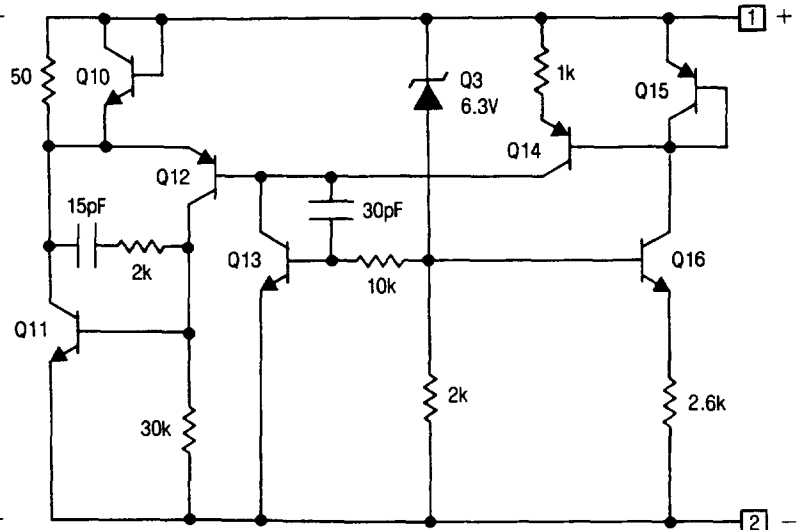
The circuit diagram shows a 12V TO 18V DC source connected to a 200k resistor. The other end of the 200k resistor is connected to the non-inverting input (pin 3) of the LT1001AC op-amp. The inverting input (pin 2) is connected to the wiper of an LM399 trimmer. The trimmer is also connected to the 12V TO 18V source and ground. The trimmer has a 6.95V label and a TRIM potentiometer symbol. The output of the op-amp (pin 6) is connected to a 5k resistor to ground and an 8.8k resistor to the non-inverting input (pin 3). The op-amp is labeled LT1001AC. The output is labeled OUTPUT 10V.

SCHEMATIC DIAGRAMS

Temperature Stabilizer



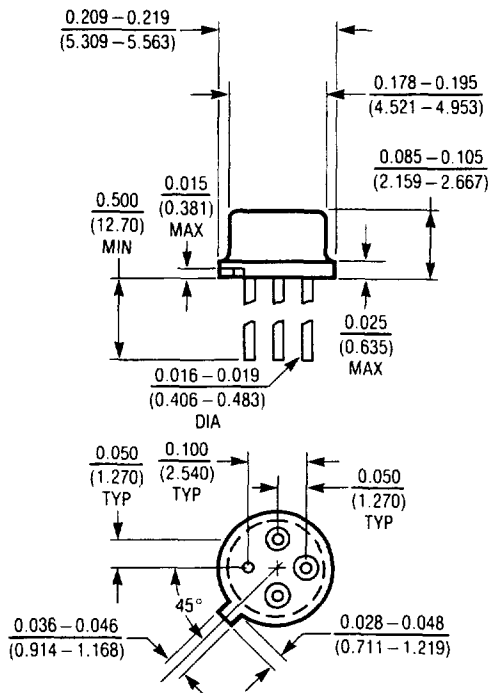
Reference



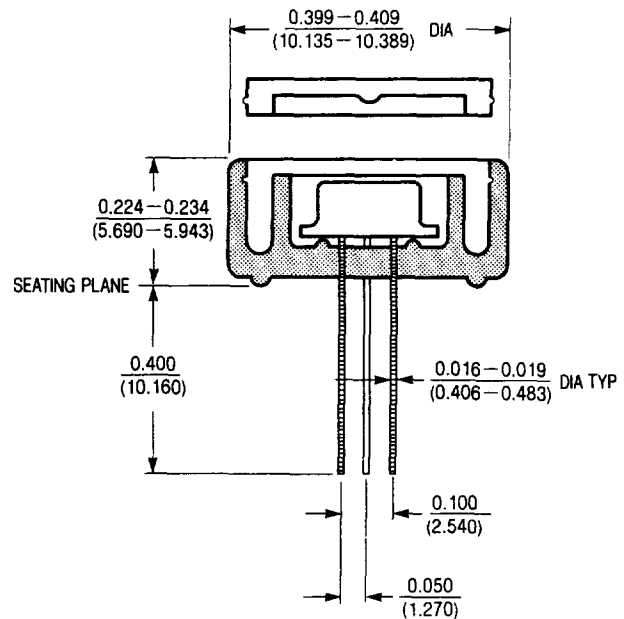
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PACKAGE DESCRIPTION

H Package, 4 Lead
TO-46 Metal Can



Thermal Shield*
For TO-46, H Package



*Thermal Shield Material is Valox™
Valox is a registered trademark of General Electric