

LM199,LM299,LM399

LM199/LM299/LM399 Precision Reference

Datasheet.Live



Literature Number: SNVS751C

LM199/LM299/LM399

Precision Reference

General Description

The LM199 series are precision, temperature-stabilized monolithic zeners offering temperature coefficients a factor of ten better than high quality reference zeners. Constructed on a single monolithic chip is a temperature stabilizer circuit and an active reference zener. The active circuitry reduces the dynamic impedance of the zener to about 0.5Ω and allows the zener to operate over 0.5 mA to 10 mA current range with essentially no change in voltage or temperature coefficient. Further, a new subsurface zener structure gives low noise and excellent long term stability compared to ordinary monolithic zeners. The package is supplied with a thermal shield to minimize heater power and improve temperature regulation.

The LM199 series references are exceptionally easy to use and free of the problems that are often experienced with ordinary zeners. There is virtually no hysteresis in reference voltage with temperature cycling. Also, the LM199 is free of voltage shifts due to stress on the leads. Finally, since the unit is temperature stabilized, warm up time is fast.

The LM199 can be used in almost any application in place of ordinary zeners with improved performance. Some ideal applications are analog to digital converters, calibration standards, precision voltage or current sources or precision

power supplies. Further in many cases the LM199 can replace references in existing equipment with a minimum of wiring changes.

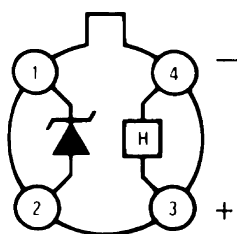
The LM199 series devices are packaged in a standard hermetic TO-46 package inside a thermal shield. The LM199 is rated for operation from -55°C to $+125^{\circ}\text{C}$ while the LM299 is rated for operation from -25°C to $+85^{\circ}\text{C}$ and the LM399 is rated from 0°C to $+70^{\circ}\text{C}$.

Features

- Guaranteed $0.0001\%/^{\circ}\text{C}$ temperature coefficient
- Low dynamic impedance — 0.5Ω
- Initial tolerance on breakdown voltage — 2%
- Sharp breakdown at 400 μA
- Wide operating current — 500 μA to 10 mA
- Wide supply range for temperature stabilizer
- Guaranteed low noise
- Low power for stabilization — 300 mW at 25°C
- Proven reliability, low-stress packaging in TO-46 integrated-circuit hermetic package, for low hysteresis after thermal cycling. 33 million hours MTBF at $T_A = +25^{\circ}\text{C}$ ($T_J = +86^{\circ}\text{C}$)

Connection Diagram

Metal Can Package (TO-46)



00571714

Top View

NS Package Number H04D

Ordering Information

Order Number	Initial Tolerance	Ambient Temperature	Package Marking	Transport Method	NSC Package
LM199AH	$\pm 2\%$	-50°C to $+125^{\circ}\text{C}$	LM199AH	Box of 500	H04A
LM199AH/883	$\pm 2\%$	-50°C to $+125^{\circ}\text{C}$	LM199AH/Q	Tray of 20	H04A
LM299H	$\pm 2\%$	-25°C to $+85^{\circ}\text{C}$	LM299H	Box of 500	H04A
LM399AH	$\pm 5\%$	0°C to $+70^{\circ}\text{C}$	LM399AH	Box of 500	H04A
LM399H	$\pm 5\%$	0°C to $+70^{\circ}\text{C}$	LM399H	Box of 500	H04A

Absolute Maximum Ratings (Note 1)

Specifications for Military/Aerospace products are not contained in this datasheet. Refer to the following Reliability Electrical Test Specifications documents: MNLM199A-X and SMD#5962-88561 .

Temperature Stabilizer Voltage	
LM199/LM299/LM399	40V
Reverse Breakdown Current	20 mA
Forward Current	
LM199/LM299/LM399	1 mA

Reference to Substrate Voltage $V_{(RS)}$ (Note 2) 40V

-0.1V

Operating Temperature Range

LM199 -55°C to +125°C

LM299 -25°C to +85°C

LM399 -0°C to +70°C

Storage Temperature Range -55°C to +150°C

Soldering Information

TO-46 package (10 sec.) +300°C

Electrical Characteristics (Notes 3, 6)

Parameter	Conditions	LM299H			LM399H			Units
		Min	Typ	Max	Min	Typ	Max	
Reverse Breakdown Voltage	$0.5 \text{ mA} \leq I_R \leq 10 \text{ mA}$	6.8	6.95	7.1	6.6	6.95	7.3	V
Reverse Breakdown Voltage Change with Current	$0.5 \text{ mA} \leq I_R \leq 10 \text{ mA}$		6	9		6	12	mV
Reverse Dynamic Impedance	$I_R = 1 \text{ mA}$		0.5	1		0.5	1.5	Ω
Reverse Breakdown Temperature Coefficient	$-25^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	LM299	0.00003	0.0001				%/°C
	$0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$					0.00003	0.0002	%/°C
RMS Noise	$10 \text{ Hz} \leq f \leq 10 \text{ kHz}$		7	20		7	50	μV
Long Term Stability	Stabilized, $22^\circ\text{C} \leq T_A \leq 28^\circ\text{C}$, 1000 Hours, $I_R = 1 \text{ mA} \pm 0.1\%$		20			20		ppm
Temperature Stabilizer Supply Current	$T_A = 25^\circ\text{C}$, Still Air, $V_S = 30\text{V}$ $T_A = -55^\circ\text{C}$		8.5 22	14 28		8.5	15	mA
Temperature Stabilizer Supply Voltage		9		40	9		40	V
Warm-Up Time to 0.05%	$V_S = 30\text{V}$, $T_A = 25^\circ\text{C}$		3			3		sec.
Initial Turn-on Current	$9 \leq V_S \leq 40$, $T_A = +25^\circ\text{C}$, (Note 4)		140	200		140	200	mA

Electrical Characteristics (Notes 3, 6)

Parameter	Conditions	LM199AH			LM399AH			Units
		Min	Typ	Max	Min	Typ	Max	
Reverse Breakdown Voltage	$0.5 \text{ mA} \leq I_R \leq 10 \text{ mA}$	6.8	6.95	7.1	6.6	6.95	7.3	V
Reverse Breakdown Voltage Change with Current	$0.5 \text{ mA} \leq I_R \leq 10 \text{ mA}$		6	9		6	12	mV
Reverse Dynamic Impedance	$I_R = 1 \text{ mA}$		0.5	1		0.5	1.5	Ω
Reverse Breakdown Temperature Coefficient	$-55^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	LM199A	0.00002	0.00005				%/°C
	$+85^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$		0.0005	0.0010				%/°C
	$0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$					0.00003	0.0001	%/°C
RMS Noise	$10 \text{ Hz} \leq f \leq 10 \text{ kHz}$		7	20		7	50	μV
Long Term Stability	Stabilized, $22^\circ\text{C} \leq T_A \leq 28^\circ\text{C}$, 1000 Hours, $I_R = 1 \text{ mA} \pm 0.1\%$		20			20		ppm
Temperature Stabilizer Supply Current	$T_A = 25^\circ\text{C}$, Still Air, $V_S = 30\text{V}$ $T_A = -55^\circ\text{C}$		8.5 22	14 28		8.5	15	mA
Temperature Stabilizer Supply Voltage		9		40	9		40	V
Warm-Up Time to 0.05%	$V_S = 30\text{V}$, $T_A = 25^\circ\text{C}$		3			3		sec.
Initial Turn-on Current	$9 \leq V_S \leq 40$, $T_A = +25^\circ\text{C}$, (Note 4)		140	200		140	200	mA

Electrical Characteristics (Notes 3, 6) (Continued)

Note 1: "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.

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.

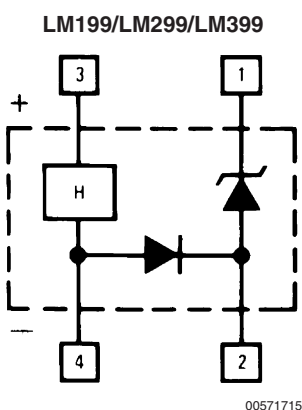
Note 3: These specifications apply for 30V applied to the temperature stabilizer and $-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ for the LM199; $-25^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for the LM299 and $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ for the LM399.

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: Do not wash the LM199 with its polysulfone thermal shield in TCE.

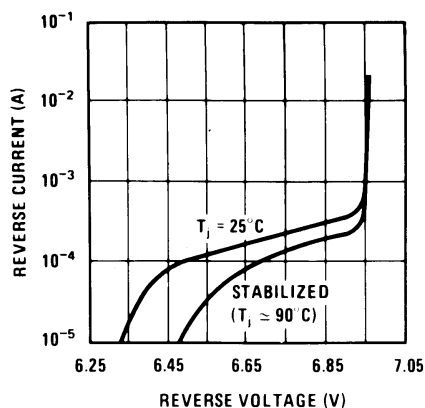
Note 6: A military data sheet is available for the LM199AH/833 and LM199AH-SMD (SMD#5962-88561) upon request.

Functional Block Diagram



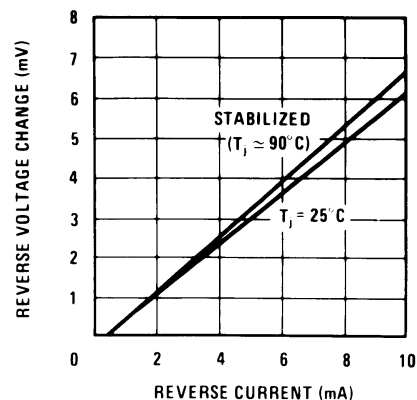
Typical Performance Characteristics

Reverse Characteristics



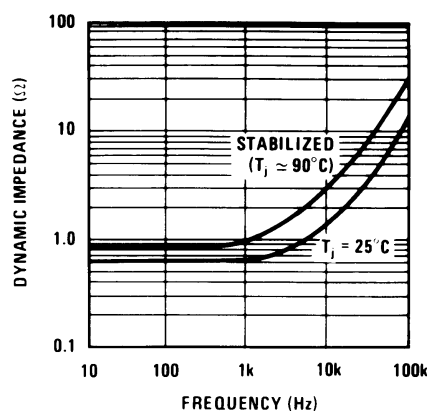
00571719

Reverse Voltage Change



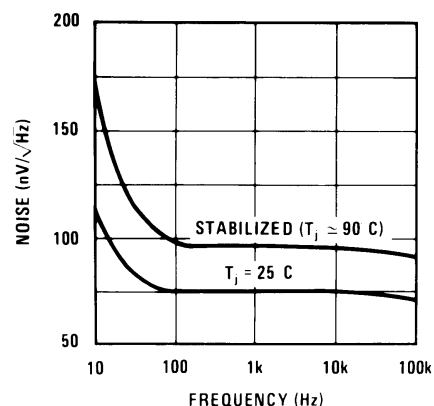
00571720

Dynamic Impedance



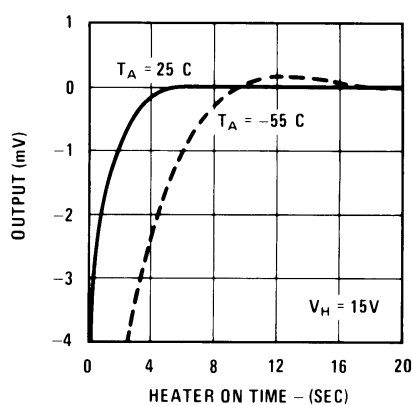
00571721

Zener Noise Voltage



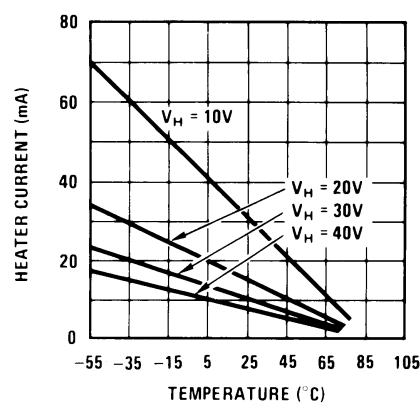
00571722

Stabilization Time



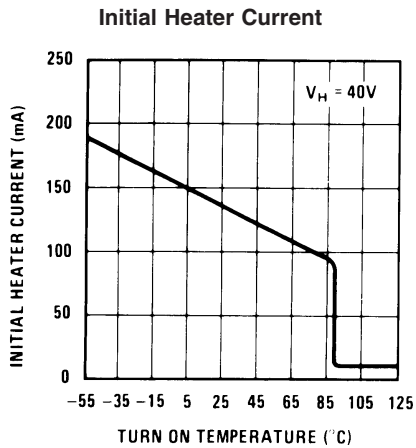
00571723

Heater Current



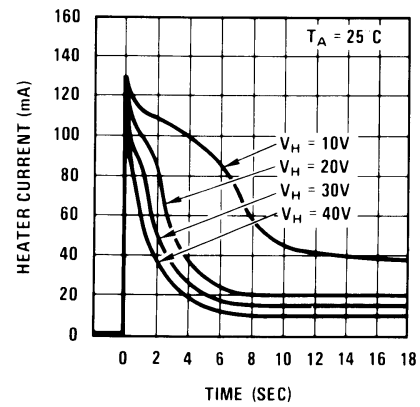
00571724

Typical Performance Characteristics (Continued)



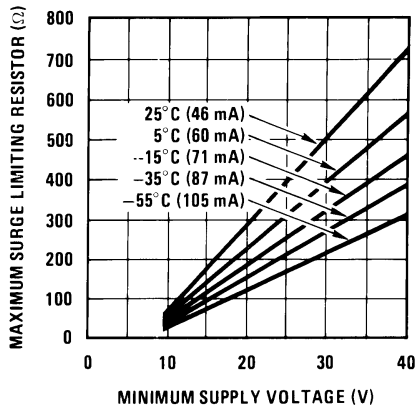
00571725

Heater Current (To Limit This Surge, See Next Graph)



00571726

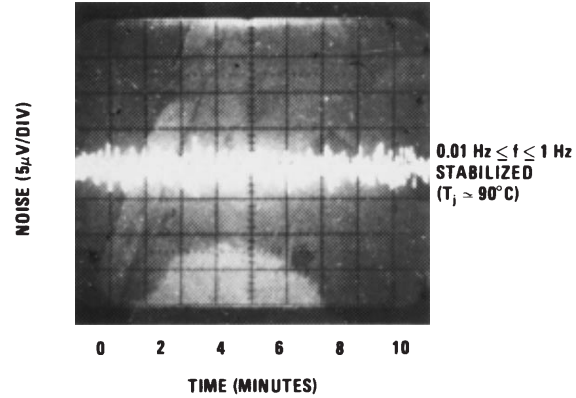
Heater Surge Limit Resistor vs Minimum Supply Voltage at Various Minimum Temperatures



00571727

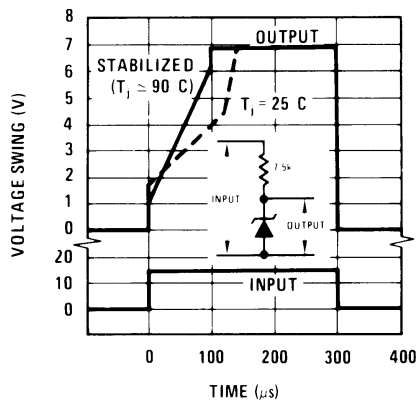
*Heater must be bypassed with a 2 μF or larger tantalum capacitor if resistors are used.

Low Frequency Noise Voltage



00571703

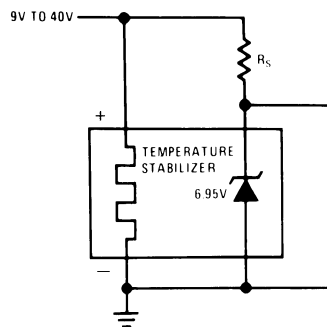
Response Time



00571707

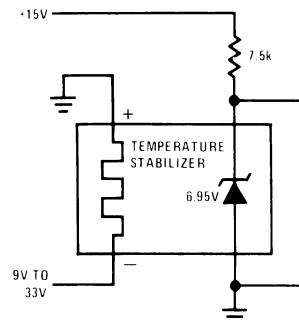
Typical Applications

Single Supply Operation



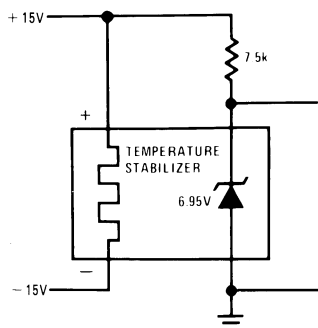
00571728

Negative Heater Supply with Positive Reference



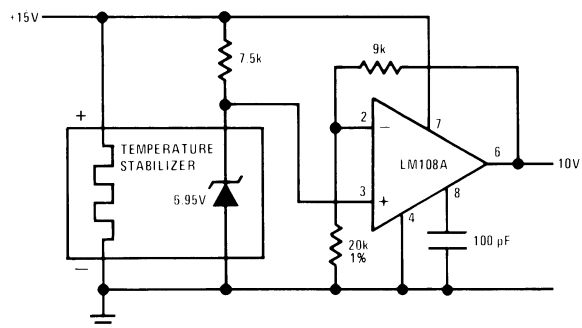
00571730

Split Supply Operation



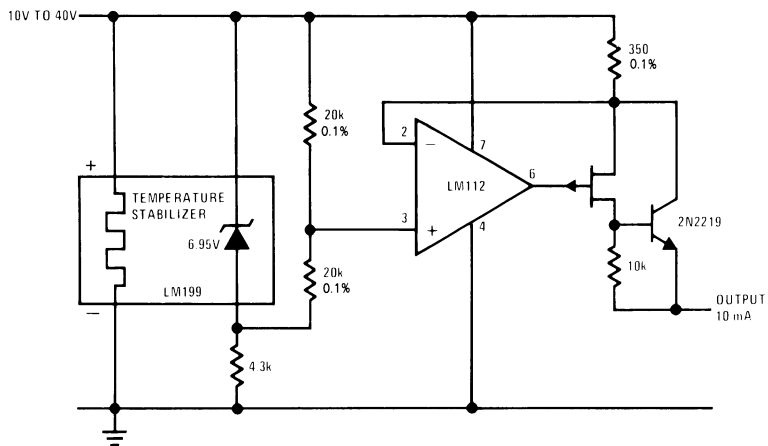
00571729

Buffered Reference With Single Supply



00571731

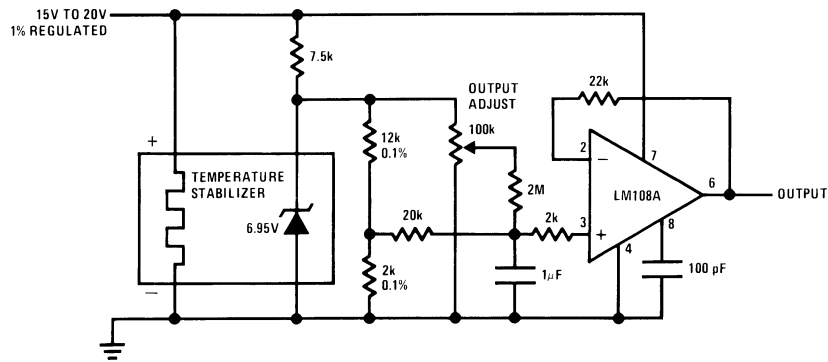
Positive Current Source



00571732

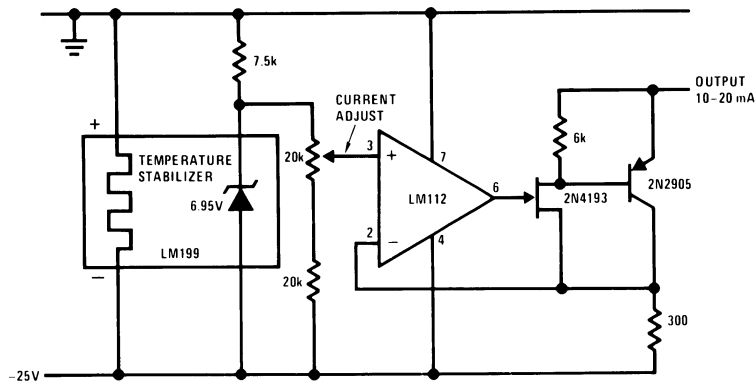
Typical Applications (Continued)

Standard Cell Replacement



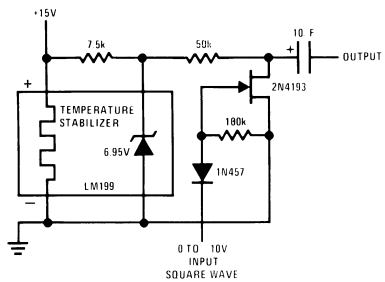
00571733

Negative Current Source



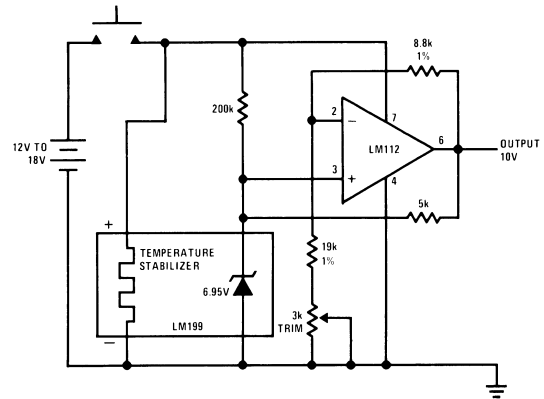
00571734

Square Wave Voltage Reference



00571735

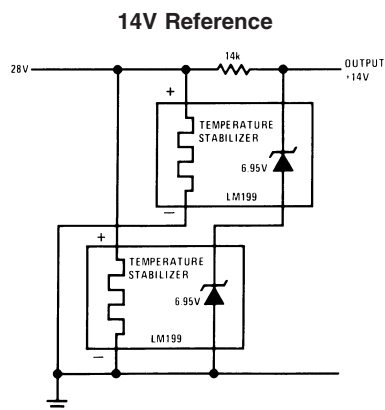
Portable Calibrator*



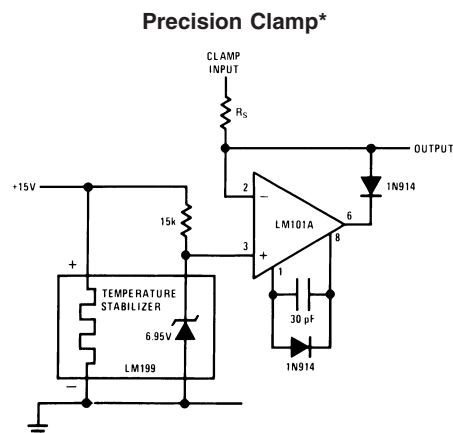
00571736

*Warm-up time 10 seconds; intermittent operation does not degrade long term stability.

Typical Applications (Continued)

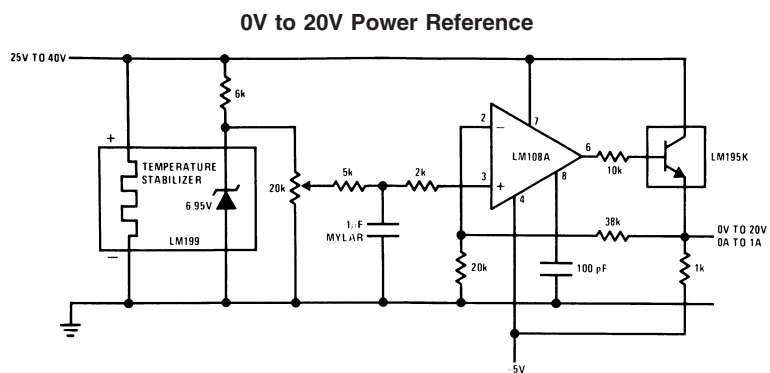


00571737

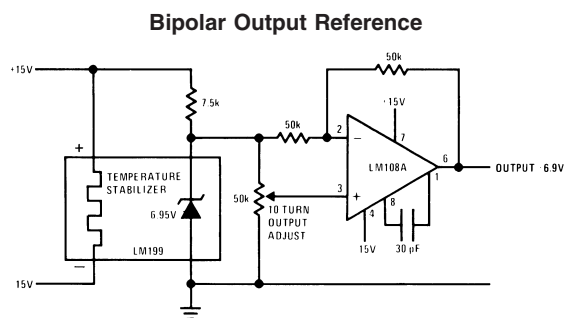


00571738

*Clamp will sink 5 mA when input goes more positive than reference

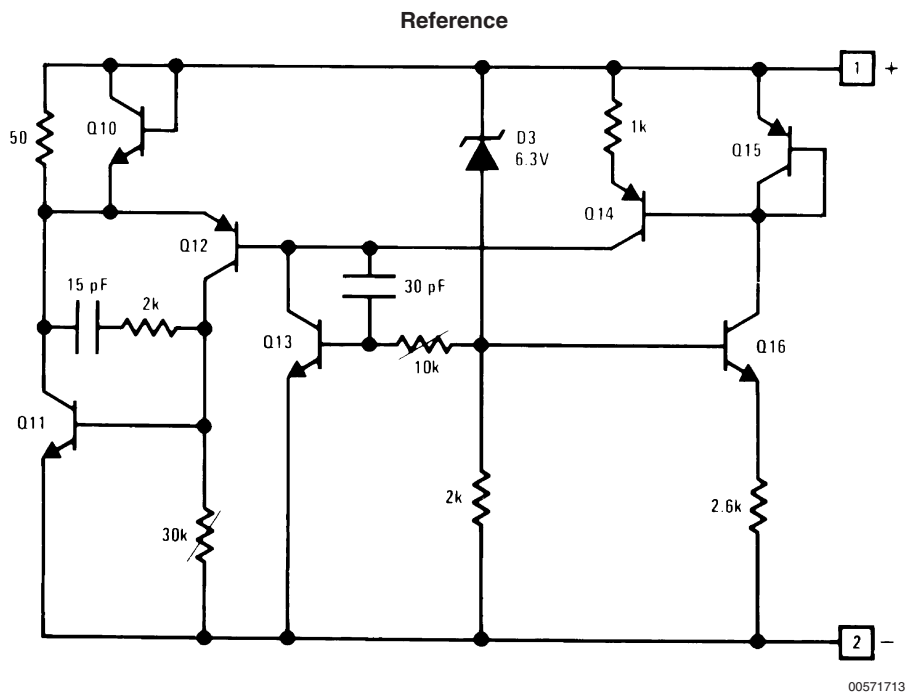
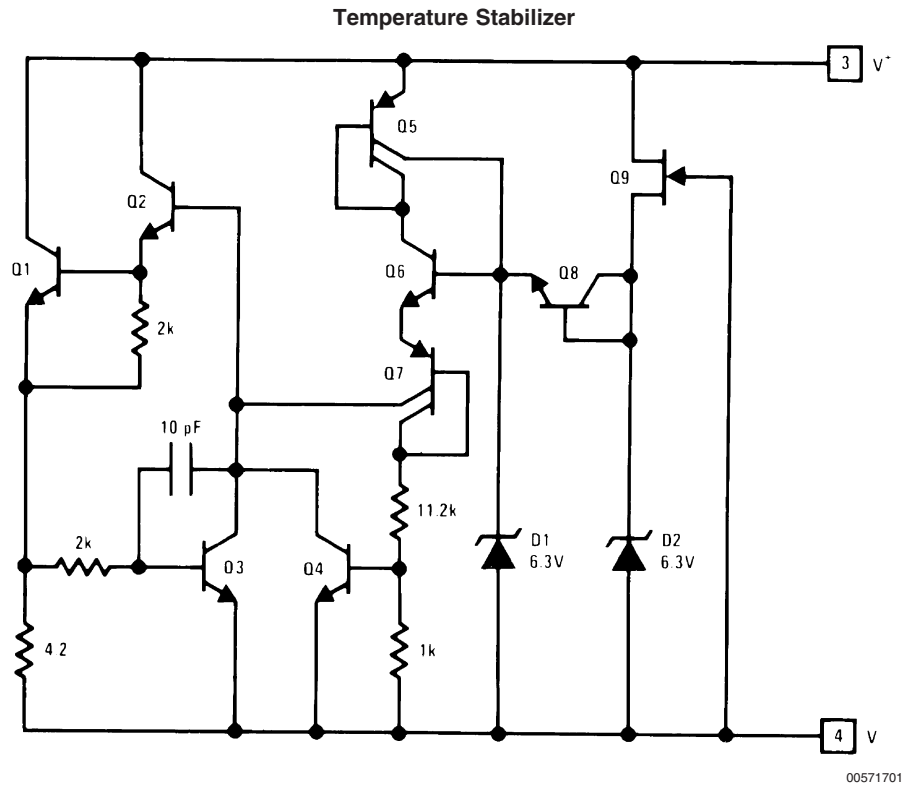


00571739



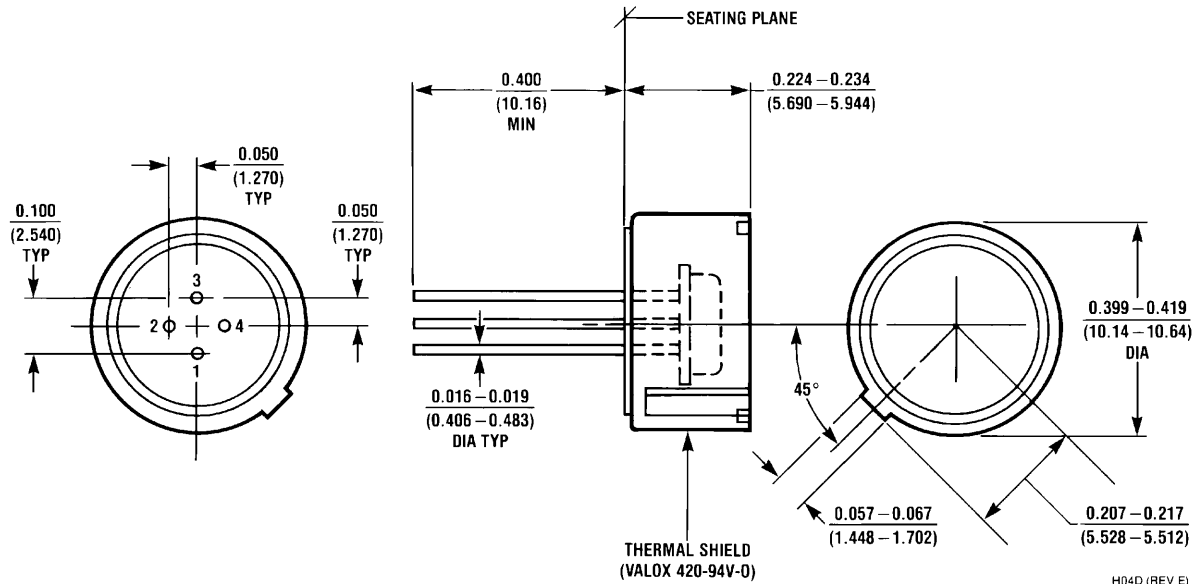
00571740

Schematic Diagrams



Physical Dimensions inches (millimeters)

unless otherwise noted



NS Package H04D

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

For the most current product information visit us at www.national.com.

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

BANNED SUBSTANCE COMPLIANCE

National Semiconductor manufactures products and uses packing materials that meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no "Banned Substances" as defined in CSP-9-111S2.



National Semiconductor
Americas Customer
Support Center
Email: new.feedback@nsc.com
Tel: 1-800-272-9959

www.national.com

National Semiconductor
Europe Customer Support Center
Fax: +49 (0) 180-530 85 86
Email: europa.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor
Asia Pacific Customer
Support Center
Email: ap.support@nsc.com

National Semiconductor
Japan Customer Support Center
Fax: 81-3-5639-7507
Email: jpn.feedback@nsc.com
Tel: 81-3-5639-7560