

LM368-2.5 Precision Voltage Reference

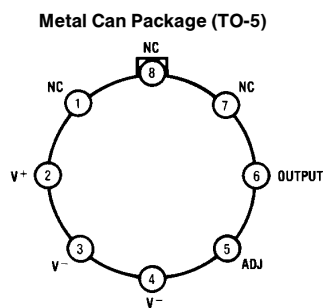
General Description

The LM368-2.5 is a precision, monolithic, temperature-compensated voltage reference. The LM368-2.5 makes use of thin-film technology enhanced by the discrete laser trimming of resistors to achieve excellent Temperature coefficient (Tempco) of V_{OUT} (as low as 11 ppm/°C), along with tight initial tolerance, (as low as 0.02%). The trim scheme is such that individual resistors are cut open rather than being trimmed (partially cut), to avoid resistor drift caused by electromigration in the trimmed area. The LM368-2.5 also provides excellent stability vs. changes in input voltage and output current. The output is short circuit proof. A trim pin is made available for fine trimming of V_{OUT} or for obtaining intermediate values without greatly affecting the Tempco of the device.

Features

- 400 μ A operating current
- Low output impedance
- Excellent line regulation (.0001%/V typical)
- Single-supply operation
- Externally trimmable
- Low temperature coefficient
- Excellent initial accuracy (0.02% typical)
- Best reference available for low-voltage operation ($V_S = 5V$, $V_{REF} = 2.500V$)

Connection Diagram



TL/H/8446-1

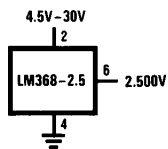
Top View

*case connected to V-

Order Number LM368H-2.5 LM368YH-2.5
See NS Package Number H08C

Typical Applications

Low Voltage Reference



TL/H/8446-2

Absolute Maximum Ratings (Note 7)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Input Voltage	35V
Power Dissipation	600 mW
Storage Temperature Range	−60°C to +150°C
Operating Temperature Range	0°C to +70°C

Soldering Information

TO-5 (H) Package (10 sec.) + 300°C
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" (Appendix D) for other methods of soldering surface mount devices.

Electrical Characteristics (Note 1)

Parameter	Conditions	LM368-2.5			
		Typical	Tested Limit (Note 2)	Design Limit (Note 3)	Units (Max. unless noted)
V _{OUT} Error: LM368		±0.02	±0.2		%
Line Regulation	5.0V ≤ V _{IN} ≤ 30V	±0.0001	±0.0005		%/V
Load Regulation (Note 8)	0 mA ≤ I _{SOURCE} ≤ 10 mA	±0.0003	±0.0025		%/mA
Thermal Regulation	T = 20 mS (Note 4)	±0.005	±0.02		%/100 mW
Quiescent Current		350	550		μA
Change of Quiescent Current vs. V _{IN}	5.0V ≤ V _{IN} ≤ 30V	3	5		μA/V
Temperature Coefficient of V _{OUT} (see graph): LM368Y-2.5 (Note 5) LM368-2.5	0°C ≤ T _A ≤ 70°C 0°C ≤ T _A ≤ 70°C	±11 ±15	±20	±30	ppm/°C ppm/°C
Short Circuit Current	V _{OUT} = 0	30	70	100	mA
Noise: 0.1–10 Hz 100 Hz–10 kHz		12 420			μVp-p nV/√Hz
V _{OUT} Adjust Range	0 ≤ V _{PIN5} ≤ V _{OUT}	1.9–5.2		2.2–5.0	V min.

Note 1: Unless otherwise noted, these specifications apply: T_A = 25°C, 4.9V ≤ V_{IN} ≤ 10.5V, 0 ≤ I_{LOAD} ≤ 0.5 mA, 0 ≤ C_L ≤ 200 pF.

Note 2: Tested Limits are guaranteed and 100% tested in production.

Note 3: Design Limits are guaranteed (but not 100% production tested) over the indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels.

Note 4: Thermal Regulation is defined as the change in the output Voltage at a time T after a step change in power dissipation of 100 mW.

Note 5: Temperature Coefficient of V_{OUT} is defined as the worst case delta-V_{OUT} measured at Specified Temperatures divided by the total span of the Specified Temperature Range (See graphs). There is no guarantee that the Specified Temperatures are exactly at the minimum or maximum deviation.

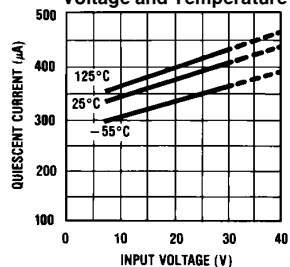
Note 6: In metal can (H), θ_{J-C} is 75°C/W and θ_{J-A} is 150°C/W.

Note 7: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its Rated Operating Conditions (see Note 1 and Conditions).

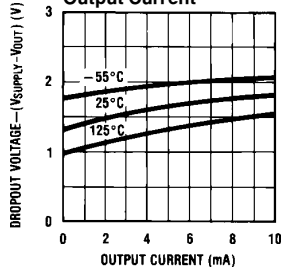
Note 8: Load regulation is measured on the output pin at a point 1/8" below the base of the package. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Typical Performance Characteristics (Note 1)

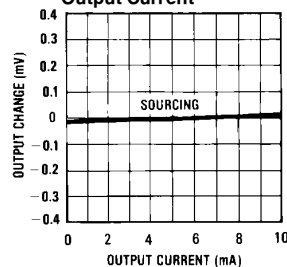
Quiescent Current vs. Input Voltage and Temperature



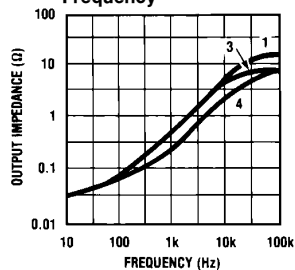
Dropout Voltage vs. Output Current



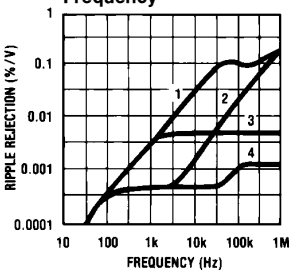
Output Change vs. Output Current



Output Impedance vs. Frequency

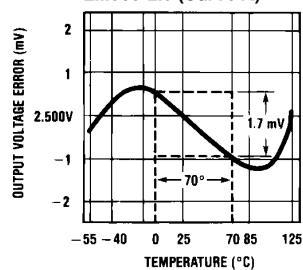


Ripple Rejection vs. Frequency

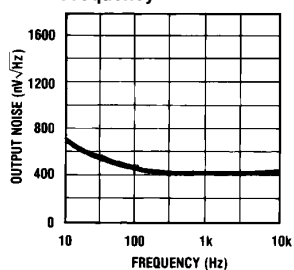


- (1) LM368 as is.
- (2) with 0.01 μ f Mylar, Trim to Gnd.
- (3) with 10 Ω in series with 10 μ f, V_{OUT} to Gnd.
- (4) with Both.

Temperature Coefficient: LM368-2.5 (Curve A)



Output Noise vs. Frequency

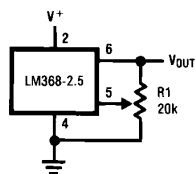


Typical Temperature Coefficient Calculations:
 LM368-2.5 (see Curve A)
 $T.C. = 1.7 \text{ mV} / (70^\circ \times 2.5\text{V})$
 $= 9.7 \text{ ppm}/^\circ\text{C}$

TL/H/8446-3

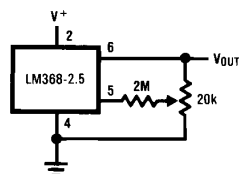
Typical Applications

Wide Range Trimmable Regulator



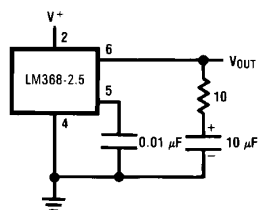
TL/H/8446-5

Narrow Range Trimmable Regulator ($\pm 1\%$ min.)



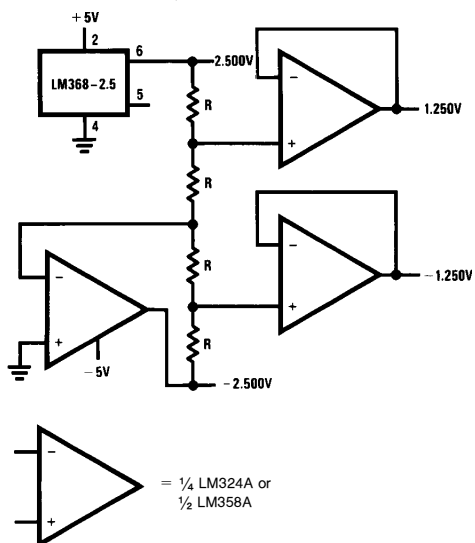
TL/H/8446-6

Improved Noise Performance



TL/H/8446-7

$\pm 2.5V$, $\pm 1.25V$ References

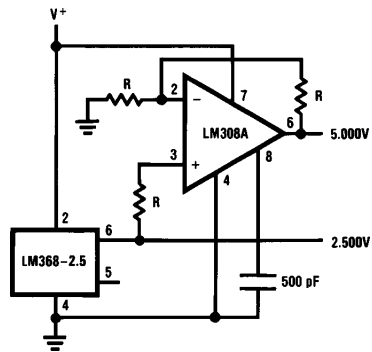


TL/H/8446-8

R = Thin Film Resistor Network,
 $\pm 0.05\%$ Matching and 5 ppm Tracking
 (Beckman 694-3-R-10K-A),
 (Caddock T-914-10K-100-05)
 or similar.

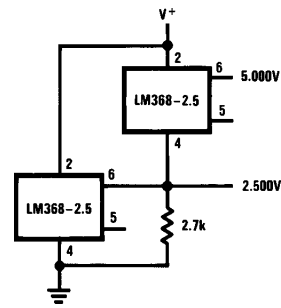
Typical Applications (Continued)

Multiple Output Voltages



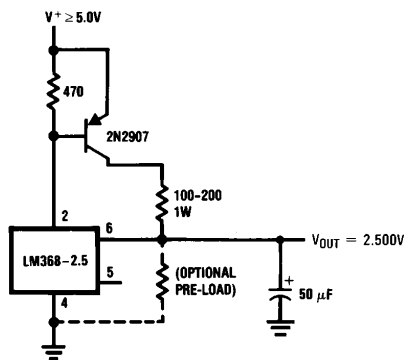
TL/H/8446-10

R = Thin Film Resistor Network
0.05% Matching and 5 ppm Tracking
(Beckman 694-3-R-10K-A),
(Caddock T-914-10K-100-05)
or similar.



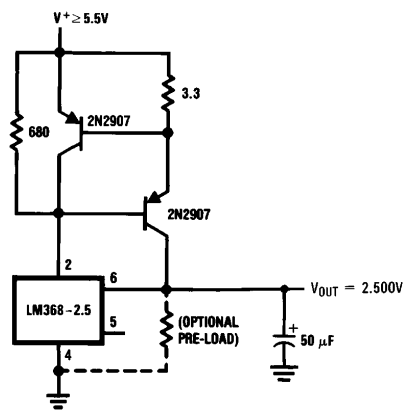
TL/H/8446-9

Reference with Booster



TL/H/8446-11

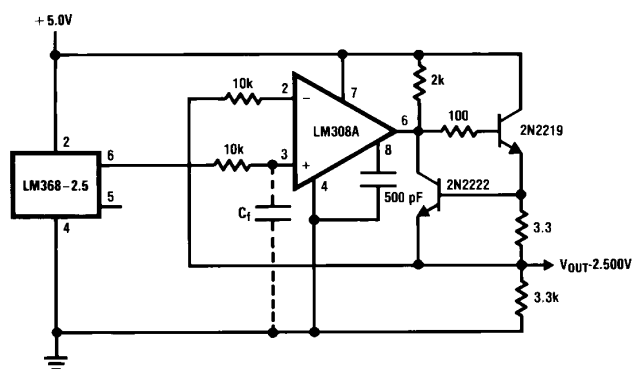
100 mA Boosted Reference



TL/H/8446-12

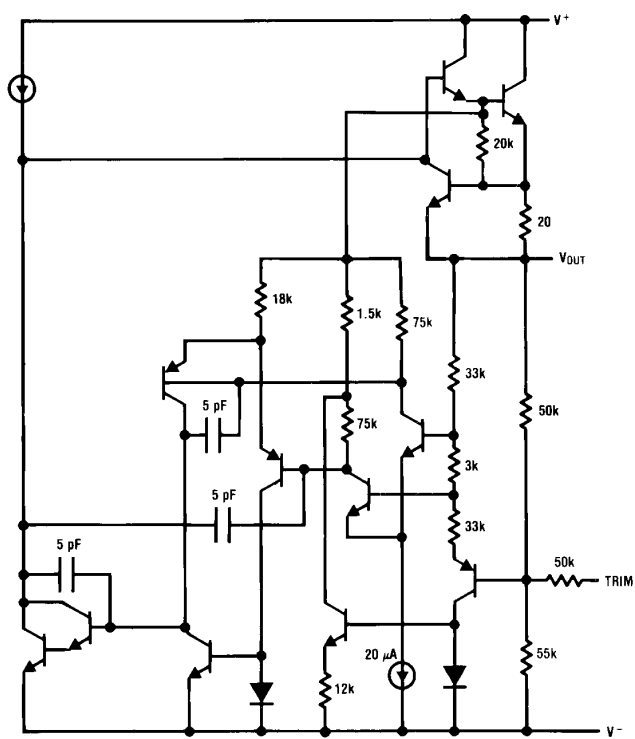
Typical Applications (Continued)

Buffered High-Current Reference with Filter



TL/H/8446-13

Simplified Schematic Diagram

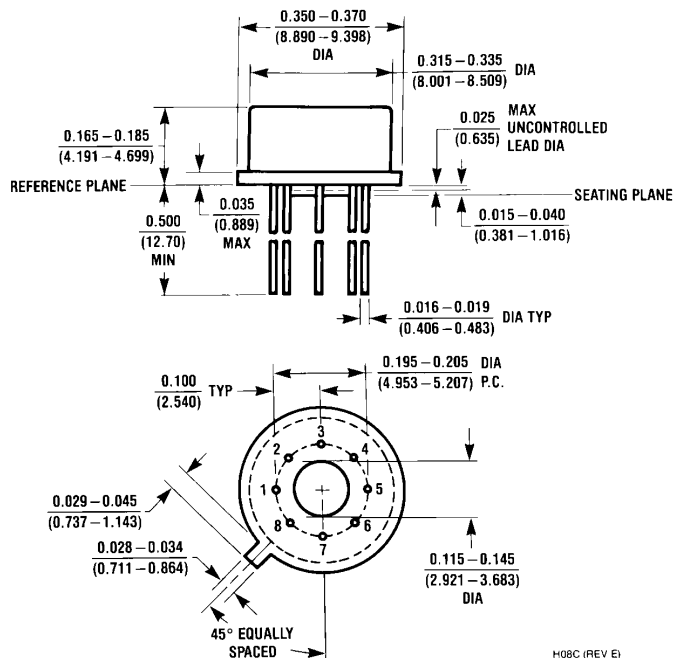


TL/H/8446-14

*Reg. U.S. Pat. Off.

Physical Dimensions inches (millimeters)

Lit. # 106560



Metal Can Package (H)
Order Number LM368H-2.5 or LM368YH-2.5
NS Package Number H08C

H08C (REV E)

This data sheet contains preliminary limits and design specifications. Supplemental information will be published at a later date. National Semiconductor reserves the right to make changes in the products contained in this document in order to improve design or performance and to supply the best possible products. National also assumes no responsibility for the use of any circuits described herein, conveys no license under any patent or other right, and makes no representations that the circuits are free from patent infringement. Applications for any integrated circuits contained in this document are for illustration purposes only and National makes no representation or warranty that such applications will be suitable for the use specified without further testing or modification.

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 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.



National Semiconductor Corporation
 1111 West Bardin Road
 Arlington, TX 76017
 Tel: 1(800) 272-9959
 Fax: 1(800) 737-7018

National Semiconductor Europe
 Fax: (+49) 0-180-530 85 86
 Email: cnjwge@tevm2.nsc.com
 Deutsch Tel: (+49) 0-180-530 85 85
 English Tel: (+49) 0-180-532 78 32
 Français Tel: (+49) 0-180-532 93 58
 Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
 19th Floor, Straight Block,
 Ocean Centre, 5 Canton Rd.
 Tsimshatsui, Kowloon
 Hong Kong
 Tel: (852) 2737-1600
 Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
 Tel: 81-043-299-2309
 Fax: 81-043-299-2408

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.