National Semiconductor

PRELIMINARY

LM368-2.5 Precision Voltage Reference

General Description

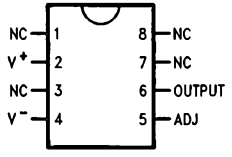
The LM368-2.5 is a precision, monolithic, temperature-compensated voltage reference. The LM368-2.5 makes use of thin-film technology enhanced by the discrete laser trimming of resistors to achieve excellent Temperature coefficient (Tempco) of V_{OUT} (as low as 11 ppm/°C), along with tight initial tolerance, (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 μA 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 Diagrams

Dual-In-Line Package (N)
or S.O. Package (M)



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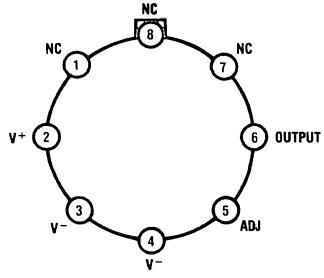
Top View

Order Number LM368N-2.5
See NS Package Number N08E

Metal Can Package



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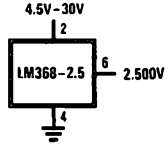
Top View

*case connected to V−

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

Typical Applications

Low Voltage Reference



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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

DIP (N) Package (10 sec.)	+260°C
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	0°C ≤ T_A ≤ 70°C	±11	±20		ppm/°C
(Note 5) LM368-2.5	0°C ≤ T_A ≤ 70°C	±15		±30	ppm/°C
Short Circuit Current	V_{OUT} = 0	30	70	100	mA
Noise: 0.1–10 Hz		12			uVp-p
100 Hz–10 kHz		420			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.

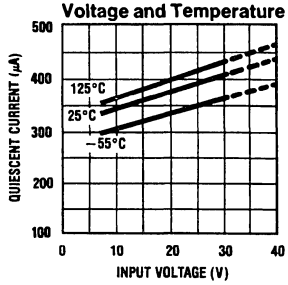
Note 6: In metal can (H), $\theta_{J\text{-}C}$ is 75°C/W and $\theta_{J\text{-}A}$ is 150°C/W. In plastic DIP, $\theta_{J\text{-}A}$ is 160°C/W. In SO-8, $\theta_{J\text{-}A}$ is 180°C/W, in TO-92, $\theta_{J\text{-}A}$ is 160°C/W.

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).

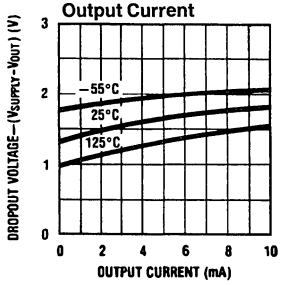
Note 8: Load regulation is measured on the output pin at a point ⅛" below the base of the package. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Typical Performance Characteristics (Note 1)

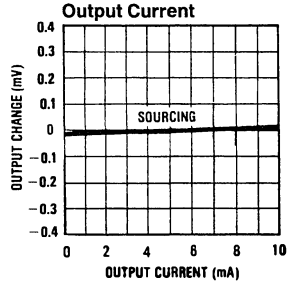
Quiescent Current vs. Input Voltage and Temperature



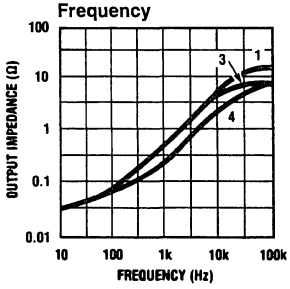
Dropout Voltage vs. Output Current



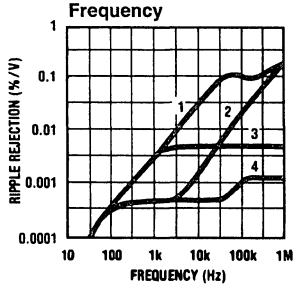
Output Change vs. Output Current



Output Impedance vs. Frequency

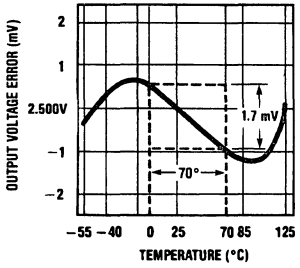


Ripple Rejection vs. Frequency

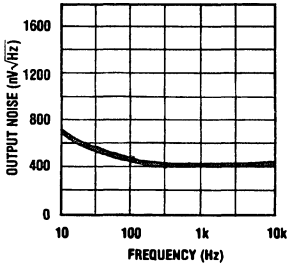


(1) LM368 as is.
(2) with 0.01 μf Mylar, Trim to Gnd.
(3) with 10Ω in series with 10 μf, V_{OUT} to Gnd.
(4) with Both.

Temperature Coefficient: LM368-2.5 (Curve A)



Output Noise vs. Frequency



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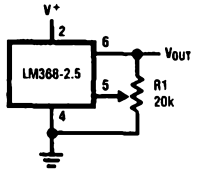
Typical Temperature Coefficient Calculations:
LM368-2.5 (see Curve A)
T.C. = 1.7 mV/(70° × 2.5V)
= 9.7 ppm/°C

Typical Applications

Wide Range Trimmable Regulator



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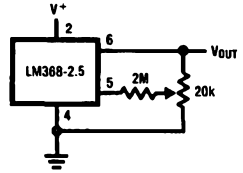
Narrow Range Trimmable Regulator (±1% min.)



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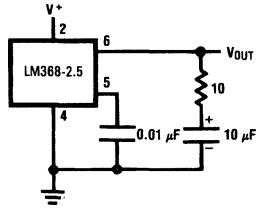
Improved Noise Performance



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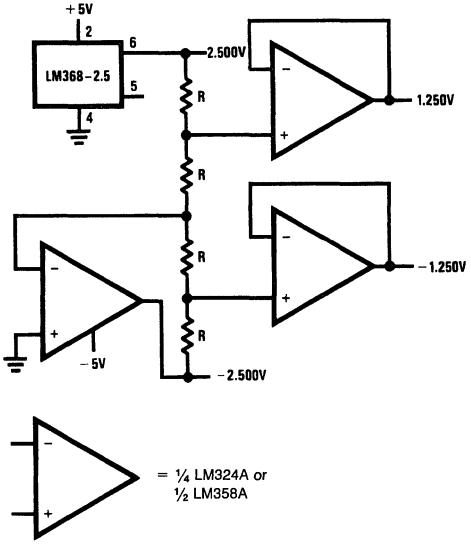
±2.5V, ±1.25V References



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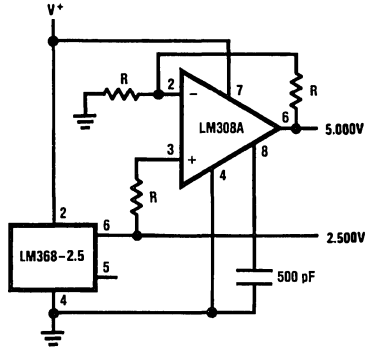
R= Thin Film Resistor Network,
±0.05% Matching and 5 ppm Tracking
(Beckman 694-3-R-10K-A),
(Caddock T-914-10K-100-05)
or similar.

Typical Applications (Continued)

Multiple Output Voltages



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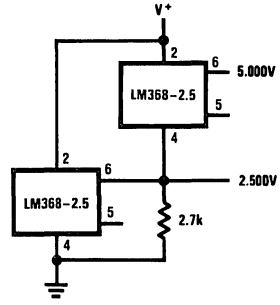

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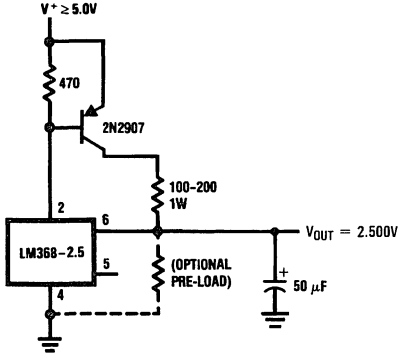
R = Thin Film Resistor Network
0.05% Matching and 5 ppm Tracking
(Beckman 694-3-R-10K-A),
(Caddock T-914-10K-100-05)
or similar.

Reference with Booster



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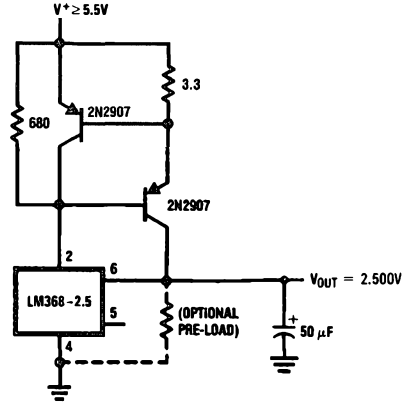
100 mA Boosted Reference



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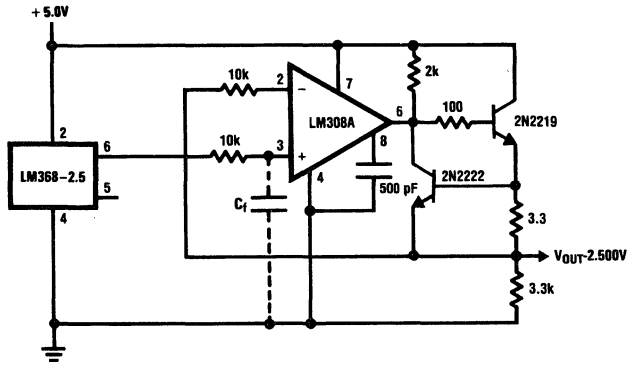
Typical Applications (Continued)

Buffered High-Current Reference with Filter



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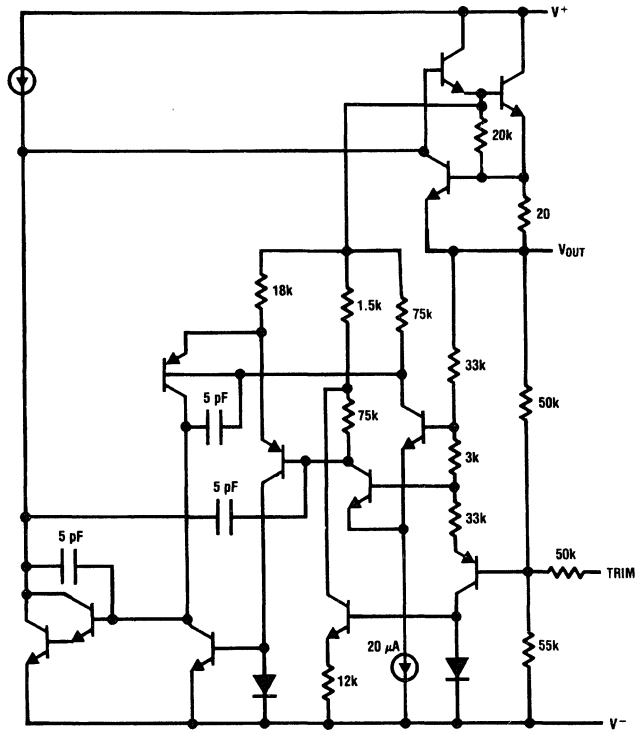
Simplified Schematic Diagram



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*Reg. U.S. Pat. Off.