

## LM368-5.0 and LM368-10 Precision Voltage References

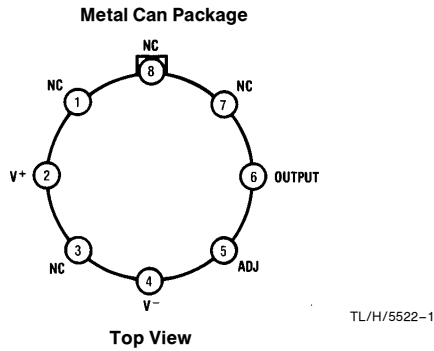
### General Description

The LM368 is a precision, monolithic, temperature-compensated voltage reference. The LM368 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 5ppm/°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 also provides excellent stability vs. changes in input voltage and output current (both sourcing and sinking). This device is available in output voltage options of 5.0V and 10.0V and will operate in both series or shunt mode. Also see the LM368-2.5 data sheet for a 2.5V output. The devices are short circuit proof when sourcing current. 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

- 300  $\mu$ A operating current
- Low output impedance
- Excellent line regulation (.0001%/V typical)
- Single-supply operation
- Externally trimmable
- Low temperature coefficient
- Operates in series or shunt mode
- 10.0V or 5.0V
- Excellent initial accuracy (0.02% typical)

### Connection Diagram

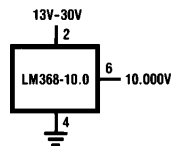


\*case connected to  $V^-$

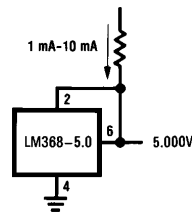
Order Number LM368YH-10,  
LM368YH-5.0, LM368H-10, LM368H-5.0  
See NS Package Number H08C

### Typical Applications

#### Series Regulator



#### Shunt Regulator



## Absolute Maximum Ratings (Note 8)

Input Voltage (Series Mode)	35V
Reverse Current (Shunt Mode)	50 mA
Power Dissipation	600 mW
Storage Temperature Range	-60°C to +150°C
Operating Temperature Range	0°C to +70°C
LM368	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			
		Typical	Tested Limit (Note 2)	Design Limit (Note 3)	Units (Max. unless noted)
$V_{OUT}$ Error		±0.02	±0.1		%
Line Regulation	$(V_{OUT} + 3V) \leq V_{IN} \leq 30V$	±0.0001	±0.0005		%/V
Load Regulation (Note 4)	$0 \text{ mA} \leq I_{SOURCE} \leq 10 \text{ mA}$ $-10 \text{ mA} \leq I_{SINK} \leq 0 \text{ mA}$	±0.0003 ±0.003	±0.001 ±0.008		%/mA %/mA
Thermal Regulation	$T = 20 \text{ mS}$ (Note 5)	±0.005	±0.01		%/100 mW
Quiescent Current		250	350		μA
Change of Quiescent Current vs. $V_{IN}$	$(V_{OUT} + 3V) \leq V_{IN} \leq 30V$	3	5		μA/V
Temperature Coefficient of $V_{OUT}$ (see graph): LM368Y (Note 6)	$0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$	±11 ±15	±20	±30	ppm/°C ppm/°C
Short Circuit Current	$V_{OUT} = 0$	30	70	100	mA
Noise:					
10.0V: 0.1 - 10Hz		30			μVp-p
100Hz - 10 kHz		1100			nV/√Hz
6.2V: 0.1 - 10Hz		20			μVp-p
100Hz - 10 kHz		700			nV/√Hz
5.0V: 0.1 - 10Hz		16			μVp-p
100Hz - 10 kHz		575			nV/√Hz
$V_{OUT}$ Adjust Range: 10.000V 5.000V	$0V \leq V_{PIN5} \leq V_{OUT}$	4.5-17.0 4.4-7.0		6.0-15.5 4.5-6.0	V min. V min.

**Note 1:** Unless otherwise noted, these specifications apply:  $T_A = 25^\circ\text{C}$ ,  $V_{IN} = 15V$ ,  $I_{LOAD} = 0$ ,  $0 \leq C_L \leq 200 \text{ pF}$ . Circuit is operating in Series Mode. Or, circuit is operating in Shunt Mode,  $V_{IN} = +15V$  or  $V_{IN} = V_{OUT}$ ,  $T_A = +25^\circ\text{C}$ ,  $I_{LOAD} = -1.0 \text{ mA}$ ,  $0 \leq C_L \leq 200 \text{ pF}$ .

**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:** The LM368 has a Class B output, and will exhibit transients at the crossover point. This point occurs when the device is asked to sink approximately 120 μA. In some applications it may be advantageous to preload the output to either  $V_{IN}$  or Ground, to avoid this crossover point.

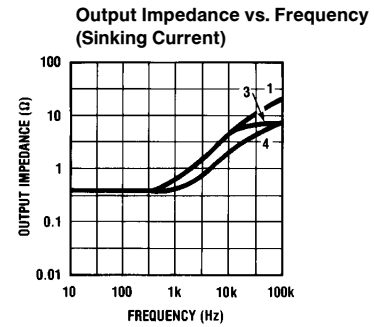
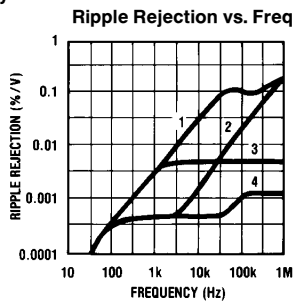
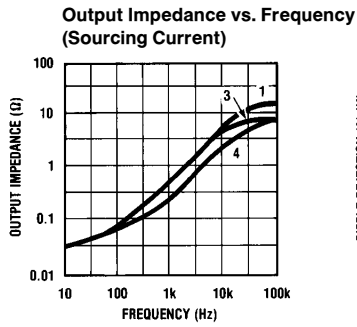
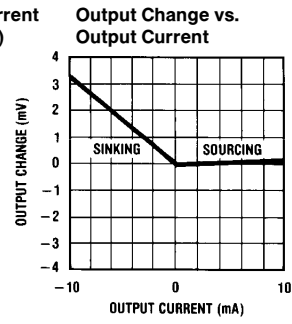
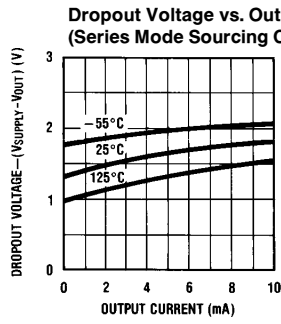
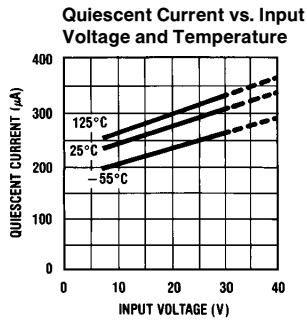
**Note 5:** Thermal Regulation is defined as the change in the output Voltage at a time T after a step change in power dissipation of 100 mW.

**Note 6:** 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.

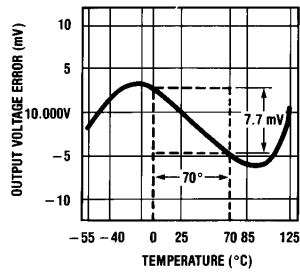
**Note 7:** In metal can (H),  $\theta_{J-C}$  is 75°C/W and  $\theta_{J-A}$  is 150°C/W.

**Note 8:** 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).

## Typical Performance Characteristics (Note 1)



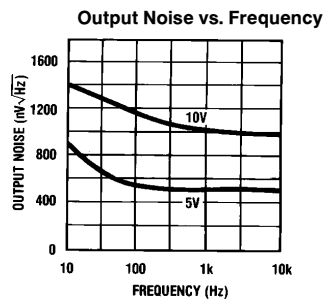
### Temperature Coefficient: LM368-10 (Curve A)



Typical Temperature Coefficient Calculations:  
 LM368-10 (see Curve A)  
 $T.C. = 7.7 \text{ mV} / (70^\circ \times 10\text{V})$   
 $= 11 \times 10^{-6} = 11 \text{ ppm}/^\circ\text{C}$

TL/H/5522-4

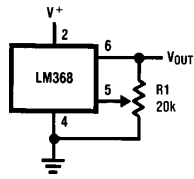
- (1) LM368 alone.
- (2) with 0.01  $\mu\text{f}$  Mylar, Trim to Gnd.
- (3) with 10  $\Omega$  in series with 10  $\mu\text{f}$ ,  $V_{\text{OUT}}$  to Gnd.
- (4) with Both.



TL/H/5522-5

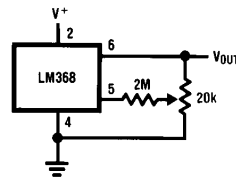
# Typical Applications

Wide Range Trimmable Regulator



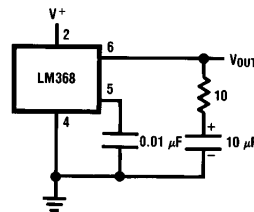
TL/H/5522-7

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



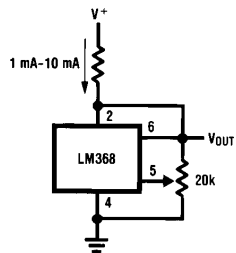
TL/H/5522-8

Improved Noise Performance



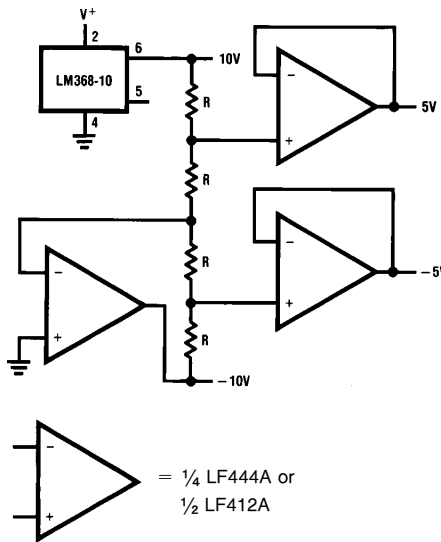
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Adjustable Zener



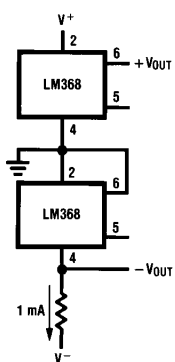
TL/H/5522-9

$\pm 10V, \pm 5V$  References



TL/H/5522-12

$\pm$  Reference

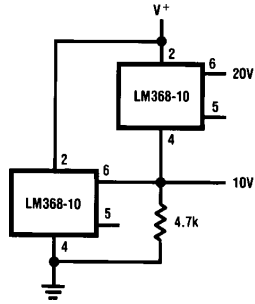


TL/H/5522-11

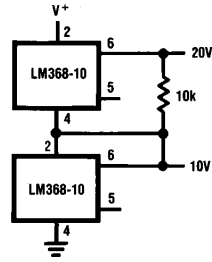
R = Thin Film Resistor Network,  
 $\pm 0.05\%$  Matching and 5ppm Tracking  
 (Beckman 694-3-R-10K-A),  
 (Caddock T-914-10K-100-05)  
 or similar.

## Typical Applications (Continued)

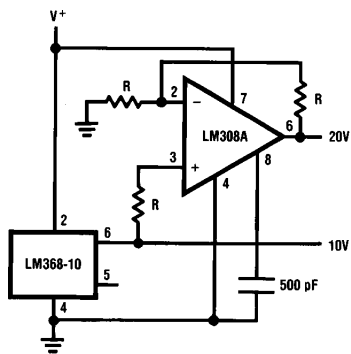
### Multiple Output Voltages



TL/H/5522-13



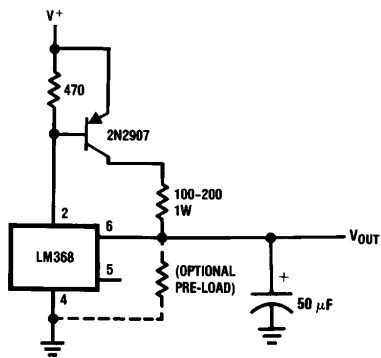
TL/H/5522-14



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

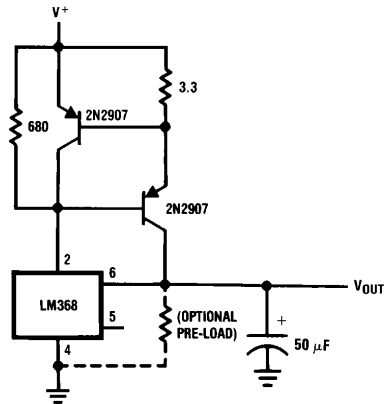
TL/H/5522-15

### Reference with Booster



TL/H/5522-16

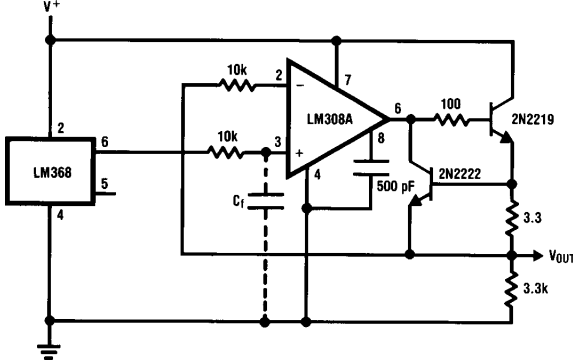
### 100 mA Boosted Reference



TL/H/5522-17

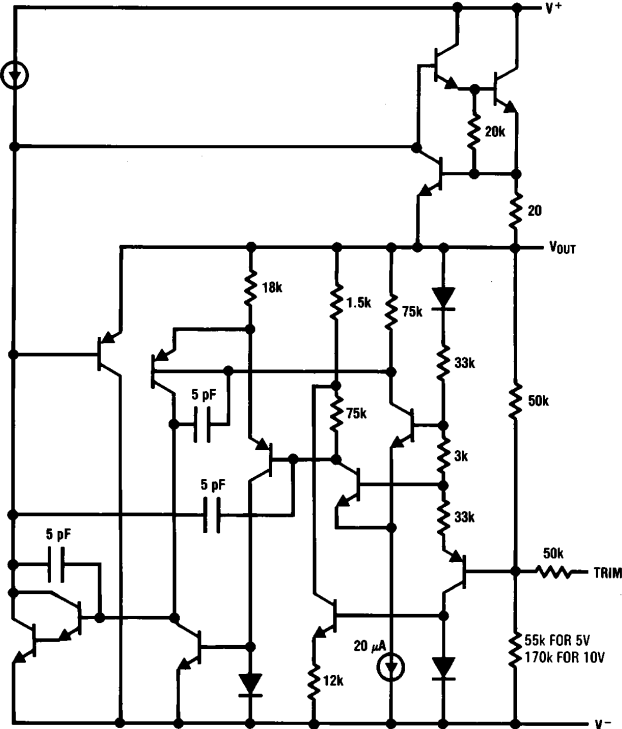
**Typical Applications** (Continued)

**Buffered High-Current Reference with Filter**



TL/H/5522-18

**Simplified Schematic Diagram**

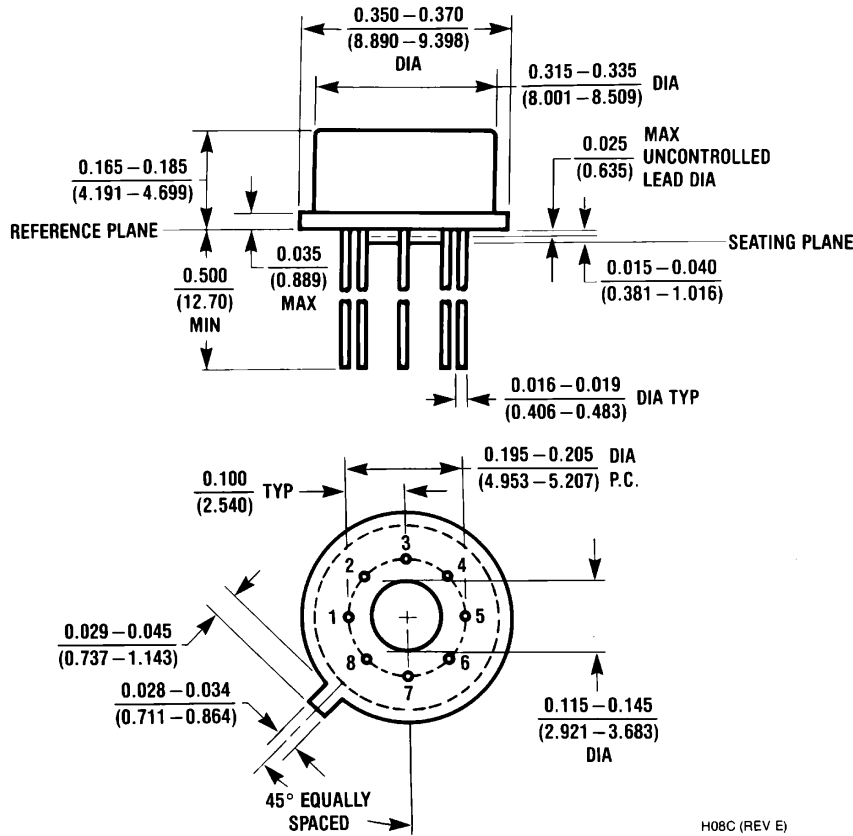


TL/H/5522-6

\*Reg. U.S. Pat. Off.



**Physical Dimensions** inches (millimeters)



Thermal resistance is 45°C/W, junction to case, and 150°C/W, junction to still air.

**Metal Can Package (H)**

**Order Number LM368YH-10,  
LM368YH-5.0, LM368H-10, LM368H-5.0  
NS Package Number H08C**

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