

FEATURES

- $\pm 1\%$ and 2% Initial Tolerance
- Operating Current of $10\mu\text{A}$ to 20mA
- 1Ω Dynamic Impedance
- Low Temperature Coefficient
- Low Voltage Reference— 1.235V
- 2.5V Device and Adjustable Device Also Available
- **285-1.2 Series and 285 Series, respectively**

DESCRIPTION

The 285-1.2/385-1.2 are micropower 2-terminal band-gap voltage regulator diodes. Operating over a $10\mu\text{A}$ to 20mA current range, they feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming is used to provide tight voltage tolerance. Since the 285-1.2 band-gap reference uses only transistors and resistors, low noise and good long term stability result.

Careful design of the 285-1.2 has made the device exceptionally tolerant of capacitive loading, making it easy to use in almost any reference application. The wide dynamic operating range allows its use with widely varying supplies with excellent regulation.

The extremely low power drain of the 285-1.2 makes it useful for micropower circuitry. This voltage reference can be used to make portable meters, regulators or general purpose analog circuitry with battery life approaching shelf life.

Further, the wide operating current allows it to replace older references with a tighter tolerance part.

The 285-1.2 is rated for operation over a -55°C to 125°C temperature range while the 285-1.2 is rated -40°C to 85°C and the 385-1.2 0°C to 70°C . The 285-1.2/385-1.2 are available in a hermetic TO package and the 285-1.2/385-1.2 are also available in a low-cost TO-92 molded package, as well as SOIC and SOT-23.

CONNECTION DIAGRAM

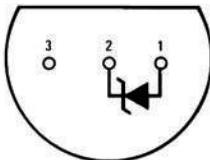
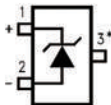


Figure 1. T0-92 Package (LP) (Bottom View)



* Pin 3 is attached to the Die Attach Pad (DAP) and should be connected to Pin 2 or left floating.

Figure 2. SOT-23

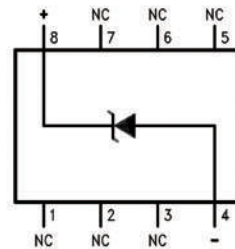


Figure 3. SOIC Package

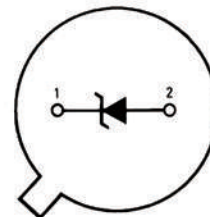


Figure 4. TO Package (NDV) (Bottom View)

ABSOLUTE MAXIMUM RATINGS ⁽¹⁾⁽²⁾⁽³⁾

Reverse Current	30mA
Forward Current	10mA
Operating Temperature Range ⁽⁴⁾	
XL185-1.2	-55°C to +125°C
XL285-1.2	-40°C to +85°C
XL385-1.2	0°C to 70°C
ESD Susceptibility ⁽⁵⁾	2kV
Storage Temperature	-55°C to +150°C
Soldering Information	
TO-92 package: 10 sec.	260°C
TO package:10 sec.	300°C
SOIC and SOT-23 Pkg.	
Vapor phase (60 sec.)	215°C
Infrared (15 sec.)	220°C
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.	

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional. For specifications and test conditions, see the Electrical Characteristics. The specifications apply only for the test conditions listed.
- (2) Refer to RETS185H-1.2 for military specifications.
- (3) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.
- (4) For elevated temperature operation, see [Table 1](#).
- (5) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin.

Table 1. $T_{J(max)}$ for Elevated Temperature Operation

DEVICE	$T_{J(max)}$ (°C)
XL185-1.2	150
XL285-1.2	125
XL385-1.2	100

ELECTRICAL CHARACTERISTICS⁽¹⁾

Parameter	Conditions	Typ	XL285-1.2		385M3-1.2 385-1.2		385-1.2		Units (Limit)
			Tested Limit ⁽²⁾ ₍₃₎	Design Limit ⁽⁴⁾	Tested Limit ⁽²⁾	Design Limit ⁽⁴⁾	Tested Limit ⁽²⁾	Design Limit ⁽⁴⁾	
Reverse Breakdown Voltage	$T_A = 25^\circ\text{C}$, $10\mu\text{A} \leq I_R \leq 20\text{mA}$	1.23 5	1.223		1.223		1.205		V(Min)
			1.247		1.247		1.260		V(Max)
Minimum Operating Current		8	10	20	15	20	15	20	μA
	385M3-1.2-N						10	15	(Max)
Reverse Breakdown Voltage Change with Current	$10\mu\text{A} \leq I_R \leq 1\text{mA}$		1	1.5	1	1.5	1	1.5	mV (Max)
	$1\text{mA} \leq I_R \leq 20\text{mA}$		10	20	20	25	20	25	mV (Max)
Reverse Dynamic Impedance	$I_R = 100\mu\text{A}$, $f = 20\text{Hz}$	1							Ω
Wideband Noise (rms)	$I_R = 100\mu\text{A}$, $10\text{Hz} \leq f \leq 10\text{kHz}$	60							μV
Long Term Stability	$I_R = 100\mu\text{A}$, $T = 1000\text{Hr}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$	20							ppm
Average Temperature Coefficient ⁽⁵⁾	$I_R = 100\mu\text{A}$								
	X Suffix		30		30				ppm/ $^\circ\text{C}$
	Y Suffix		50		50				ppm/ $^\circ\text{C}$
	All Others			150		150		150	ppm/ $^\circ\text{C}$ (Max)

- (1) Parameters identified with boldface type apply at temperature extremes. All other numbers apply at $T_A = T_J = 25^\circ\text{C}$.
(2) Production tested.
(3) A military RETS electrical specification is available on request.
(4) Specified by design. Not production tested. These limits are not used to calculate average outgoing quality levels.
(5) The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures between the operating T_{MAX} and T_{MIN} , divided by $T_{\text{MAX}} - T_{\text{MIN}}$. The measured temperatures are -55°C , -40°C , 0°C , 25°C , 70°C , 85°C , 125°C .

THERMAL CHARACTERISTICS

Thermal Resistance	TO-92	TO	SOIC	SOT-23
θ_{JA} (junction to ambient)	180 $^\circ\text{C}/\text{W}$ (0.4" leads) 170 $^\circ\text{C}/\text{W}$ (0.125" leads)	440 $^\circ\text{C}/\text{W}$	165 $^\circ\text{C}/\text{W}$	283 $^\circ\text{C}/\text{W}$
θ_{JC} (junction to case)	N/A	80 $^\circ\text{C}/\text{W}$	N/A	N/A

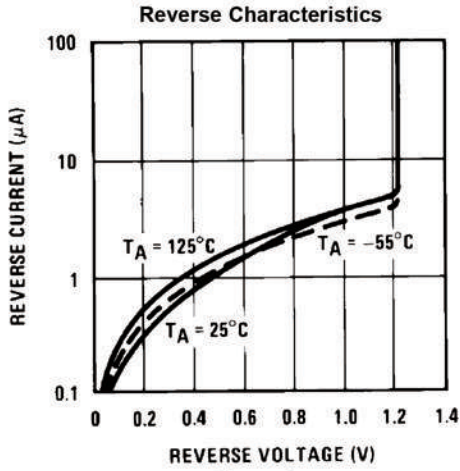


Figure 5.

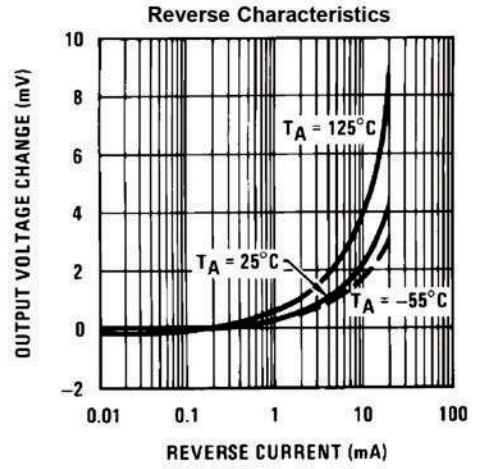


Figure 6.

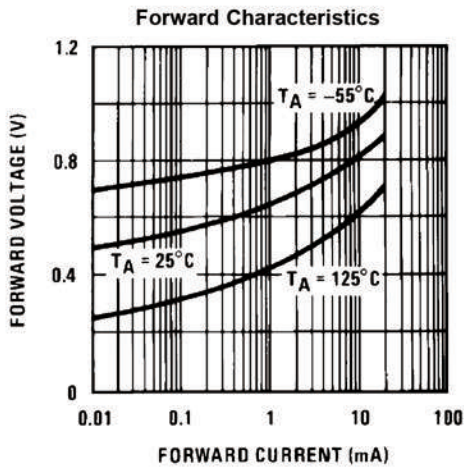


Figure 7.

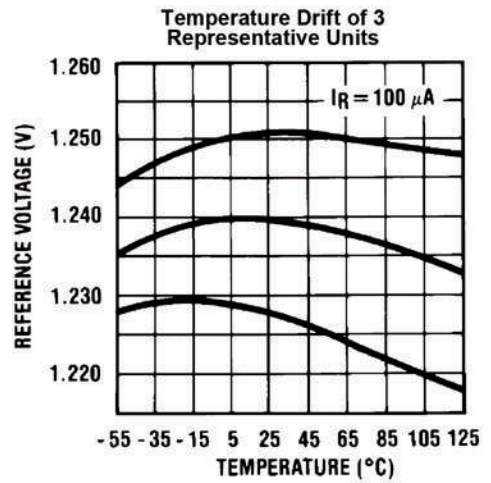


Figure 8.

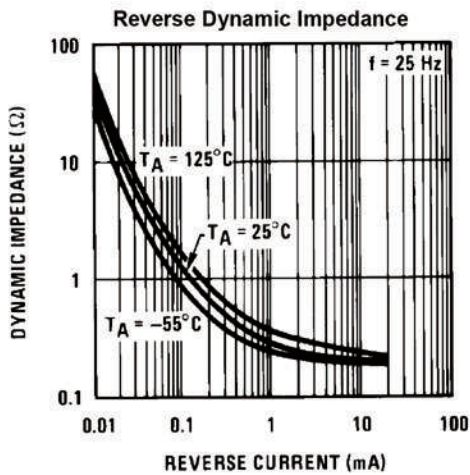


Figure 9.

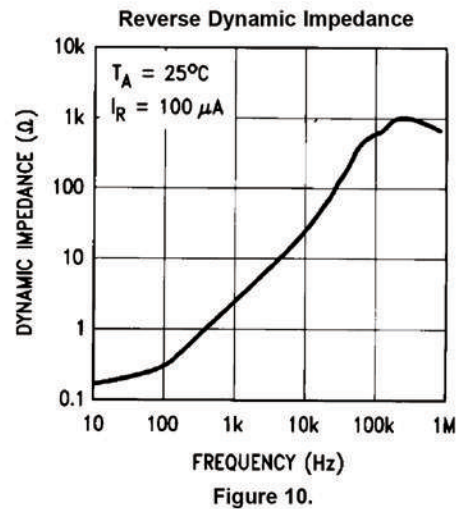


Figure 10.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

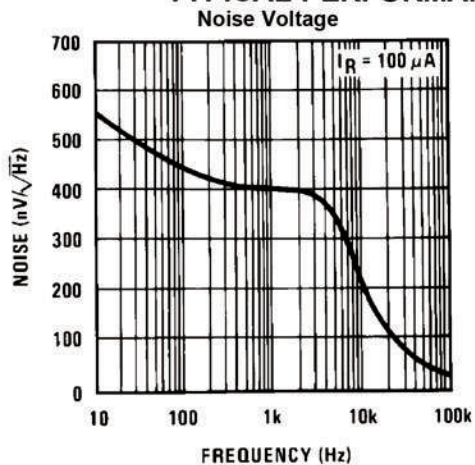


Figure 11.

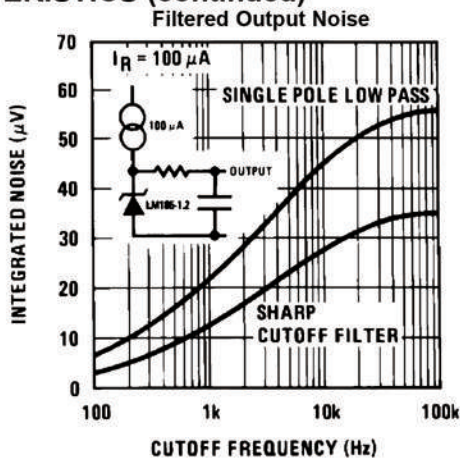


Figure 12.

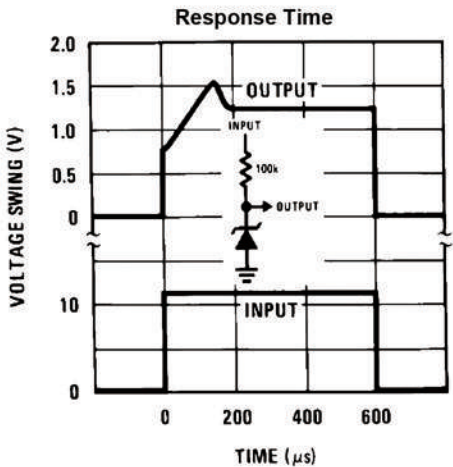


Figure 13.

TYPICAL APPLICATIONS

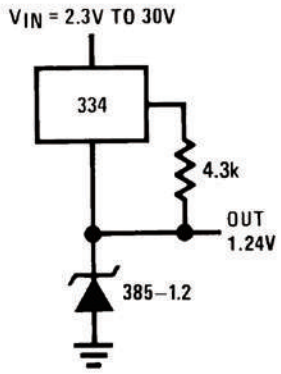


Figure 14. Wide Input Range Reference

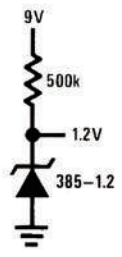


Figure 15. Micropower Reference from 9V Battery

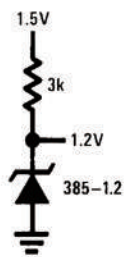
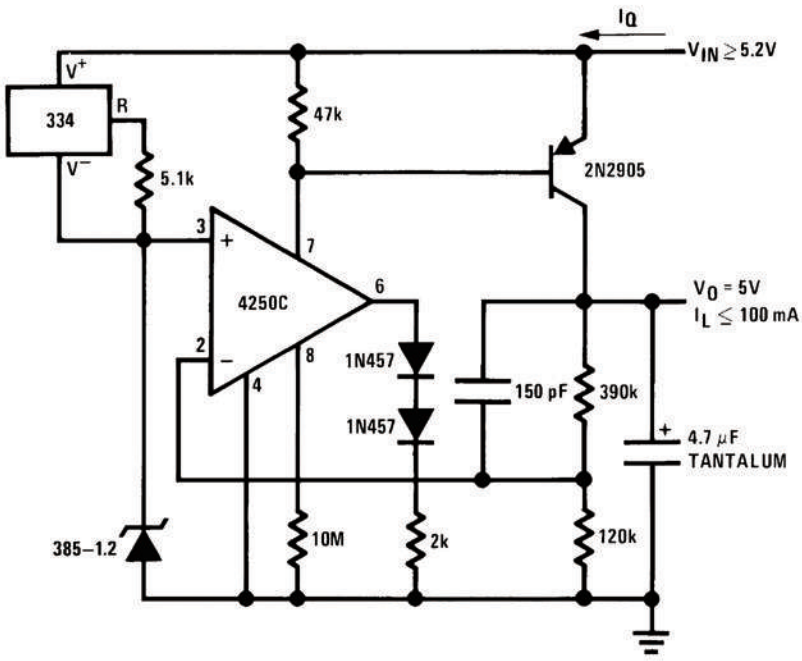
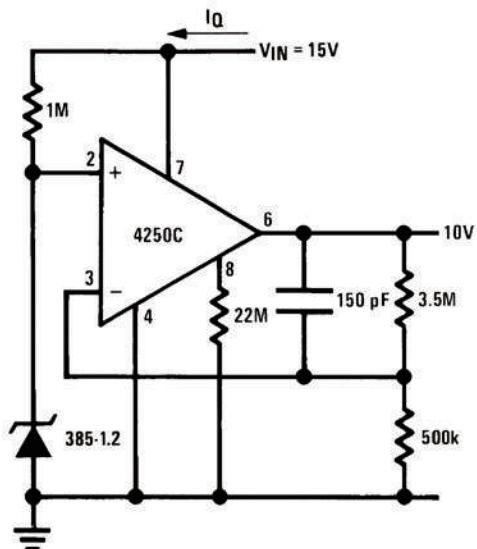


Figure 16. Reference from 1.5V Battery



*I_Q = 30μA

Figure 17. Micropower* 5V Regulator



* $I_Q = 20\mu\text{A}$ standby current

Figure 18. Micropower* 10V Reference

$$*I_{OUT} = \frac{1.23V}{R2}$$

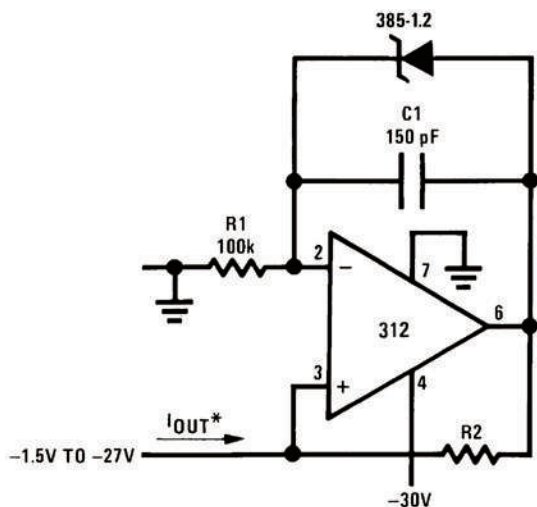


Figure 19.

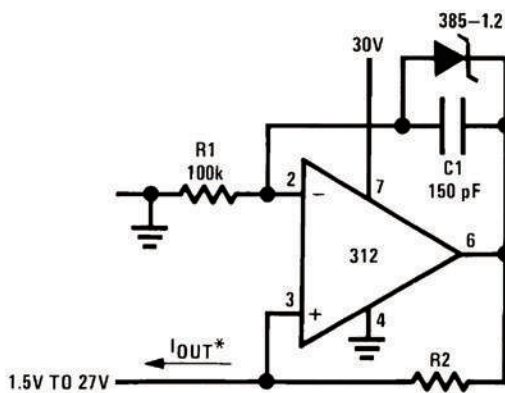
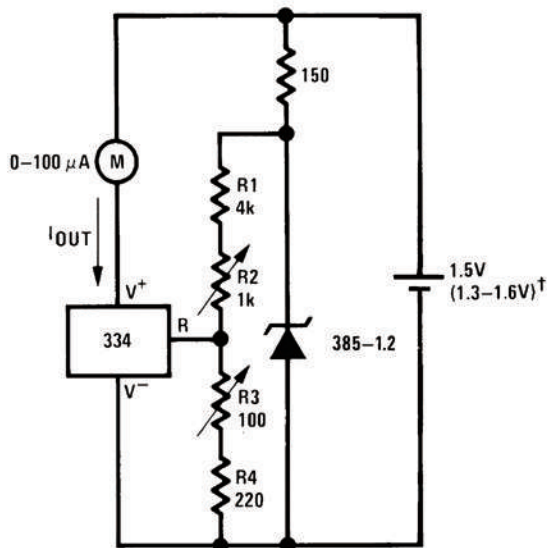


Figure 20. Precision 1µA to 1mA Current Sources

METER THERMOMETERS

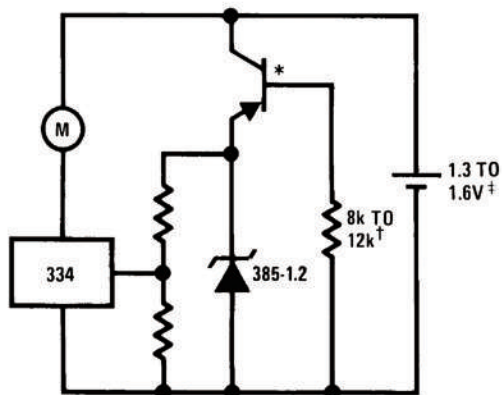


Calibration

1. Short 385-1.2-N, adjust R3 for $I_{OUT} = \text{temp}$ at $1\mu A/^{\circ}K$
 2. Remove short, adjust R2 for correct reading in centigrade
- † I_Q at 1.3V=500μA
 I_Q at 1.6V=2.4mA

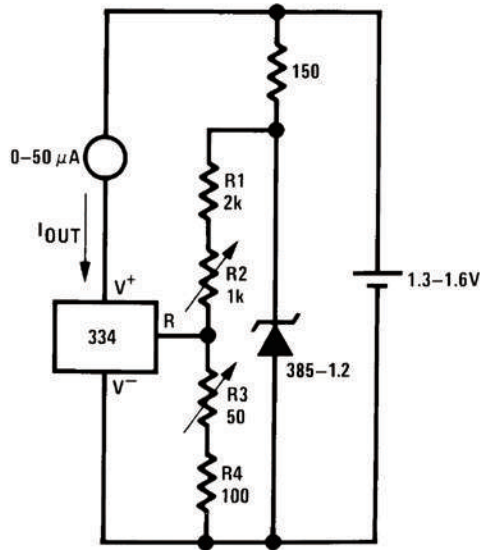
Figure 21. 0°C-100°C Thermometer

Figure 22.



- *2N3638 or 2N2907 select for inverse $H_{FE} \approx 5$
 †Select for operation at 1.3V
 ‡ $I_Q \approx 600\mu A$ to $900\mu A$

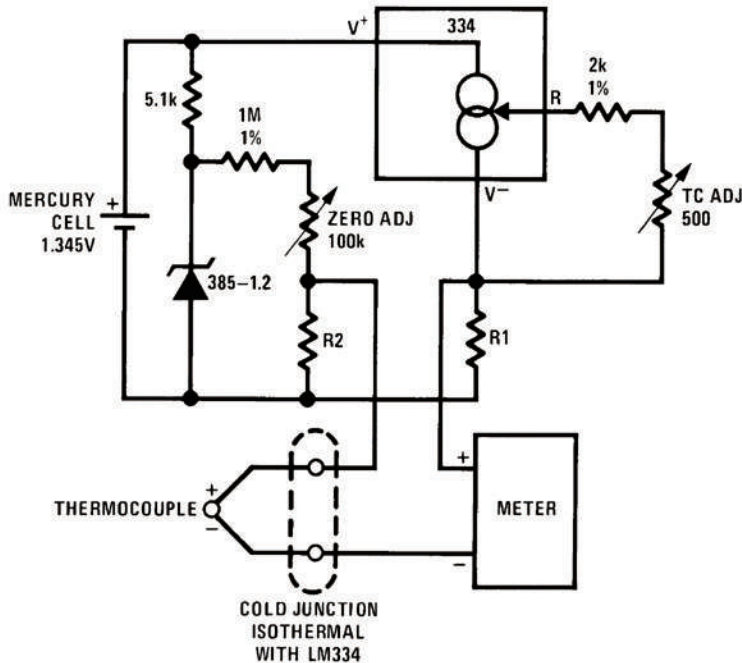
Figure 23. Lower Power Thermometer



Calibration

1. Short 385-1.2-N, adjust R3 for $I_{OUT} = \text{temp}$ at $1.8\mu\text{A}/^\circ\text{K}$
2. Remove short, adjust R2 for correct reading in $^\circ\text{F}$

Figure 24. 0°F–50°F Thermometer



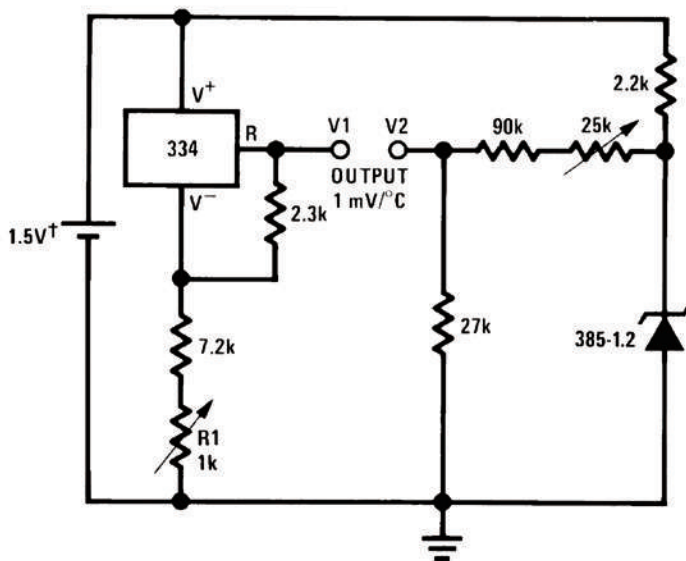
Adjustment Procedure

1. Adjust TC ADJ pot until voltage across R1 equals Kelvin temperature multiplied by the thermocouple Seebeck coefficient.
2. Adjust zero ADJ pot until voltage across R2 equals the thermocouple Seebeck coefficient multiplied by 273.2.

Figure 25. Micropower Thermocouple Cold Junction Compensator

Thermocouple Type	Seebeck Coefficient ($\mu\text{V}/^\circ\text{C}$)	R1 (Ω)	R2 (Ω)	Voltage Across R1 @ 25°C (mV)	Voltage Across R2 (mV)
J	52.3	523	1.24k	15.60	14.32
T	42.8	432	1k	12.77	11.78
K	40.8	412	953 Ω	12.17	11.17
S	6.4	63.4	150 Ω	1.908	1.766

Typical supply current 50 μA



Calibration

1. Adjust R1 so that V1 = temp at 1mV/°K
 2. Adjust V2 to 273.2mV
- †I_Q for 1.3V to 1.6V battery voltage = 50 μA to 150 μA

Figure 26. Centigrade Thermometer

SCHEMATIC DIAGRAM

