XL285-1.2 SOP8 XL385-1.2 SOP8
XB385M3-1.2 SOT23 XT385-1.2 TO92

FEATURES

- **±1% and 2% Initial Tolerance**
- **Operating Current of 10μA 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 10μA 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

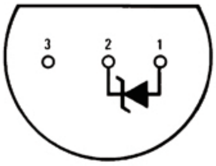
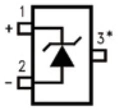


Figure 1. T0-92 Package (LP)
(Bottom View)



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

Figure 2. SOT-23

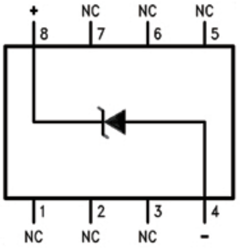


Figure 3. SOIC Package

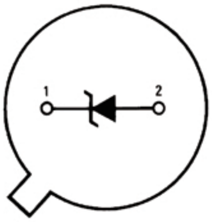


Figure 4. TO Package (NDV)
(Bottom View)

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	T_A = 25°C,	1.235	1.223		1.223		1.205		V(Min)
Voltage	10µA ≤ I_R ≤ 20mA		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	10µA ≤ I_R ≤ 1mA		1	**1.5**	1	**1.5**	1	**1.5**	mV (Max)
	1mA ≤ I_R ≤ 20mA		10	**20**	20	**25**	20	**25**	mV (Max)
Reverse Dynamic Impedance	I_R = 100µA, f = 20Hz	1							Ω
Wideband Noise (rms)	I_R = 100µA, 10Hz ≤ f ≤ 10kHz	60							µV
Long Term Stability	I_R = 100µA, T = 1000 Hr, T_A = 25°C ±0.1°C	20							ppm
Average Temperature Coefficient (5)	I_R = 100µA								
	X Suffix		**30**		**30**				ppm/°C
	Y Suffix		**50**		**50**				ppm/°C
	All Others			**150**		**150**		**150**	ppm/°C (Max)

(1) Parameters identified with boldface type apply at temperature extremes. All other numbers apply at $T_A = T_J$ = 25°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 $T_{MAX} - T_{MIN}$. 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°C/W (0.4″ leads) 170°C/W (0.125″ leads)	440°C/W	165°C/W	283°C/W
θ_{JC} (junction to case)	N/A	80°C/W	N/A	N/A

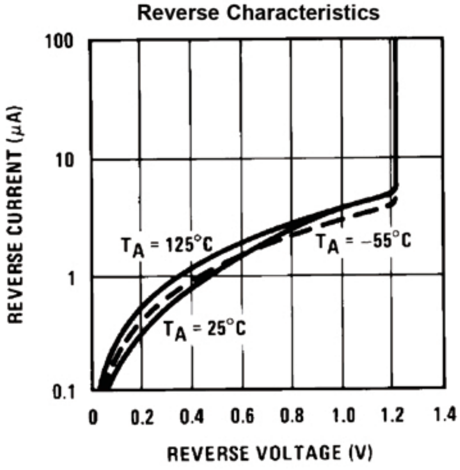


Figure 5.

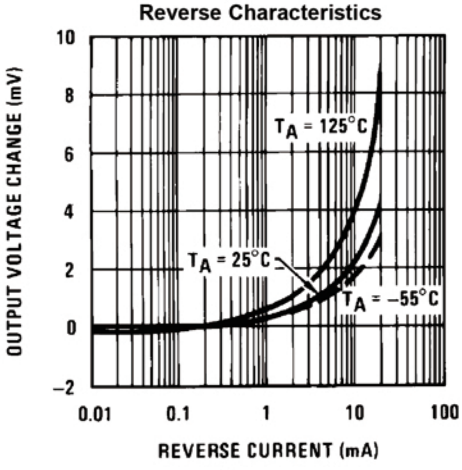
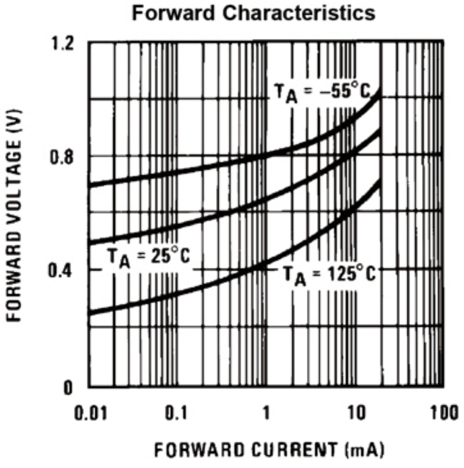


Figure 6.



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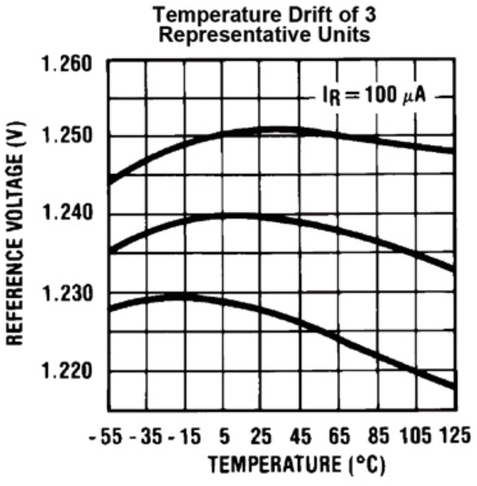

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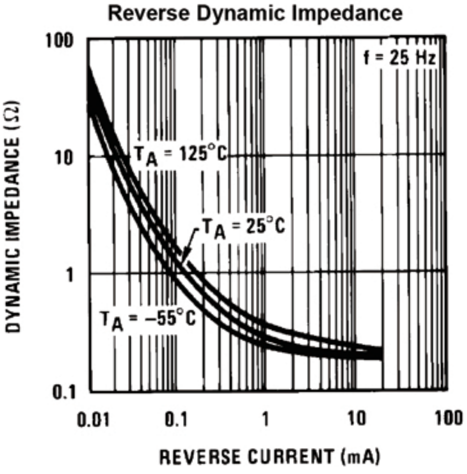

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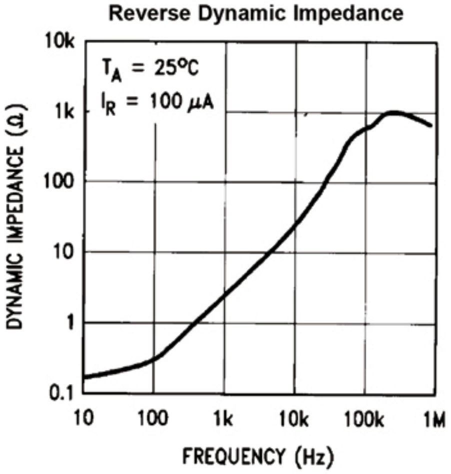


Figure 10.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Noise Voltage

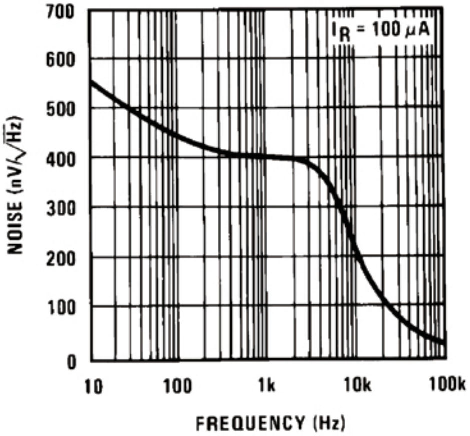


Figure 11.

Filtered Output Noise

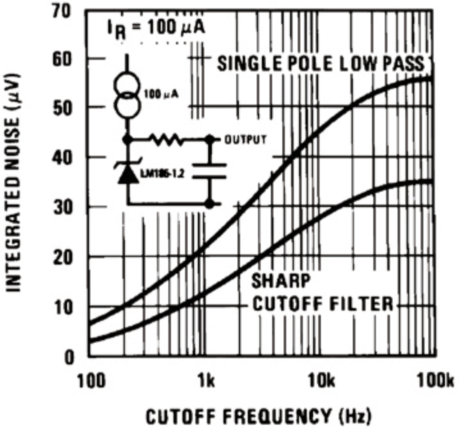


Figure 12.

Response Time

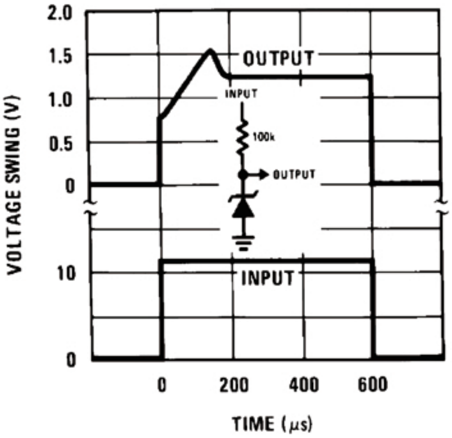


Figure 13.

TYPICAL APPLICATIONS

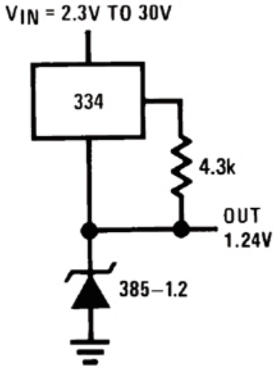


Figure 14. Wide Input Range Reference

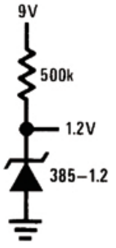


Figure 15. Micropower Reference from 9V Battery

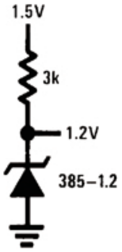
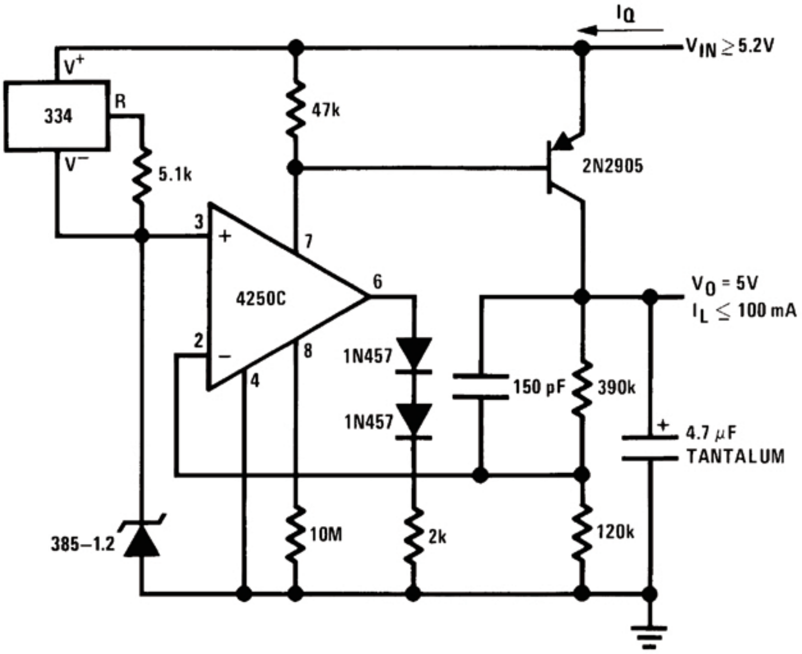
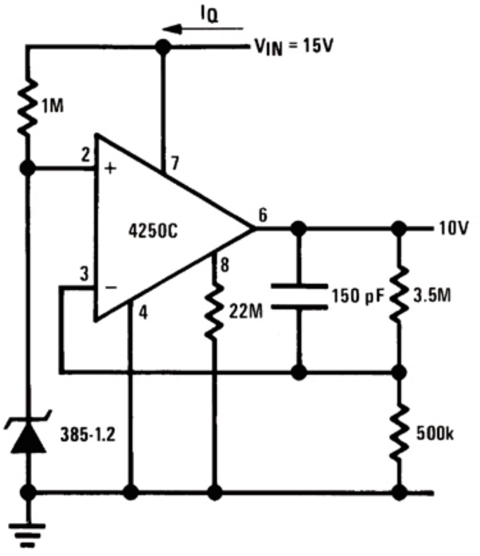


Figure 16. Reference from 1.5V Battery



*$I_Q \approx 30\mu A$

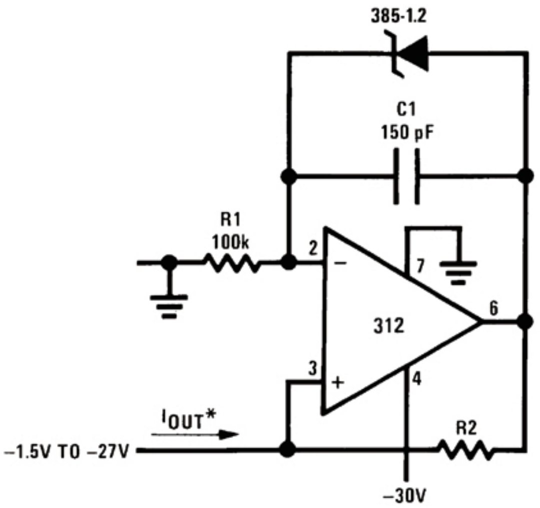
Figure 17. Micropower* 5V Regulator



*I_Q ≈20μA standby current

Figure 18. Micropower* 10V Reference

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



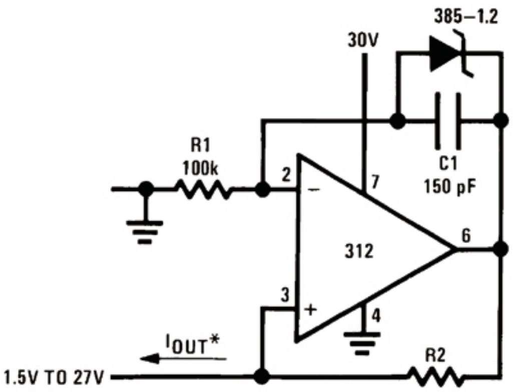
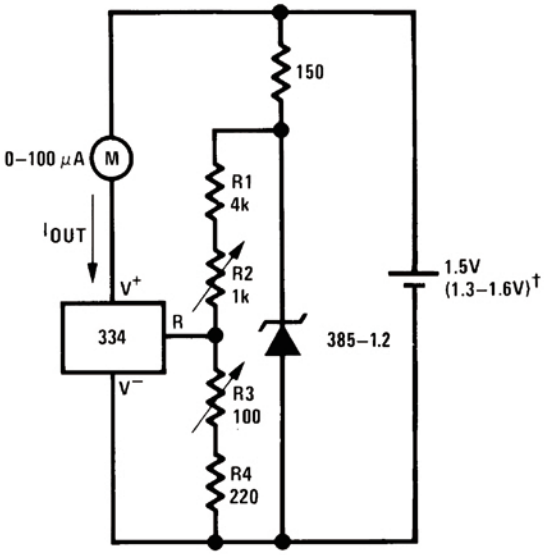


Figure 19.

Figure 20. Precision 1μA to 1mA Current Sources

METER THERMOMETERS



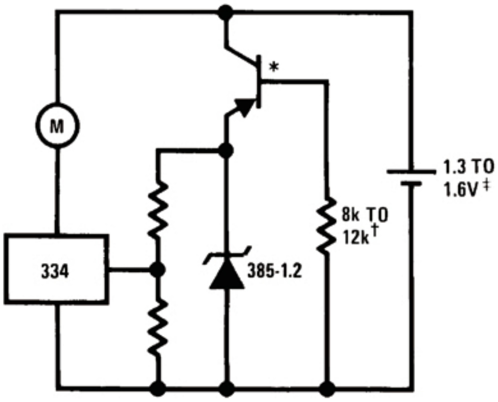
Calibration

1. Short 385-1.2-N, adjust R3 for I_{OUT}= temp at 1µA/°K
2. Remove short, adjust R2 for correct reading in centigrade

†I_Q at 1.3V≈500µA
I_Q at 1.6V≈2.4mA

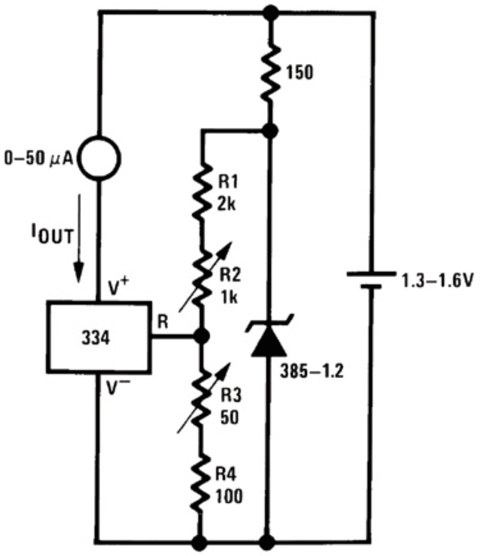
Figure 21. 0°C−100°C Thermometer

Figure 22.



*2N3638 or 2N2907 select for inverse H_{FE} ≈ 5
†Select for operation at 1.3V
‡I_Q ≈ 600µA to 900µA

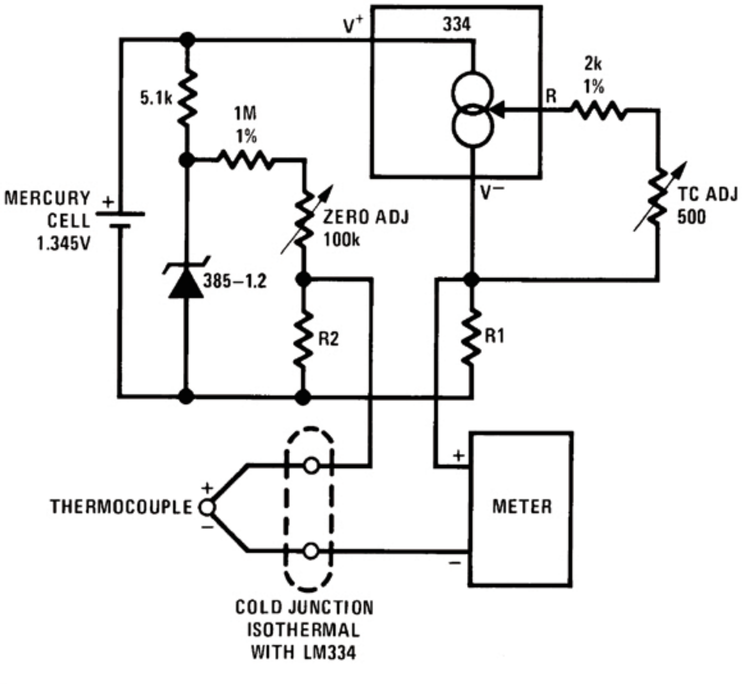
Figure 23. Lower Power Thermometer



Calibration

1. Short 385-1.2-N, adjust R3 for I_{OUT}= temp at 1.8μA/°K
2. Remove short, adjust R2 for correct reading in °F

Figure 24. 0°F−50°F Thermometer



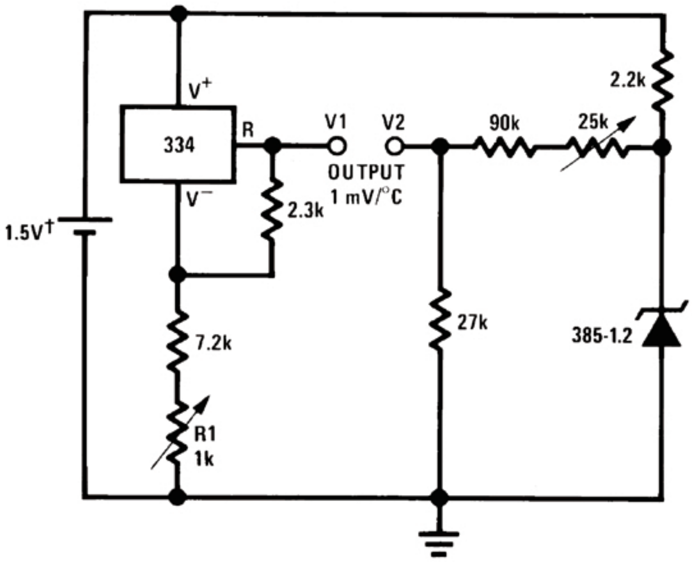
Adjustment Procedure

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	**Seebeck**	**R1**	**R2**	**Voltage**	**Voltage**
Type	**Coefficient**	**(Ω)**	**(Ω)**	**Across R1**	**Across R2**
	(µV/°C)			**@ 25°C**	**(mV)**
				(mV)	
J	52.3	523	1.24k	15.60	14.32
T	42.8	432	1k	12.77	11.78
K	40.8	412	953Ω	12.17	11.17
S	6.4	63.4	150Ω	1.908	1.766

Typical supply current 50µA



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 = 50µA to 150µA

Figure 26. Centigrade Thermometer

SCHEMATIC DIAGRAM