The George Washington University
School of Engineering and Applied Science
Department of Electrical and Computer Engineering
ECE 20 - LAB

Experiment # 3a
Diode Application II: Biomedical Applications

Kit Part #	***Spice Part Name***	***Part Description***	***Symbol Name*** ***(used in schematics throughout this lab manual)***
1N4002	D1N4002	Series Silicon Diode	D1 – D4
KC0004N-ND		Thermal Resistor	Vthermistor
Battery	VDC	9 Volt Battery	9 V
Resistor	R	2.2k Ω Resistor	R1
Resistor	R	Value determined in prelab	RL
Capacitor	C	Value determined in prelab	C1-C2

Objectives:
- Use zener diodes & varistors as overvoltage protection (e.g., to protect high impedance bioamplifier inputs)
- To learn how to build and analyze a thermistor instrumentation device
- To learn how to use diodes for protection/limiting circuits

Prelab: ***(Submit electronically prior to lab meeting,*** *also have a printed copy for yourself during lab)*

1. Read through lab, generate an equipment list.
2. Download and **Print** the specification sheet for the thermistor in your kit *(see the lab website for links to spec sheet downloads, ensure this part # matches your ECE 20 kit parts list)*

   a) From the spec sheet, for the thermistor with your model #, populate the following table

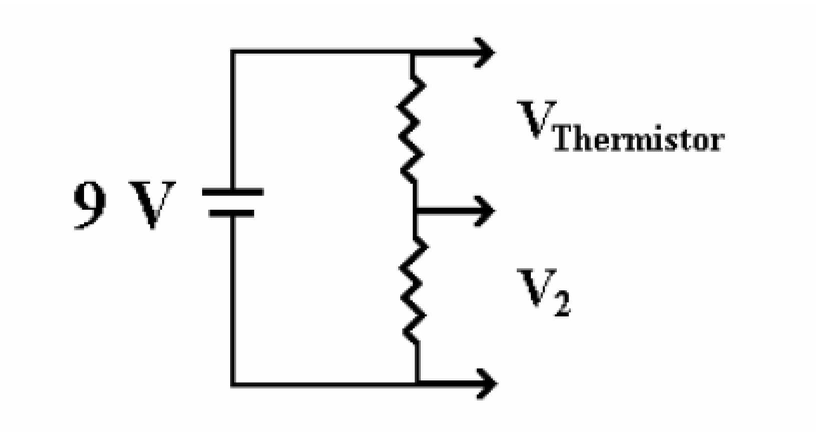
Characteristic	**Value + unit**
Resistance at 25C	
Max operating temp	
Resistance Ratio	

Table 1.2 – Spec Sheet Values

LAB:

1.- Thermistor Calibration

A thermistor is a semiconducting device whose resistance depends strongly on temperature. Therefore, it is very sensitive to temperature change. It is often made part of a simple circuit as shown below.



In the example shown,

$$V_{Thermistor} + V_2 = 9 = iR_{Thermistor} + iR_2 \quad (1)$$

From this, it follows that:

$$\frac{V_{Thermistor}}{V_2} + 1 = \frac{R_{Thermistor}}{R_2} + 1 \quad (2)$$

and thus

$$R_{Thermistor} = R_2 \frac{V_{Thermistor}}{V_2} \quad (3)$$

The voltage ratio is independent of the battery voltage, so that small drifts in a simple 9 V battery will not affect the measurement of $R_{thermistor}$.

a) Build the thermistor circuit shown using a 9 volt battery as the power source and a 2.2 kΩ resistor in addition to the thermistor.

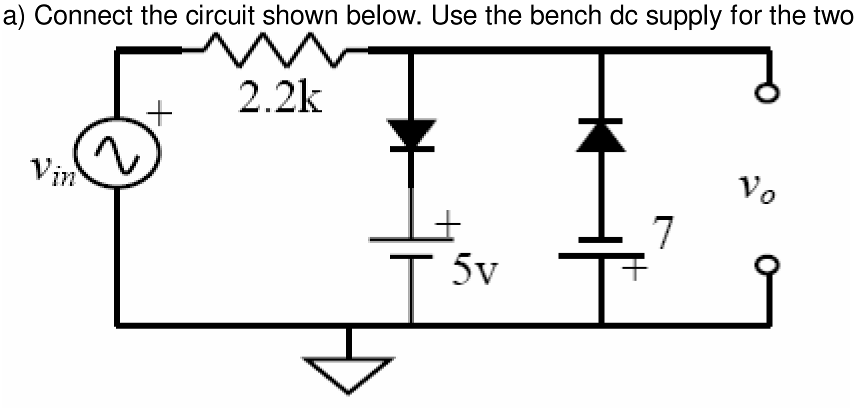
b) Now we will calibrate the output voltage with temperature. Measure the voltage output with the thermistor in the room temperature air. Measure the temperature with a **thermometer**. Then place the thermistor in the supplied warm, cold, and room temperature water baths and record the output voltages.

c) Plot the voltage output of the circuit and the temperature to calibrate the device. Is this plot linear?

2.- Diodes as protection circuits

As you discovered in lab #1, diodes have low resistances to current flow in one direction and high resistances in the other direction. This property can make them very useful in constructing circuits that can prevent large voltages from damaging sensitive measurement equipment in the laboratory and hospital environments.

a) Connect the circuit shown below. Use the bench dc supply for the two dc voltage sources.



Apply a sinusoidal voltage vin at a frequency of 1kHz for the following cases:

1) vin=2 volt amplitude
2) vin=6 volt amplitude
3) vin=10 volt amplitude

Be sure that your oscilloscope is on d.c.-coupled input.

b) Sketch the input voltage, the output voltage, and the voltage across the 2.2 KΩ resistor for each of the three cases. Use waveform math to display *chan1 – chan2* for the voltage across the 2.2kΩ resistor.

c) For the 10 volt input, print out the input and output waveforms to include in your lab report.

3.- Conclusion

a) Explain the waveshape of the output voltage and the voltage across the 2.2 KΩ resistor for each of the three experimental cases.
b) From your observations of the three cases explain why the circuit is called a clipper or a limiter circuit.
c) List two practical applications of a thermistor
d) With the help of the specification sheet for the thermistor: Does the resistance of a thermistor go up or down with increasing temperature?