Special Sensor Report

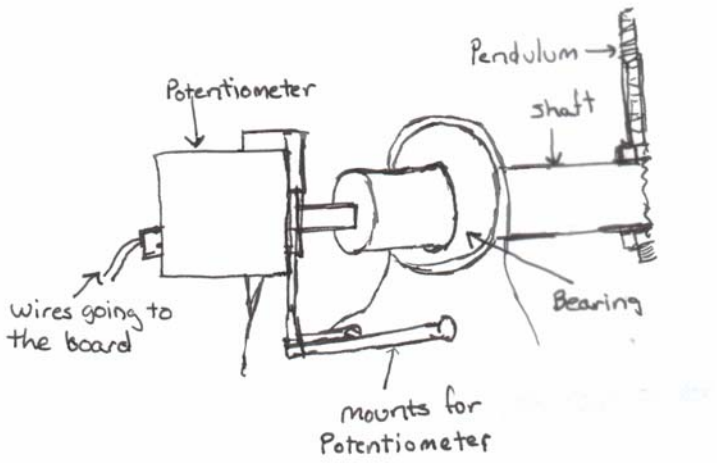
Potentiometer to Sense Position of Pendulum

Greg Beckham
SEAL

IMDL Spring 2004

Description:

The Potentiometer, in this case a Alpha model number B5K, is a common device used that produced an adjustable voltage divider circuit. In this case, the potentiometer is mounted to a shaft such that when the shaft turns, the voltage divider circuit within the potentiometer changes. The following is an illustration of how the device is hooked up.



When attached in this manor, the potentiometer is able to sense the position of the pendulum as the ball falls forward or backwards. The bearing provides the shaft with the ability to move smoothly, and the mounts for the potentiometer stop the potentiometer from moving when the pendulum rotates.

Advantages and Disadvantages:

Another sensor option would be to use a shaft encoder to since the position. The advantages of that sensor technology are that they can read the exact position of the sensor without having the use an analog to digital converter. Also, this type of sensor can have a greater resolution than a potentiometer. However, in order to get a shaft encoder that is good enough to be useful for this type of application one would have to spend at least $50. A potentiometer however offers ample accuracy and the A/D converter in the Atmel ATMicro128 is fast enough that readings can be taken fast enough in order to adjust to the moving pendulum. Also, a potentiometer is much less expensive than an encoder. The one that I am using was $2.79, some very good potentiometers can be found for $25.

Specifications:

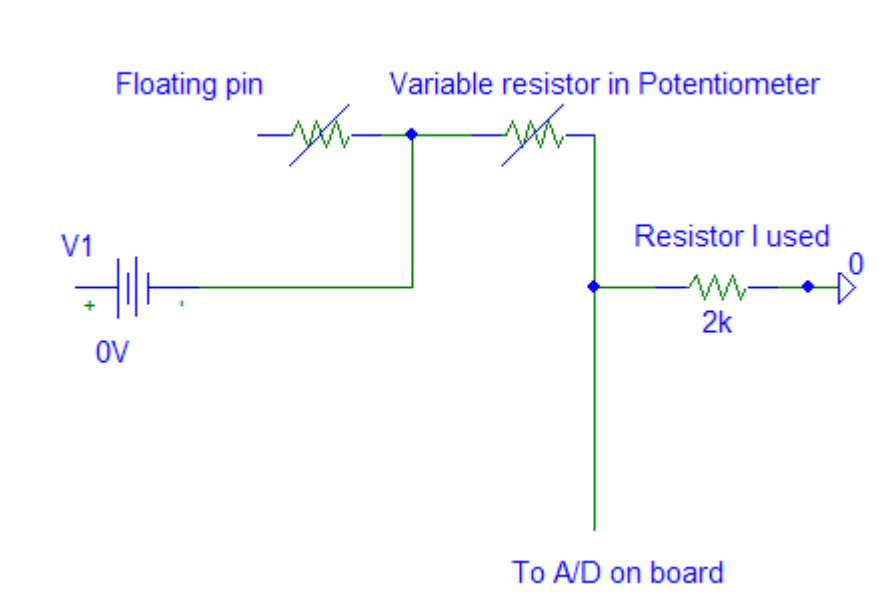
The potentiometer I am using was purchased from Radio Shack model number 271-1714 http://www.radioshack.com/product.asp?catalog%5Fname=CTLG&category%5Fname=CTLG%5F011%5F002%5F011%5F000&product%5Fid=271%2D1714 . It is a 5K potentiometer which means that the resistance across the entire voltage divider circuit is always 5 Kilo Ohms. It has a linearity tolerance of 20% which indicates that as you turn

the potentiometer the resistor value the circuit generates will change linearly within 20%. My potentiometer has a 5% resistance tolerance which indicates the amount of resistance that is experienced as you try to turn the shaft of the potentiometer. This potentiometer is not an exact sensor. Much better potentiometers can be obtained that have a smaller linearity tolerance which will give more exact data. However, I found that since there is a very small angle in which the pendulum can move before it is unrecoverable, the values obtained from the potentiometer in this range are adequate for this application.

Also the potentiometer I am using has a 6mm diameter shaft, which was originally an inch and a half long. I cut the shaft down to about a half inch in length and then pushed it into my pendulum assembly.

Usage:

A Potentiometer normally has 3 leads one for power, one for ground, and the other for the output voltage. In my application I used the potentiometer only as a variable resistor. So I left the power pin floating and connected the output pin to +5v and the ground pin to the middle of a voltage divider I designed. I then combined this with another resistor which I selected and used the voltage between the potentiometer and the other resistor as my input voltage to the A/D. The circuit to use this sensor is shown in the figure below.



This is a very simple circuit that connects the variable voltage of the potentiometer to the A/D converter on the board. The board is then programmed to read the A/D and react accordingly. The 2K resistor was chosen by moving the pendulum to the front tolerance and getting a resistance value, and then moving it to the back tolerance and recording a resistance. Then using the equation $\sqrt{R1}\sqrt{R2}$ given to my by the TA, I was able to find a resistor value for my voltage divider that would give me the best resolution for my design. Using this circuit I was able to obtain a resolution of less than a half of a degree

of movement of the pendulum. This allowed me to react very quickly to small changes in to position of the pendulum and get under it before it fell so far that I could not recover.

I was unable to find a datasheet on the Radio Shack website or anywhere else on the internet.