1 Introduction

A potentiometer is an electrical component that can be used both as a variable resistor, and as a voltage divider. The aim of the experiments described in this report is to analyze the behaviour of the potentiometer.

2 Background/Theory

A potentiometer is a resistor that has three terminals. Two of the terminals constitute the full resistance value, while the third one is a sliding contact. Figure 1 displays the different contacts of the potentiometer.

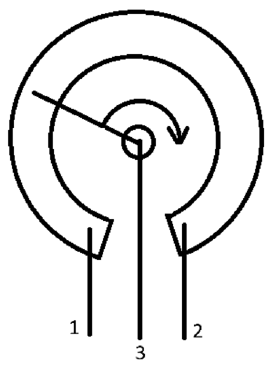


Figure 1: Drawing of a potentiometer
with labeled terminals

The resistance between terminals 1 and 2 is constant, while the resistance between 1 and 3 is determined by the following equation:

$$R_{13} = kR \tag{1}$$

Since the potentiometer can be used as a voltage divider, the value of the potential difference between terminals 1 and 3 will be determined by:

$$V_{13} = kV_{tot} \tag{2}$$

When adding a load resistor in parallel to terminals 1 and 3, the voltage across them becomes:

$$V_{13} = \frac{kR_{13}}{R_{13} + k(1-k)R_p}V \tag{3}$$

3 Methods & Materials

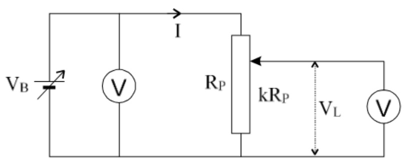
All of the circuits in the experiments are built using the provided connection boards. Measurements are done using the AM-520 HVAC multimeter.

3.1 Experimental Set-Up unloaded potentiometer

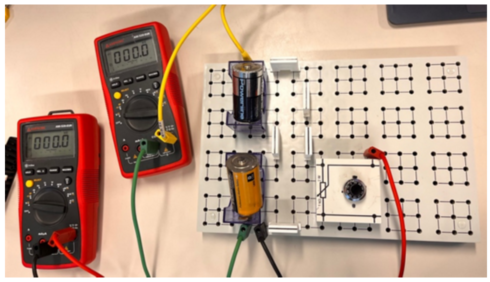
The unloaded potentiometer circuit consists of a voltage source and a potentiometer. Both the voltage of the power source and the potential difference between terminals 1 and 3 are measured.

The measurements are taken incrementally, going from k = 1 to k = 0.1.

Figures 2(a) and 2(b) display both the electrical diagram, and a picture of the physical set-up of the circuit.



(a) Circuit diagram of unloaded potentiometer circuit(refr)



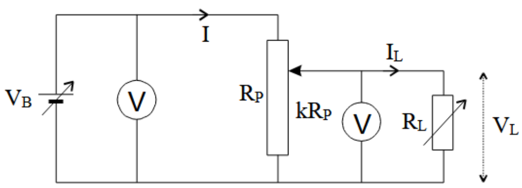
(b) Picture of the unloaded potentiometer circuit

Figure 2: Experimental set-up of the unloaded potentiometer circuit

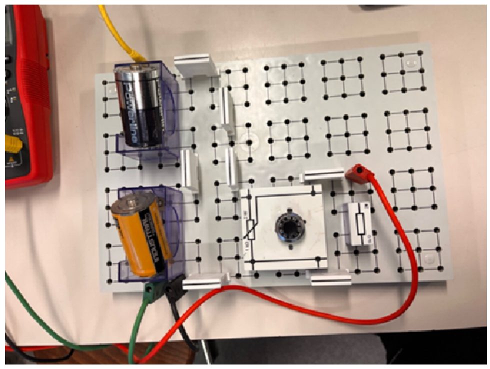
3.2 Experimental Set-Up with fixed resistor

The set-up for the second experiment is identical to the first experiment, however a load resistor is added in parallel to the terminals 1 and 3. The measurements are taken in the same way.

Figures 3(a) and 3(b) display both the electrical diagram and a picture of the experiment.



(a) Circuit diagram of the loaded potentiometer circuit



(b) Picture of the loaded potentiometer circuit with fixed resistance

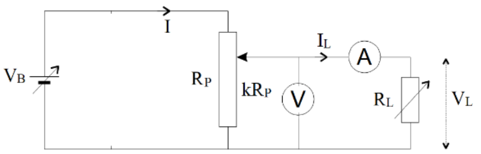
Figure 3: Experimental set-up of loaded potentiometer with fixed resistance

3.3 Experimental Set-Up with fixed load current

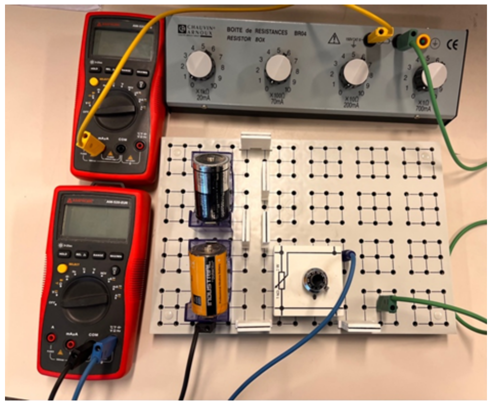
The set-up for the third experiment omits the voltmeter measuring the power source, replacing it with an ammeter in line with the load resistor. The load resistor being used becomes a decade resistor.

The experimental flow is also changed, as now with a change in the k-value, the decade resistor is adjusted in order for the current load to remain the same, then the resistance of the decade resistor, and the voltage drop is measured.

Figures 4(a), and 4(b) display the circuit diagram and picture of this experiment.



(a) Circuit diagram of the constant current load circuit(refr)



(b) Picture of the constant current load circuit

4 The Unloaded Potentiometer

4.1 Measurement Results

Table 1 displays the measured voltage values in terms of k, the theoretical voltage, and the error in measurement.

Table 1: Measured and expected voltage in terms of K

k	$Measured\ V$ V	ΔV V	$Expected\ V$ V
0.1	0.302	0.009	0.296
0.2	0.594	0.009	0.592
0.3	0.89	0.017	0.888
0.4	1.184	0.014	1.184
0.5	1.481	0.013	1.480
0.6	1.776	0.021	1.775
0.7	2.076	0.023	2.071
0.8	2.365	0.024	2.367
0.9	2.663	0.025	2.663
1	2.957	0.031	2.959

4.2 Graphs

Figure 4 displays the measured voltage in terms of K.

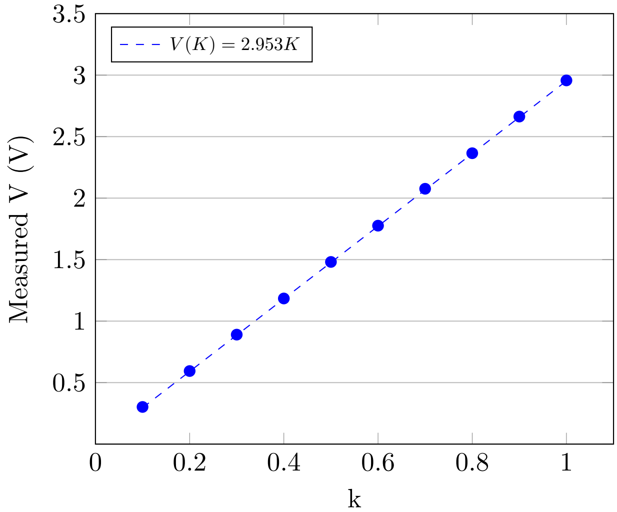


Figure 5: Measured voltage drop in terms of k

4.3 Discussion

The main goal of this experiment was to determine the effect of changing the k-value of the potentiometer on the voltage load of the varying resistance. When looking at the graphical representation of these values seen on figure 3, we see a linear relationship between the k-value and the voltage drop on the potentiometer.

Analyzing the difference between the measured and expected voltage, we see that the measured values are accurate, as the difference between them and the expected values falls within the measurement error.

5 Potentiometer loaded with fixed resistor

5.1 Measurement results

Table 2 displays the measurements for k, the unloaded potentiometer value, both loads, with their measured and theoretical values, and percent deviations.

Table 2: Measured and theoretical load values in terms of k

k	$Unloaded\ V$ V	$Load\ 1$ V	$Load\ 1\ theoretical$ V	$PD\ 1$ %	$Load\ 2$ V	$Load\ 2\ theoretical$ V	$PD\ 2$ %
0.1	3	0.274	0.156	75.85	0.253	0.111	56.02
0.2	3	0.514	0.329	56.27	0.451	0.239	46.98
0.3	3	0.739	0.522	41.46	0.628	0.388	38.28
0.4	3	0.957	0.740	29.32	0.809	0.562	30.53
0.5	3	1.184	0.987	20.00	0.993	0.770	22.47
0.6	3	1.433	1.269	12.97	1.21	1.022	15.55
0.7	3	1.717	1.594	7.74	1.47	1.334	9.27
0.8	3	2.039	1.973	3.35	1.801	1.730	3.97
0.9	3	2.448	2.421	1.11	2.268	2.249	0.86
1	3	2.952	2.959	0.24	2.948	2.959	0.37

5.2 Graphs

Figure 5 displays the voltage across the load resistor in terms of K, comparing them to the theoretical values, and the voltage drop on the unloaded potentiometer.

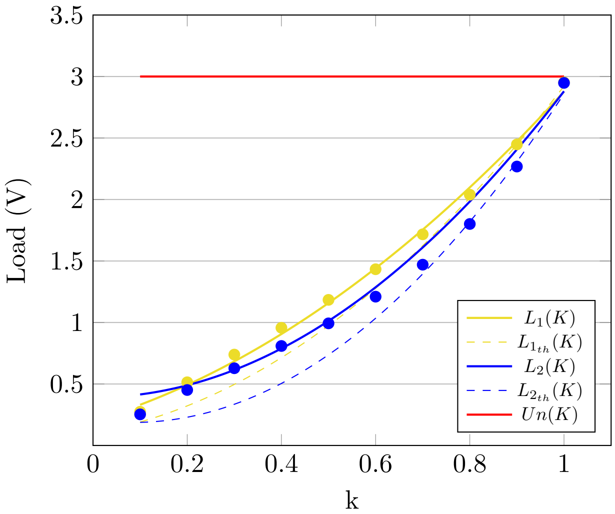


Figure 6: Loads in terms of k

Figure 6 displays the relationship between percent deviation and K.

5.3 Calculations

5.4 Discussion

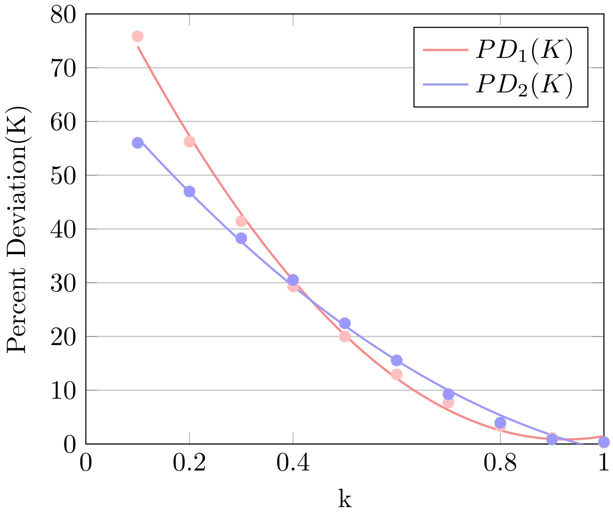


Figure 7: Percent deviation in terms of k