Junior Design

ECE 3090 - Spring 2018

Measuring the Internal Resistance of a Battery: Experiment Report

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Objective
The purpose of this experiment is to find the internal resistance of a 7.2 V rechargeable battery without altering or destroying the composition and shape of the battery with the maximum precision and accuracy.

Required Equipment
- Battery (Vex rechargeable 7.2 V)
- Multimeter to measure the current through the circuit
- Function Generator (1 V peak) to act as the AC source
- 20 Ω Resistor to be the load of the circuit
- 1.3kΩ to ensure that the battery doesn not burn down the resistor before its current decreases to 0
- 470 uF Capacitor to block the current coming through the battery
- Breadboard

Procedure
1. The load resistor was measured using the multimeter
2. The circuit from Figure 1 was set up, replacing RL with a 1.3kΩ resistor [2]
3. The function generator was set to "High Z" and the AC voltage to 1 Vp (2 Vpk-pk) at a frequency of 1 kHz
4. The 1.3kΩ was replaced with a 20Ω resistor after 3 seconds of setting up the circuit

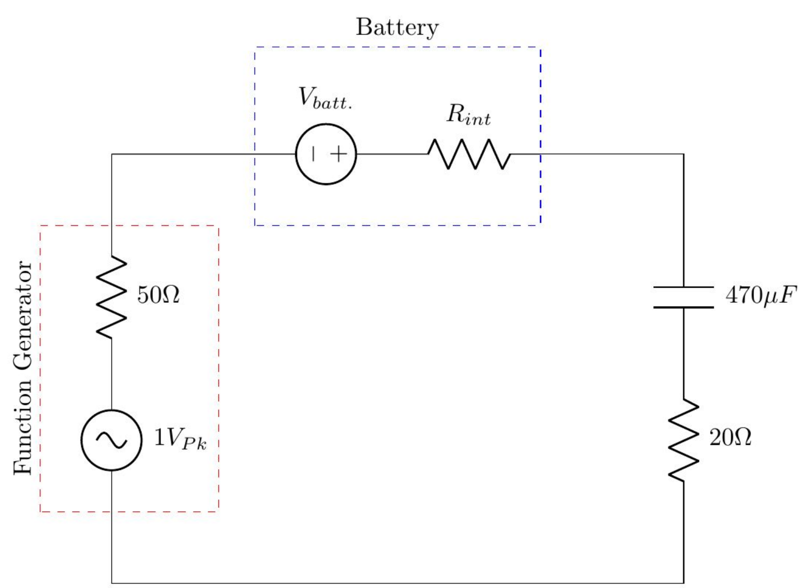


Figure 1 shows the circuit diagram used to find the internal resistance of the given battery assuming an internal resistance of 50 Ohms for the function generator

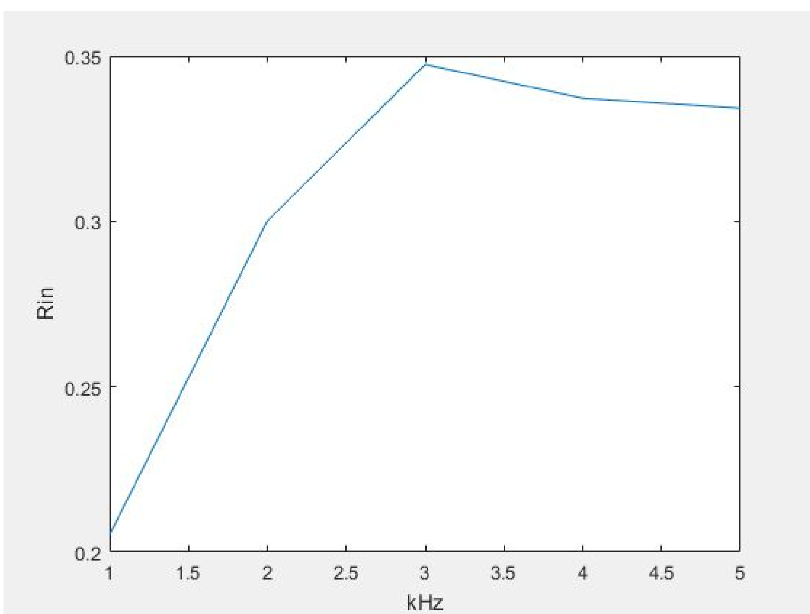
4. A multimeter was used to measure the voltage across RL
5. A multimeter to measure the current through the circuit
6. The RMS voltage of the AC source was measured
7. The measured current and voltage differences were used to find the internal resistance of the battery (and the internal resistance of the function generator was taken into account [3])
8. The frequency of the AC source was increased by 1 kHz with each trial and repeated 5 more times [1]

Preliminary Calculations

There were no preliminary calculations necessary.

Results and Analysis

	Without battery			With battery		
f (Hz)	V_R (V)	I_{tot} (mA)	R_1 (Ω)	V_R (V)	I_{tot} (mA)	R_{int} (Ω)
1000	0.19530	9.86	51.9074	0.19484	9.83	0.2052
2000	0.19537	9.88	51.7952	0.19501	9.83	0.3001
3000	0.19535	9.89	51.7449	0.19504	9.83	0.3474
4000	0.19535	9.89	51.7449	0.19514	9.83	0.3372
5000	0.19533	9.89	51.7469	0.19515	9.83	0.3342



As the real value of the internal resistance is unknown, it is not possible to measure how accurate the measured internal resistance is. The mean internal resistance of the battery was 0.30482 Ω and the variance of was 0.0034 Ω. A variance this low is promising as the results do not vary greatly from the mean.

Conclusion

From the results in can be concluded the experiment was precise in calculating Rint, however the accuracy cannot be judged without a nominal value. With a mean of 0.30482 Ω, the measured Rint was within the range of 0-1 Ω [1], meaning it is safe to assume the experiment was able to give reasonable results. There might be a slight degree of error due to the impedance of the wires used and the assumed value of the internal resistance of the function generator.

Questions

How does the internal resistance of a battery affect the behavior of most real world circuits? In which cases does this resistance have a significant effect on the circuit?

The internal resistance of a battery is residual in most batteries and has a small impact on most real world circuits. The internal resistance might have a significant effect on circuits with smaller load resistances. It is necessary to keep in mind that if the battery is connected to a circuit with another battery as a source it may overheat or damage the circuit.

What is the percent error for the voltage compared to a theoretical circuit with no internal resistance? What is the minimum circuit resistance for a 1% error?

From the table of results, the mean of the voltage through the load is 0.1953 V without R_{in} and with R_{in} is 0.1950 V. The percent error would be ((0.1953-0.1950)/0.1953)*100 = 0.15%.

The mean of the R_{in} is 0.30482 Ω. Because the total resistance is R_{in} + R, the percent error is (R_{in} + R - R)/(R_{in} + R). If we set this to 0.01, we get R = 30.1772 Ω to make up a 1% error

References

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