

**California Polytechnic State University Pomona**

DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

IINTRO TO MICROCONTROLLERS LAB

ECE 3301L.03

Report #6

**LAB 6 – Digital Voltage Meter / Ohm Meter**

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# INTRODUCTION

## Objective

In this lab, students will test their knowledge of C code and the Pickit to create a voltage and ohm meter with status LEDs. The value will be displayed on a seven segment display with a decimal point if necessary, and the RGB LEDs will change to different colors to denote the range of the value being read. Students will measure a variety of resistors from a different reference resistance, and must understand why certain readings are inaccurate based on what reference they used.

## Summary

For hardware, students will be introduced to using buzzers in circuits along with an increased struggle in maintaining order and organization of the build. With the requirement of so many resistors, it is important for students to be able to keep track of what resistor is which value as that is an important aspect of this lab. In our case, we chose to label each resistor with small sticky note flags to be able to tell them apart.

For software, students are once again mainly writing their own code from scratch with only a few bits of code being provided in the lab manual. Some functions from previous labs may be reused and repurposed, but with the added challenge of incorporating the buzzer and the decimal point on the seven segment display, software development still requires students to debug quite a bit.

# DATA AND RESULTS

Initial readings and error analysis:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **V (DVM)** | **V (TeraTerm)** | **% difference** |
| 0.5V | 0.5023 | 0.504 | 0.338443161 |
| 1.5V | 1.507 | 1.507992 | 0.065826145 |
| 2.5V | 2.503 | 2.504032 | 0.041230523 |
| 3.5V | 3.505 | 3.504032 | 0.027617689 |
| 4.0V | 4.005 | 4 | 0.124843945 |

|  |  |  |  |
| --- | --- | --- | --- |
| 1kΩ reference | | | |
| **Resistor** | **RL (DVM) in kΩ** | **RL (TeraTerm)** | **% difference** |
| 0.022kΩ | 0.0234kΩ | 0.022978kΩ | 1.803418803 |
| 0.220kΩ | 0.2217kΩ | 0.217596kΩ | 1.851150203 |
| 0.470kΩ | 0.4707kΩ | 0.464952kΩ | 1.221159975 |
| 1kΩ | 1.0030kΩ | 0.996144kΩ | 0.683549352 |
| 2.2kΩ | 2.1940kΩ | 2.180176kΩ | 0.630082042 |
| 10kΩ | 10.03kΩ | 9.894048kΩ | 1.355453639 |
| 22kΩ | 22.09kΩ | 20.795408kΩ | 5.860534178 |
| 33kΩ | 33.30kΩ | 31.017090kΩ | 6.855585586 |
| 47kΩ | 47.22kΩ | 41.689456kΩ | 11.7122914 |
| 100kΩ | 99.70kΩ | 77.765632kΩ | 22.00036911 |

|  |  |  |  |
| --- | --- | --- | --- |
| 10kΩ reference | | | |
| **Resistor** | **RL (DVM) in kΩ** | **RL (TeraTerm)** | **% difference** |
| 0.022kΩ | 0.0234kΩ | 0.019570kΩ | 16.36752137 |
| 0.220kΩ | 0.2217kΩ | 0.219568kΩ | 0.961659901 |
| 0.470kΩ | 0.4707kΩ | 0.470352kΩ | 0.073932441 |
| 1kΩ | 1.0030kΩ | 0.998960kΩ | 0.402791625 |
| 2.2kΩ | 2.1940kΩ | 2.175964kΩ | 0.822060164 |
| 10kΩ | 10.03kΩ | 10.000000kΩ | 0.299102692 |
| 22kΩ | 22.09kΩ | 22.000000kΩ | 0.407424174 |
| 33kΩ | 33.30kΩ | 33.026367kΩ | 0.821720721 |
| 47kΩ | 47.22kΩ | 46.265624kΩ | 2.021126641 |
| 100kΩ | 99.70kΩ | 92.408200kΩ | 7.313741224 |

|  |  |  |  |
| --- | --- | --- | --- |
| 100kΩ reference | | | |
| **Resistor** | **RL (DVM) in kΩ** | **RL (TeraTerm)** | **% difference** |
| 0.022kΩ | 0.0234kΩ | 0.097752kΩ | 317.7435897 |
| 0.220kΩ | 0.2217kΩ | 0.195700kΩ | 11.72755977 |
| 0.470kΩ | 0.4707kΩ | 0.490696kΩ | 4.248141066 |
| 1kΩ | 1.0030kΩ | 0.986224kΩ | 1.672582253 |
| 2.2kΩ | 2.1940kΩ | 2.093750kΩ | 4.569279854 |
| 10kΩ | 10.03kΩ | 9.871344kΩ | 1.581814556 |
| 22kΩ | 22.09kΩ | 21.759760kΩ | 1.494975102 |
| 33kΩ | 33.30kΩ | 32.987312kΩ | 0.939003003 |
| 47kΩ | 47.22kΩ | 46.495120kΩ | 1.535112241 |
| 100kΩ | 99.70kΩ | 98.837888kΩ | 0.864706118 |

Volt Meter readings:

A digital multimeter with wires

Description automatically generated

A screenshot of a computer

Description automatically generated

A digital multimeter with wires and a keyboard

Description automatically generated with medium confidence

A screenshot of a computer

Description automatically generated

A close-up of a digital multimeter

Description automatically generated

A screenshot of a computer

Description automatically generated

A close-up of a digital multimeter

Description automatically generated

A screenshot of a computer

Description automatically generated

A close-up of a digital multimeter

Description automatically generated

A screenshot of a computer

Description automatically generated

Ohm Meter readings:

A screenshot of a computer

Description automatically generated

A screenshot of a computer

Description automatically generated

A screenshot of a computer

Description automatically generated

We did not take screenshots of every resistor measurement as that would be repetitive given that we wrote down the TeraTerm output in the tables at the beginning of the section, and there were an abundance of measurements that would take up a lot of space in the report.

# CONCLUSION

In this lab, students successfully integrated hardware and software components to create a functional voltage and ohm meter using C code and the Pickit. The experience reinforced essential skills in circuit organization, particularly the importance of accurately identifying and labeling resistors, which proved vital for precise measurements. Additionally, the challenge of writing custom code, along with incorporating new elements such as buzzers and the decimal point of the seven segment display, deepened students' understanding of programming and debugging processes. By analyzing the accuracy of their readings based on reference resistances, students gained practical insights into the impact of reference resistance on measurement outcomes. Overall, this lab not only enhanced technical skills but also fostered problem-solving abilities, preparing students for more complex projects in future coursework.