California State University, Channel Islands (CSUCI)
Department of Computer Science

COMP-462: Embedded Systems
Lab Report
Fall 2019

Lab Number: Lab 1

Lab Topic:

Calculating and Measuring Voltage and Current Through Simple Circuits, Introduction to Keil µVision 5

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I. Objectives

This experiment aimed to introduce students to calculating and measuring voltage current through simple electronic circuits, as well as familiarize students to the Keil µVision programming environment. The goals for this lab would be for students to be able to accurately compare expected and actual values of voltage and current through an electronic circuit, and for students to be able to successfully upload and run code written in Keil µVision to the Tiva LaunchPad's onboard microcontroller.

II. Introduction

In an electronic circuit, voltage, current, and resistance are related to each other through a formula known as Ohm's Law:

$$V = I * R$$

The current (represented by "I") passing through a circuit can therefore be calculated by dividing the input voltage ("V") by the total resistance ("R") across the entire circuit. Thus, it is also possible to calculate the voltage passing through a certain resistor by using the calculated current and multiplying it to the resistor's resistance value. In the first part of the lab, we used Ohm's Law to calculate the values of voltage and current passing through two simple circuits.

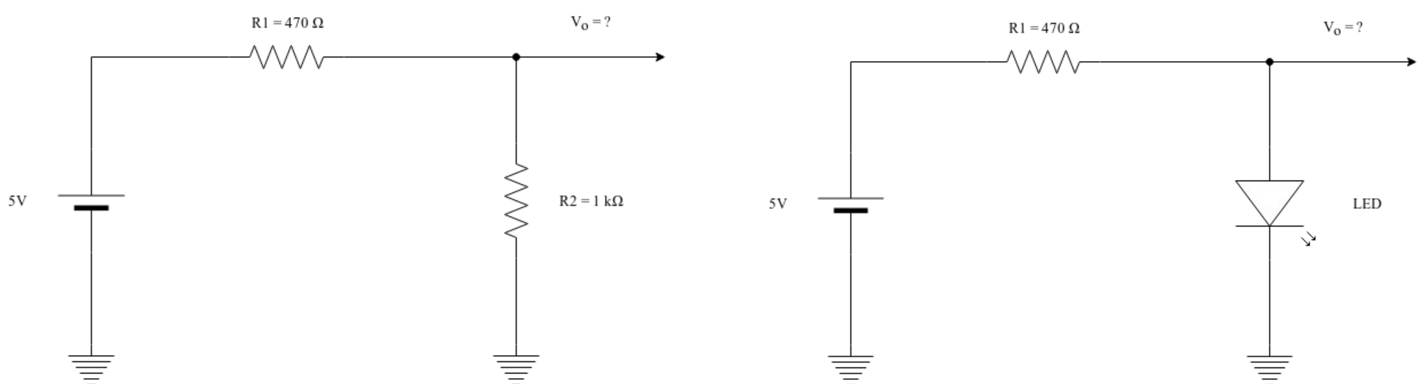

Figure 1: Simple voltage divider circuit (left) and an LED circuit (right)

The second part of the lab consists of using Keil µVision to upload code to a microcontroller. Using code provided by the instructor, we were able to create a simple LED circuit connected to the microcontroller. When the code is executed, the LED will blink periodically.

III. Procedure

1. The current passing through the voltage divider on the left of Figure 1 was calculated by dividing the input voltage by the sum of the resistor values, as the resistors were in series. V_o was calculated using the calculated current.

2. Using a breadboard and a 5V power supply, we physically recreated the voltage divider circuit to the left of Figure 1.

3. We measured the current across the entire circuit by connecting the multimeter from R2 to ground. We verified the result of the voltage calculation for V_o by measuring the voltage across R2.

4. For the second circuit, because LEDs have variable resistance, the resistance of the LED was measured using a multimeter. Using the measured resistance, current and V_o were calculated using the same method as Step 1.
5. After comparing the measured and expected values of the two circuits, a simple circuit consisting of an LED in series with a resistor was connected to a Tiva LaunchPad. The circuit was powered by a 5V power supply and the LED was connected to pin PA4 of the LaunchPad.
6. Using code provided by the instructor and Keil µVision, code was uploaded into the LaunchPad's microcontroller to periodically switch the PA4 port from input to output, therefore turning the LED on and off repeatedly.

IV. Problems

Only one problem was encountered during the setup of the circuits, and it was due to a lapse in familiarity with the power supplies provided. Rather than plugging the ground wire into the negative port of the power supply, we had instead plugged it into the third port, which had been confusingly labeled with the symbol for ground, and thus no current flowed through the circuit. Once the ground wire had been connected to the negative port of the power supply, current was able to flow through the circuit and the problem was rectified.

V. Results

The two circuits in the first part of the lab were built with no complications, and the expected values closely matched the measured values of current and V_o. Below are the calculations and measurements made for the two circuits:

Circuit 1 (Voltage Divider):

<u>Expected:</u>

$I = 5V / (470\Omega + 1000\Omega) = \underline{3.4\ mA}$

$V_{R2} = V_o = 3.4\ mA * 1000\Omega = \underline{3.4V}$

$V_{R1} = 3.4\ mA * 470\Omega = 1.59\ V$

<u>Measured:</u>

$I = \underline{3\ mA}$

$V_{R2} = V_o = \underline{3.45V}$

Circuit 2 (Voltage Divider w/ LED):

<u>Measured:</u>

$I = \underline{6.43\ mA}$

$R_{LED} = \underline{307.31\Omega}$

$V_{LED} = \underline{1.976V}$

$V_{R1} = 3.016V$

Expected:

$I = 5V / (470\Omega + 307.31\Omega) = \underline{6.43\ mA}$

$V_{LED} = 6.43\ mA * 307.31\Omega = \underline{1.976V}$

For the second part of the lab, no complications were found when using a 470Ω resistor in series with an LED. When connected to the LaunchPad's PA4 port, the LED would blink periodically, turning on and off as predicted. The code can be summarized as a timed while loop that continuously switches port PA4's I/O bit between 0 and 1 by XOR'ing the port's bits with a constant. This switches the port from providing input – and therefore no current and turning the LED off – to output, which turns the LED on.