CALIFORNIA STATE POLYTECHNIC UNIVERSITY, POMONA
COLLEGE OF ENGINEERING

ECE 3301L Spring 2025 Session 1 | **Microcontroller Lab** | **Felix Pinai**

LAB 6: Digital Voltage Meter / Ohm Meter

Using the provided schematics, you will need to design the following meters:

A) Voltage Meter:

Connect AN0 (RA0 @pin 2) directly to the wiper pin of a potentiometer (see schematics). Write a program that will measure the voltage input VL0 at AN0 (RA0) and display its value on the two 7-segment displays with the upper digit in Volt and the lower digit representing the 1/10V unit. **Turn on the Decimal Point (connected to PORTD bit 7)** of the leftmost digit (Upper digit) to show the decimal point. In addition, your team will need to show the same result on the TeraTerm software by doing the output through the use of 'printf'.

Hint: Copy the function 'Get_full_ADC(void)' used in the previous lab to measure the value of the input voltage. Make sure that on the register ADCON0 you select AN0 (pin RA0) as the voltage source. Don't forget to use the function 'void Select_ADC_Channel(char channel)'

Also, you must make sure that the register ADCON1 has the proper value to force the pin AN0 as an analog input. In addition, don't forget to program that same register so that the external voltage VREF = 4.096V as the VREF+ reference voltage for the A/D while using GND as the source for VREF-. Do visit the datasheet of the PIC18F4620 at the A/D chapter and look for ADCON1's definitions.

Make 4 measurements from 0.5 to 4V in increments of 1.0V (do not go past 4.0V). For each measurement, take only the data shown on the **output of TeraTerm (not the 7-segment display)** and then measure the same voltage using a DVM. Show the percentage error between the value from the DVM and the one shown on TeraTerm for each measurement.

	V(DVM)	V(TeraTerm)	% difference
0.5V			
1.5V			
2.5V			
3.5V			
4.0V			

B) Ohm Meter:

You will need to acquire the following resistors:

* 1 200 ohm with 1% precision
* 1 2 Kohm with 1% precision
* 1 20 Kohm with 1% precision

Note: **Use the unit of Kohm instead of ohm because for the purpose of this lab it would prevent overflow in the computations.**

In addition to the above resistors, you also need to get the following resistors to be used as unknown resistors RL:

* 1 22 ohm
* 1 220 ohm
* 1 470 ohm
* 1 1Kohm
* 1 2.2Kohm
* 1 10Kohm
* 1 22Kohm
* 3 33Kohm
* 1 47Kohm
* 1 100Kohm

Before doing the lab, measure each resistor using the DVM and record its value and put them on a spreadsheet:

Resistor (in Kohms)	RL(DVM) (in K ohms)	RL(TeraTerm)	% difference
0.022			
0.220			
…			
100			

You don't have to get the exact value of the resistors listed above but something close to those resistors. However, there should be a resistor with the value up close to 100K ohms.

Once all the resistors are measured, sort them in either ascending or descending order. Next, place them such that one side of each resistor is connected to ground (refer to the schematics). The other side of each resistor is not connected to anything originally. When a resistor is to be measured, use a wire to connect the open end of that resistor to the reference resistor mentioned in the one of the following three parts.

Part B1)

Referring to the schematics for this lab, connect the 200 ohm 1% precision resistor at Rref1 and an unknown resistor at RL. The junction of Rref1 and RL is called VL1 and it must be connected to AN1 (pin RA1). Modify the program for the Voltage meter above that measures the input voltage at RA1 and uses that value in conjunction of the KVL and KCL laws to derive the value of the unknown RL based on the fact that Vref is 4.096V.

Once the equation is derived, run the program and pick the lowest resistor from the list of the resistors above. The program should output out the value of the resistor onto the 7-segment display.

If the unknown resistor is less than 10K, show the decimal point on the upper digit so that we will see the values on the both 7-segment displays showing values from 0.0 to 9.9K. If the resistor is greater than 10K, then turn off the decimal point to only show the integer portion of that value indicating it is from 10 to 99.

In addition, you need to use the serial port to display the same result on the TeraTerm. Record the value displayed on the TeraTerm. Use the 'printf' function to display the floating point result.

Once one resistor is measured, do the measurements for the next resistor on the list.

Make 10 measurements using the resistors that I have asked you to obtain and tabulate them along with the values measured of each unknown resistor using a DVM. Show the percentage error between the value shown on TeraTerm (not the value from the display) and the measured value for each measurement (the one that you have measured at the start of the experiment). Sort the results in ascending order of the resistors RL.

After a value of resistance is measured, call a function to do the following additional tasks:

a) Set the color of the RGB LED D1 to reflect the range of value of the unknown resistor. Use the following color table:

Resistance Range	D1's color
Below 10K	Off
10K-19 K	Red
20K-29 K	Green
30K-39 K	Yellow
40K-49K	Blue
50K-59 K	Purple
60K-69K	Cyan
Above 70K	White

As required in the previous lab, write the routine such a way that it only needs no more than 5 lines of instructions to implement the task.

b) Output the color for the RGB D2 based on the conditions below:

1) If the resistance is greater than 300 ohm (0.3K), turn off D2
2) If the resistance is between 0.2K and 0.3K set D2 to RED
3) If the resistance is between 0.1K and 0.2K set D2 to GREEN
4) If the resistance is between 0.07K and 0.1K set D2 to BLUE
5) If the resistance is less than 0.07K, set D2 to WHITE

c) At the same time, when that resistor is below 70 ohms (or 0.07 Kohm) turn on the buzzer circuit by calling the routine Activate_Buzzer() below:

```
void Activate_Buzzer()
{
        PR2 = 0b11111001 ;
        T2CON = 0b00000101 ;
        CCPR2L = 0b01001010 ;
        CCP2CON = 0b00111100 ;
}
```

The buzzer will use the pin from PORTC bit 1.

If the unknown resistance is higher than 70 ohms, turn off the buzzer by calling the routine Deactivate_Buzzer();

```
void Deactivate_Buzzer()
{
        CCP2CON = 0x0;
        PORTCbits.RC1 = 0;
}
```

Part B2)

This part will use the alternate circuit built with the resistor Rref2 and RL to measure an unknown resistor. Rref2 is 2Kohm 1% instead of the 200 ohm 1% used as Rref1. The voltage VL2 is connected to AN2 (or RA2). Change the program in Part B1) to determine the value of RL. Use the same set on unknown resistors used in Part B1) and repeat the same measurements. Make another spreadsheet table to show all the measurements. **Don't forget to change ADCON0 accordingly in order to select AN2.**

The RGB LEDs D1, D2 and the buzzer should have the same implementation as in part B1.

Part B3)

This part will use the alternate circuit built with the resistor Rref3 and RL to measure an unknown resistor. Rref3 is 20 Kohm 1% instead of the 2K ohm 1% used as Rref2. The voltage VL3 is connected to AN4 (or RA5). Change the program to determine the value of RL. Use the same set on unknown resistors used in part 1 and repeat the same measurements. Make another table to show all the measurements. Don't forget to change ADCON0 accordingly.

Same requirements for D1, D2 and buzzer as in part B1/B2.

When all the three parts of this ohmmeter section are completed, fill the three spreadsheets with the %error for every measurement of all three tables. Study the columns for the errors in each case to come up with the explanations of the use for each of the reference resistance. Demonstrate to the instructor when all the data are collected and the error calculations are completed.

Notes: In some instances, you can get some error percentages that can be in the order of more than 50%. That is expected.