MECHATRONICS I

LABORATORY LECTURE & EXERCISES

LAB 2 - DMM, Bb, RESISTORS (H)

PARTS LIST:

1.) DMM & test leads
2.) Wire cutter/stripper
3.) Breadboard
4.) Jumper wire (22 AWG)
5.) Resistors (2x 1 kohm)
6.) Potentiometer
7.) Capacitor
8.) Arduino board
9.) Power supply brick

INTRODUCTION

In this lab exercise we will learn some basic bread-boarding skills. This includes cutting and stripping wire, building simple resistor circuits on the solderless breadboard, and using the DMM. We will use the DMM to take various circuit measurements (continuity, voltage, resistance). We may also use the DMM to measure the frequency and duty cycle of a PWM signal from Arduino.

REFER to the CT GUIDE
- Ch 5 Electricity; (Ch 6) Electrical Components (wire, breadboards, resistors, cutter/stripper tool, pots); (Chap 8.1) Tools; (Ch 9) Multi-meters

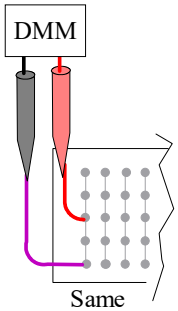
EXERCISES

Conduct the following exercises which involve taking electrical measurements using the DMM.
Insert the black lead into the "COM" port. Insert the read lead into the right-most red port.
Collect measurement data and record on ANSWER SHEET.

2.1 Breadboard connectivity

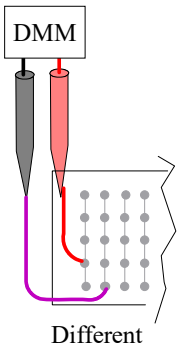
Here we will verify the connectivity of the breadboard using continuity testing of DMM.

1. Cut and strip wire one red and one black wire from the spool (~ 3" long). The wire is 22 AWG.
2. Set the DMM to measure continuity (dial on Ω > press "Select" until you see the "speaker").The DMM sounds a tone if the resistance between 2 points is lower than a threshold (~ 50 Ω). Verify the continuity of the following. Record "tone" or "no tone" on the ANSWER SHEET.



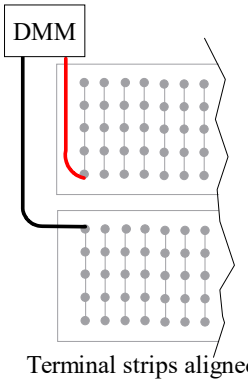
Same terminal strip (equiv to joining 2 wires)

Figure 2.1-a



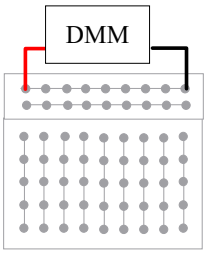
Different terminal strips

Figure 2.1-b



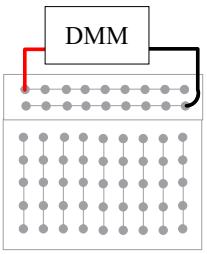
Terminal strips aligned across the notch

Figure 2.1-c



Single bus strip

Figure 2.1-d

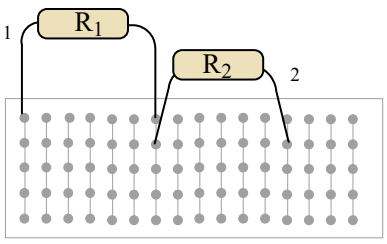


Adjacent bus strips

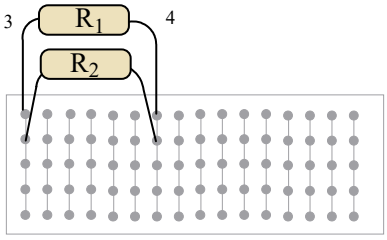
Figure 2.1-e

2.2 Measure R

1. Set DMM (set DMM: "Ω" > press "Select" until "Ω" is displayed)
2. Measure each resistor separately with each R in Bb (breadboard).
   Record values.
   If the R value is not right, obtain the proper-valued resistor.
3. Measure resistance of 2 Rs in series (DMM leads at pts 1 & 2).
4. Measure resistance of 2 Rs in parallel (DMM leads at pts 3 & 4).

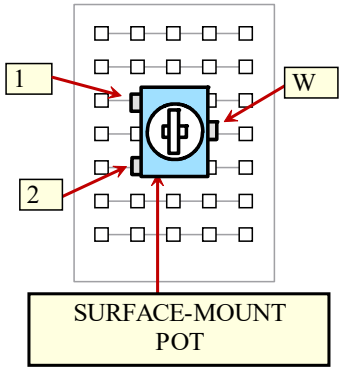


Rs in series



Rs in parallel

2.3 Potentiometer



Measure resistance of a potentiometer (or "pot") - a 3-terminal variable resistor.

1. Check overall pot resistance (DMM leads at 1 & 2). This should be a fixed resistance value.
2. Check reduced resistance (leads at 1 & W, & turn pot TOWARDS lead 1 part way, then all the way - Measured resistance should decrease and approach 0 Ohms.

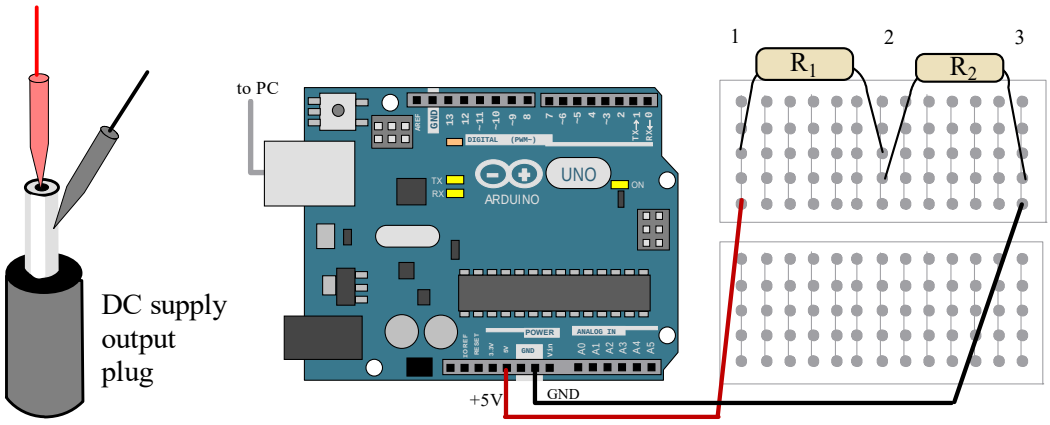
3. Check increased resistance (leads at 1 & W, pot AWAY from lead 1 part way, then all the way).
   - Measured resistance should increase, and approach the overall pot resistance.
4. Record all values.

2.4 Voltage Measurement

Measure voltage output of a DC power supply "brick" (12 VDC or less) (DMM setting: "V" & "DC")

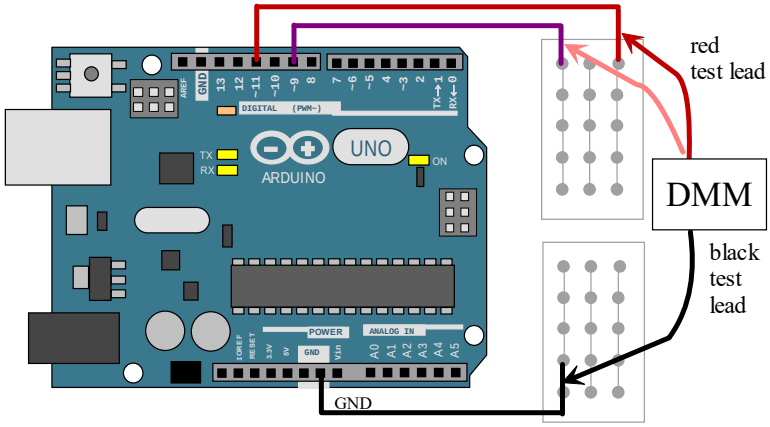
1. Plug in DC power supply. (SKIP FOR NOW)
2. Touch the DMM leads as shown (red to center, black to outside). Record voltage.
3. Reverse the leads (black to center, red to outside). Record voltage.
4. Which contact on the plug is GND? (this is based on DMM reading changes when reversing leads)

5. Apply voltage to the resistive circuit shown
   Use Arduino's 5VDC supply as a power source.
   Measure voltage at different points (see answer sheet)



2.5 Arduino

Measure various parameters on the Arduino micro-controller



(a) DIGITAL VOLTAGE
- Measure voltage of an Arduino I/O pin (at HIGH and LOW) (dial "V" > select "DC").
- Command one of the I/O pins to be HIGH and another one LOW.

- Place a wire in the I/O pin and the other side of the wire to the breadboard.
- Measure the pin when it outputs a HIGH, and then a LOW. Record data.

```
// Lab 2 - Digital I/O ---------------
// Check digital I/O voltage

int ledPin1 = 9;     // specify pin (~)
int ledPin2 = 11;    // specify pin (~)

void setup()
{
   pinMode(ledPin1, OUTPUT);  // set pin as output
   pinMode(ledPin2, OUTPUT);  // set pin as output

   digitalWrite(ledPin1, HIGH);
   digitalWrite(ledPin2, LOW);
}

void loop()
{ }

// end ----------------------------------
```

(b) PWM FREQUENCY
- Measure frequency of PWM signal from Arduino (dial "Hz/Duty" > select "Hz").
- Use analogWrite() & one of the PWM pins (denoted "~").
- If your DMM can't measure "Hz" (frequency), just write "DMM can't do it" on the answer sheet.

(c) PWM DUTY CYCLE
- Measure "duty cycle" of Arduino's PWM output ("Hz/Duty" > select "%")
- Use analogWrite (pin, value) which takes values from 0 to 255
- Record duty cycle for inputs shown on the answer sheet (varies VAL for various values between 0 & 255
- If your DMM can't measure "Duty", just write "DMM can't do it" on the answer sheet.

```
// Lab 2 - PWM Frequency ---------------
// Check PWM frequency

int ledPin = 11;     // specify pin (~)

void setup()
{
   pinMode(ledPin, OUTPUT);  // set pin as output
}

void loop()
{
   analogWrite(ledPin, VAL);  // VAL is a value between 0 to 255
}

// end ----------------------------------
```

ANSWER SHEET

Students will submit the completed answer sheet.

2.1. Verify breadboard connectivity

a. _____ Check within a terminal strip. (figure 2.1-a)
b. _____ Check between 2 different terminal strips. (figure 2.1-b)
c. _____ Check 2 terminal strips across from the "channel". (figure 2.1-c)
d. _____Check within a bus strip (figure 2.1-d)
e. _____ Check between 2 different bus strips (figure 2.1-e)

2.2. Measure resistance with DMM

a. _____ (kΩ) R_1.
b. _____ (kΩ) R_2.
d. _____ (kΩ) Rs in series
e. _____ (kΩ) R_s in parallel

2.3 Measure resistance of a potentiometer (or "pot")

_____ Overall pot resistance (Ω)
_____ Reduced R (leads @ 1 & w, dial CCW) (Ω)
_____ Higher R (leads @ 1 & w, dial CW) (Ω)

2.4 Measure voltage output of a DC power supply "brick" (12 VDC or less)

2. _____ Voltage reading (red lead at center, black on outside)
3. _____ Voltage reading (black lead at center, red on outside)
4. _____ Which contact is GND? (outside or center)

2.4 Measure voltage on resistive circuit (pt 1 = power, pt 2 = in-between, pt 3 = gnd)

a. _____ Overall voltage (red lead at 1, black lead at 3)
b. _____ Voltage across R1 (red lead at 1, black lead at 2)
c. _____ Voltage across R2 (read lead at 2, black lead at 3)

2.5 Measure various parameters on the Arduino micro-controller

a. DIGITAL VOLTAGE
_____ V (digital HIGH)
_____ V (digital LOW)

(b.) _____ PWM FREQUENCY (Hz)

c. PWM DUTY CYCLE
_____ (for input = 2)
_____ (for input = 64)
_____ (for input = 128)
_____ (for input = 192)
_____ (for input = 250)