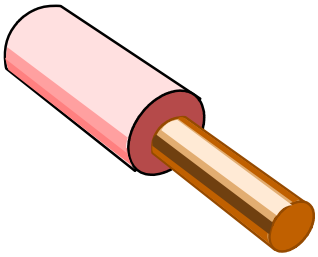
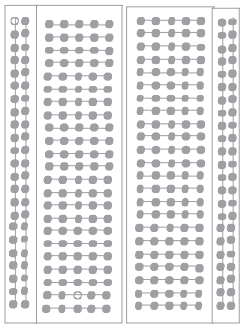
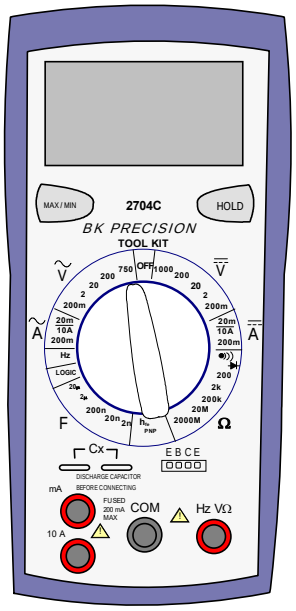
LAB 2 - WIRE, Bb, DMM (measure R & V) (1.5h)







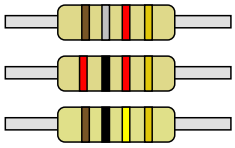
In this lab you will learn how to work with wire, resistors, and the solderless breadboard. You will use the digital multi-meter (DMM) to take resistance and voltage measurements.

REFER to the **CT GUIDE** on the following topics: wire, breadboard, resistors, potentiometers, the trainer, DMM use, and continuity testing.

Note, when using the DMM, always place the red test lead in the "Hz VΩ" port. For this class we will never measure electric current so never put any test lead in the "mA" or "10A" ports.

2.1 EQUIPMENT LIST

1. Trainer system (XK-700) (for the breadboard (Bb) and power supply, possibly the pot)
2. Power supply (and power jack adapter) (10v)
3. Solderless breadboard
4. Wire cutter/stripper
5. Digital multi-meter (DMM)
6. Resistors



	Nominal	Measured (kΩ)
1.8 kΩ: (brown – gray – red)	_____	_____
2.0 kΩ: (red – black – red)	_____	_____
100 kΩ: (brown – black – yellow)	_____	_____

7. Potentiometer (1 kΩ or similar, for continuity threshold test) (small screwdriver)
8. Hookup wire (a spool of wire will be kept in front of the lab. obtain a couple of pieces)
9. Jumper wire kit (22 AWG wire)
10. Caliper (to measure wire diameter) (please share! return to front desk after using it)

2.2 VERIFY RESISTOR VALUES

First determine the resistor nominal values from the color bands. Refer to the **CT GUIDE** on the 4-color band resistor code (section 6.3). But then ALWAYS measure R using DMM to verify it is correct.
(or any other component too like capacitors or inductors)

(***) Record for each R: (1) color bands, (2) corresponding number, & (3) "nominal" resistance (in kΩ).

record data on ANSWER SHEET!!

Note for resistors: if the resistor leads are bent up badly, then discard it and get a replacement.

2.3 WIRE SIZE

Here we will cut and strip some wire, then measure wire size and verify its AWG value. BE CAREFUL when using the wire cutter/stripper. Always keep your fingers away from the cutting area. Only use 22 AWG wire or smaller (smaller wire has BIGGER numerical AWG value, like 24 AWG) with our breadboards.

STEPS

1. Use a wire cutter/stripper tool to cut a 2 to 3 inch piece of hookup wire (from spool)
2. Strip (remove) about 1/2" of insulation. Do not cut the metal underneath.
3. Measure the wire size using the caliper (not a standard tool in a circuits lab). Calipers must be shared. Return the caliper to the designated area when done.
4. (***) Convert measurement to AWG value (see table below or look in CT guide or online).

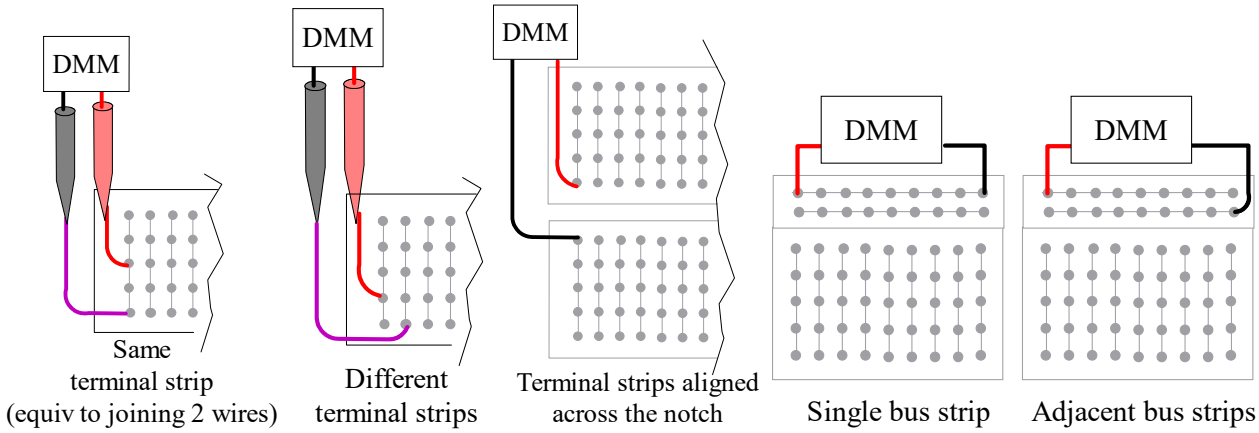
AWG#	Wire Diameter (in)	AWG#	Wire Diameter (in)
18	.0403	21	.0285
19	.0359	22	.0253
20	.0320	23	.0226
		24	.0201

2.4 BREADBOARD

Here we will verify the solderless breadboard's connectivity using CONTINUITY testing feature of the DMM. First REFER to **CT GUIDE** on breadboards (section 6.2).

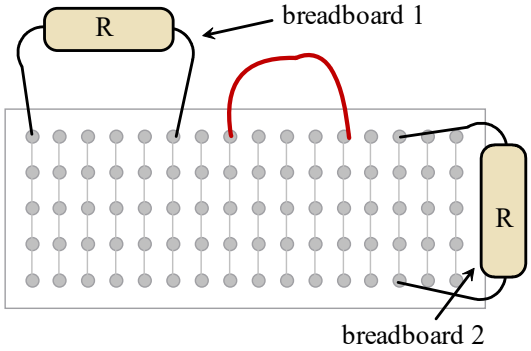
STEPS

Verify the connectivity of the following. Note whether the DMM produced a "tone" or produced "no tone".
(***) Record results.



2.5 INSERTING WIRE INTO BREADBOARD

Refer to the **CT GUIDE** regarding the insertion of wire into a solderless breadboard. Now practice inserting a resistor and a piece of hookup wire into the breadboard as shown.



2.6 MEASURE R WITH DMM

Here you will measure resistance using the DMM. Here we will investigate different ways of holding the resistor to get the best accuracy.

2.6.1 HOLDING A RESISTOR

Measure the 100k resistor while holding the resistor these different ways

1. DRY fingers - holding the resistor leads against the DMM test leads using your fingers. Make sure your fingers are touching the DMM test leads while doing this.
2. WET fingers - same as above but make sure you fingers are wet (there's a faucet/sink in the lab).
3. BREADBOARD 1 - insert R into the breadboard (remember the leads must be in different terminal strips). Then touch the leads with the DMM test leads.
4. BREADBOARD 2 - insert R into breadboard where both R leads are in one terminal strip as shown

RECORD DATA

_____ DRY FINGERS
_____ WET FINGERS

_____ BREADBOARD 1
_____ BREADBOARD 2

(***) Which method was most accurate?
Note the DMM "computes" R by applying a small known current across its terminals & measuring the amount of voltage that forms across the resistance.
(***) Knowing this, explain how the "bad" method is producing the erroneous measurement?
(***) What's wrong with measuring R using "breadboard 2"?

2.6.2 DMM RANGE SETTINGS

Measure the **1.8k resistor** using different range settings on the DMM. Record the displayed value below. This exercise applies to manual ranging DMM's. There are also auto-ranging DMM's which select the range automatically.

Displayed value	DMM range setting
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Which range setting was best for measuring R? (***) Record answer.

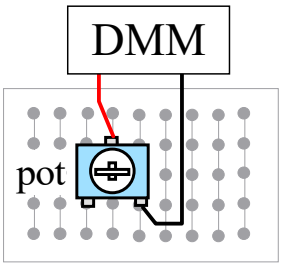
Why not just pick the highest range setting to ensure no overload occurs? (***) Record answer.

2.6.3 MEASURE RESISTORS WITH DMM

Now measure each of the resistors using proper holding technique and proper DMM range. Include a calculation of percent difference ("% diff" = 100*(measured - nominal)/nominal).
(***) Record results.

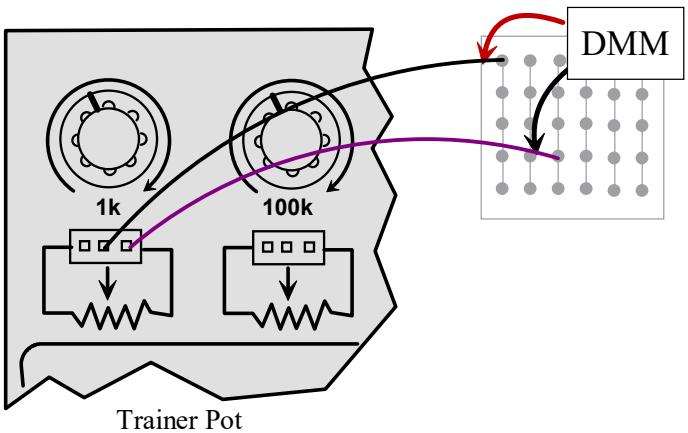
In all future labs always double check the color bands to verify you have the correct resistors. Also measure the resistance of each resistor using the DMM. Do this at the START of the lab and write the record the results.

2.7 CONTINUITY THRESHOLD



Surface-mount pot

OR



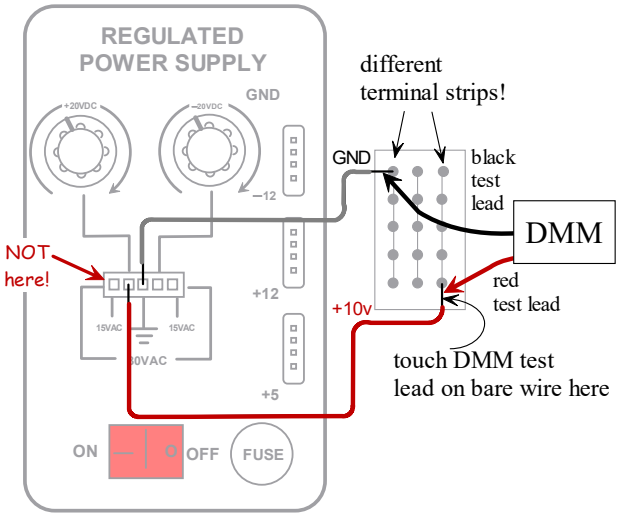
Trainer Pot

The DMM can also check "continuity" between 2 points in a circuit. Continuity means that resistance between 2 points is below some small threshold (e.g., if a wire connects the 2 points). If there is resistance is higher than the threshold then there is NO continuity (e.g., if the wire is broken). The DMM tests continuity just like with resistance measurement, except that it sounds a tone if the measured R is below some threshold. It sounds no tone if R is above the threshold. Here we will find out roughly what this threshold is for our DMM using a potentiometer (or "pot"). The figure shown shows a pot mounted on the breadboard, but you can also use the pots on the trainer. It is important that one DMM lead go to the pot wiper.

STEPS

1. Set the DMM to continuity testing (or similar).
2. Touch the DMM test leads together. The DMM should tone. This is commonly done as a first step.
3. Test continuity across resistor R_3. (tone or no tone?)
4. Center the wiper of a potentiometer (1 kΩ or similar) by turning it with a small screwdriver. (or use the potentiometer on the trainer)
5. Test continuity across the pot wiper and one of the other pot leads (either one). It should not tone.
6. Slowly turn the wiper to one side. Usually the DMM in continuity mode will show resistance value.
7. Slowly turn the wiper to one side so the resistance drops. Do this until the DMM tones.
8. (***) Record the threshold value.

2.8 MEASURE DC VOLTAGE WITH DMM



Now you will measure DC voltage using the DMM. We must select the proper variable type (DC voltage... don't pick AC voltage), and then the voltage range on the DMM.

STEPS

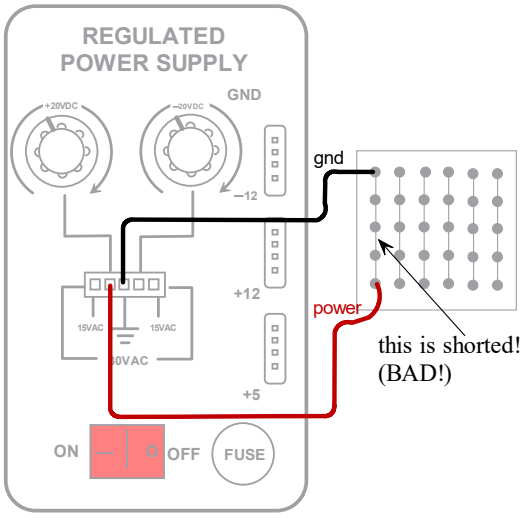
1. Turn power OFF on trainer.
2. Wire up the circuit as shown.
3. You will draw DC voltage from the regulated power supply on the trainer.
4. Notice the "hot" wire goes to the SECOND terminal on the trainer's power supply, not the first terminal. The second terminal is controlled by the + voltage dial.
5. Adjust the (+) voltage dial so voltage is **10V**.
6. Set the DMM to measure DC voltage with the proper range setting.
7. Touch the red tip to (+) wire and black tip to (–) wire.
8. Suggestion – a good technique for measuring with the DMM is to strip a little extra insulation from the wire (say, 5/8"). After inserting the wire into the Bb, some bare metal will show. Touch the DMM test lead to this exposed wire.
9. (***) Record result.

10. Swap the positions of the DMM test leads: touch red tip to (–) wire and black tip to (+) wire.
11. (***) What is the DMM reading now?
12. (***) What does this tell you about how the DMM measures DCV?

2.9 SHORTING POWER SUPPLIES

NEVER connect different "source" voltages to each other directly. This includes any equipment that produces a voltage signal (e.g., DC power supply on trainer, any power supply, function generator output, etc.). This effectively shorts the power supply. Short circuits are dangerous and can damage equipment or components (or at least blow a fuse). Some power supplies have overload protection, but many do not.

(***) Initial on answer sheet indicating you understand. If not, please talk to me.



2.10 FINISHING & FOLLOW UP

Clean up your area and check out with the instructor (sign out is on the answer sheet).
Transfer a portion of your answers (as indicated) to the answer sheet (only the answer sheet is turned in).
Complete the follow-up questions on the answer sheet.

LAB 2 – ANSWER SHEET

WIRE, RESISTORS, DMM, BREADBOARD, & MEASURING RESISTANCE

Team Number: _____

Name 1: _____ Name 2: _____

2.2 Resistor Color Codes

	Color bands	Numbers	Nominal value (kΩ)
R_1 =	_____.	_____. x 10^____. ± ___.	_____.
R_2 =	_____.	_____. x 10^____. ± ___.	_____.
R_3 =	_____.	_____. x 10^____. ± ___.	_____.

2.3 Wire Size: _____ AWG (Measured wire diameter: __ _____ __

2.4 Breadboard

Verify the connectivity of the following. Note whether the DMM produced a "tone" or produced "no tone".

1._____. A single terminal strip.
2._____. Between different terminal strips
3._____. Between terminal strips aligned across the notch.
4._____. Within a single bus strip
5._____. Across 2 adjacent bus strips

2.6.1_____. Best way to hold R while measuring resistance?

_____ Why do the other methods produce error?
_____ What's wrong with breadboard 2?

2.6.2 Best range setting

Setting: _____ Hi range problem:

2.6.3 Measure Rs with DMM

Nom value (kΩ)	Measured R	% diff	DMM range setting used
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

2.7 Continuity Threshold

_____. Record the threshold value

2.8 Measure DCV with DMM

_____. (step 9) Record DCV
_____. (step 11) Record DCV with test leads reversed
_____. What does this tell you about how the DMM measures DCV?

2.9 No short circuits... I understand (initial here, each student):