

Introduction to Lab Equipment

DMM, Breadboard, and Voltage Source Fundamentals

Introduction

The Digital Multimeter (DMM) is one of the most common testing tools used in electrical circuit analysis. It is a versatile tool that can measure AC or DC voltage or current. It also measures resistance, checks continuity and can check diode polarity. In order to properly build and test electrical circuits one must be comfortable with taking measurements using the DMM. One must also be able to understand and interpret the DMM readings.

A breadboard or “protoboard” is one of the simplest and most common tools for quickly building circuits. It doesn't require any soldering or special connectors to make the circuit connections. Connections are made to the breadboard through little holes which have connectors to hold components or wires. Inside the breadboard various of these connectors are connected together. The pattern is such that one can easily “wire” numerous components together to create all sorts of test or experimental circuits. When using breadboards one must be very careful in the hookup to make sure components are not accidentally shorted together or left as open circuits. This is why it is important to fully understand the underlying wiring/connections that make a breadboard work.

Almost every circuit that you will construct will require some sort of DC power-supply. Understanding how to properly connect and setup the DC power supply will help to make all experiments go smoothly.

Objectives

- Use DMM to measure voltage and resistance
- Be able to set up power supply to produce up to 3 required voltages
- Discover the layout and connectivity of a breadboard

Procedure

Prelab: Read CH3 of the DMM user manual and *PCC Power Supply Information*. Under Equipment Guides on the spot website. *PCC Power Supply Information* applies specifically to the analog power supplies in ST313. The same concepts apply to the new digital supplies in ST315.

Task 1: DMM Checkout

The measurement the DMM takes is controlled by the selection buttons on the front panel. The DMM in our lab can measure AC or DC voltage or current. For this class we are mostly interested in DC. It can also measure resistance. When you push the resistance selection button, make sure **2x4 wire** is displayed. If **4 Wire** is displayed push the resistance button again until **2x4 wire** is displayed.

Perform steps 1-3 of *DC_Meter_Pre_Flight_Checkout.xlsx*. This can be found on the website under Equipment Guides. Make sure you record the voltage and resistance measurements of your probe. Ideal, when the probes are connected together like this, they create a short circuit.

With the probes still connected for measuring resistance, select the continuity check. This is the button

Introduction to Lab Equipment

with the audio symbol on it. Make sure the audio symbol is displayed. If you get a diode (arrow and line) press the button again. Now touch the probes together. The DMM should beep. This check is used to determine if there is a short or open circuit. A beep means a short and an open is silent. Page 3-15 of the DMM user manual indicates that it considers anything less than 20 Ohms as connected and it admits a tone.

Task 2: Breadboard Layout

The first thing that we will do in this lab is figure out what the breadboard layout is. You need to use the DMM to probe the breadboard and determine which holes are connected and which are left as open. Create a diagram in your lab notebook showing the holes. In your diagram, connect holes that are electrically connected with a line. The DMM can be used to measure the resistance or continuity between any two points. Practice with both methods. You should be using the $V\Omega$ HI and LO connectors on the DMM.

Tip: Start at one hole, maybe A1. Then move out in a circle until you have a pattern of what is connected to A1. Then check some random places that might be farther away to see how far the connection goes. You don't have to check every combination of holes, there is a pattern that you should start to recognize. Check enough to be comfortable with the pattern and be able to explain it.

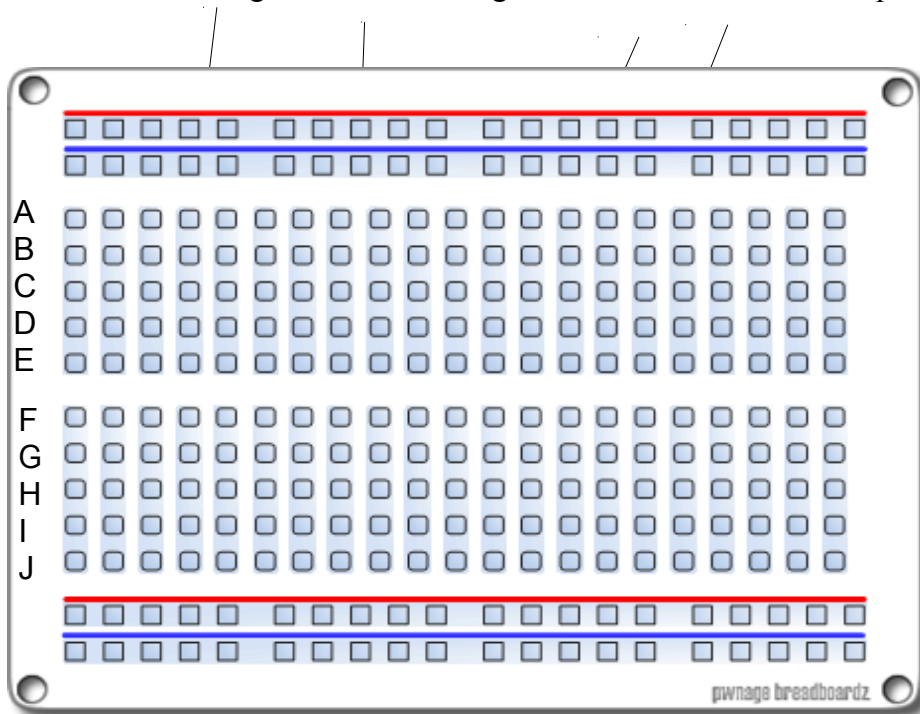


Figure 1: Sample Breadboard layout

Your breadboard sketch should look something like [Figure 1](#). This figure does not show all

connections and opens. You do not have to draw every hole on your breadboard, but you do need to show enough to completely understand how the breadboard is connected.

Analysis

Are breadboard holes that are connected a short or open circuit?

How much resistance is there between holes that are connected? (the answer is not zero, record the DMM reading)

What type of circuit are breadboard holes that are not connected?

How much resistance is there between holes that are not connected?

Task 3: Measuring Resistors

1. Find a guide that you like for “resistor color codes” online. Read and understand this guide. Make sure you are able to understand how to read the resistor color bands.
2. Use the color bands to find a 100Ω , 330Ω , $1K\Omega$, and $4.7K\Omega$ resistor from your kit. What is the tolerance of each of these resistors? Use the DMM to measure the actual value of the resistor? What is the error % from ideal for each resistor? Is this error in the allowable tolerance? Make a chart to record this information. The chart should have five columns: Ideal Value, Actual Value, Tolerance, Error, Acceptable. The acceptable column is just a yes/no or check column.

Task 4: Measuring Voltage

**** Record all DMM measurements in a data table in your notebook. Confirm all power supply settings with the DMM. Do not just rely on the meter on the supply.**

1. Connect the DMM to the 6V supply, (+6V and COM). Set the power supply meter to +6V. Practice adjusting the 6V supply using the DMM as the reference voltage, not the meter on the power supply. Finally set the 6V supply to 3.5V. Record the actual setting from the DMM.
2. Connect the DMM to the +20V supply, (+20V and COM). Set the power supply meter to +20V. Adjust this setting to 15V. Record the actual DMM reading.
3. Leaving the power supply meter to the +20V supply, use the DMM to measure the +6V supply and -20V supply.
4. Now adjust the -20V supply so that it is -5V.

5. Set up the power supplies to create the following six sets of voltages. There may be multiple ways to solve this problem. These settings are not required to be in +6, +20, -20V order. For example, for Test 1, you will get your power supply to source +5V, +4V, and -4V simultaneously.
- A. In your data table, indicate what voltage was provided by the +6, +20, and -20 terminals.
- B. Indicate the DMM reading for each voltage

Test	Voltages
1	+5,+4,-4
2	+3,-3,+5
3	+3,+7,-7
4	+7, -4, +4
5	+2, +5, -3
6	+8, +3, -3