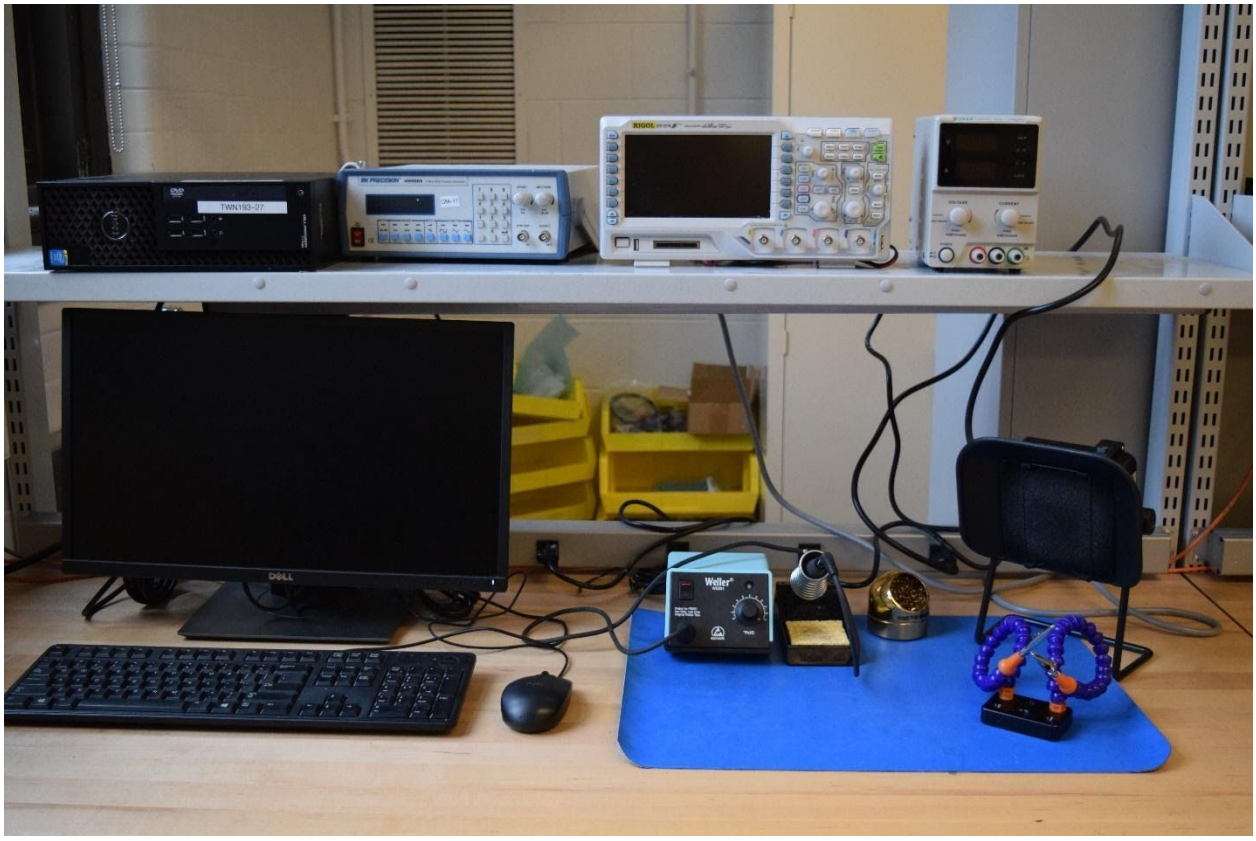
Lab 0 Equipment Familiarization

The purpose of this lab is to introduce you to the equipment you will be using for the rest of the semester.



In normal times, you would be working in the GM lab. This is a GM workstation which is a typical electronics workbench. On the top shelf from left to right you will see a computer, function generator, oscilloscope, and variable power supply. These have cables that can be found on a rack in the lab (organized by type) and should not be stored/left at the workstation. Part of the current lab will be on understanding the use of these. On the table surface from left to right you will see the computer monitor and peripherals, a soldering iron with brass sponge, and an exhaust fan with helping hands in front of them. We will discuss the use of these in a later lab.

During COVID19 we will have substitutes for these items so you will become familiar with facsimiles. This includes a kit of parts that you should pick up (see Front page of Canvas for the signup link).

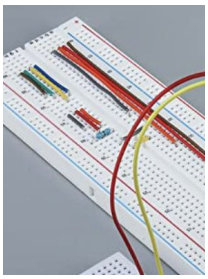
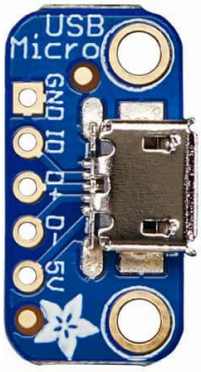
MEAM510 2021A Kit

Here is the list of components of the kit made available to you.

Category	**Item**	**part num**	**Qty**
Tool	4'x6" Plastic Box	6764TE	1
Tool	safety glasses	11228-00000-100	1
Tool	Solder kit	handskit	1
Tool	mini USB cable		1
Tool	micro USB cable		1
Tool	protoboard		1
Tool	wire kit		1
Tool	multimeter	DM-850	1
Tool	socket to pin lead		10
Actuators	DC motor low speed		2
Actuators	cheap RC servo	SG90	2
Battery	portable USB battery	BESTON	1
In the 4x6" component box			
Category	**Item**	**part num**	**Qty**
Battery	microUSB breakout board	1833 adafruit	1
MCU	teensy 2.0		1
MCU	header rows 2x12		24pins
MCU	ESP32 Pico	ESP32-PICO-Kit	1
Components	blue LED	LTL2T3TBK5 5mm blue LED	1
Components	red LED	LTL-4224 5mm Red LED	5
Components	green LED	LTL-4238 5mm Green LED	5
Components	IR LED	LTE-4208	4
Sensors	visible phototrans	TEPT4400	2
Sensors	IR Phototransistor	LTR-4206 940nm	2
Sensors	hall effect	A1326	2
passives	10 ohm res		5
passives	100 ohm res		5
passives	1K ohm res		5
passives	10K ohm res		5
passives	100k ohm res		5

passives	0.1 uF ceramic cap		2
passives	10 uF tantalum cap		2
passives	100 uF electrolytic cap		2
passives	toggle SPDT switch		1
passives	switch sensor	ESE-11HS1	2
passives	100 ohm pot		1
passives	100kΩ Trim Pot		1
passives	2k ohm stem pot		2
passives	small magnet		2
IC	nand gates	74HC00	1
IC	darlington driver	ULN2003	1
IC	h-bridge	SN754410 and FAN8100	1 of ea
IC	level converter	BOB-12009	1
IC	opamp	MCP6044	1

For this lab 0, you will use the following components from the kit:

 Multimeter	 ESP32 Pico	 Solderless Breadboard and wire kit	 USB battery charger	 microUSB breakout board

In addition, we have sent you a soldering iron kit and safety glasses. Please always use safety glasses when soldering. There is a small chance that solder may pop causing a tiny bit of very hot metal or flux to jump in the air with a chance of landing in your eye.

1. Multimeters

There are a variety of DMMs (Digital Multimeter). An example is on the left. It digitally measures multiple things. It has probes (seen on the right side of the picture) that attach to the holes in the bottom of the DMM. If you notice there are more holes on the bottom than there are probes. COM means common and is the reference connector for the other two holes, this will often be connected to ground and is sometimes referred to as ground because of that. You don't have to connect the black cable to COM, but using black for ground or COM is standard and will avoid confusion especially when talking to other people.

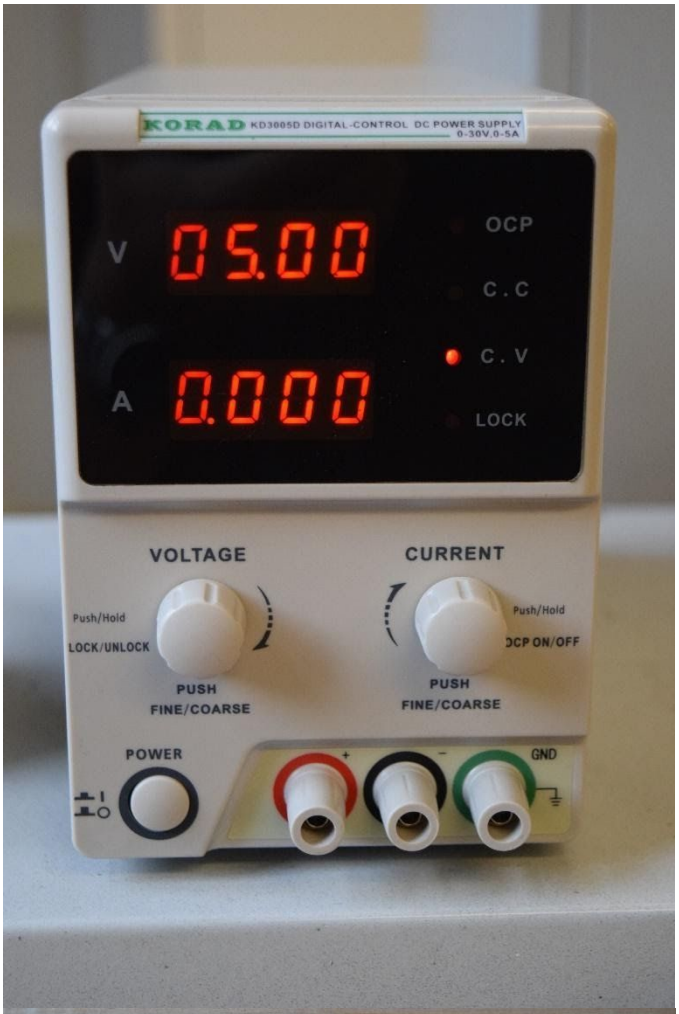
0.1.1. What happens if you use the wrong two plugs to measure something? **LOOK THIS UP**, your and the equipment's safety are one of the few areas we don't want you to learn through experience. List at least 2 consequences.

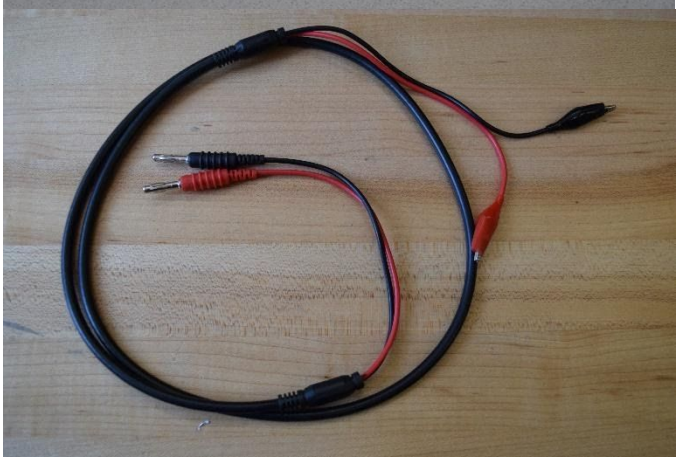
0.1.2. A dial selector is often used to choose what the DMM will measure. Often there will be many scales for the same type of read. What types of readings can your multimeter measure? Not all DMMs are the same, so it is important to know what yours can do, and how to connect it to correctly measure what you want. (If you need to, you may want to google "How to use a multimeter for beginners" on youtube).

0.1.3. Find a battery and measure the voltage across the battery. Is this what you would expect? Does it match the voltage stated on the battery? If not, why?

0.1.4. A connectivity test is used to determine if two points are connected with very little resistance (shorted). Sometimes these things are supposed to be connected, sometimes they are not, and a connectivity test can help determine if things are connected properly. This is a **very useful** function of the DMM. Many DMM's beep when the tested points are connected. Use the multimeter to do a connectivity test to see what parts around you are shorted together. Write down 2 things that are connected.

2. Power Supply





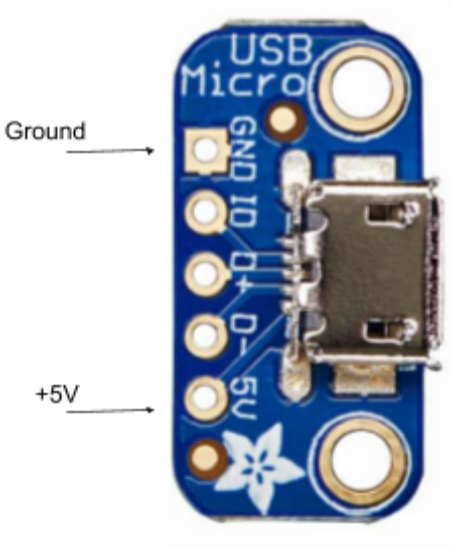
This is a variable power supply. It is able to supply a voltage depending on what voltage you need. It also can limit the current that can be drawn by whatever is connected to it. This can prevent damage to parts that are sensitive to high currents if something is improperly connected. When in use, it displays the voltage supplied and the amount of current drawn. When the CV (constant voltage) light is illuminated, the power supply will maintain the output voltage set by the dial, thereby supplying as much current as required to maintain that voltage. (Some power supplies require that you press in the knob to select the digit to change.) Conversely, if the CC (constant current) light is illuminated, the power supply has reached the current limit set by the current dial, and the voltage will decrease as needed to maintain the desired current.

Below it you can see the cables that are used with it. These are banana to alligator cables. The end that looks like a peg is the banana end as if it was yellow and you were in need of glasses it would kind of look like a banana. The alligator end has articulated jaws which you can pretend are alligators. You can plug the banana end into the positive and negative receptacles on the variable power supply. The voltage between these two is what is displayed on the readout. You can connect the ground to one of these if you need them referenced to a ground.

Unfortunately, we cannot send these power supplies to every student during COVID19 so we will use batteries instead. However, being familiar with power supplies can be important for any future mechatronics work.

Find the BESTON usb phone charger from the kit. This is a standard extra battery for charging your phone or other devices. It has two USB-A ports (the large size port) and one USB-B micro port. The micro port is used to recharge the battery. The USB-A ports are used to access the battery charge. The unit claims to have 8000mAh of charge, which is plenty for most of what we plan to do in this class. The blue LED's on one side indicate roughly how much charge is left in the battery.

Solder the 5 header pins into the microUSB breakout board. The board could look something like this, though many would consider the board to be upside-down. It could be used either way. Also, we are only concerned with the GND and 5V line, so you only need to solder those pins. In fact, removing the middle three pins (by pushing or pulling them out with pliers) may give you more flexibility in mounting them into a breadboard.



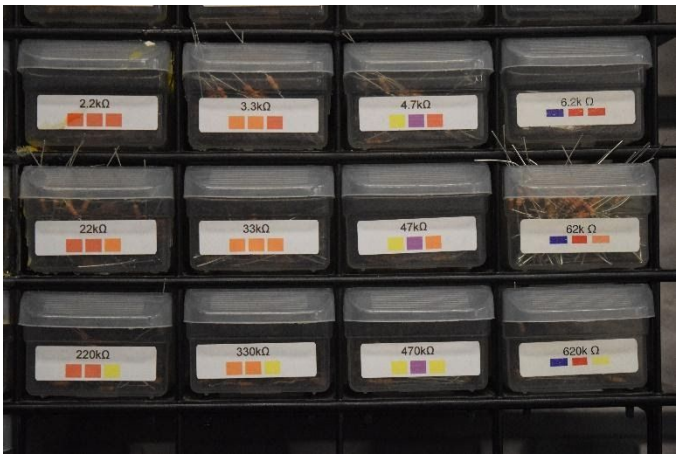
If you have not soldered before, this is a relatively easy one to practice on. This video is an example of soldering pins to a board. https://www.youtube.com/watch?v=XYIqK4uzNYQ

Don't forget to wear safety goggles that are supplied in the kit.

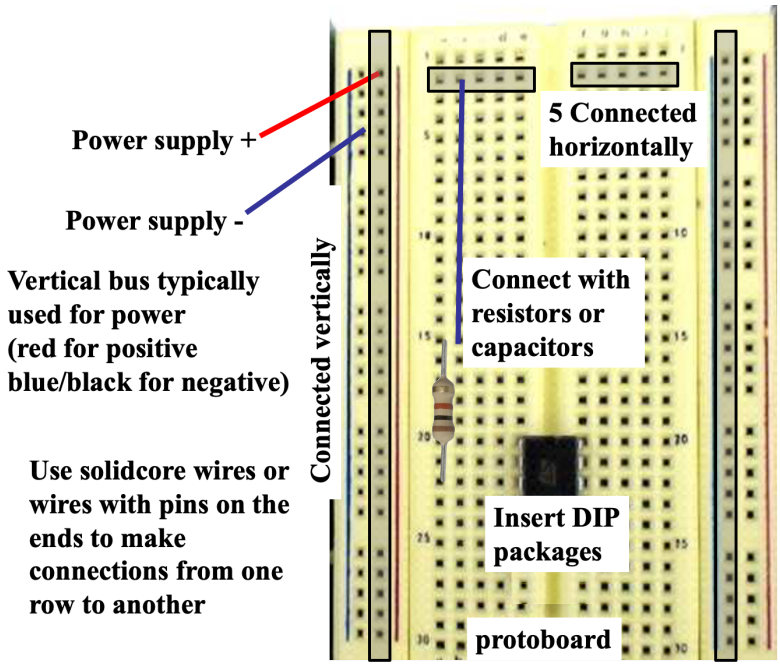
Take the USB cable that comes in the box with the battery and plug the USB-A port into the battery and the microUSB break out board and plug it into the microUSB side of the cable. Use the volt meter setting of the DMM to verify the voltage measured between the ground and +5V pins show 5 volts.

Power supplies are often the start of every debugging session. You will be checking that your power is correct dozens of times during a debugging session, so getting comfortable with this is important.

3. Resistors



At times, you will get access to the GMlab "ministore" which includes racks of hundreds components and resistors. When working in a lab with other people there are best practices that can be followed to make work quick and easy, such as putting tools in the correct spot and only taking the number of components you need to avoid waste or components being placed in the wrong spot. Even if you follow these practices others may not, which means when you take your components you may need to check that they are what you intend to take. We have several tools that can help with this, resistors have color codes on them which tell you their value, these color codes are listed on the drawer making it easy to check what you have pulled from a drawer is what is supposed to be in that drawer. But sometimes you are already at your bench and are too lazy to pull up a color chart to figure out the resistance. The DMM can be one way to check.



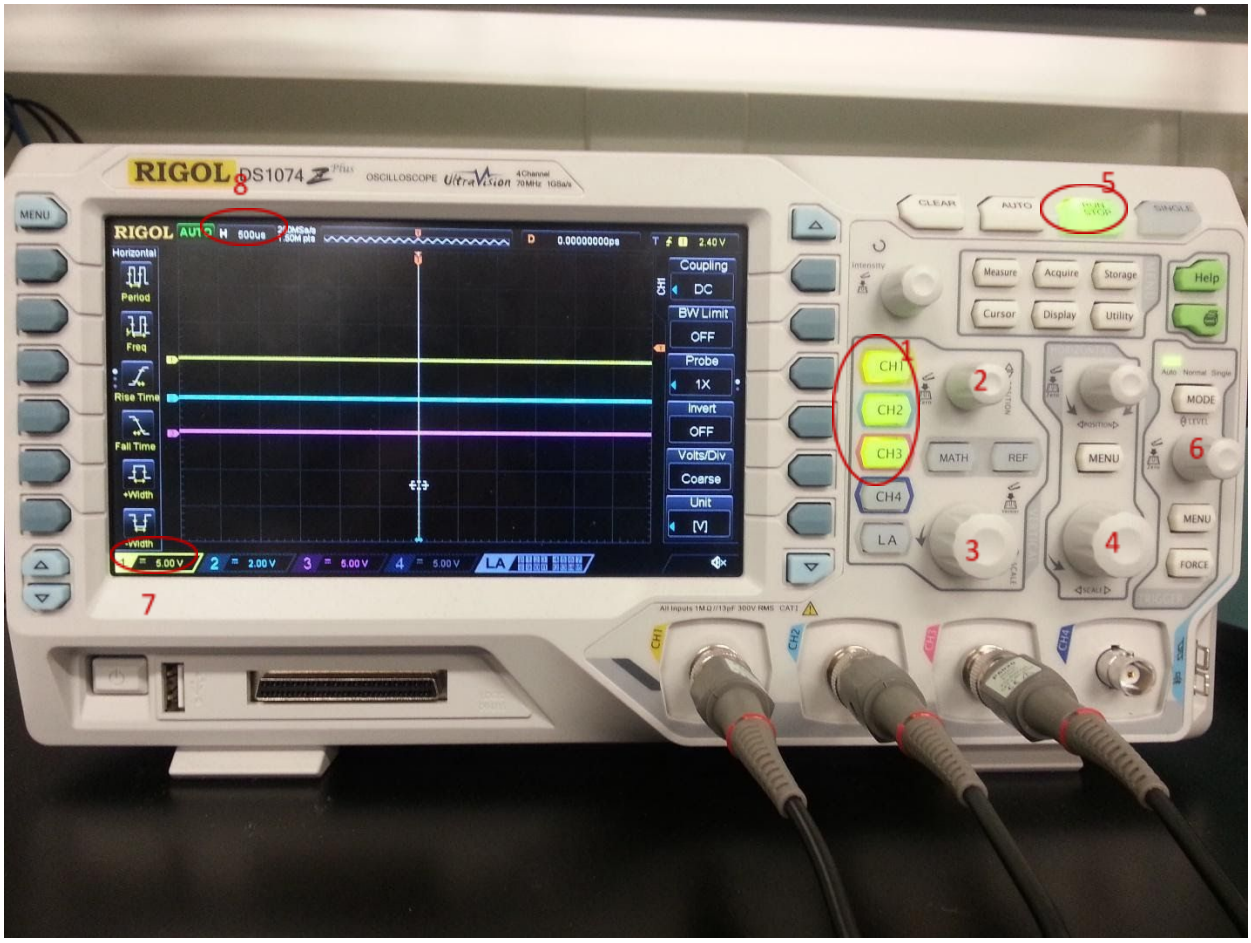
You will also often use a solderless breadboard for testing things out. The solderless breadboard is used to easily electrically connect components together in an easily reversible way. The figure shows how the pins are connected underneath the cover. Use the connectivity tester to verify which holes are connected horizontally and which holes are connected vertically.

0.3.1. Use the DMM to measure a variety of resistors from your kit. Combine two different resistors in parallel, and take a separate measurement of two in series. Are the readings within tolerances? Try holding the resistor to the probes with your fingers touching the metal? How does the resistor change if you make the connection to the resistor without touching it? If the readings are different, why?

0.3.2. Connect the two resistors that are larger than 1Kohm in series on the protoboard. Attach one end of the two to 5V of the battery and the other end to ground. Measure the voltage at the

three points of the two resistors (each end and the middle). What is the voltage? How does this match expectation as a voltage divider? What would the current be going through either resistor?

4. Oscilloscope



This is an oscilloscope. It is used when more detail is needed for a signal than a multimeter can supply. It is a very useful tool.

Unfortunately we cannot give oscilloscopes to every student. Instead we have a replacement that approximates the functionality of an oscilloscope. The ESP32 Pico in your kit has been programmed with the OscilloSorta program.

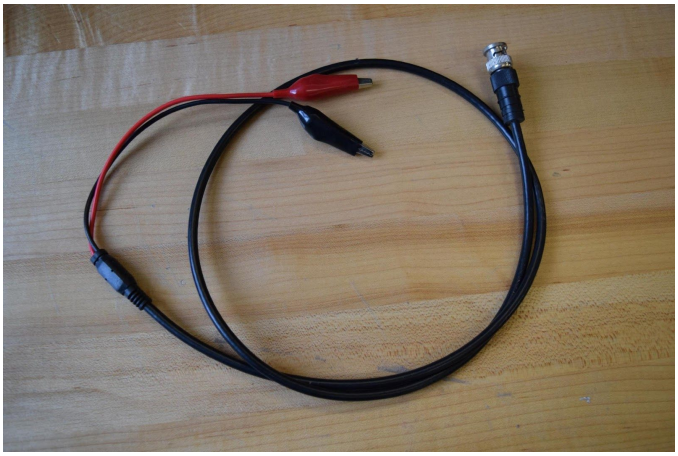
Read through and do the activities in the *OscilloSorta 0.3 Tutorial* document. Take pictures or screenshots of activities 6, 7, and 8 and include in your Lab 0 submission and label them as 0.4.1, 0.4.2 and 0.4.3.

This is a scope probe. It has a BNC cable on one side that plugs into the scope and a "probe tip" on the other side. In addition, a black alligator clip is there to connect a ground reference. Many probes have a 1X –

10X switch and the scope has a 1X – 10X setting. This setting attenuates the signal so the signal voltage is either 1:1 or divide by 10. On the *OscilloSorta*, we will use a similar mechanism as this 10x probe function. After doing the *OscilloSorta 0.3 Tutorial,* do the following.

0.4.4 In the case of using the OscilloSorta, it can only read from 0 to 3.3V. We will often want to read signals with larger voltages. One way to do this is to use two resistors as a "voltage divider". In this case, there are three legs, the source signal (e.g., the scope probe tip), the line to the scope (e.g., the wire that goes to the scope or OscilloSorta) and ground. Find two resistors from the kit that can be used in this fashion to reliably measure signals that may be around 5V (may be a little higher or a little lower). Be sure that 5V is not going directly into the ESP32 pin as this may damage it. Take a picture of the breadboard setup with the resistors, and OscilloSorta wires going to Channel 1. Submit this picture and clearly indicate which wires go to the source signal, to Channel 1 of the ESP32 and to ground. Submit a screen shot or photo of OscilloSorta scope face showing the output when the source signal is 5V from the BESTON power battery (and sharing the same ground) and the output.

5. Function Generator



This is a function generator. It supplies a voltage that varies with time on its output. It is not capable of supplying a lot of current, so it should not be used in situations where a significant current is needed. Below you can see the cable that should be used with it. It has alligator connectors on one end and a BNC connector on the other end. While this connector will work on the oscilloscope and vice versa, they are not interchangeable. The black wire is the reference and the red wire is the signal. You can change the signal shape, frequency, amplitude and DC offset.

During COVID19 we'll use the OscilloSorta function generator. Refer to the tutorial document there. There is nothing to submit for this part of Lab 0.

6. RETROSPECTIVE

This section is not graded. It is purely used to inform the teaching staff for future labs. Briefly submit an estimate of the hours you spent on this lab. Indicate any troubling spots (areas that could be improved in instruction) or other thoughts you may have about this lab or logistics for the course thus far.