CG1111: Engineering Principles and Practice I

Preparation for Week 1, Studio 2

Laboratory Safety and Equipment Familiarization

Overview

1. Safety
2. Resistor Color Codes
   - ❖ **Activity 1**

3. Breadboard
4. DC Power Supply
5. Digital Multimeter
6. Analog Ammeter
   - ❖ **Activity 2**

7. Function Generator
8. Oscilloscope
   - ❖ **Activity 3**

- ❖ **Online Quiz**

1. Safety

- Expectation from students
  - Watch the prescribed videos listed below
  - Attempt the safety quiz online to obtain the safety certificate (without which you will **not** be allowed to work in the lab)

- Videos to watch
  - Introduction to Laboratory Safety and Health in NUS
  - Unsafe Acts
  - Basic Electrical Safety

1. Safety – Safe Practices

- What to wear?
  - Covered (closed-toe) shoes
  - Long hair, very loose clothing and accessories must be secured before working in the laboratory
  - Wear goggles when working on equipment that involves cutting or shaping metals
- Never work alone in the laboratory
- Do not touch any electrical equipment with wet hands
- Never use any damaged or faulty equipment – report it to lab officer immediately
- More details on safety are available at the DSA Lab Safety Notice Board near its entrance

1. Safety – Emergency Procedure

- What to do in an emergency?
  - Accidents
    - ✓ Report them to Lab Officer immediately
    - ✓ Do not attempt to render first aid if you are not trained to do so
    - ✓ Contact NUS Campus Security and other agency if needed (Please save these numbers to your phone contacts)

S/N	Agency	24-hrs Hotline
1	**Campus Security**	**6874 1616**
2	Faculty of Engineering Safety Office	6601 3765
3	Police	999
4	SCDF (Fire Brigade and Ambulance)	995

1. Safety – Emergency Procedure

- What information to give when calling for an ambulance or the Singapore Civil Defence Force (SCDF) at 995 in an emergency?

  You should have these details ready:

  - ✓ Contact Person's Name & Tel No. :
  - ✓ Floor & Unit No. : *e.g. E4A-04-08*
  - ✓ Building Block No. : *e.g. E4A*
  - ✓ Street Name : *e.g. Engineering Drive 3*

As NUS campus and roads leading to the building is complex, you need to also inform NUS Campus Security at 68741616, which would then lead the ambulance to the location of the emergency.

1. Safety – Evacuation Procedure

- What to do in a Fire Emergency?
  - Inform the lab officer immediately
  - If fire **alarm** is activated, everyone must **evacuate** the laboratory and the building
  - Calmly exit from the fire exits and leave the building. DO NOT use the lifts
  - Gather at the designated Emergency Assembly Point, where attendance would be taken to ensure that all occupants have been evacuated safely
  - The designated Emergency Assembly Point for DSA lab is located in the carpark next to E6 building, as shown in the next slide.

1. Safety – Evacuation Procedure

- Emergency Assembly Point for BLK E4A

Assembly Point 39

1. Safety – Basic Electrical Safety

- Typical Electrical Incidents
  - Electric Shock
  - Electrical Burns
  - Electrocution
  - Loss of muscle control
  - Fire / Explosion

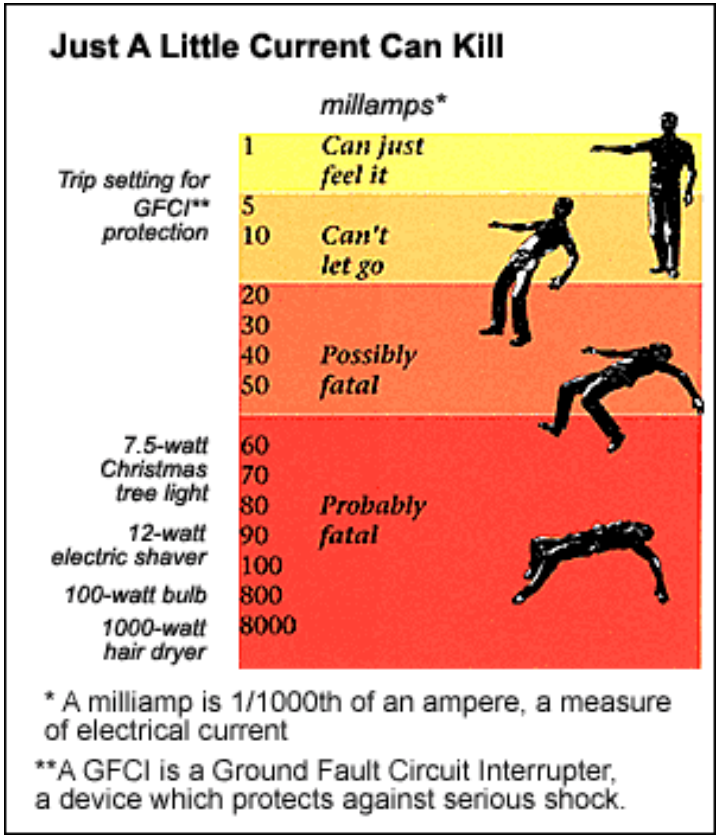
Figure 1

- Typical Electrical Hazards
  - Defective Equipment
  - Damaged Electrical cords
  - Exposed Electrical wires (see Figure 1)
  - Overloading of electrical circuits, plugs or extension cords (see Figure 2)
  - Using Electrical equipment in wet or damp conditions

Figure 2

1. Safety – Basic Electrical Safety

- A Common Misconception:
  - "Low voltages are harmless".
  - This is not true!
  - Current as little as **60 mA** can kill!



"Electrical Injuries." *The Merck Manual of Medical Information: Home Edition*. Pennsylvania: Merck, 1997.	"At currents as low as 60 to 100 milliamperes, low-voltage (110-220 volts), 60-hertz alternating current traveling through the chest for a split second can cause life-threatening irregular heart rhythms. About 300-500 milliamperes of direct current is needed to have the same effect."	0.06–0.1 A (AC) 0.3–0.5 A (DC)

1. Safety – Basic Electrical Safety

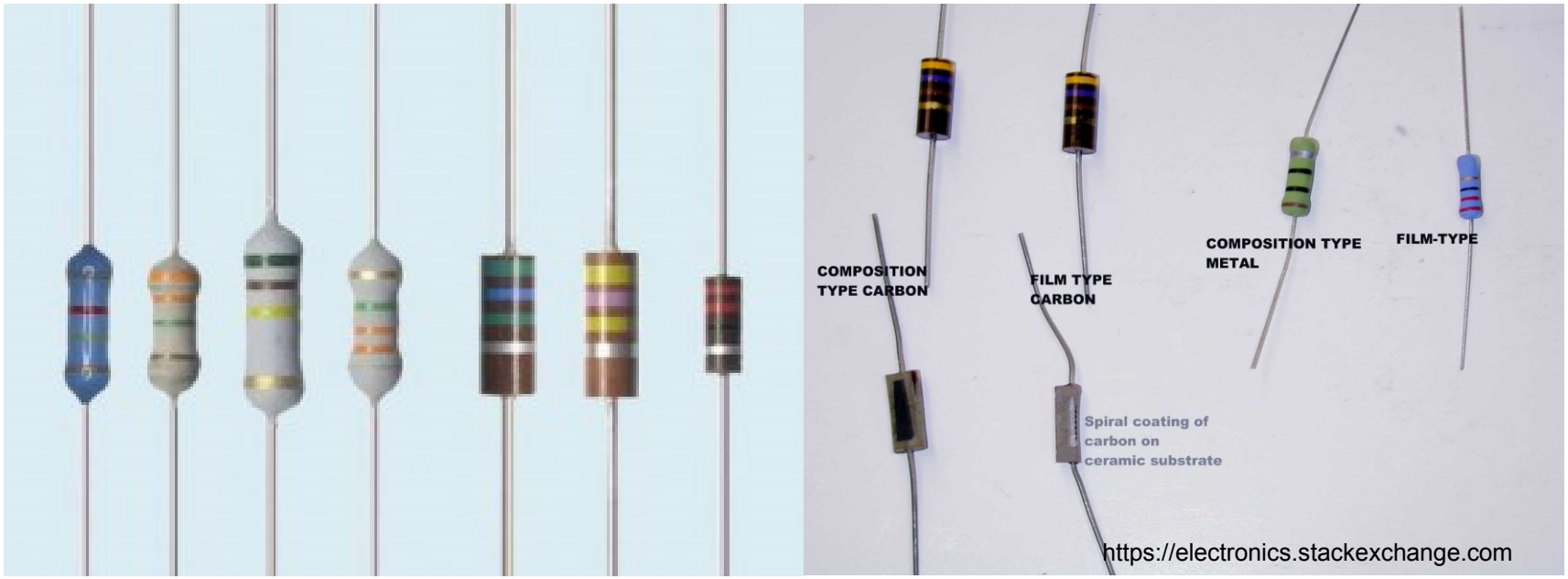
- Major causes of electrical accidents
  - Ignorance, negligence and forgetfulness
  - Working on live electrical equipment deliberately
  - Disabling and working without safety devices (e.g. removing grounding connectors) or tampering with safety devices (e.g. inappropriate fuse replacement)
- Every NUS lab equipment should have its **Safe Work Procedure**
  - Please ask for it if you need it

- Bottom Line:

Always follow safety procedures

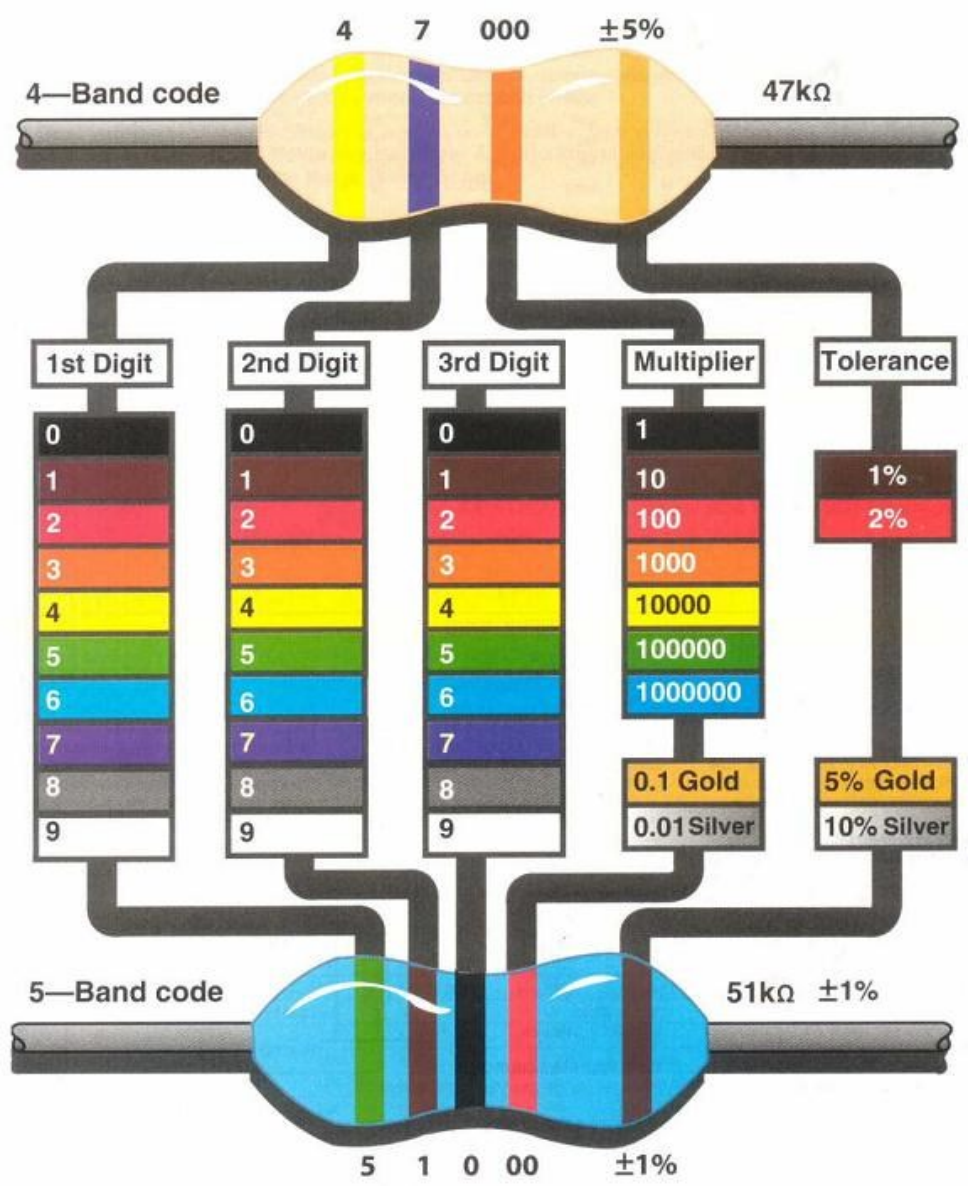
2. Resistor Color Codes

- Resistor manufacturers usually provide the resistance values of the resistors on their casings in the form of colour codes.
- The resistance value indicated is only the ***nominal value*** of the resistor, which is an approximation to the actual resistance value and there is a possibility of a slight deviation from the nominal value, which is known as the ***tolerance***.
- This information is usually coded in 4 or 5 bands, although the rarer 3-band (fixed 20% tolerance) and 6-band (with temperature coefficient) resistors also exist.



2. Resistor Color Codes

- For the 4-band resistors available in our lab, the first 3 bands indicate the resistance value, while the fourth band represents the tolerance value.
- Do you know some of the common resistor color codes mnemonics?
- What about coming up with one yourself?



ACTIVITY 1

Overview

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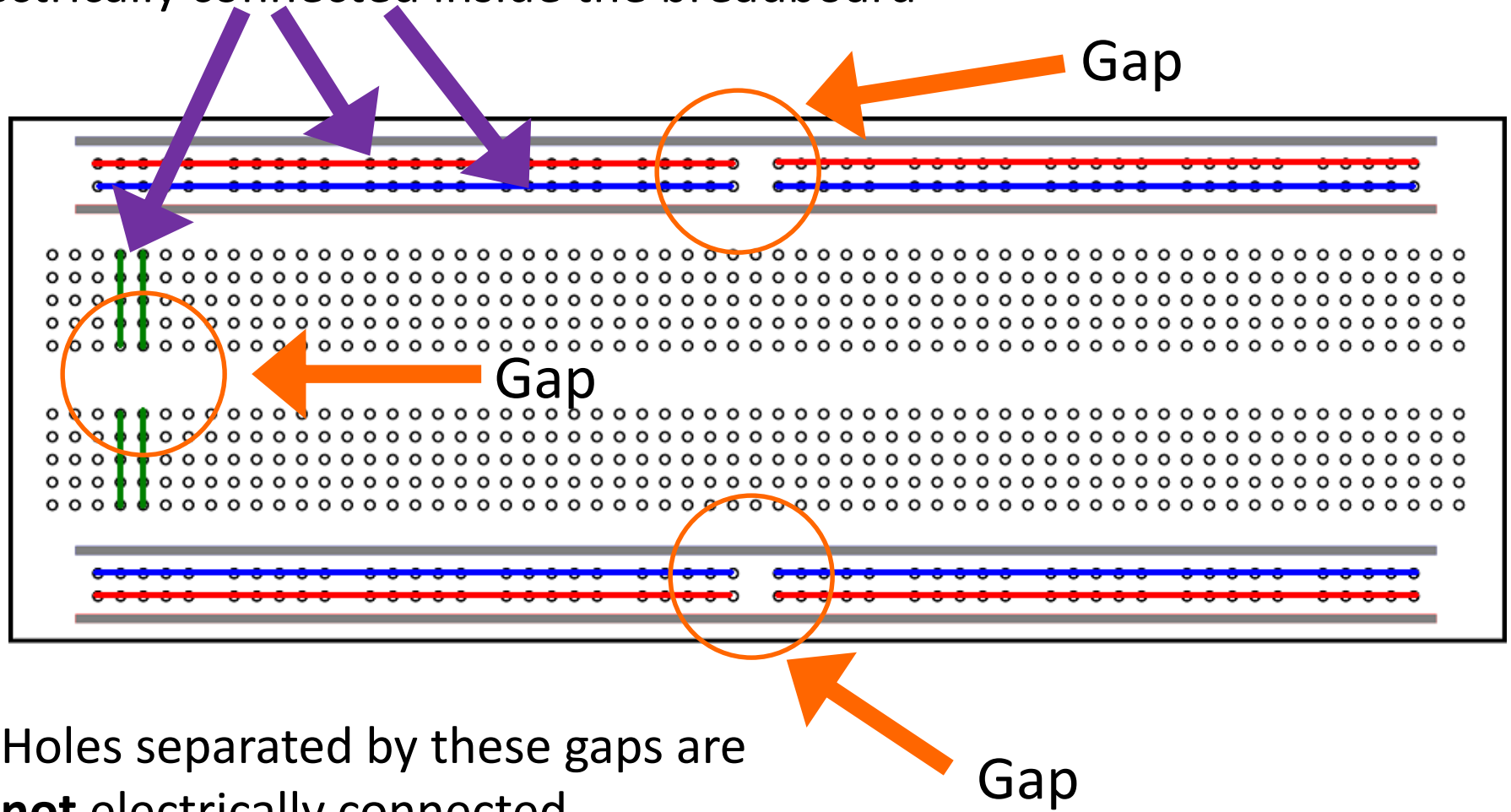
- ❖ **Online Quiz**

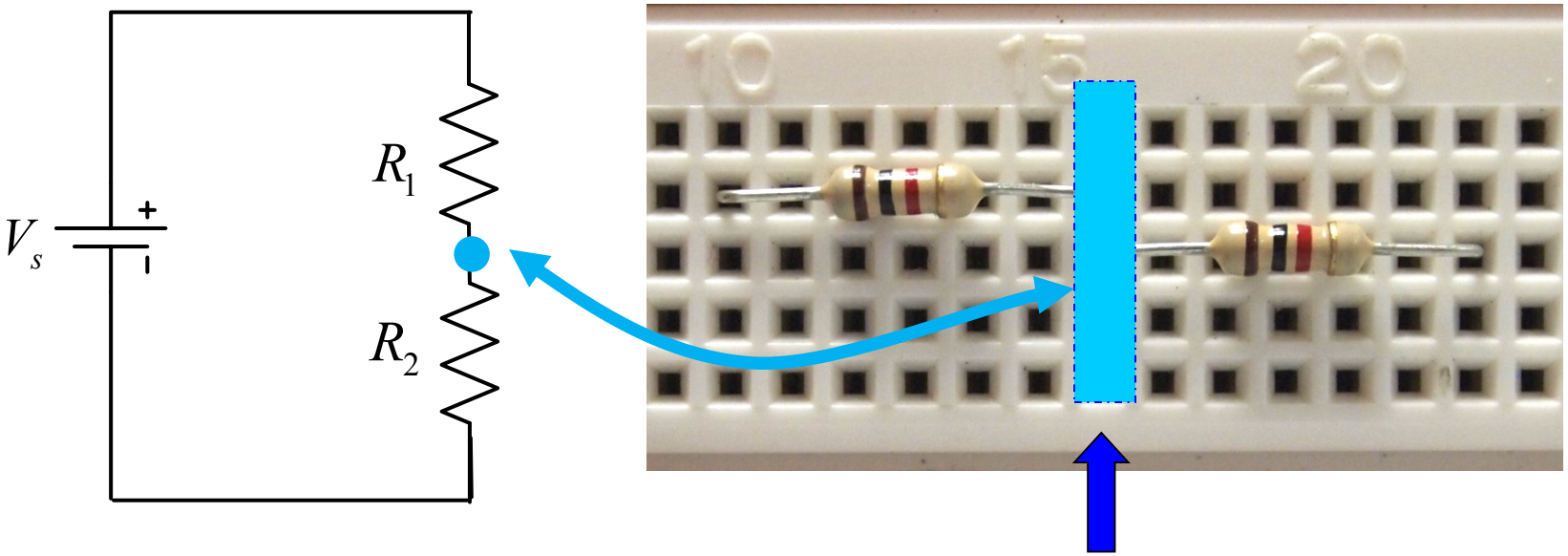
3. Breadboard – Electrical Connections

These adjacent holes, joined by the same lines, are electrically connected inside the breadboard



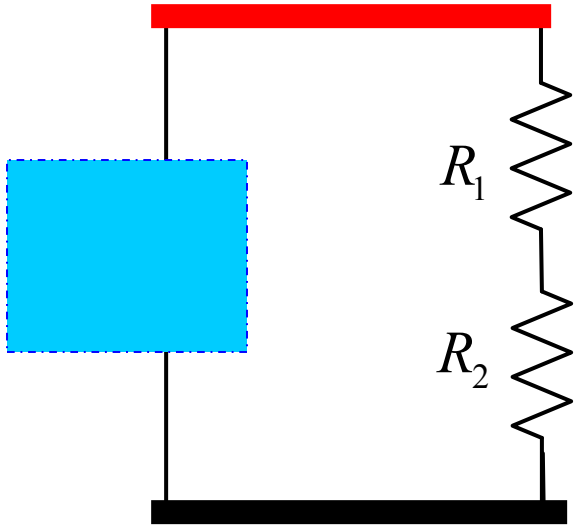
Holes separated by these gaps are **not** electrically connected

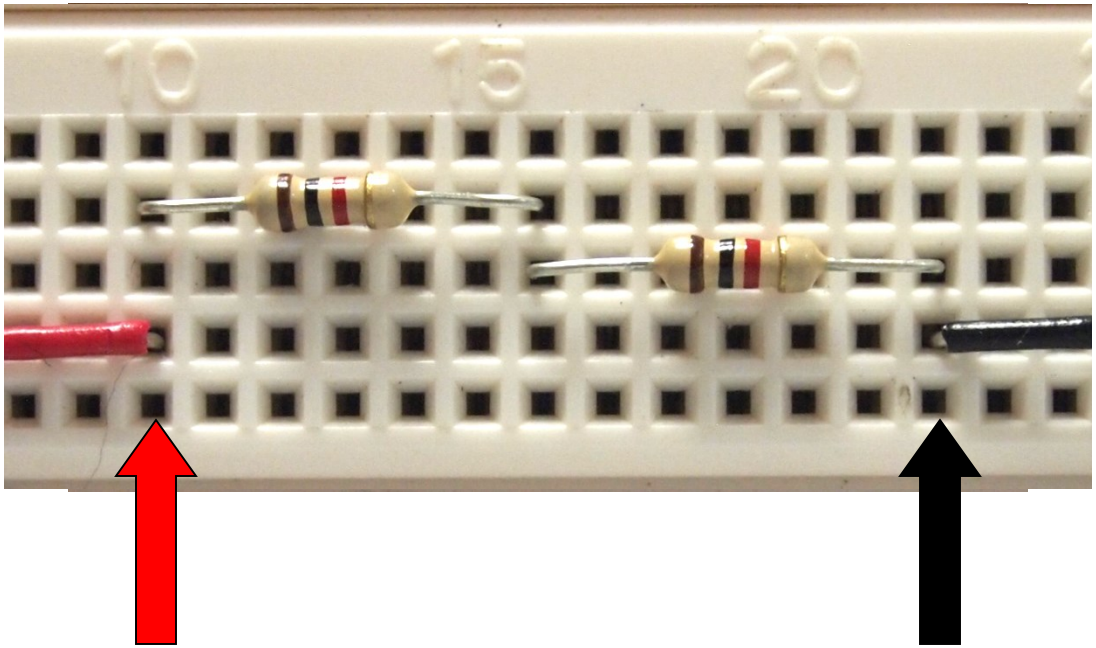
3. Breadboard – Series Connections



Use the electrically connected holes to connect components.

3. Breadboard – Series Connections



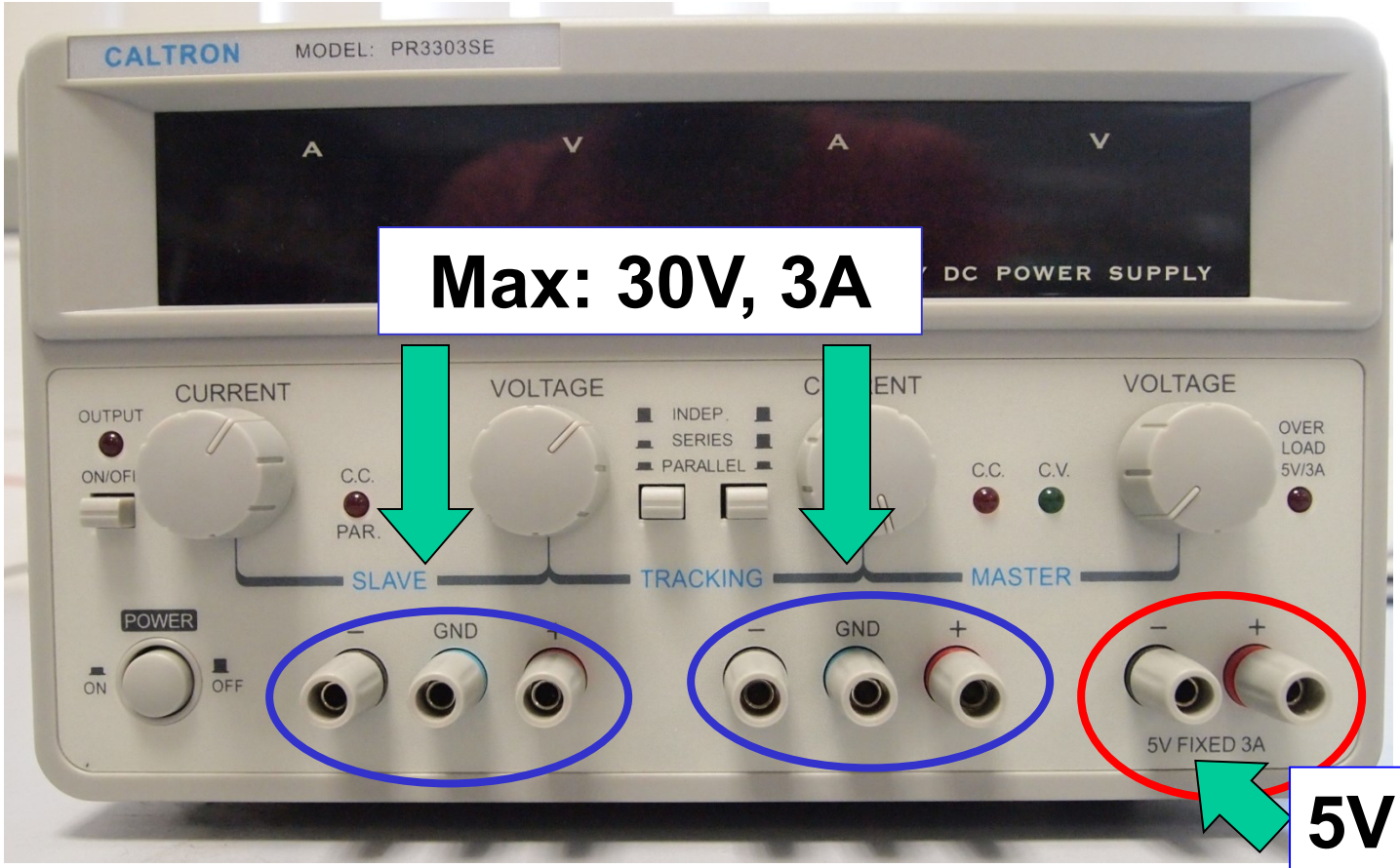


Place two wires here to connect to the source, V_s

3. Breadboard – Parallel Connections

- How would you make parallel connections?

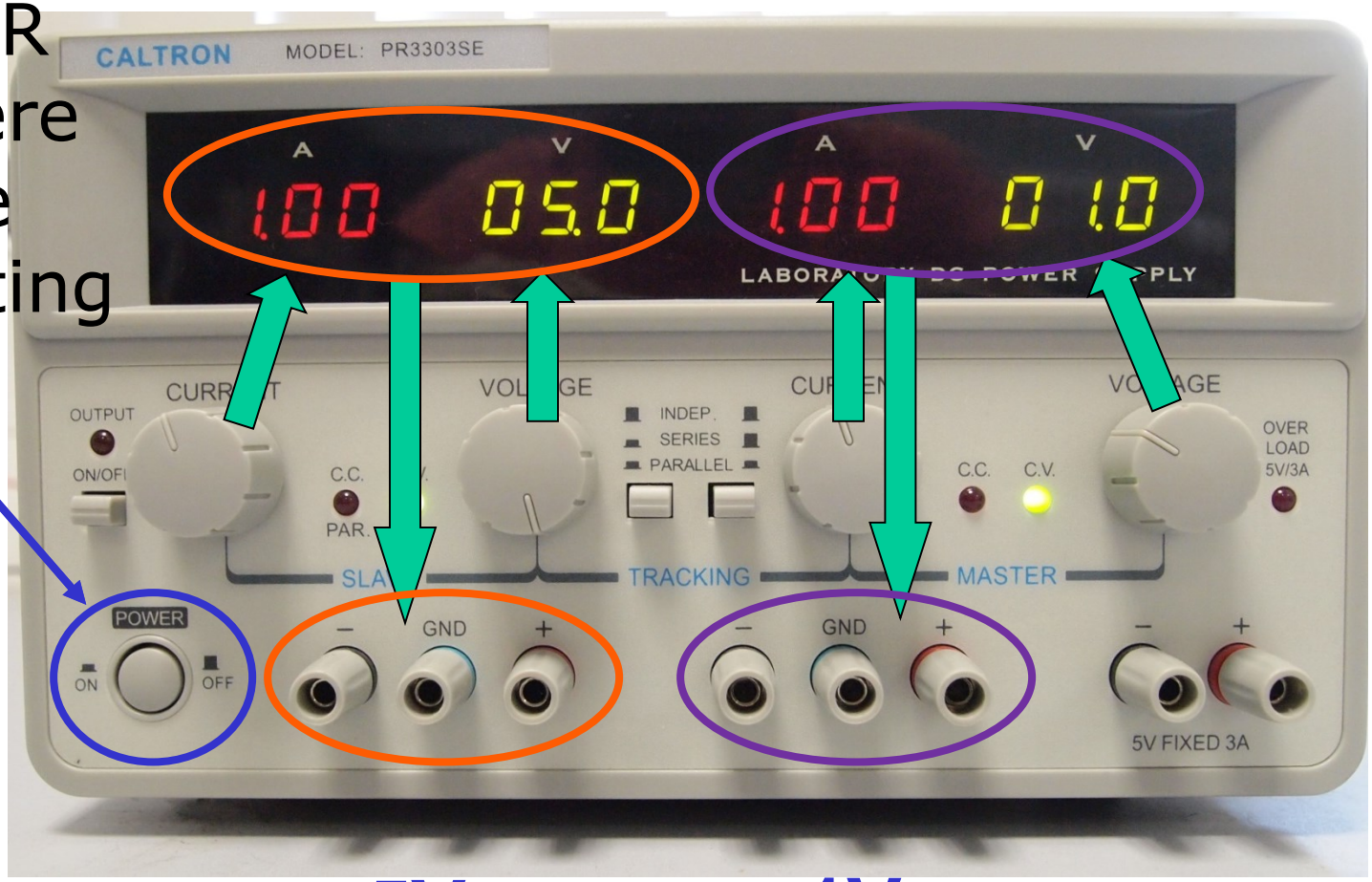
4. DC Power Supply : Carltron PR3303SE



- 3 DC Power Supplies (PS)
- 2 Variable, Max: 30V, 3A & 1 Fixed 5V, 3A Max

4. DC Power Supply : Carltron PR3303SE

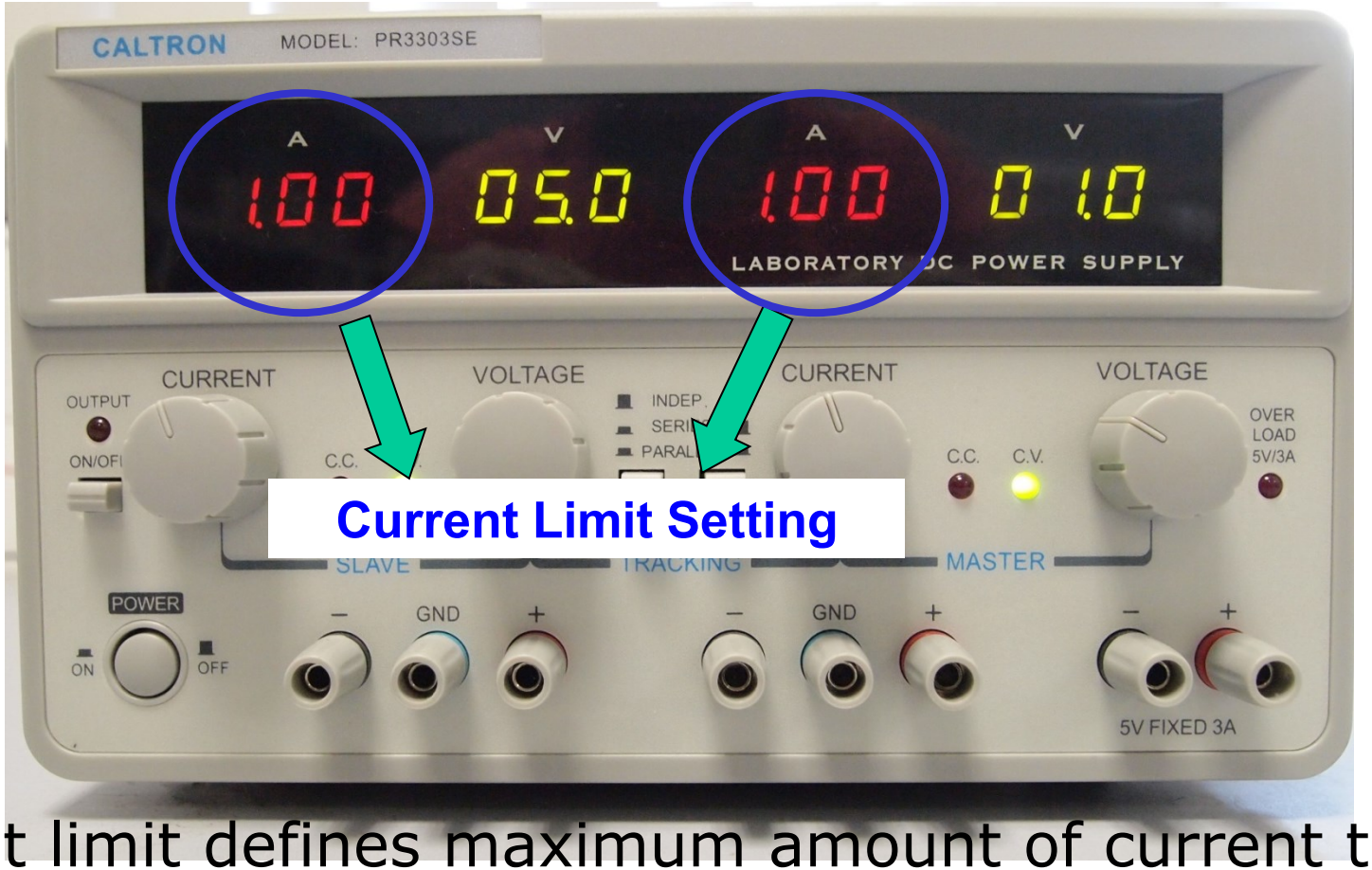
Turn POWER ON here before adjusting



- 5V + **- 1V +**

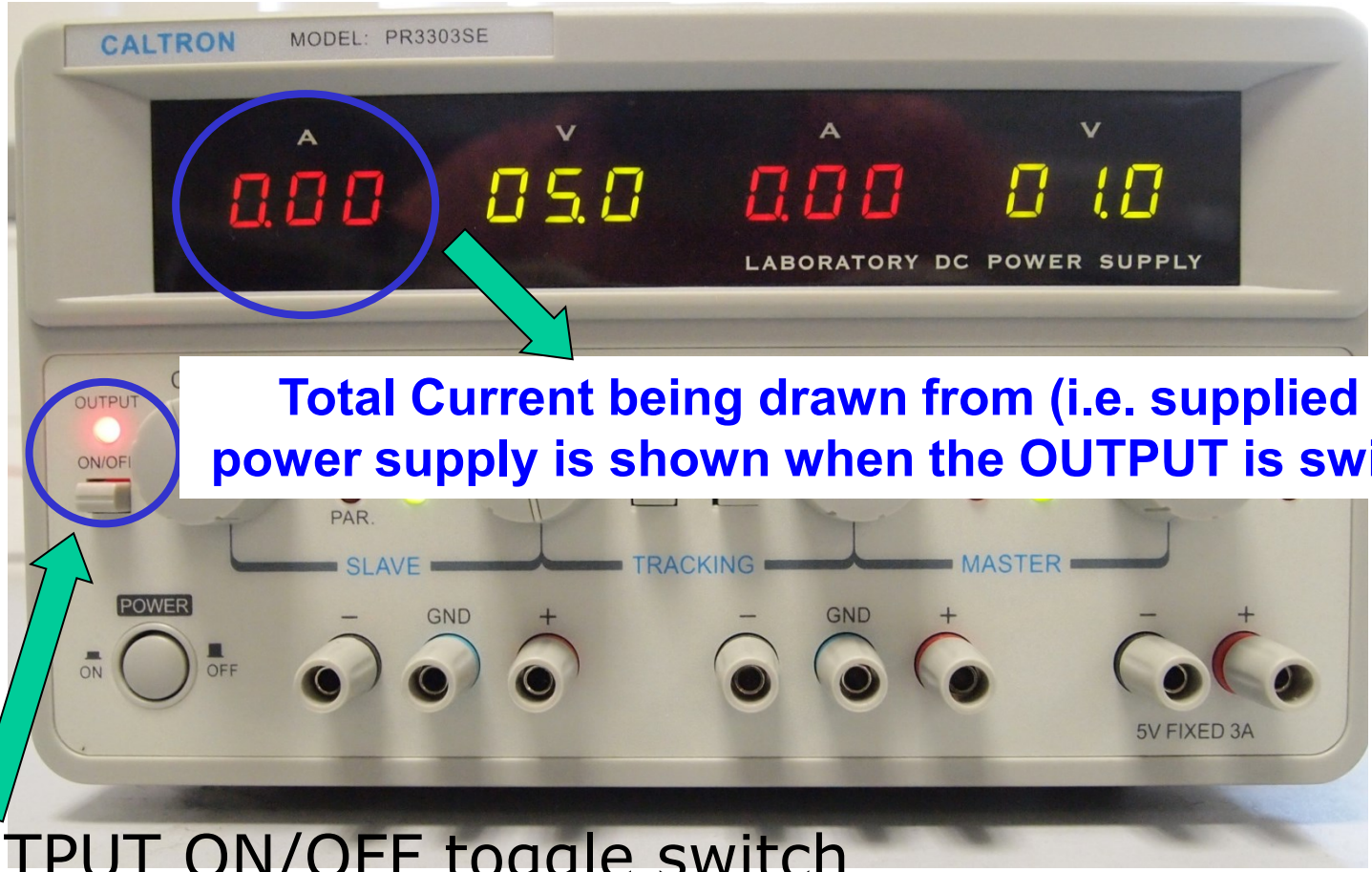
- Left PS: 5V, 1A. Right PS: 1V, 1A.

4. DC Power Supply : Carltron PR3303SE



Current limit defines maximum amount of current that be can supplied. Beyond that, voltage falls to maintain the current at the setting; **C.C.** will be lit – **C**heck the **C**urrent.

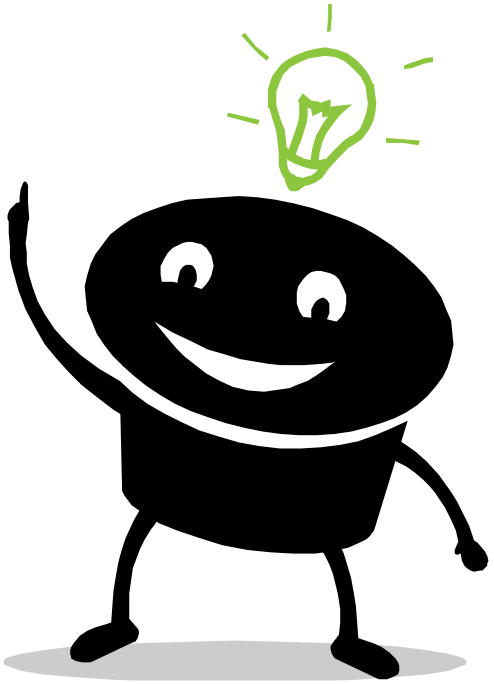
4. DC Power Supply : Carltron PR3303SE



Total Current being drawn from (i.e. supplied by) the power supply is shown when the OUTPUT is switched ON

- OUTPUT ON/OFF toggle switch
- Always switch off OUTPUT before making any changes to your circuit or the power supply settings.

4. DC Power Supply : Question 1



- Voltage Setting = 5V
- Current Limit Setting 0.3A

- **Connect a 100 Ohm resistor directly to the power supply.**

What do you think will happen?

4. DC Power Supply : Question 2

How do we ensure that the 5V and 1V set above are not floating?

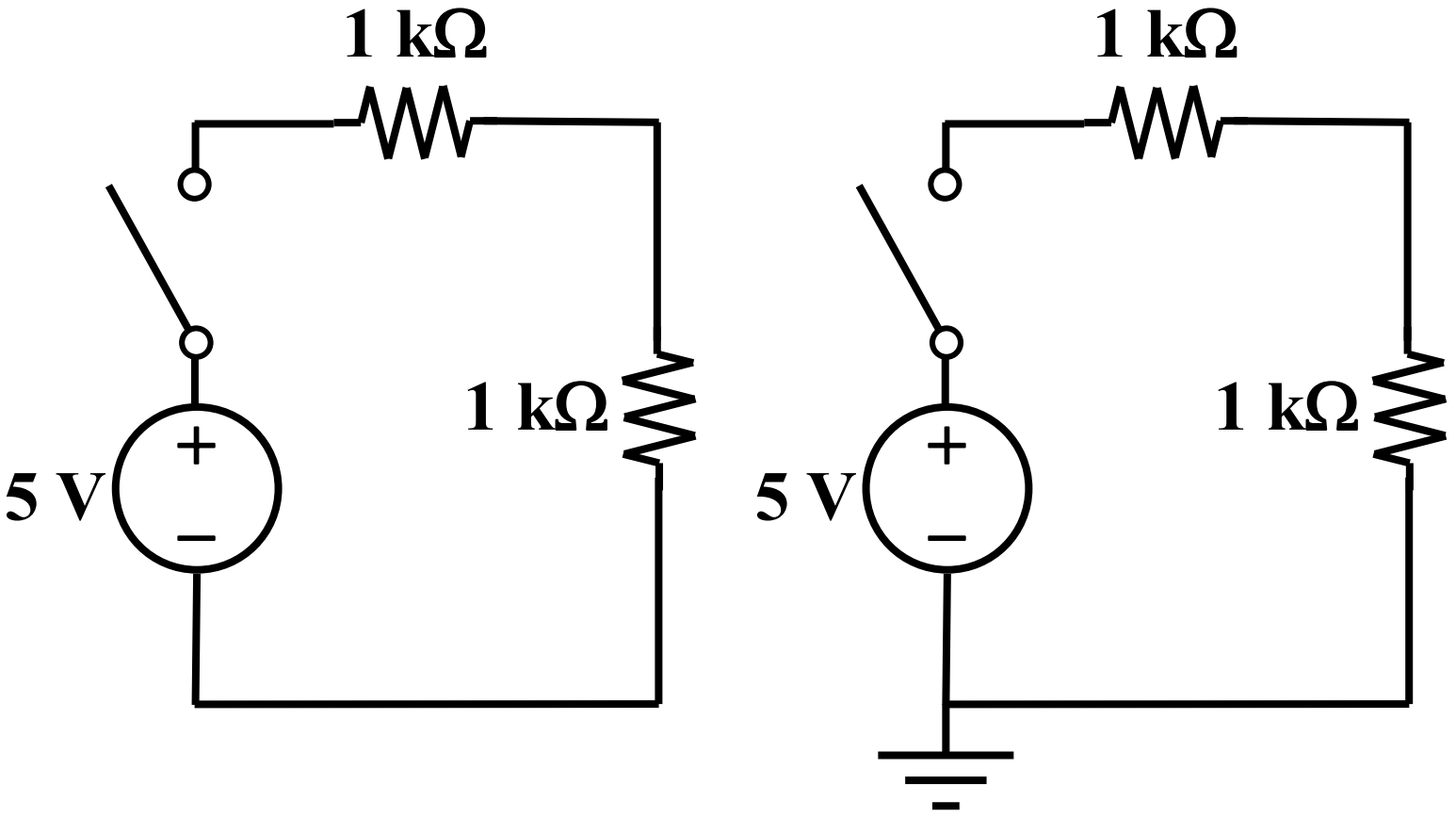
4. DC Power Supply : Question 2

How do we ensure that the 5V and 1V set above are not floating?

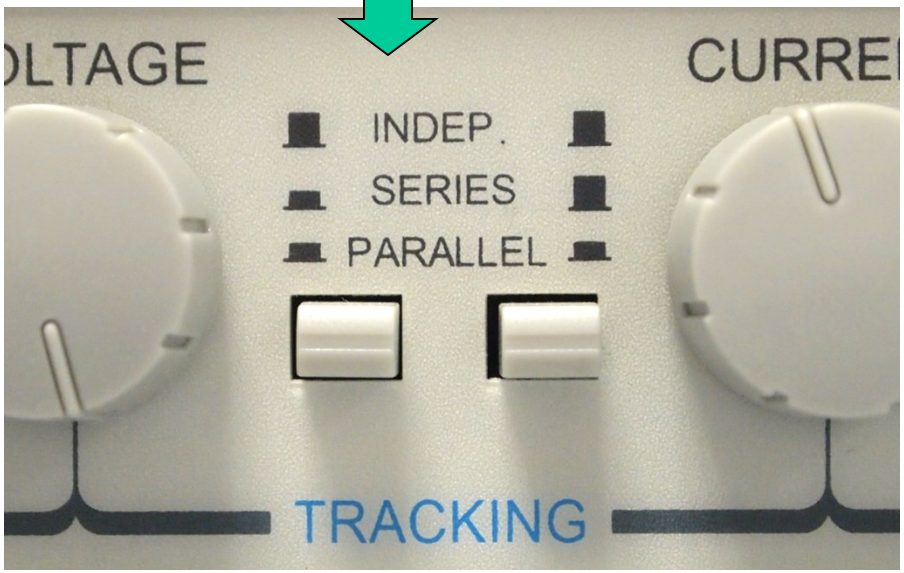
Ans: Notice that there are 2 **GND** sockets? Connect the negative outputs of the 5V and 1V supplies to these GND to make these supplies absolute w.r.t. ground.

4. DC Power Supply : Question 2

Take note of the difference in the circuit diagrams of a floating and a grounded circuit.

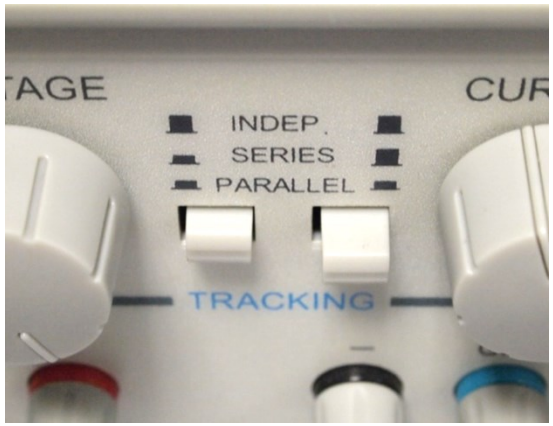


4. DC Power Supply : Series and Parallel Configurations



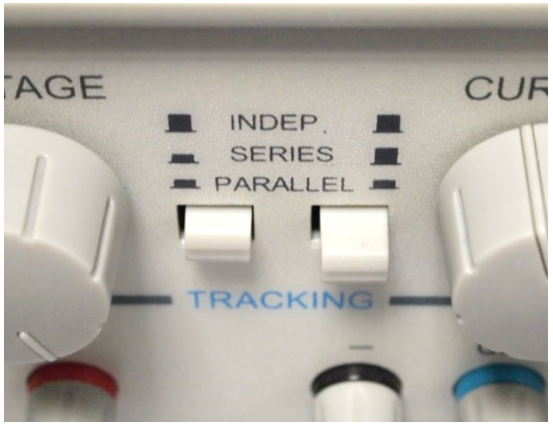
Independent Setting

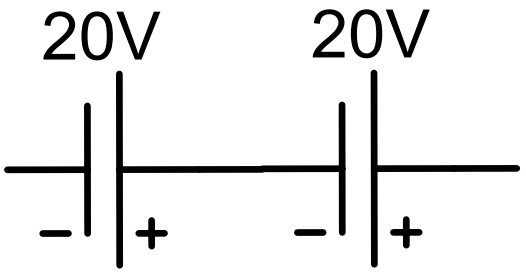
Series Setting



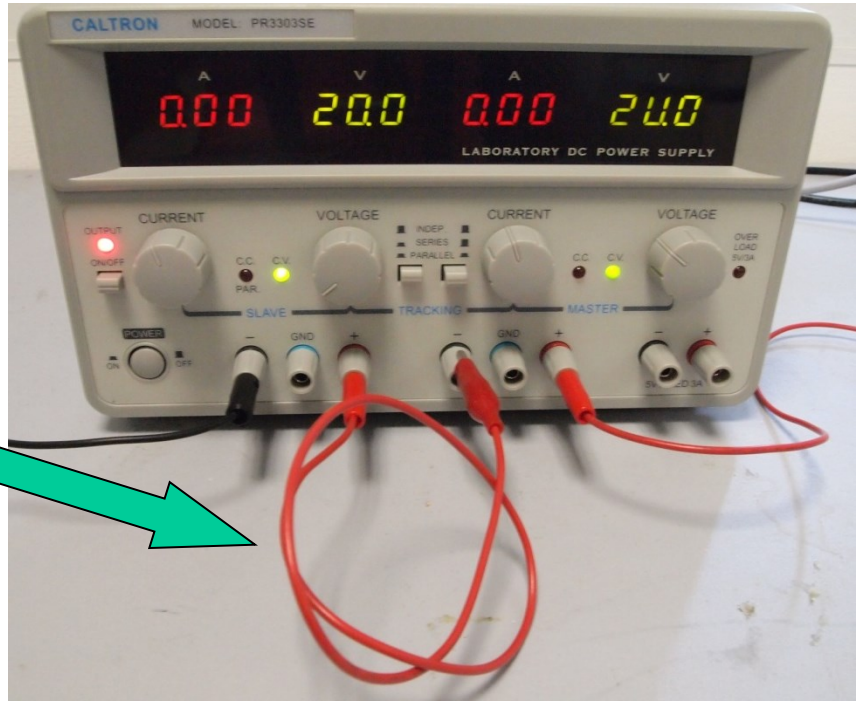
4. DC Power Supply : How to get 40V Output?

Series Setting

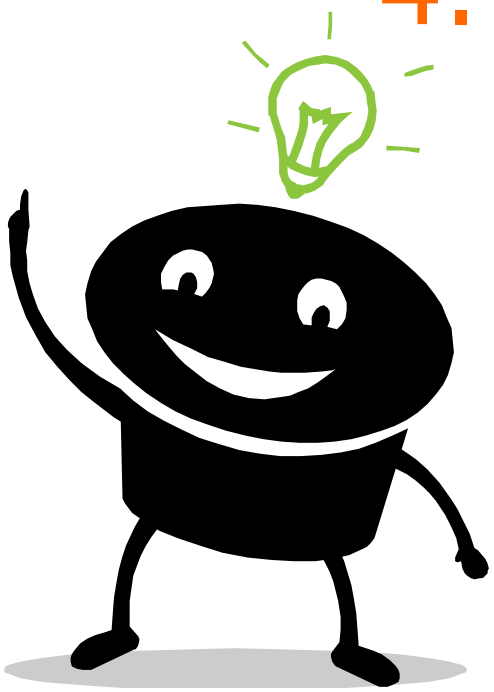


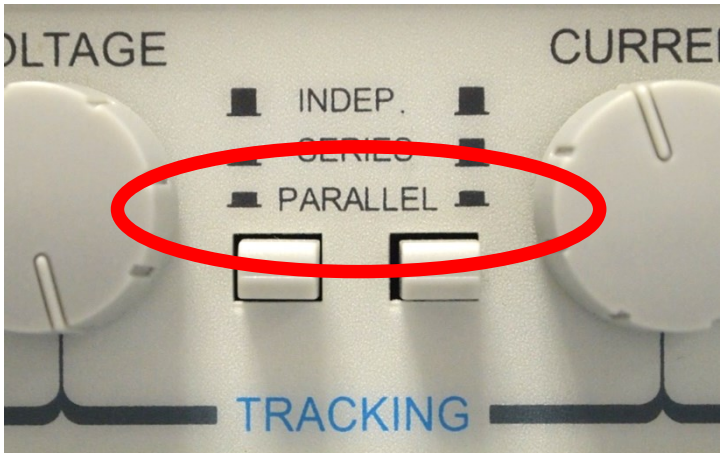


- Set series setting
- Connect externally
- Master supply on the right controls voltage of both sources



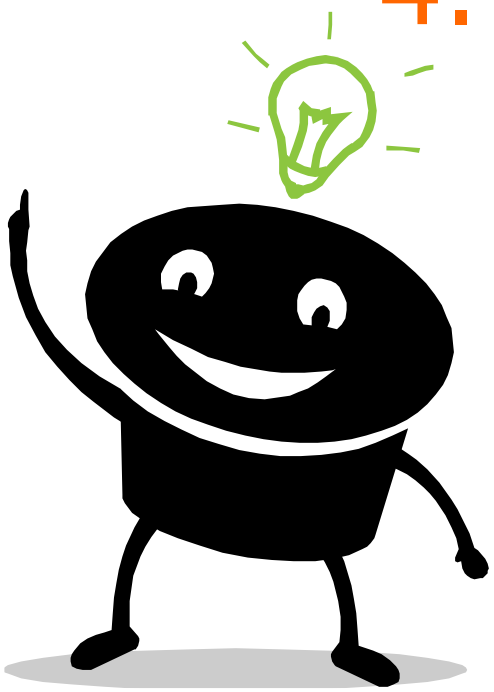
4. DC Power Supply : Question 3

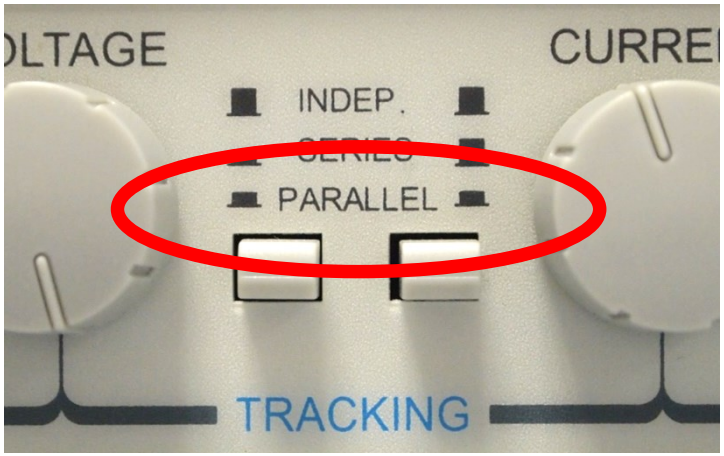




Can you think of a scenario when the Parallel setting is needed?

4. DC Power Supply : Question 3





Can you think of a scenario when the Parallel setting is needed?

Ans: Yes, when the total current output is required to be **more than 3A** (i.e. the maximum current output of each power supply). In parallel mode, only the **master supply** needs to be connected and controlled.

5. Digital Multimeter

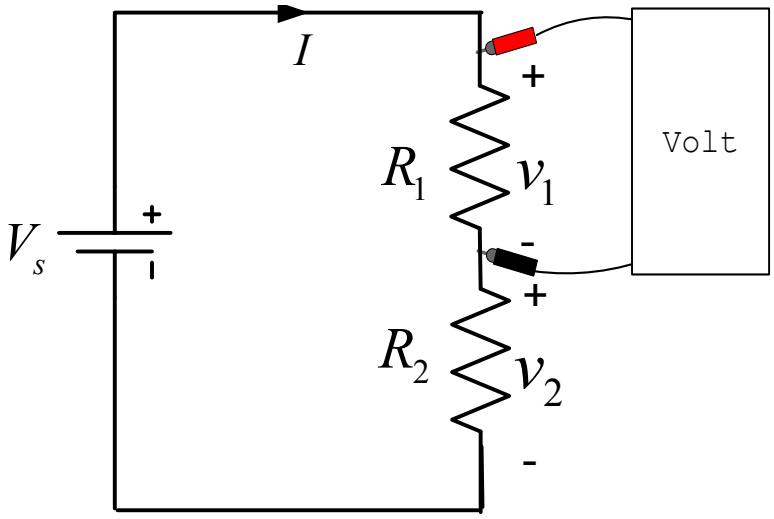
White labels are the primary function, while the blue ones are alternative functions, toggled by the SELECT button.

Insert the red test lead into one of the red terminals and the black test lead into the COM terminal.

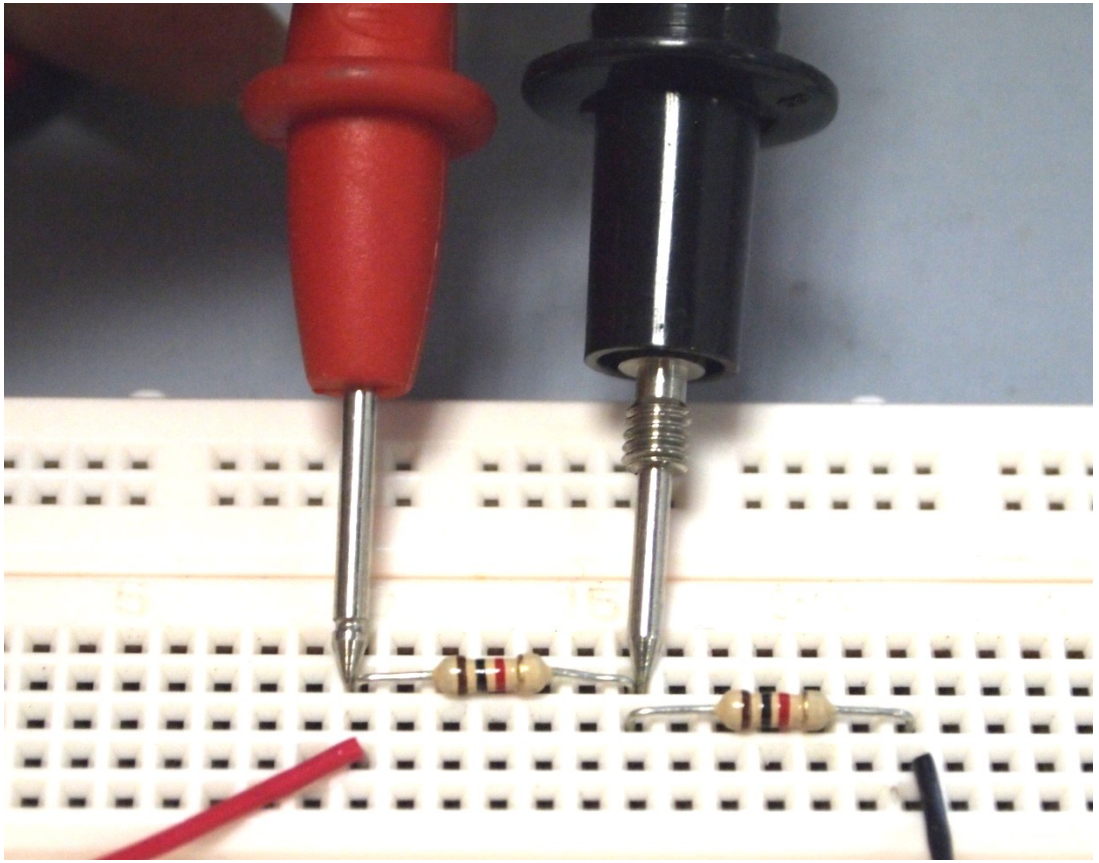
Rotary switch to select the quantity of interest.

DC quantities are shown with a bar while AC quantities are shown with a tilde sign (~) above the quantity symbols.

5. Digital Multimeter – Measure Voltage in Parallel



- Set the multimeter to read DC Voltage
- Place your multimeter probes across the component (i.e. in parallel)
- The polarity is important

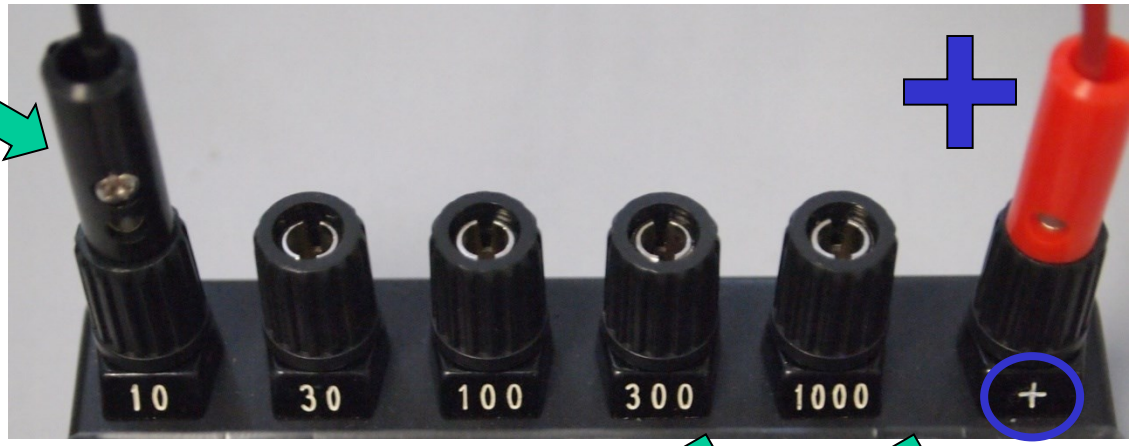


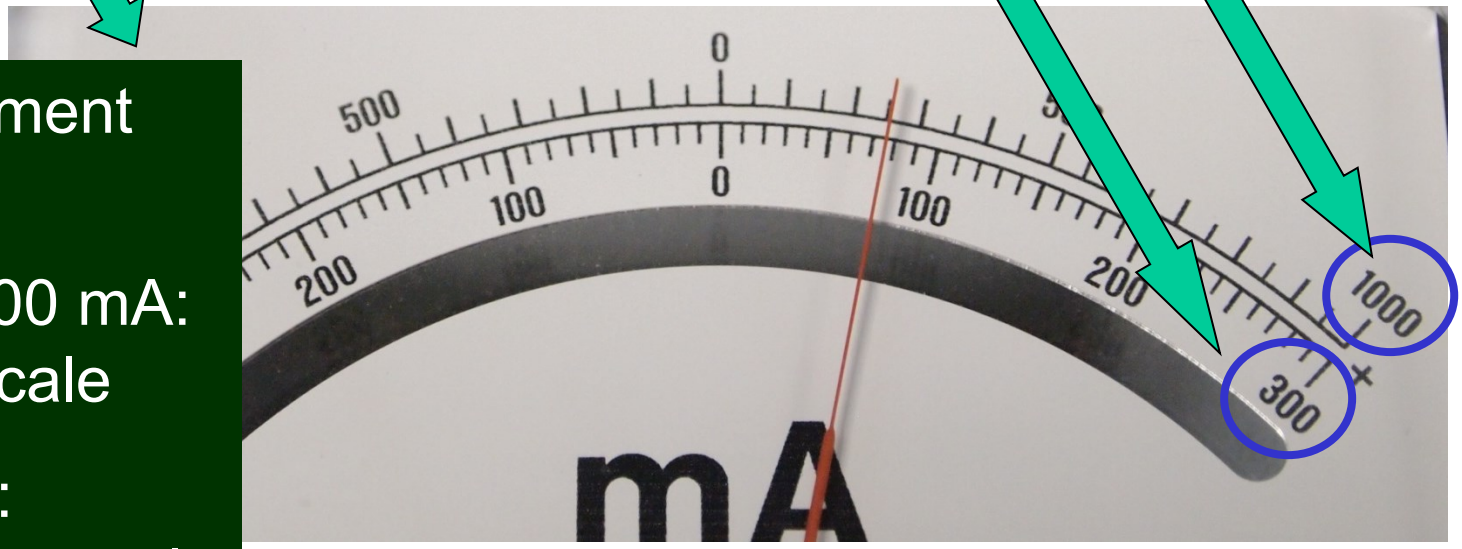
6. Analog Ammeter

Analog Ammeter

- Current measurement, default unit is **mA**.

6. Analog Ammeter - Connections

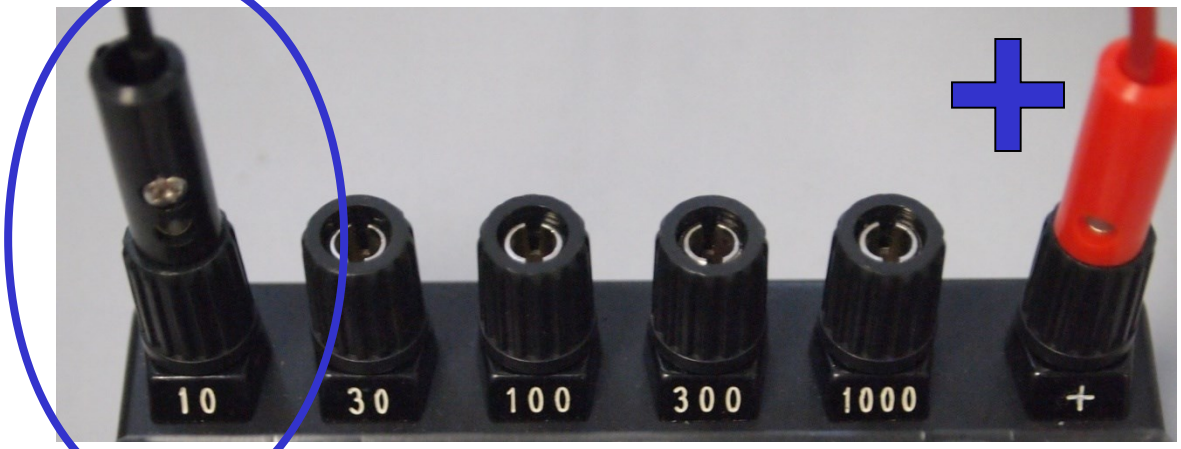


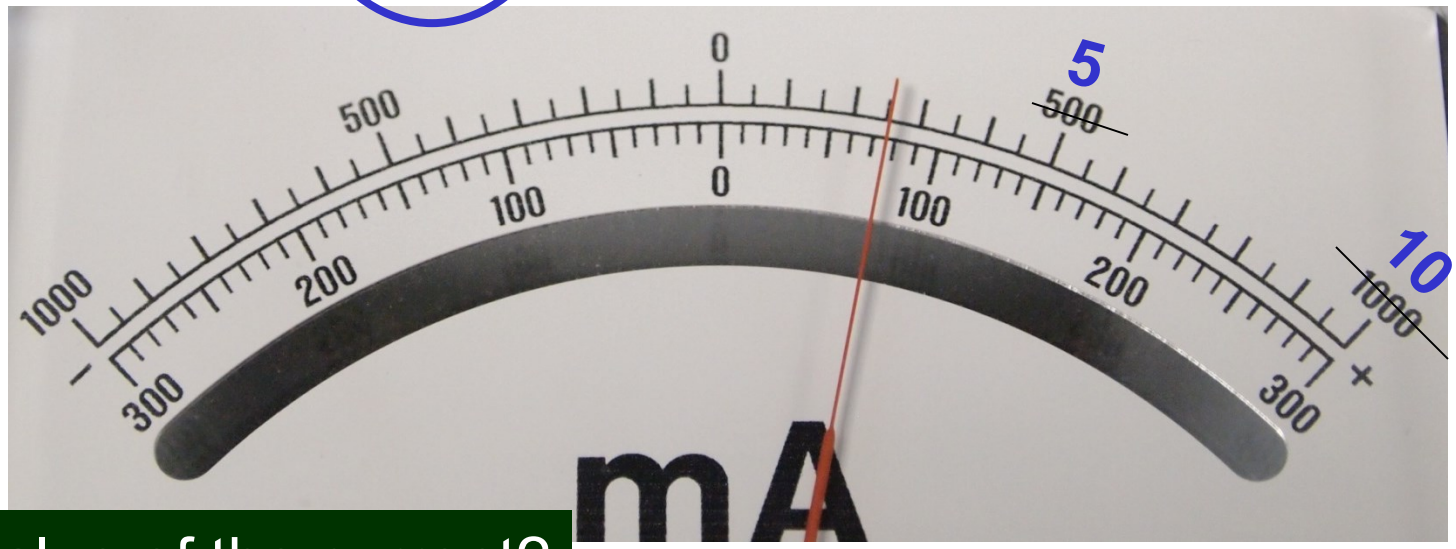


For measurement range of

- 10, 100, 1000 mA: use the top scale
- 30, 300 mA: use the bottom scale

6. Analog Ammeter - Reading Value

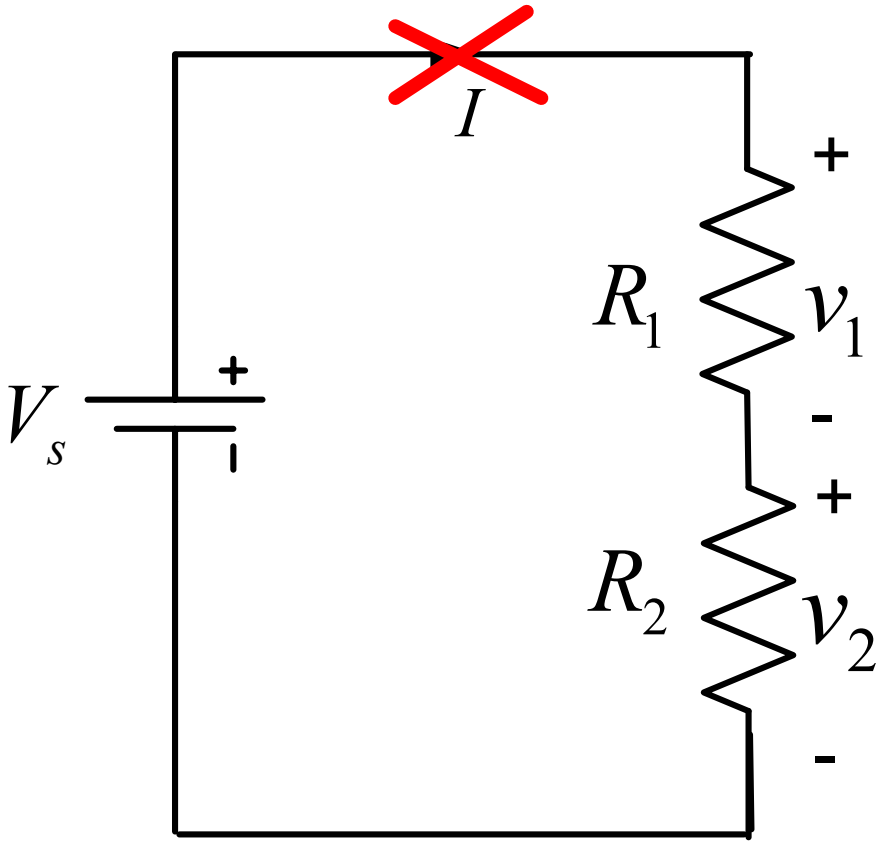




What is the value of the current?

6. Analog Ammeter - Measure Current in Series

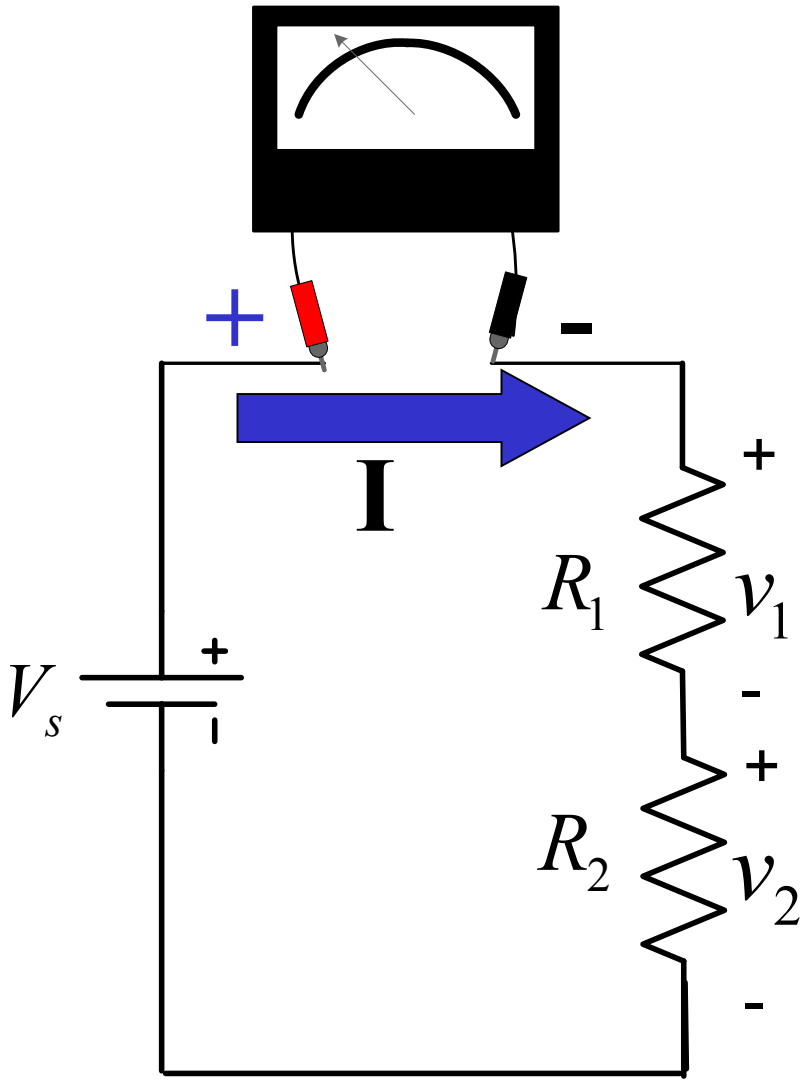
- **Current is measured in *series* :**



Because the ammeter needs to be in series with the circuit, you will need to break the circuit to insert the ammeter

1) Break the circuit at

6. Analog Ammeter - Measure Current in Series



2) Place ammeter in series

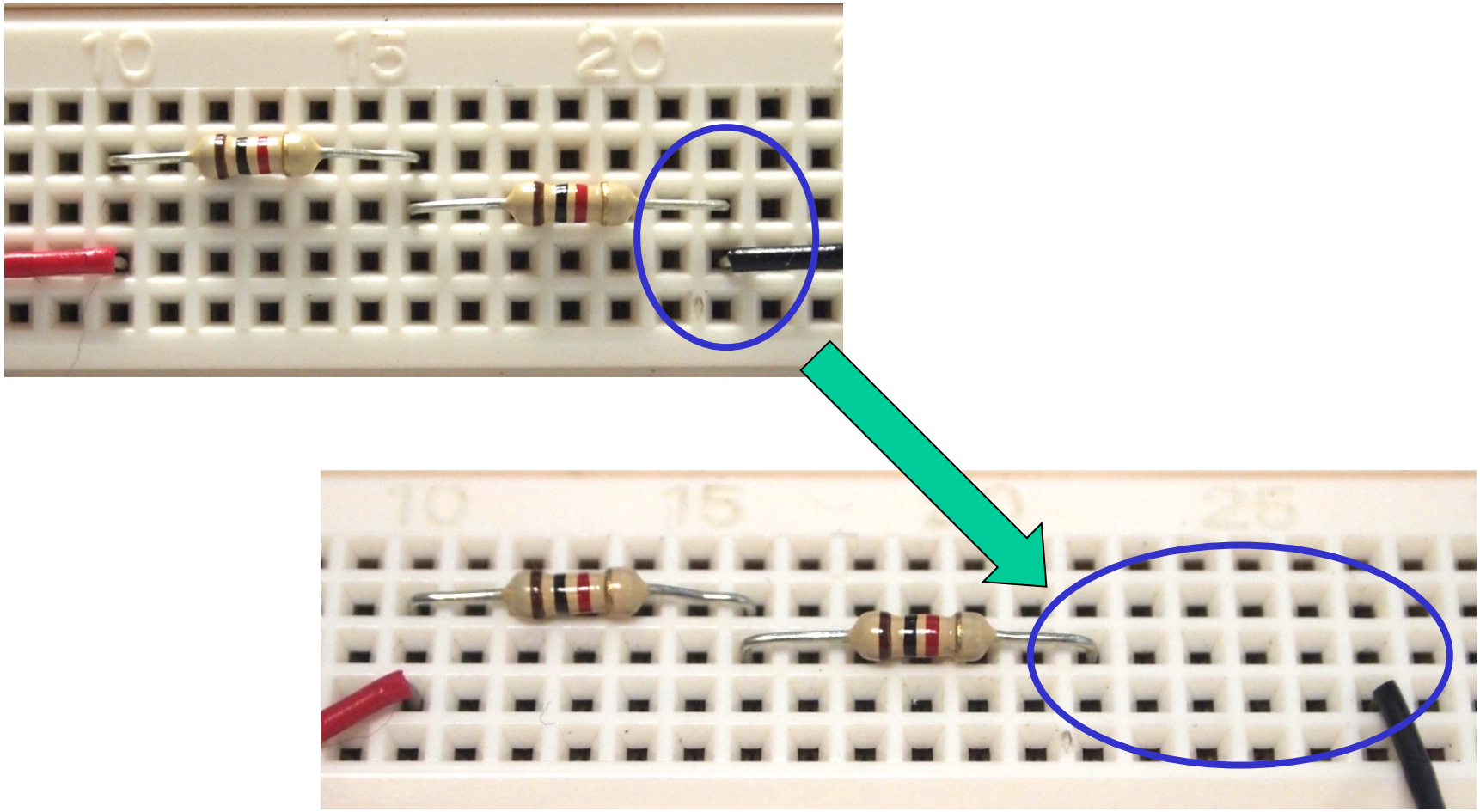
Imagine ammeter to be another resistor that needs to be placed in series!

- ✓ **The polarity of the ammeter is important.**
- ✓ **Place the ammeter in the direction of the current flow to get positive readings, and vice versa.**

6. Analog Ammeter - Measure Current in Series

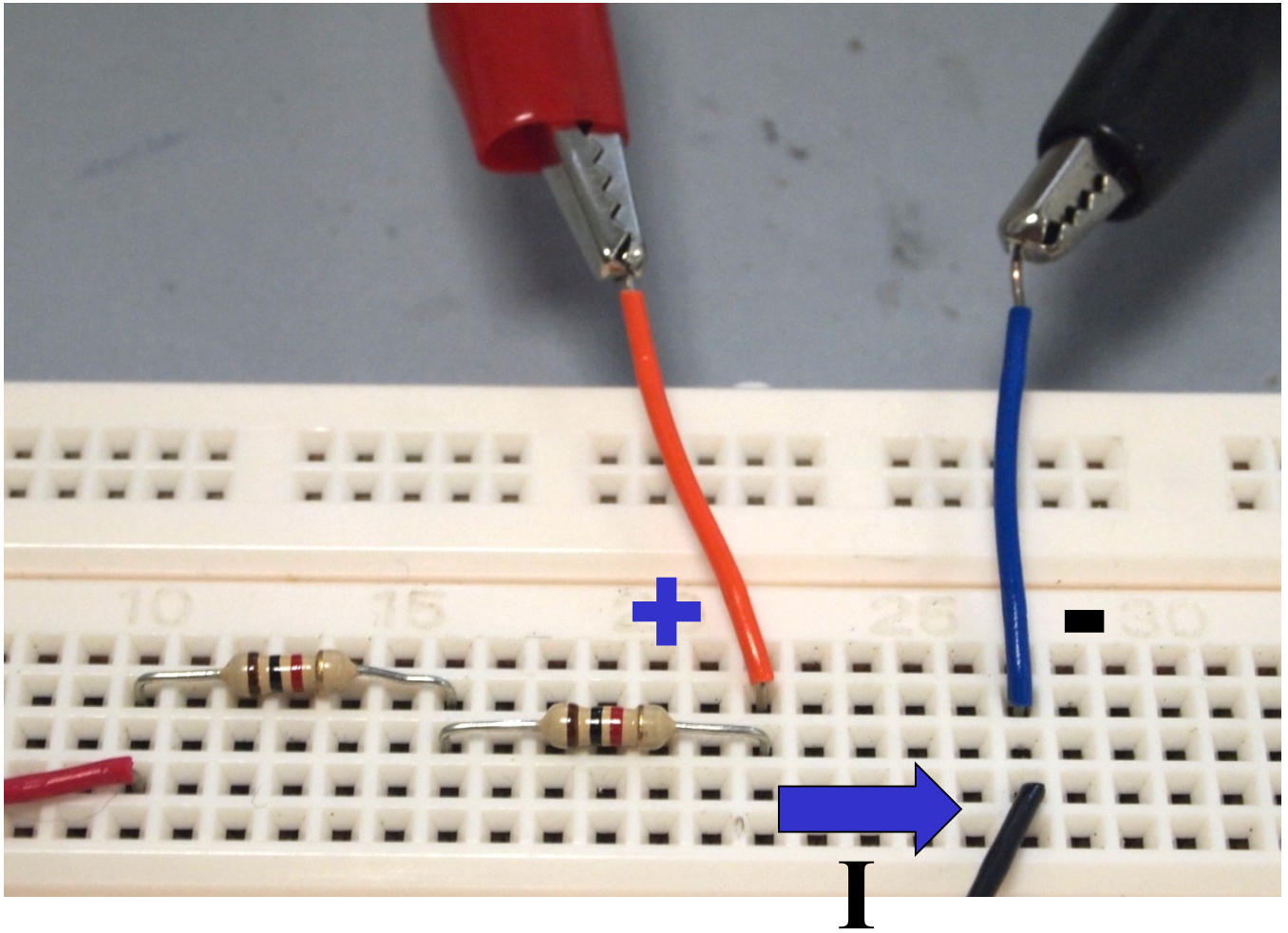
And to do these on the breadboard …

1) Break the circuit



6. Analog Ammeter - Measure Current in Series

2) Place ammeter in series



ACTIVITY 2

Overview

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2. Resistor Color Codes
   - ❖ **Activity 1**

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7. Function Generator
8. Oscilloscope
   - ❖ **Activity 3**

   - ❖ **Online Quiz**

7. Function Generator

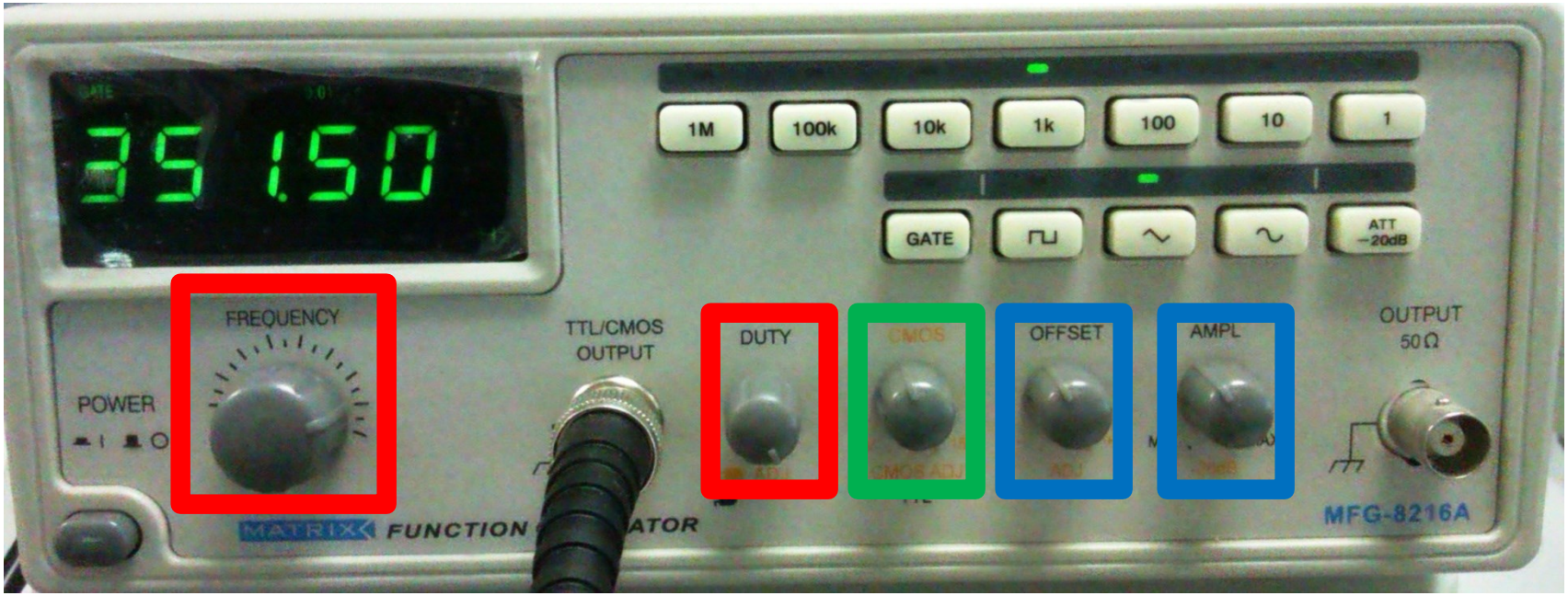
- Main Output Port
  - Square (aka Rectangular) waveform
  - Triangle (aka Triangular/Sawtooth) waveform
  - Sine (aka Sinusoidal) waveform

7. Function Generator

- TTL/CMOS Output Port
  - Square waveform generated regardless of waveform selection
    - ✓ TTL: fixed 0V to 5V
    - ✓ CMOS: 0V to adjustable max value (5V-15V)

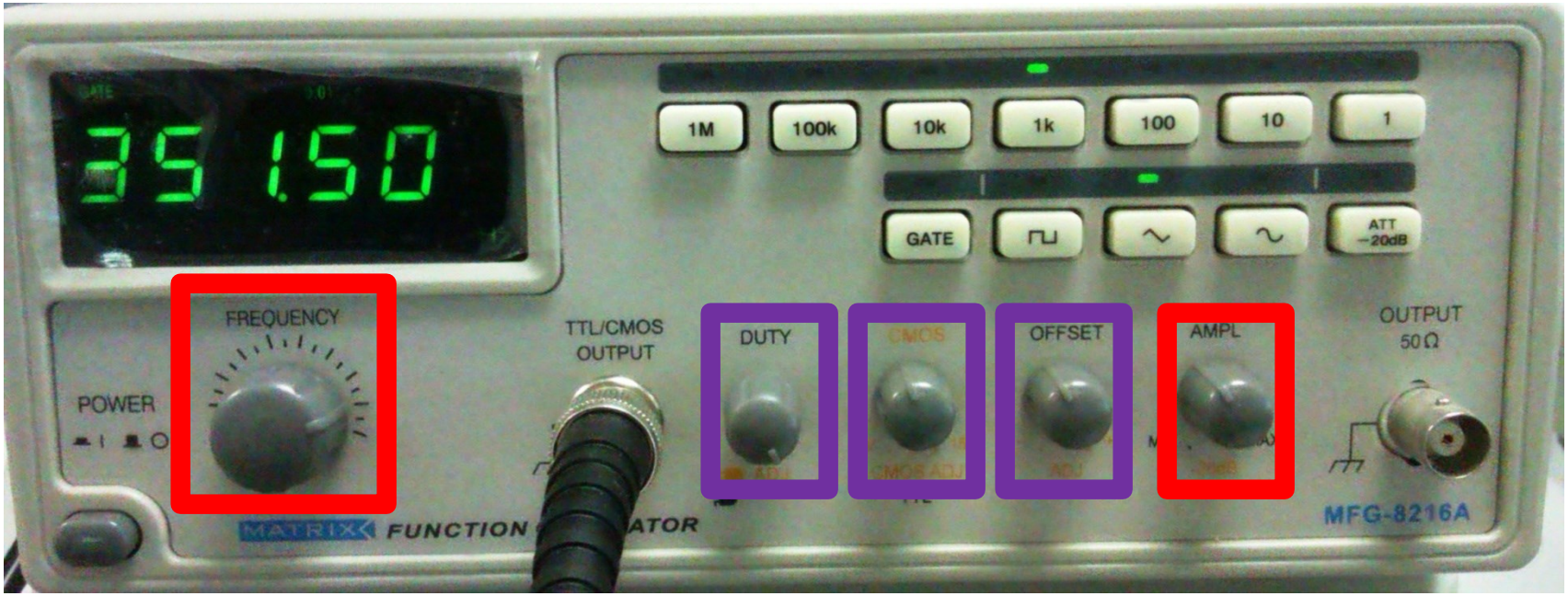
7. Function Generator

- Parameter Knobs
  - Frequency (all)
  - Duty cycle (all)
- CMOS Adjustment (CMOS only)
- Offset (Main only)
- Amplitude (Main only)



7. Function Generator

- Parameter Knobs
  - Labeled in black: direct adjust
    - ✓ Frequency / Amplitude
  - Labeled in orange: pull up to adjust
    - ✓ Duty cycle / CMOS Adj / Offset



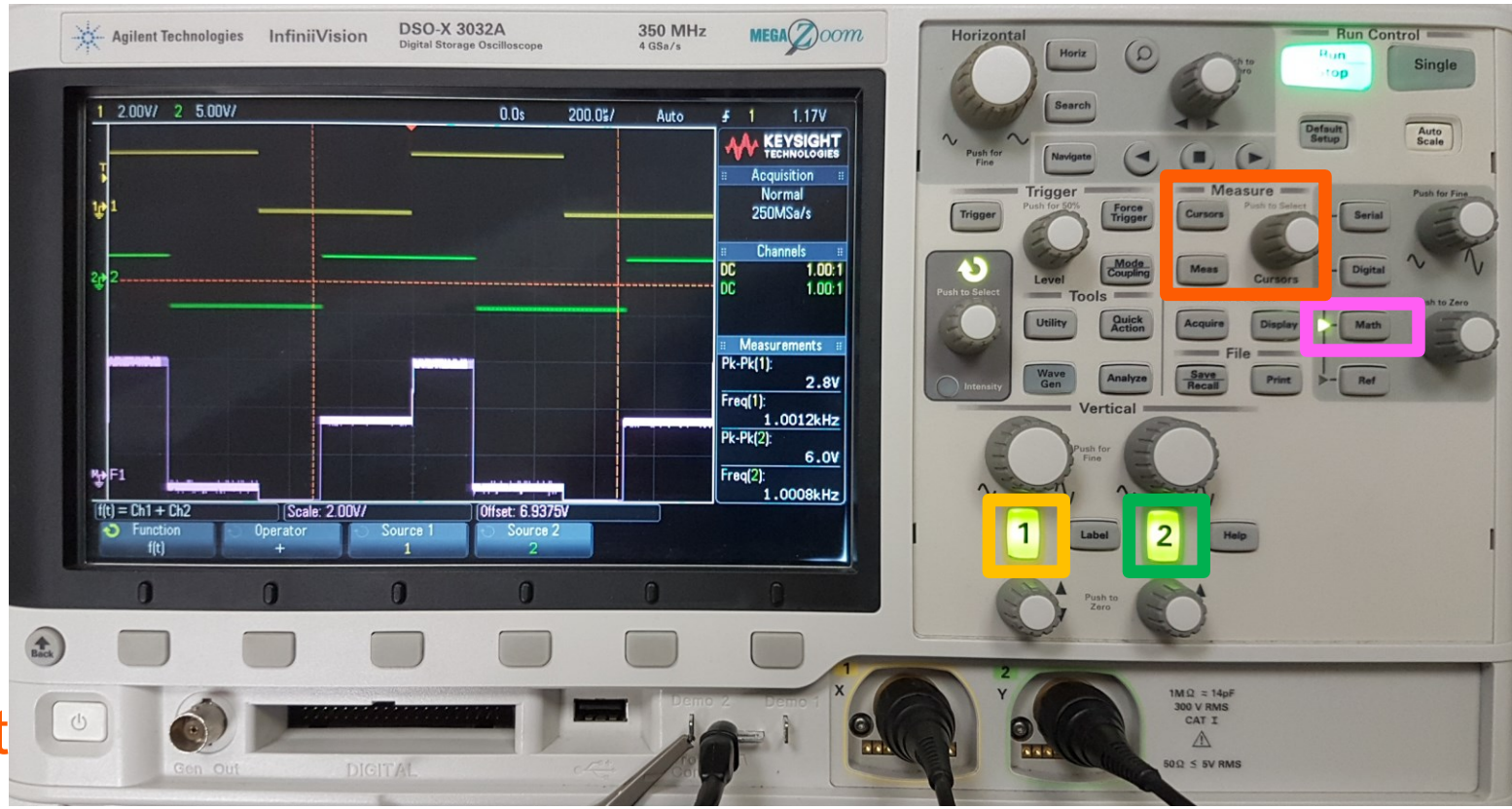
7. Function Generator

- Scale Buttons
  - 1Hz to 1MHz

Output Frequency = Frequency Knob Value x selected Scale

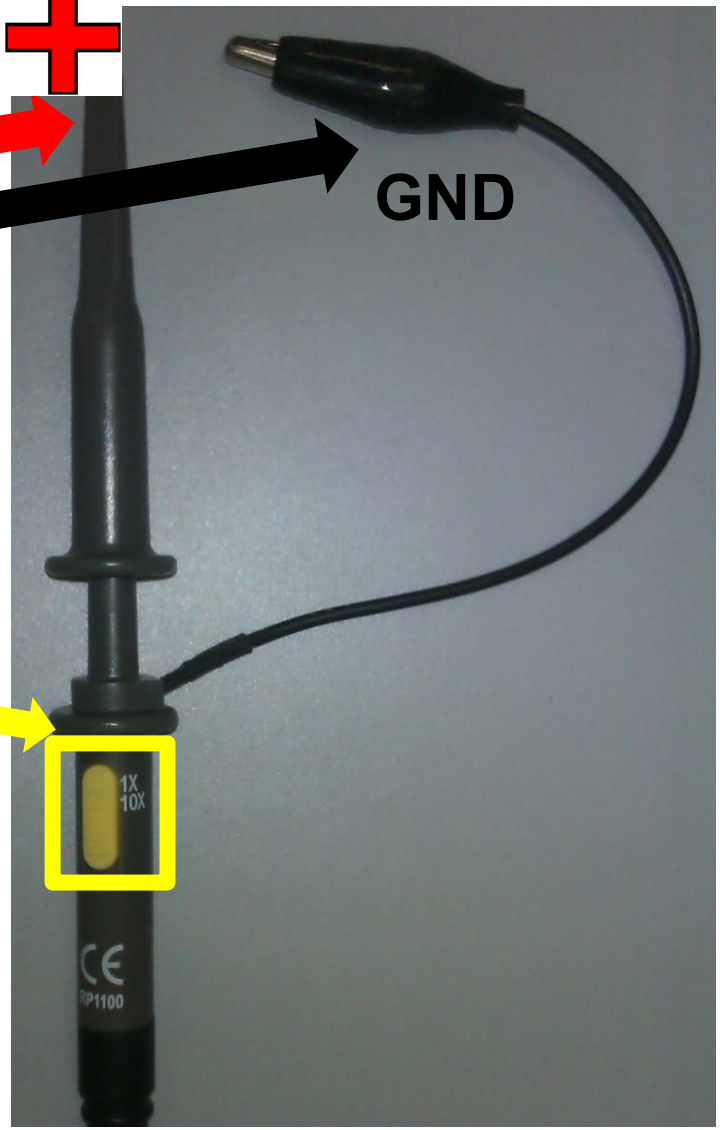
8. Oscilloscope

- Channel Buttons/ Signals Colors
  - Chan. 1 (yellow)
  - Chan. 2 (green)
  - MATH (pink)
  - Meas-urement
  - X-Y Cursors (orange)



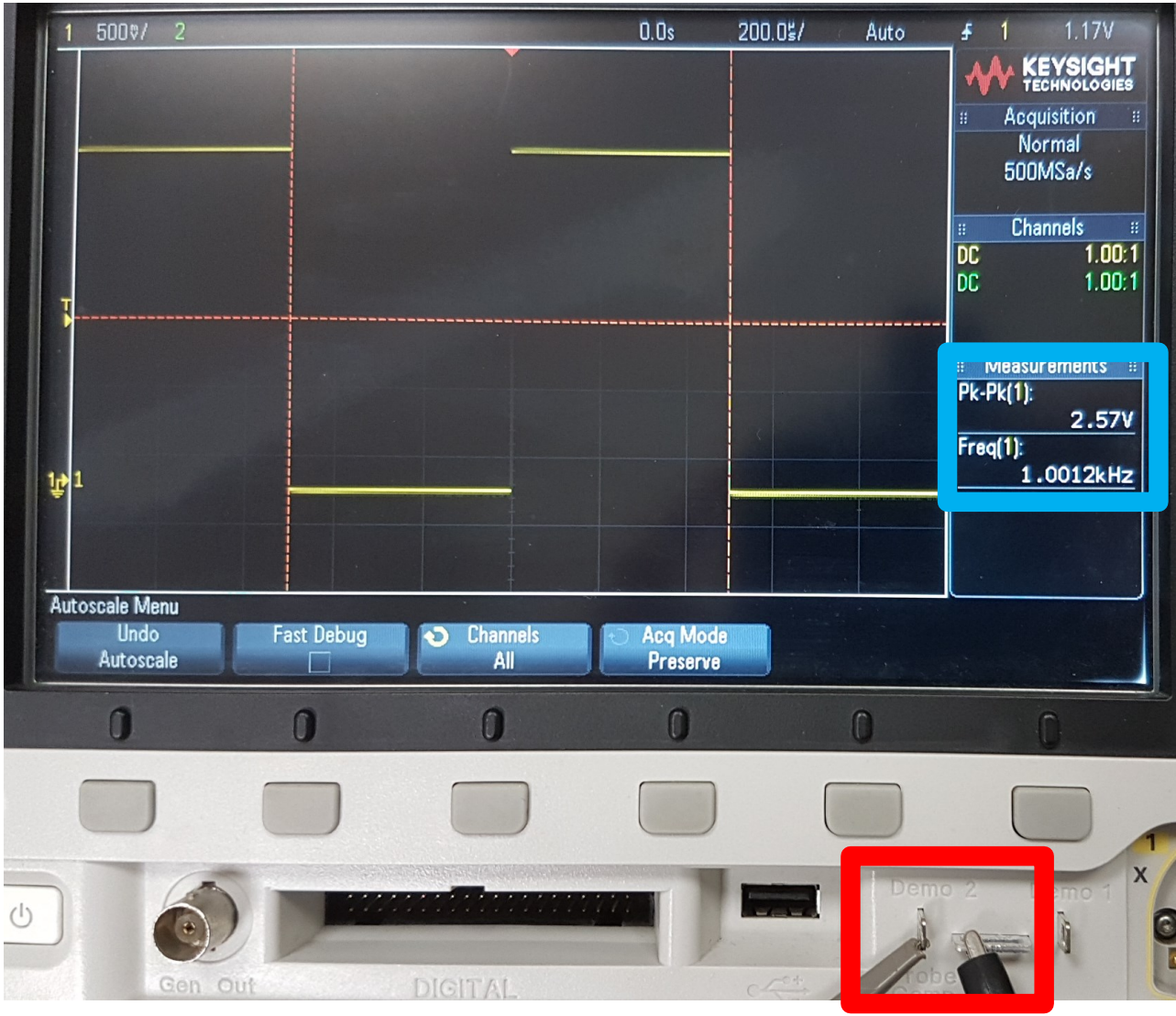
8. Oscilloscope Probe

- Two Ports
  - Positive
  - Ground
    - ✓ This terminal of both channels are internally connected to ground
- Attenuation Factor
  - Ensure 1x (**not** 10x) is selected



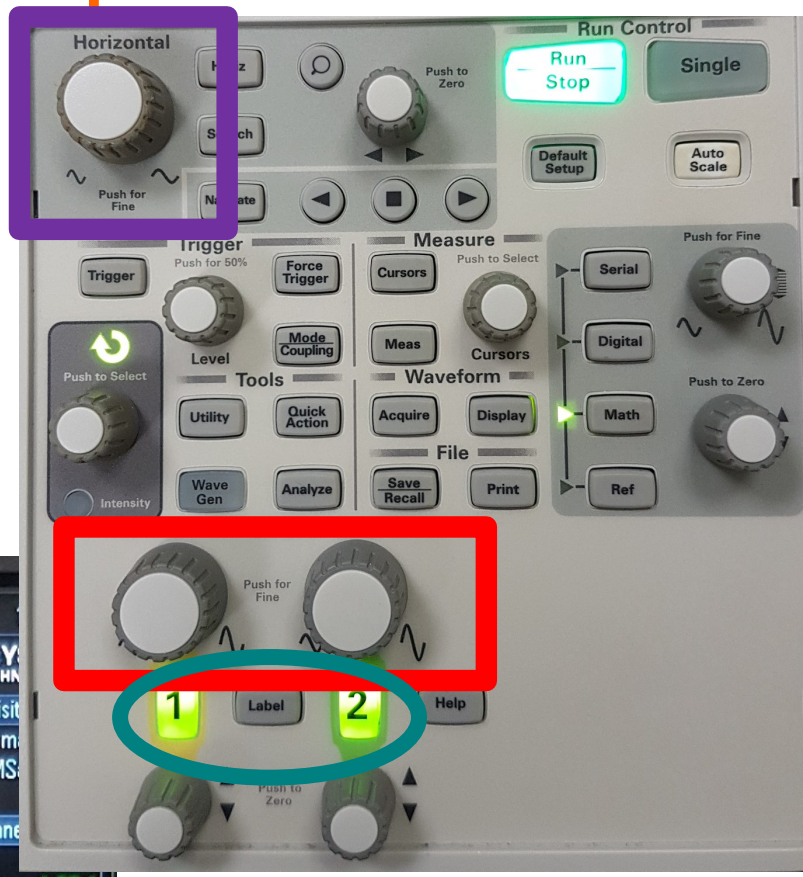
8. Oscilloscope

- Test Signal
  - Aka **Demo 2**
  - For probes compensation and testing
  - Approximately 2.6Vpp, 1kHz square wave



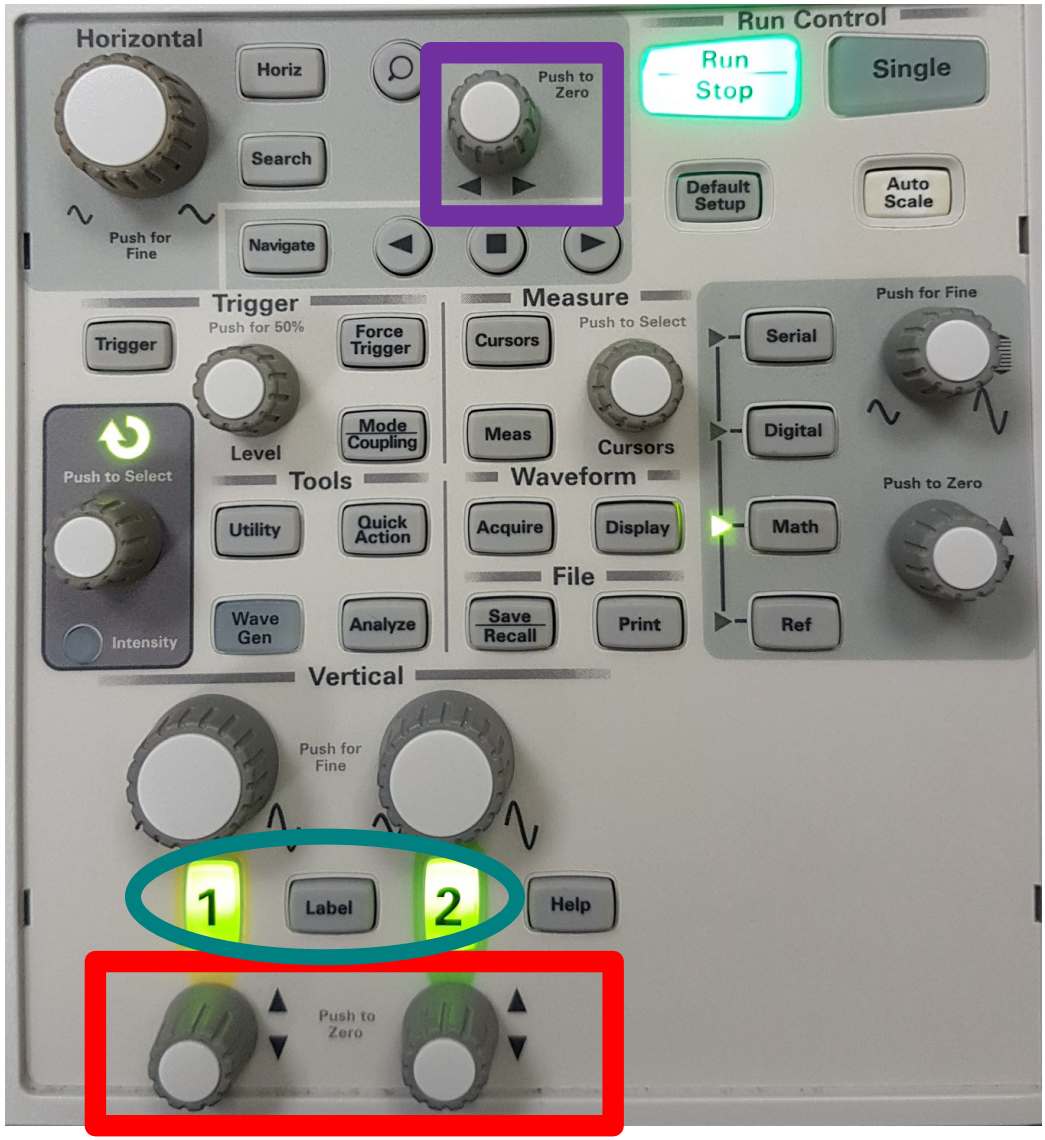
8. Oscilloscope

- Scale Knobs
  - Vertical scales (volt/div)
  - Horizontal scales (time/div)
  - Always select Channel 1 or 2 first before adjusting the scales



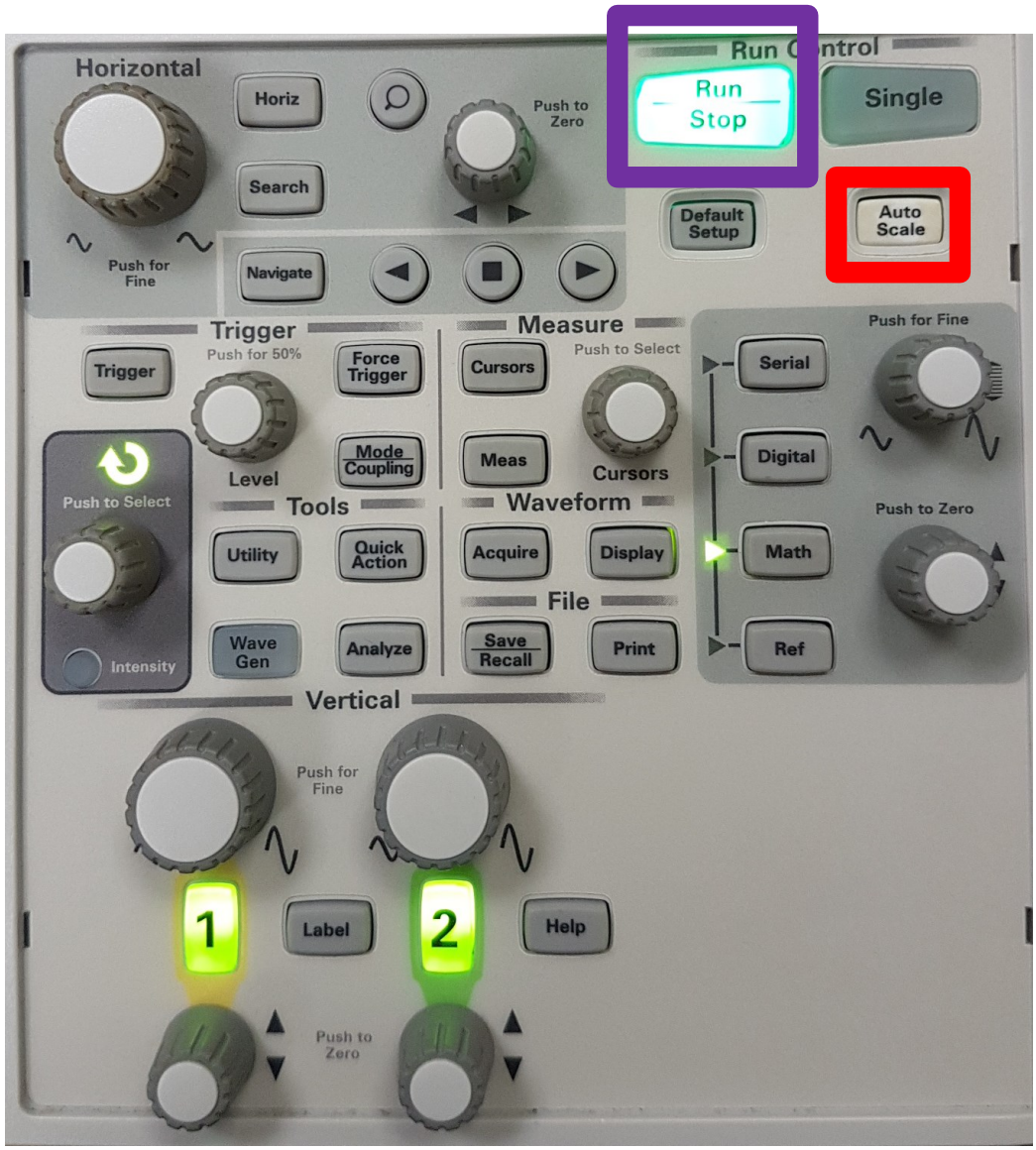
8. Oscilloscope

- Position Knobs
  - Vertical position
  - Horizontal position
  - Always select Channel 1 or 2 first before adjusting the positions



8. Oscilloscope

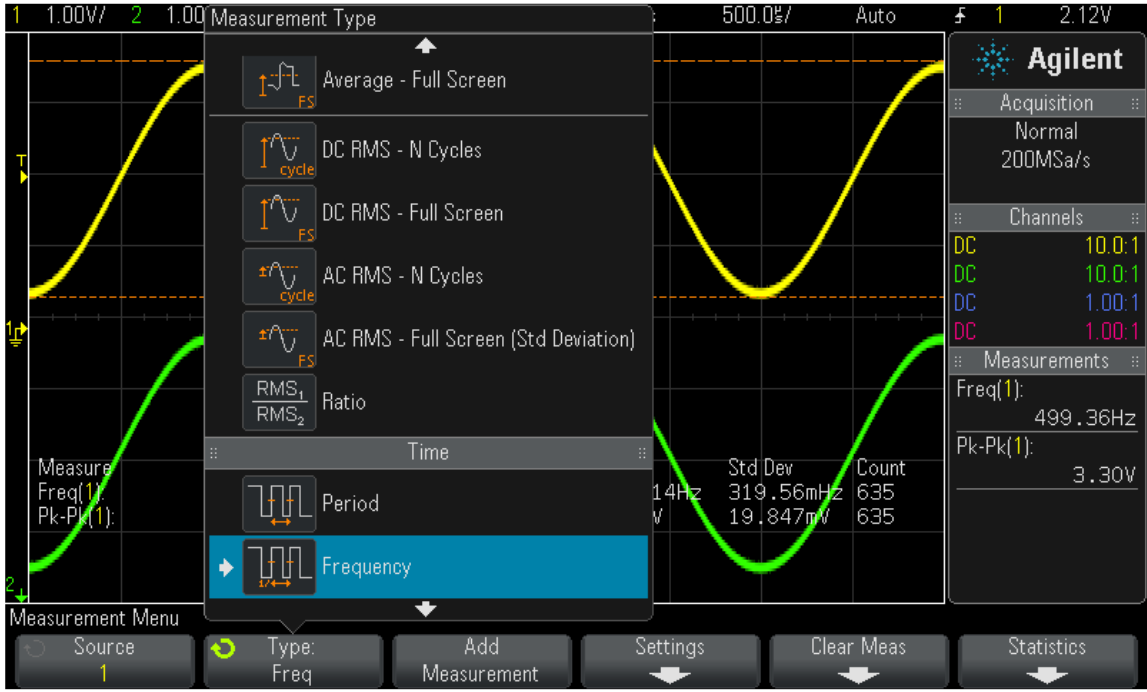
- Run Control
  - –Auto Scale
    - ✓ Auto set time/volt scales to best fit of input signal
    - ✓ Recommended if signal is unknown
  - –Run/Stop
    - ✓ Run/stop the waveform



8. Oscilloscope

- Measure Control
  - Meas(ure) button
    - ✓ To display the Measurement Menu

  - Entry knob
    - ✓ Used together with the grey softkeys under the menu to select a measurement to be made
    - ✓ Push to select
    - ✓ Rotate anticlockwise to scroll down the list



8. Oscilloscope

- Coupling
  - Channel Coupling
    - ✓ DC coupling is useful for viewing waveforms that do not have large DC offsets
    - ✓ AC coupling is useful for viewing waveforms with large DC offsets
  - Always select Channel 1 or 2 first before selecting the channel coupling

ACTIVITY 3

ONLINE QUIZ

End of Week 1 Studio 2