CG1111 Engineering Principles and Practice I

Laboratory Safety and Equipment Familiarization
(Week 2, Studio 1)

Time	Duration (mins)	Activity
0:00	15	Safety – Safe Practices
0:15	20	Activity 1 – Resistor Color Codes & Resistance Measurement Using DMM
0:35	25	Activity 2 – Simple Circuit Buliding On Breadboard & Taking Measurements With DMM
1:00	5	Questions and Answers. End of Studio
1:05	60	Activity 3 – BitScope DSO Setup **[Homework]**

Objectives:
At the end of this studio, you should be:

- Aware of the laboratory (lab) safe practices and the Emergency Assembly Point (EAP) for E4A
- Familiar with the SI units of resistance, current and voltage
- Familiar with resistor color codes
- Familiar with breadboard, USB breakout cable and handheld digital multimeter (DMM)
- Competent in constructing simple electrical circuits containing a voltage source and resistors
- Competent in making simple DC circuit measurements using handheld DMM
- Familiar with the usage of BitScope Micro as arbitrary waveform generator (AWG) and oscilloscope

Equipment:

- Breadboard and connecting wires
- Resistors (150 Ω, 820 Ω, 1.5 kΩ)
- Handheld DMM
- USB breakout cable as DC power supply (constant 5 V source)
- BitScope as AWG and oscilloscope
- Long-nose plier

Safe Practices
Safety comes first in the lab. Always keep safety in mind.

- Always wear covered shoes to the lab.
- Long hair, loose clothing and accessories must be secured before working in the lab.
- Do not touch any equipment with wet hands.
- Never use any damaged or faulty equipment. Report it to your TA/the lab officer immediately.
- Always follow the prescribed Safe Work Procedures (if any) to avoid accidents when working with NUS lab equipment.
- Never work alone in the lab. If you need to work in the lab outside the studio hours, please seek prior permission from the lab officer.
- Take note of the emergency contact numbers, the emergency and evacuation procedures.
- Be familiar with the Emergency Assembly Point for E4A

Activity 1 - Resistor Color Codes & Resistance Measurement Using DMM (20 mins)

All resistors have their nominal values indicated, most commonly by the color codes printed on them. But engineers often need to know their actual resistance values for circuit analyses.

In this activity, you will learn to use the DMM to find out the actual resistance values and learn to read the resistor color codes.

1. From the set of resistors provided, study the color bands on each resistor and determine the order of the bands.
2. With the help of the resistor color codes given in the *Week 2 Studio 1 Preparation* document or any *resistor color code calculator app**, find out and record the nominal resistance value and its tolerance in Table 1 below. The SI unit of resistance is Ohm, represented by the Greek letter Ω (omega).
3. Determine and record in Table 1 the actual resistance values of all the resistors provided using the ohmmeter of the handheld DMM.
4. Notice that the actual resistance value for any resistor in good working condition is always within the tolerance of the nominal value.

Table 1. Comparison of nominal and actual resistance values.

S. No	Band 1 (color, code)	Band 2 (color, code)	Band 3 (color, code)	Tolerance (color, %)	Nominal Value (Ω)	Actual Value (Ω)
1						
2						
3						

Tips: In case you run out of time, you may record just one resistor in the lab and complete the rest at home.

**Resistor color code calculator app* recommendations, not necessarily the best:

- iPhone: Vivid Planet Software, https://apps.apple.com/sg/app/resistor-code-calculator/id804698595
- Android: Jedemm Technologies, https://play.google.com/store/apps/details?id=com.jedemm.resistorcalculator&hl=en

Activity 2 – Simple Circuit Building On Breadboard & Taking Measurements With DMM (25 mins)

A breadboard is a construction base for quick prototyping and testing of electronics and electrical circuits. In this activity, you will learn to build a simple electrical circuit containing a voltage source and three resistors on a breadboard, and taking voltage and current measurements with the DMM. Please refer to the *Week 2 Studio 1 Preparation* document if you are unsure of the breadboard internal connections.

1. Wire the circuit as shown in Figure 1, on the breadboard. You should only connect the 5 V supply to the circuit ***last***, after you have double-checked all the other circuit connections. The red and black wires of your USB breakout cable are represented here as the + and – terminals of the 5 V supply respectively.

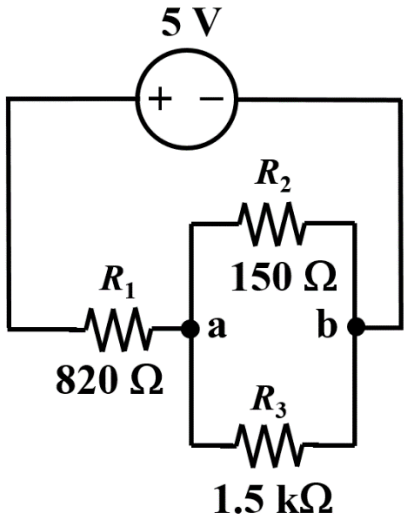

Figure 1. A simple electrical circuit containing a voltage source & resistors.

2. Voltage measurement using the DMM (voltmeter):

    a. Ensure that the red probe is connected to the **V** terminal of the DMM and the black probe to the **COM** terminal, since the convention is to place the red probe at the positive polarity and black at the negative polarity/common/ ground. The polarity is important for meaningful readouts in voltage and current measurements.

    b. Select a suitable DC voltage range with the rotary dial. But as the supply voltage is 5 V, it is always safe to start by choosing the range that is immediately higher than 5 V, i.e. 20 V in this case.

    c. To measure the voltage across a resistor, place the DMM probes across it (i.e. in parallel). Observe the sign and value of the voltage shown.

    d. Now swap the position of the probes and observe the new sign and value, to understand that polarity is important and it matters in voltage measurements.

    e. Measure and record in Table 2 the voltage across the 3 resistors, R1, R2 and R3.

3. Current measurement using the DMM (ammeter):

    a. Because an ammeter needs to be in series with the circuit for it to make current measurements, you will need to break the circuit somewhere to insert the DMM.

    b. A convenient place to break the circuit is between the voltage source and the components. However, this does not work for resistors in parallel. Thus, if you are interested in knowing the current flowing through R2, you will break the circuit at point **a** (or **b**) shown in Figure 1 and insert the DMM between R2 and point **a** (or **b**), treating the DMM just like another resistor in series with R2.

c. Disconnect the 5 V supply from your circuit first as a safety precaution. Place the DMM probes according to the direction of the current flow and select a suitable current range with the rotary dial.

d. You can now connect the 5 V supply to the circuit. If you are not sure what range to choose, always start with the maximum range. After getting an initial reading, you can decrease the range to obtain a more accurate reading if necessary.

e. If you did not figure out the direction of current flow correctly, the negative current obtained indicates that the current flows in from your black probe, through the DMM and out from your red probe.

f. Swap the position of the probes to observe the change in sign and understand that the polarity is important and it matters in current measurements.

4. Measure and record in Table 2 the current flowing through the 3 resistors, R1, R2 and R3.

5. Do your measurements make sense? Explain.

Table 2. Voltage and current of all resistors in Figure 1.

Resistor	Voltage (V)	Current (A)
R1		
R2		
R3		

Activity 3 – BitScope DSO Setup (60 mins, homework)

The objective of this activity is to setup BitScope DSO on your computer (laptop/PC) so that you can use it as a waveform generator and an oscilloscope. At the end of this activity, you should be able to observe the sinusoidal waveform with different frequencies on your computer.

1. DSO download, installation and setup:

a. Download BitScope DSO from http://my.bitscope.com/download/?p=download. At the top selection panel, as shown in Figure 2, leave the File Type and Release Version as the default Software Apps and Production respectively. Ensure the Operating Systems and CPU Architecture selected match that of your computer.

Figure 2. Selection Panel at BitScope download website.

b. Below the selection panel, you will find the various BitScope software applications available for download (see Figure 3). For this module, **bitscope-dso** is sufficient to carry out most of the tasks. But, please feel free to explore other applications later.

	File	Description	Size
☑	bitscope-dso_2.8.FE22H_i386.zip	BitScope DSO 2.8	3615k
☐	bitscope-logic_1.2.FC20C_i386.zip	BitScope Logic 1.2	1497k
☐	bitscope-meter_2.0.FK22G_i386.zip	BitScope Meter 2.0	1176k
☐	bitscope-chart_2.0.FK22M_i386.zip	BitScope Chart 2.0	1593k
☐	bitscope-proto_0.9.FG13B_i386.zip	BitScope Proto 0.9	934k
☐	bitscope-console_1.0.FK29A_i386.zip	BitScope Console 1.0	817k
☐	bitscope-server_1.0.FK26A_i386.zip	BitScope Server 1.0	243k
☐	LIAComms-02.zip	BitScope Network Utility 02	256k

Figure 3. BitScope software applications available for download.

c. Click **Download** and follow the instructions to install BitScope DSO application on your computer.

d. To setup DSO for BitScope Micro (BS05), plug in your BS05 and run **BitScope DSO 2.8**.

e. Click **SETUP** and ensure that the PORT selected for USB connection is the same as the one shown under Ports (Com & LPT) in your Device Manager (or its equivalent in System Information on Macs). By default the DSO is preconfigured to connect with BitScope via *COM4* or *COM5*.

f. To check if the setting works, click **POWER** to turn on the DSO.
   i. If the bottom left status bar tells you that you are NOT CONNECTED, you will have to try another COM port.
   ii. If you see the green Data, red Sampling and yellow CHA LEDs blinking repeatedly, diagonally across your BS05 board – congratulations! Your DSO is working and it is setup with your BS05.

g. If, for some reasons, your installation is not successful, and before you email support@bitscope.com for advice, here are a few things you can try:

   i. Use the driver provided by *ftdichip* instead, as the one provided by BitScope may not work on some laptops: https://www.ftdichip.com/Drivers/CDM/CDM21228_Setup.zip

   ii. Refer to the installation guide – it is available at the BitScope download website. On the selection panel (Figure 2), change the File Type to Guides & Manuals instead and download **ubig** (USB BitScope Installation Guide), shown in Figure 4.

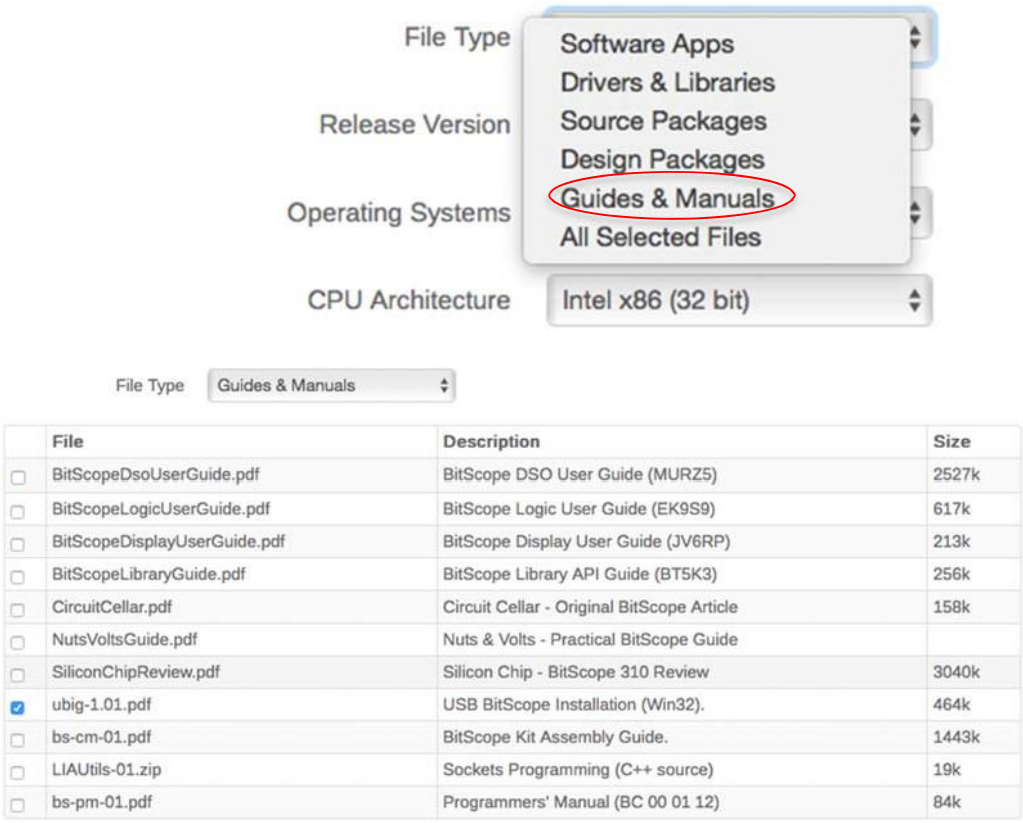

Figure 4. Guides and Manuals available for download.

2. DSO power up and testing:

   To verify that your DSO and BS05 are both connected and working together properly, you perform a simple **loop-back test**, i.e. you feed the signal generated by AWG to both CHA and CHB. If the waveforms displayed match, it means both your DSO and BS05 are working fine.

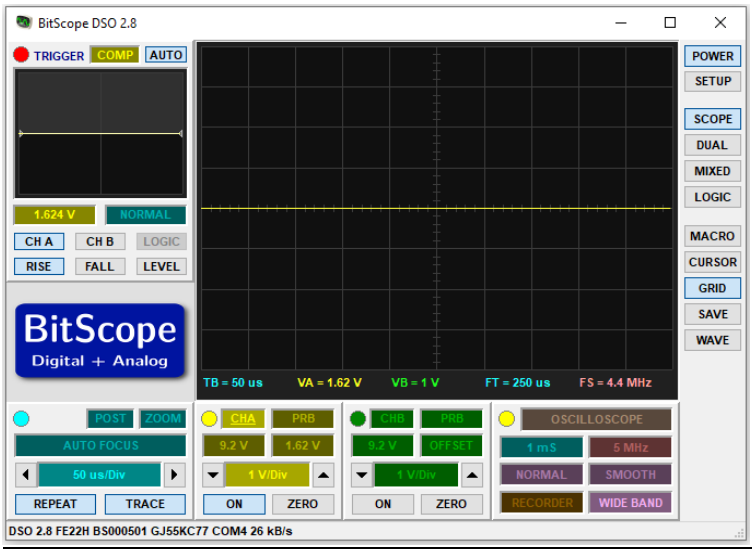

Figure 5. The default BitScope DSO Panel upon powering up.

a. Upon successful setting up and powering up of DSO by clicking the **POWER** button at the top right corner, the default BitScope DSO panel appears as shown in Figure 5.

b. Connect the red probe to AWG pin and connect its mini-grabber to one end of a wire, which serves as a simple bus.

c. Connect another two test probes, one to CHA and another to CHB. Connect both their mini-grabbers to the other end of the wire, as shown in Figure 6.

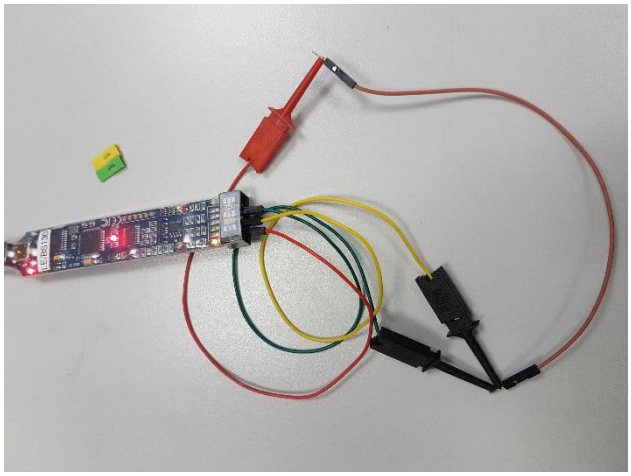

Figure 6. Probes connection for simple loop-back test.

d. Click the WAVE button, which is the last button on the right hand side of the DSO panel, to generate the default sine wave (Tone). A sine wave now appears on the smaller display, as shown in Figure 7. All its parameters below the display are adjustable. Note: the voltage parameter is the peak- to-peak voltage, not the amplitude.

e. As only CHA is turned on by default, you should see a yellow sine wave only in the main display. Proceed to turn on CHB by clicking ON button at the CHB channel control panel located below the main display. Once enabled, the CHB green sine wave appears and superimposes on CHA yellow sine wave, as shown in Figure 7.

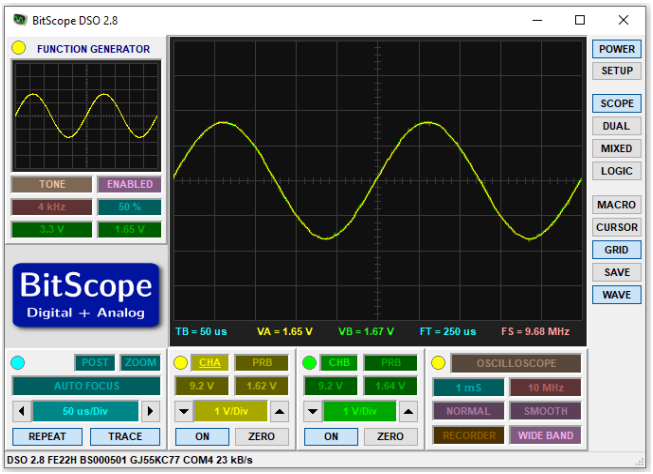

Figure 7. Indiscernible CHA (yellow) and CHB (green) waveforms.

f. You may adjust the scale to distinguish the signals on the display, as shown in Figure 8, by setting the appropriate parameter (unit: mV/Div). You may want try out both the coarse and fine adjustments and see their effects.

g. Congratulations, you have successfully completed the DSO setup and testing its basic function as a AWG and an oscilloscope with your BS05.

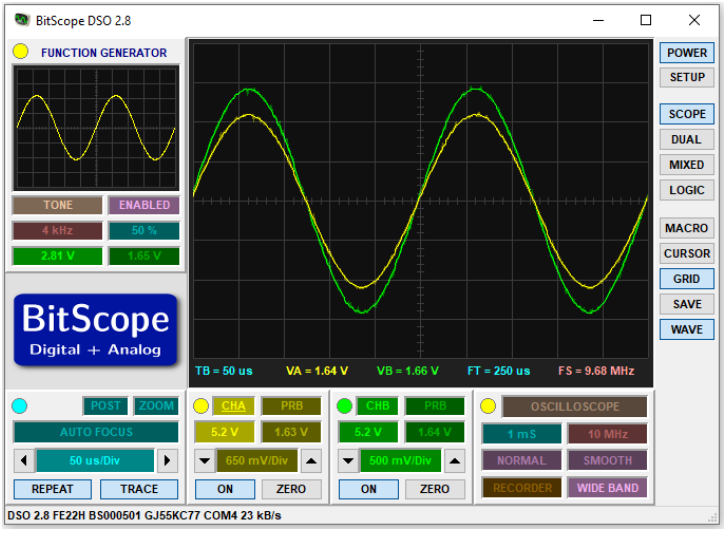

Figure 8. Distinguishable waveforms after parameter adjustments.

Please feel free to clarify any doubts about this studio with your TA or instructor.

END OF STUDIO SESSION