MEAM 5100: Laboratory Assignment-0

Student Saurav Agrawal
ID 58987928
Professor Dr.Mark Yim

0.1.1 What do you measure with Probe in 10A (or equivalent A slot) and COM? What do you measure with Probe in V/mOhm etc. and COM? If you incorrectly measure something that does not correspond to the correct probe what are things that can happen and why?

We measure high current input when the probe is connected to the "10A" measurement mode. A is the unit of measurement for current. The digital multimeter monitors high current in this mode, usually up to 10 amps or more.

0.1.2 What things can your multimeter measure? Not all DMMs are the same so it is important to know what the one you have can do, and how to connect it to correctly measure what you want.

The multimeter used in Lab 0 was AstroAI Digital Multimeter 6000 Counts, Model DM6000AR. Going from left to right in the multimeter, It measured voltage in both AC and DC. Further, it measured continuity(which helps to identify short circuits), resistance and diode testing. Next, it measures capacitance, following which it measures frequency and duty cycle. It can also measure temperature. It measures current in both AC and DC.

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

I took a 9V battery, tried to find the potential difference across it, and found it to be 8.6 V. The user manual of AstroAI Digital Multimeter 6000 Counts, Model DM6000AR, shows that the input impedance for voltage measurement is 1M ohm. So, the DMM has a negligible impact on the voltage reading. The difference in reading might be caused by the age of the battery or due to the battery usage in the past, resulting in lower potential differences among battery terminals.

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. Change the setting on the multimeter to do a connectivity test to determine what parts of your workstation are shorted together. Write down 2 things that are connected. Note: The DMM will beep if things are shorted together, however, if the batteries are low in the DMM it may not beep. You should still see a reading on the device if there is low or high resistance.

We connected the DMM to the metal plate, which created a complete circuit, and we could hear the sound. We also tried the metallic part of the pliers, providing the sound as it completed the shortening circuit. Then we tried it with the 9V battery, and we found that when the positive terminal of the battery was touched with the positive of DMM, we could hear the sound, but no sound was heard when we reversed the polarity.

0.2.1. Turn the voltage knob. Does the current display change as you do this? Why or why not? Does anything happen to the CV and CC lights? Turn the current knob all the way counter-clockwise (to 0). Does the voltage display change as you do this? Does anything happen to the CV and CC lights?

As we turn the voltage knob clockwise, the voltage display increase to the new set voltage. Since I did not put any load on the circuit, the current display was 0, as the load drew no current. CV light was on, and the CC light was inactive. When the current knob was turned counter-clockwise to 0 the voltage display too showed the 0 V

CV light was still on and CC light was still inactive.

0.2.2. Using the DMM, measure the voltage difference between the (-) and (+) outputs as you adjust the voltage knob. Do the multimeter and the power supply agree? Does the current display show any current? Now measure the voltage between the ground and positive terminals. See if you can explain the difference between the ground and negative (black and green) terminals

When measuring the voltage difference between the (-) and (+) outputs by adjusting the voltage knob, we found the DMM reading slightly deviating from the reading in the voltage display by the Variable power supply. The current display showed a 0 reading, as the circuit had no load for the current to pass. The voltage reading in the Variable Power Supply was 5 V, whereas in DMM, it was 4.6 V. The voltage between the ground and the positive was 1.5 mV. The voltage between the ground and the negative was 1.2 mV.

0.3.1. Use the DMM to measure a variety of resistors from 1K to 10M. Write out a table of results. Combine resistors to vary resistances. Are the readings within tolerances? Were you touching the resistor or probes with your fingers? If you were, how does the resistor change if you make the connection to the resistor without touching it? If the readings are different, why?

Resistance Rating	tolerance	DMM value without touching	DMM value touching
1.5 K ohm	5 percent	1.476 K ohm	1.3 K ohm
6.2 K ohm	5 percent	6.16 K ohm	5.95 K ohm
22 K ohm	5 percent	22.01 K ohm	18.2 K ohm
470 K ohm	5 percent	465.5 K ohm	210.8 K ohm

It is seen that when we touch the resistance while taking the measurement using the DMM, we get variable values of resistance depending upon the pressure applied by fingers while measuring, resulting in faulty values of the resistance.

0.3.2 Connect the same range of resistors to a 5V supply. Use the power supply current reading to determine how much current is flowing through the circuit. Write a table with expected current (Ohm's Law) vs. actual current measurement and the resistance values used. Do the values match? If not, why do you think this is happening?

Resistance Rating	tolerance	Expected Current	Actual Current
1.5 K ohm	5 percent	3.33 mA	3.38 mA
6.2 K ohm	5 percent	0.8 mA	0.81 mA
22 K ohm	5 percent	0.227 mA	0.22 mA
470 K ohm	5 percent	0.0106 mA	0.0105 mA

It is seen that the theoretical values and the values detected by the DMM are very close, with a negligible error rate.

0.3.3. Measure the voltage drop across the resistor using the DMM. Does this match the variable power supply? Does this fit what you would expect from the V=IR relationship? If not, why do you think this is happening?

Resistance Rating	tolerance	Voltage drop Measured
1.5 K ohm	5 percent	5.020 V
22 K ohm	5 percent	5.040 V
470 K ohm	5 percent	5.022 V

It is seen that the theoretical values and the values detected by the DMM are very close, with a negligible error rate.

0.4.1. Repeat 0.3.3 with the scope and probe set to 1X. Then repeat it with both set to 10X. Is the result different? If so, why? Regardless of your findings, why would this feature be included?

Resistance Rating	Oscilloscope 1x	Oscilloscope 10x
1.5 K ohm	5.1 V	0.53 V

When we measure the voltage across the resistor using the scope and the probe for different settings of 1x and 10x, we find that the voltage drop seen in the 10x setting is 1/10 th of the voltage drop in the 1x setting. This voltage scaling helps measure high voltage signals and reduce the risk of overloading the oscilloscope input. These settings also help improve the amplitude signals' resolution and increase the voltage measurement's accuracy.

0.5.1 Connect the function generator to the scope and test the different wave functions. You will need to adjust the scope settings, and you may need to change the power range on the function generator as well. Feel free to explore different settings to get a better sense of both machines. What does the duty cycle do to each of them?

The duty cycle is a measurement parameter in an oscilloscope representing the proportion of a waveform's total duration spent in the "on" or "active" state. It is particularly relevant when analyzing periodic waveforms, such as square waves. It is typically expressed as a percentage and represents when a device, signal, or system is active or operational. The duty cycle on an oscilloscope is often associated with square waves. Here, we have tried to explore the duty cycle of a square wave at different percentages. First, I tried exploring the duty cycle at 75 per cent to see how the wave looks in the oscilloscope.
Next, keeping the other variables the same, we tried to change the duty cycle to 25 per cent to see the changes in the waveform. This can be seen in the figure below.

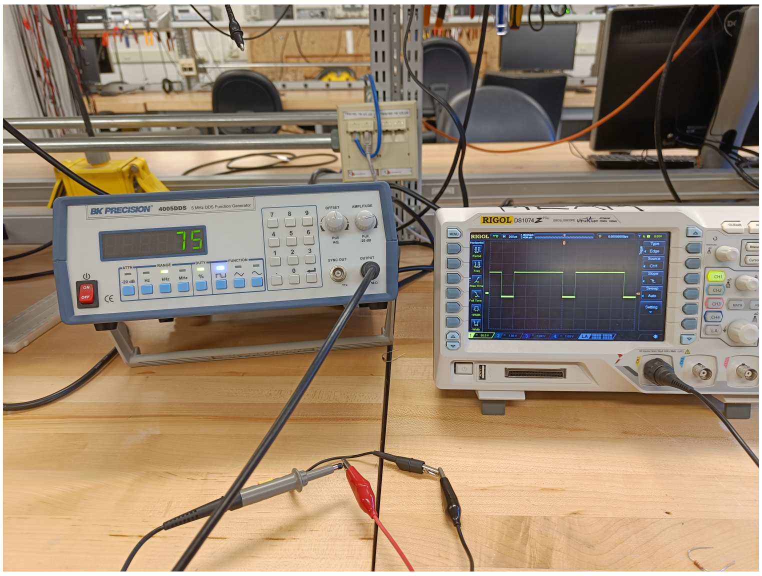

Figure 1: Duty cycle 75 percentage

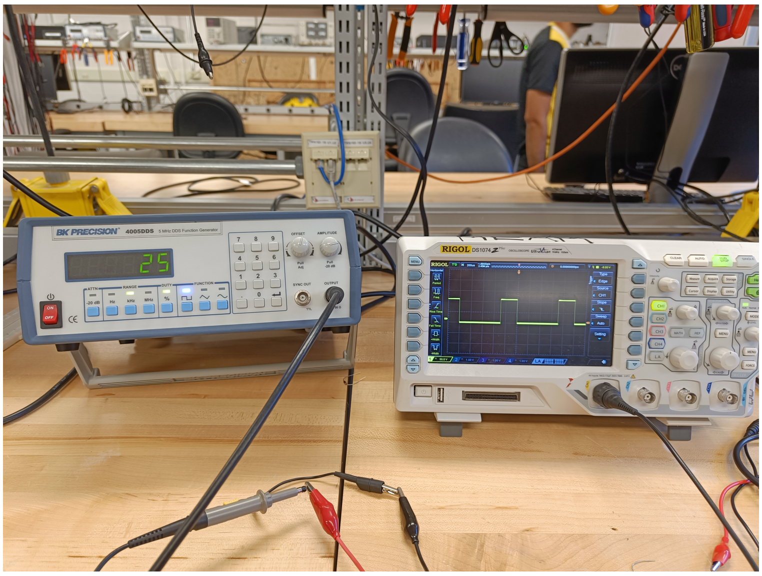

Figure 2: Duty cycle 25 percentage

0.5.2 Adjust the offset of a square wave so that it is always positive. What happens when you now change the amplitude by a factor of 15?

The initial amplitude seen was 1.38 V. When the amplitude is changed by a factor of 15, the amplitude value varies to 20.1 V, and the Value of Vmin and Vm max changes after offsetting it initially to positive. After increasing the amplitude 15 times, even if we try to make the offset positive, we cannot do so, and also, the square waves distort, as shown in the figure. The Vmin stay negative even in the maximum offset.

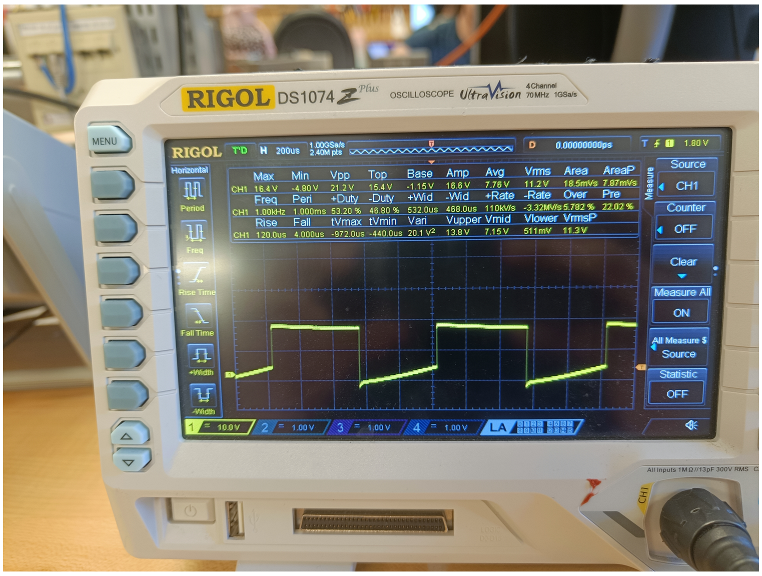

Figure 3: 15 times amplitude and offset

0.5.3 Change the frequency of the signal by a factor of 1000 and set it to a sine wave. Adjust the scope so you can see the signal, and trigger it on a falling edge. What happens when you move the trigger up and down? How is this different from what happens with a square wave??

Initially, I was working on a frequency of 1 KHz and multiplying it by a 1000 We 1 MHz factor. The setting of the function generator was set to sine waves. Triggering was set on the falling edge. The trigger in the falling edge looks like the below figure. As the trigger moves up and down, we get a new starting point of the wave. The oscilloscope captures the waveform when the signal transitions from a higher to a lower voltage, which can be seen in the image.

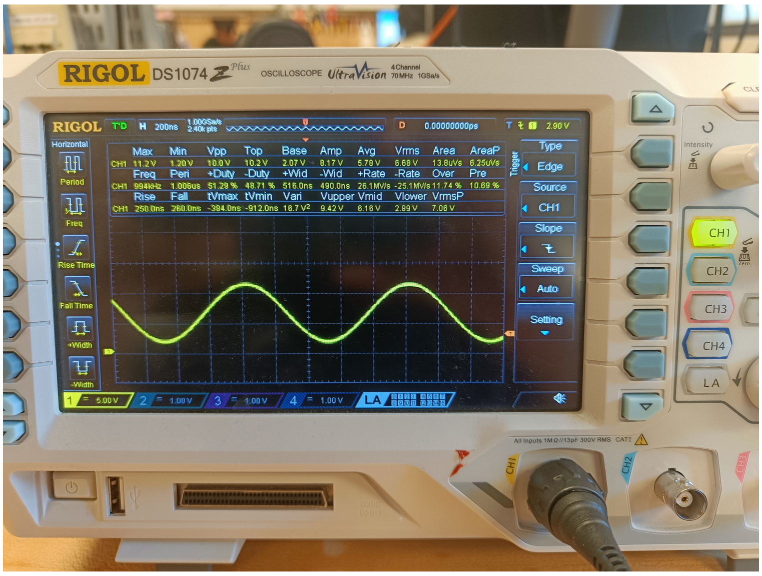

Figure 4: Sine Wave trigger on falling edge

When the wave is changed to square waves, the movement of the trigger has no movement on the wave. The square wave starts from the low voltage section as we have selected the trigger by falling edge setting. As we zoom into the wave over time, we see that the waveform is not precisely rectangular but slightly bent (curved at the end). This could arise due to the physical system and the limitation of the components used for measuring the voltages.

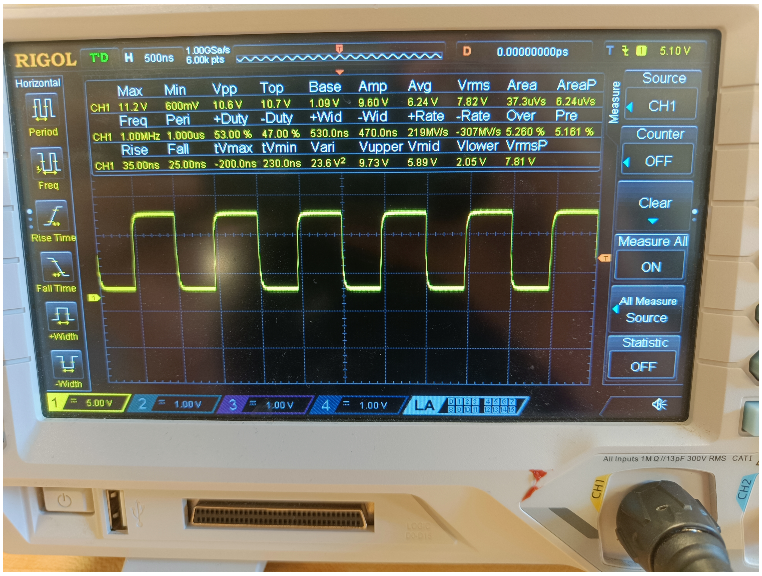

Figure 5: square Wave trigger on falling edge