Digital Instrument Control Using Computer Programming 2

Sejin Jeon
Sogang University Physics Department
Student ID 20231262
(9th Week Post-Experiment Lab Report)

I. PRACTICE 1 (DATA & ANALYSIS)

A. *U3-HV (DAQ Board)*

In this first practice of the session, presentation slides presented to us were used to test both the analog and digital input/outputs. At first, the "U3_code.py" was opened and each line of code was ran. Here is the complete list of codes that were ran.

1. **Analog input** : The function generator's output was connected with the U3 DAQ board, and AIN0 was connected with GND. The offset of the DC voltage was varied to see how the response would change. As seen in the figure, the following two lines

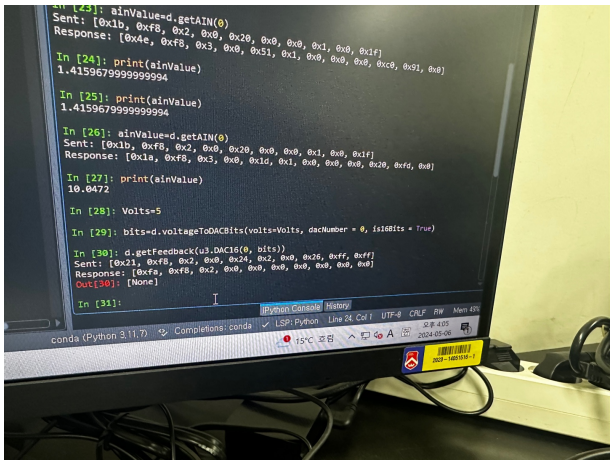

FIG. 1

of code accurately gave the voltage values that were input into the system using the function generator.

```
##### analog input #####
ainValue=d.getAIN(0)
print(ainValue)
```

FIG. 2

2. **Analog output** : This time, a certain voltage was set through the code (*thus the output*) using the code lines provided. The implementation looked like the following. As seen in the figure, following three lines of code accurately changed the voltage

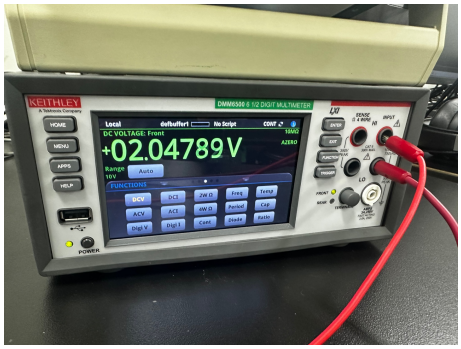

FIG. 3

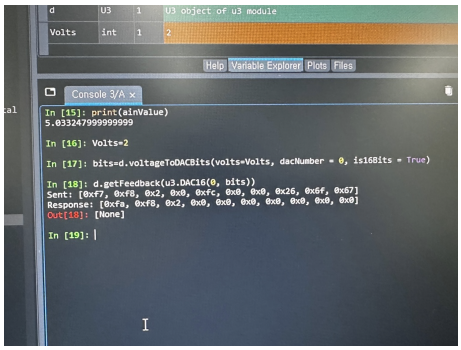

FIG. 4

voltage output of the DAQ board, and the multimeter detected this output of voltage.

```
###### analog output #####
Volts=2
bits=d.voltageToDACBits(volts=Volts, dacNumber = 0, is16Bits = True)
d.getFeedback(u3.DAC16(0, bits))
```

FIG. 5

3. **Digital input** : The way that the digital input was different with the analog input was that it was able to address signals in a more discrete way, indicating whether the input was there or not through the numbers "0" and "1". When the DC voltage offset was set as 2 V, the command in the manuel gave a "1", while when the DC voltage offset was set as 0 V, the command in the manuel gave a "0". The two lines of the code used can be seen in the figure below, while the results of the experiment can be seen below that.

```
DIn=d.getDIState(ioNum = 6)
print(DIn)
```

FIG. 6

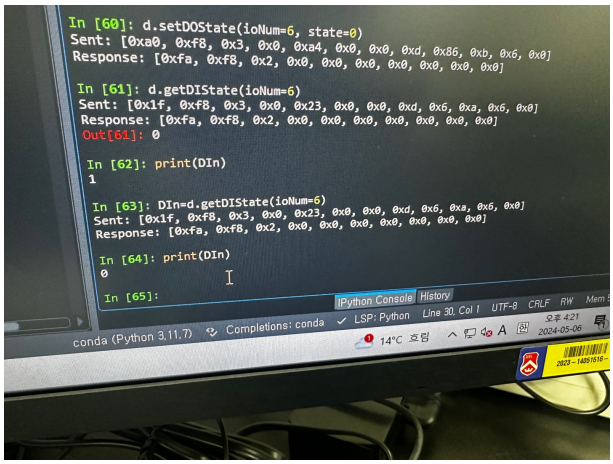

FIG. 7

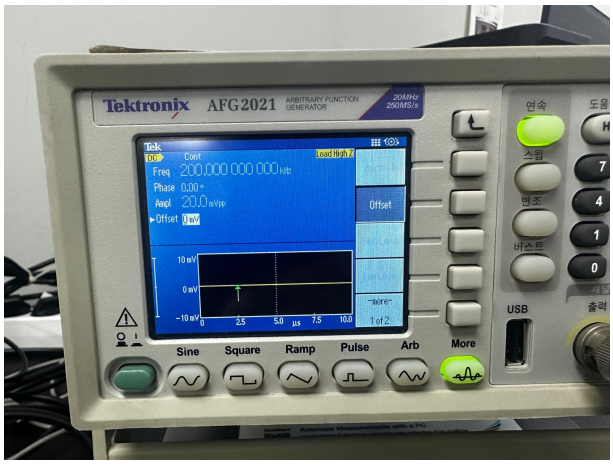

FIG. 8

4. **Digital output** : Similar to the relation between the digital and analog and digital input, the digital output set the state of the digital output in descrete ways, where setting the state “0” sent a direct current of 0 volts while the state “1” sent a direction current of 3 volts both measured by the multimeter. The line of code used and the results of the practice can be seen in the images below.

```
d.setDOState(ioNum=6, state=0)
```

FIG. 9

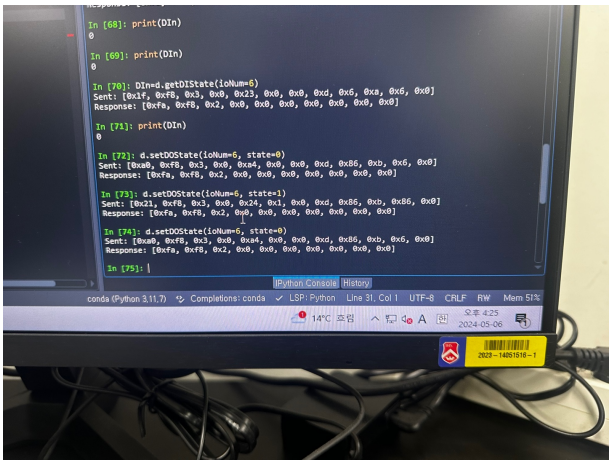

FIG. 10

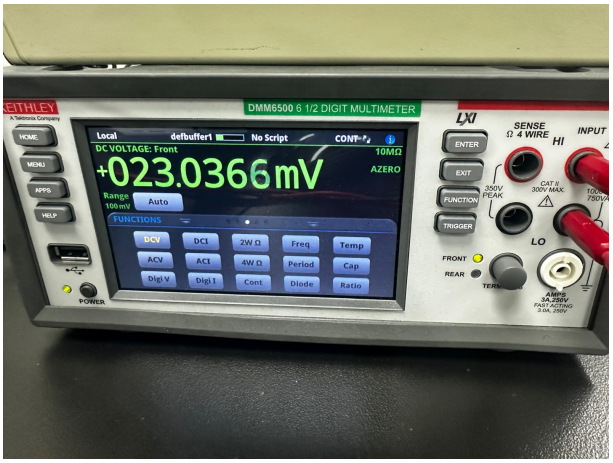

FIG. 11

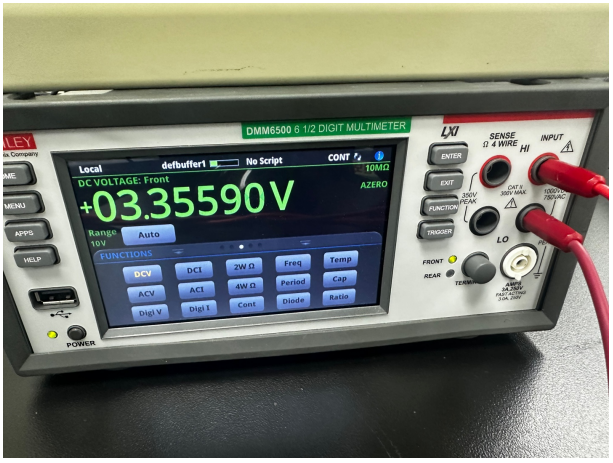

FIG. 12

II. PRACTICE 2 (DATA & ANALYSIS)

A. *AFG 2100* and *U3-HV* (Graphing Program)

In the second practice, the basic file "U3_code.py" was used as a basic file for the python code, and the file "AFG_Keithley_pyqt_matplot.py" was used to create a program that would change the DC output voltage of the AFG 2100 and measure this changed voltage and plot the graph. The screenshots of the program can be seen below. The major changes from the original code made were the following:

1. **import of the u3 package and initialisation code**. This enabled the UI to fit the U3 rather than the AFG function generator.
2. **Changing the button click connection code** was also important, as these settings inherently changed the buttons' effects from initiating code for the function generator to initiating code for the U3.
3. **Changing the instrument method definitions**. When changing the button click connection code, it was also important to change the certain definitions of the functions that were used.

Overall, the code drew the linear graph shown in FIG 16. The graph, however, shown a downwards plot rather than an upwards plot, and this error along with other aspects of the experiment will be dicussed further later on.

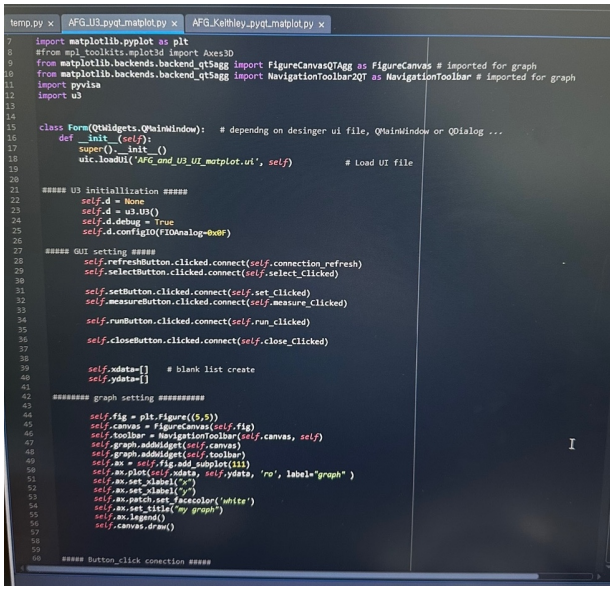

FIG. 13

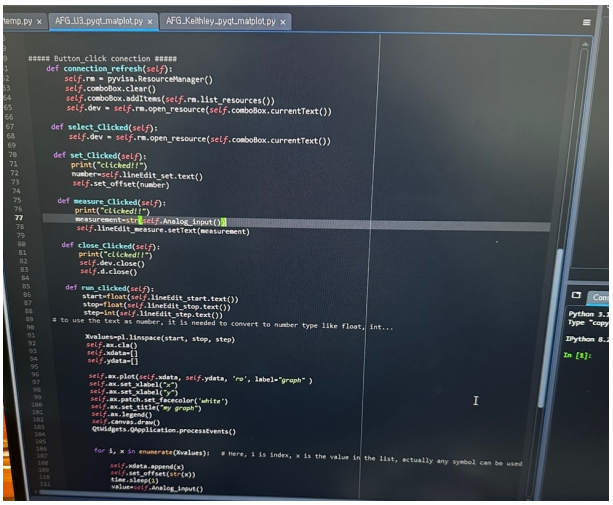

FIG. 14

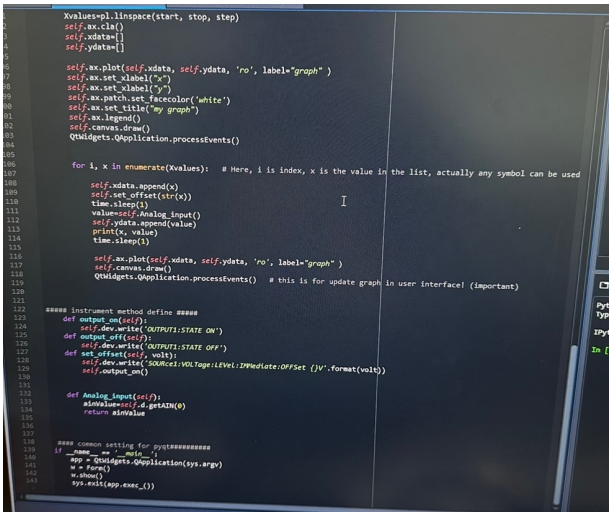

FIG. 15

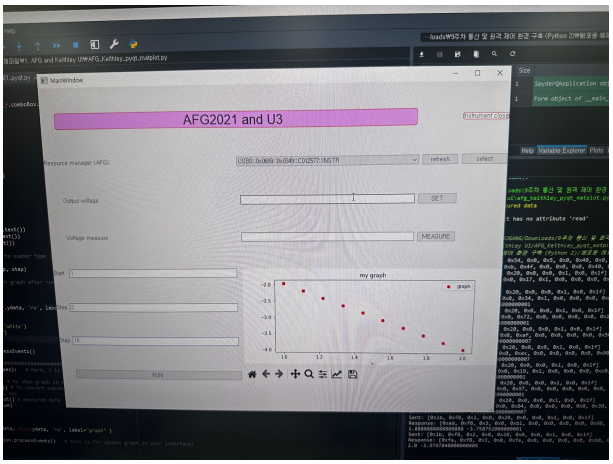

FIG. 16

III. DISCUSSION

Throughout the experiment there were a few errors that needed to be evaluated and there were also quite a few improvements that could be made. They are listed as paragraphs below.

The linear decent of the graph was a major error in the code that was created, as there was suppose to be a linear increase. This was a subtle problem in the code that was made, and this problem was due to the settings in the plotting program that was provided. This was quickly fixed lated on.

Impedance of the multimeter led to quite a few problems, as the analog output didn't correctly correlate to the measurements made by the multimeter. This was fixed by changing impedance of the multimeter, which changed the impedance of the measurement device to correctly calibrate to the signals sent.

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[1] The Sogang University Physics Department. Experimental physics 1 manual. *"Creating a Communications and Remote Control Environment (Python 2)"*.