Building a Library of LabView Programs to Support Engineering Education

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Andrew Bell
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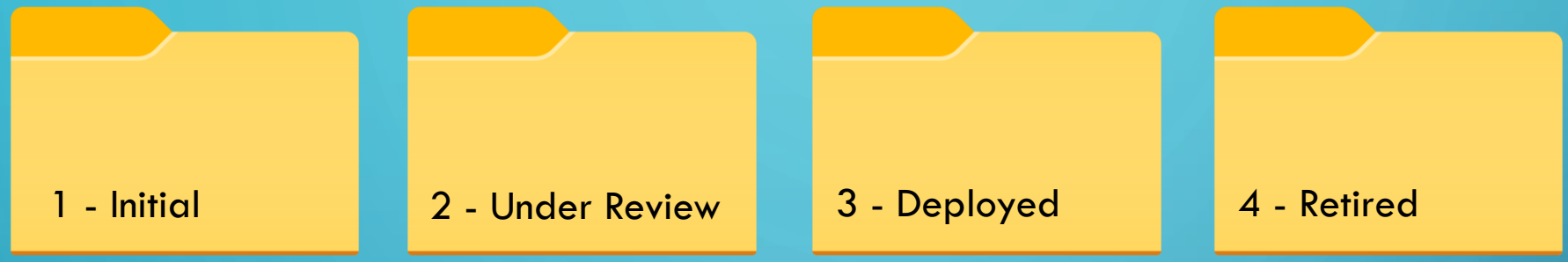
Abstract: LabView is a very powerful NI graphical programming language that can be used to design and build many executable programs to support education. These programs can be used in classes to support lectures and labs that are currently used in the education of students. The programs' design is based on need defined by the instructor. Since LabView is so intuitive, students can quickly develop job skills by building these programs. The programs can then be deployed as executable programs that can be loaded and used on personal and school computers.

History: Hired Work Student to write programs to support engineering programs and grants. Emily Kwolek (IT Student) was hired without any previous experience with LabView and began to work on updating and writing LabView Programs.

Strategy: Setup a Google Drive with this structure



1. **Initial** – contains reference material and initial program
2. **Under Review** – working directory of programs being developed
3. **Deployed** – VI and EXE files that can be installed on GRE computers
4. **Retired** – Programs which have been replaced

Programs: Status and types of programs created

	Program	Name	Version	Deployed	Analog	Digital	Mechanical	MEMS	Other
1	555 designer (lab 9)	L9D	1	yes		X			
2	6 Gate	6G 1.1	1.1	yes		X			
3	Boolean's theorems	BTP 2.0	2	yes		X			
4	capacitive and inductive reactance	XC & XL 1.3	1.3	yes	X				
5	component calculators	version 1.4	1.4	no	X				
6	coplanar equal angle	CEA 1.0	1	no			X		
7	coplanar unequal angle	CUA 1.0	1	no			X		
8	Data Aquisiton Control	DAC	2.1	yes				X	
9	data trimmer	Data Trimmer 1.0	1	no			X		
10	ibeam	ibeam 1.1	1.1	no			X		
11	KOH	KOH_rev A	rev A	no				X	
12	miniLou	MiniLou	1	yes		X			
13	miniLou hardware	MLHI 1.1	1.1	no		X			
14	miniLou virtual hardware	MLVI 1.0	1.2	no		X			
15	number conversions	NCP 1.7	1.7	yes	X	X			
16	op amp filters	op amp filters 1.8	1.8	no	X				
17	parallel plate capacitor	PPC 1.5	1.5	yes	X				
18	Pressure Sensor Process	PSP 1.1	1.1	yes				X	
19	RC & RL time constant	RC & RL 1.8	1.8	yes	X				
20	resistor tolerance program	RTP 1.8	1.8	yes	X				
21	Rooter			no					X
22	slider	Slider 1.0	1	no					X
23	Wheatstone Bridge			no	X			X	
24	wire resistance	WRC 1.4	1.4	yes	X				
25	wire resistance with temp	WRC 1.4	1.4	yes	X				

Deployed program are loaded on GRE computers and include VI and EXE versions

Dialog with Emily - So how did you learn LabView?

[7/18 10:13 AM] Andrew Bell
I would like to talk to you about "how you learned LabView" Back 100721 I setup a Google Drive for our LabView programs and you were off to the races. I may have provided you access with https://www.ivytechengineering.com/LabView/ how did you get started and how did you write the LabView programs?

[7/18 11:27 AM] Emily L Kwolek
First I watched those videos, and followed along making the thermometer converter. Then I looked at each program and how it functioned. When I met with something unfamiliar, I searched online for either the NI database or community for people who have had similar problems.

[7/18 11:39 AM] Emily L Kwolek
Also, not all of the latest programs that have been deployed are in that PowerPoint. Missing are Boolean's Theorems, Number Conversions, Capacitive and Inductive Reactance, RC & RL time constant, and the Resistor Tolerance Program.

[7/18 11:41 AM] Emily L Kwolek
I did document Boolean's Theorems and Number Conversions in a different PowerPoint though. Not sure which one at the moment.

[7/18 12:45 PM] Andrew Bell
ok, so watching the videos and then looking at the various programs to understand how things are done?

[7/18 12:48 PM] Emily L Kwolek
Yes, I learn best by doing something while step-by-step instructions are shown, so that part went very quickly. Then for when I ran into problems I emulated how other people solved similar problems, adjusting for how the program in question was meant to run.

[7/18 12:48 PM] Emily L Kwolek
Good news BTW, I was able to get AltSpace running on both the Oculus II and my PC.

[7/18 12:49 PM] Andrew Bell
Did you just Google the questions you had or did you use anything from NI?

[7/18 12:50 PM] Emily L Kwolek
The only things I used directly from NI were the datasheets for each module to understand how to set up inputs and outputs on the more complicated modules. Everything else I just Googled and found results on the NI Community forums.

[7/18 12:51 PM] Andrew Bell
I believe the way you learned LabView is a good way to learn it. Using examples and asking questions. We also had some documentation on what the programs needed to do and I gave you feedback as you developed the code. It makes sense ...

[7/18 12:53 PM] Emily L Kwolek
Right. And as I learned more about what LabVIEW can do, I was able to listen to your feedback and immediately have ideas pop into my head as to how to implement them and what is the most feasible way to do things.

[7/18 12:56 PM] Andrew Bell
Do you think the pace of writing the programs and doing edits was too fast, too slow or about right in terms of the pressure you may have felt. How about deploying the software, making executable programs and other tasks related to the LabView programs?

[7/18 12:59 PM] Emily L Kwolek
I never really felt a big pressure, there were a few days where I worked on it as much as I could but couldn't get anywhere until I took a break from it and looked at it with fresh eyes the next day, but most of the time I just made the edits necessary in a couple of hours or so and submitted it for the next day's review. Deploying the software/making executables was probably the easiest part. Once I had the software programmed, it was a very simple matter to get it working on the GRE computers.

[7/18 1:02 PM] Andrew Bell
I suspect that you enjoyed the tasks and found the development of these programs fun and enjoyable? The method I sometimes use for learning in my courses is "discovery based learning" which allow student to discover how do things. Was this acceptable to you.

[7/18 1:03 PM] Emily L Kwolek
I did find the development of software very rewarding. It's great to plug away at a problem for hours or days and then finally, finally it works exactly the way you want it to. And yes, your method of allowing me to discover solutions on my own made the material stick in my brain all the better.

LabView is a graphical programing language that was develop by NI and is used in industry. LabView is taught in some of our engineering courses. These comments were made by Emily Kwolek, a student worker in the IT program, with no LabView programing background. She developed and updated numerous programs that were converted to executables and deployed to our GRE computers for student use. Emily worked part time for about 4 hours per day from October 2021 till July 2022.

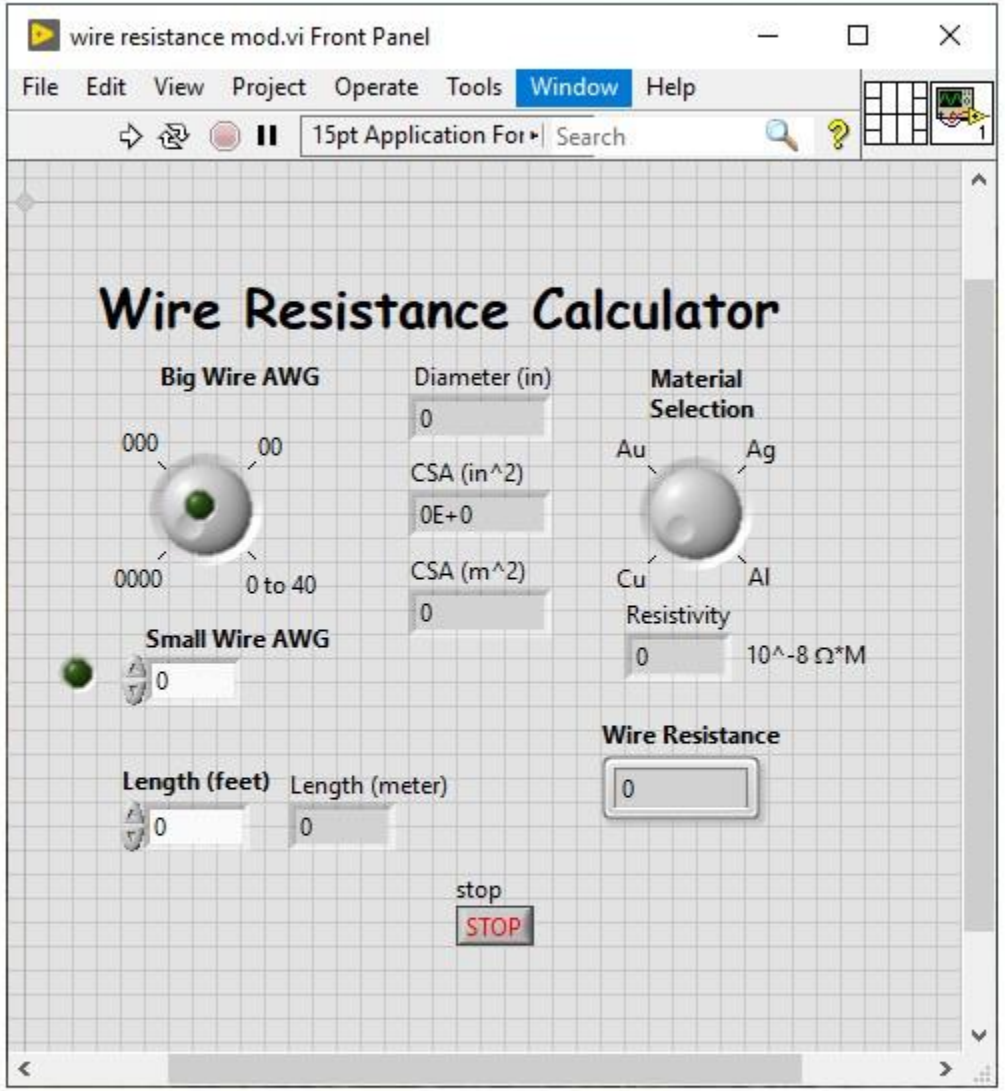
LabView Programs

These are LabView programs that were created in support of our NSF ATE Grant and EECT 111, 112, 122 and METC 237.

1.) Wire Resistance Program (difficulty – medium but easy to add new features)
2.) Parallel Plate Capacitor Programs (difficult – easy, ripe for updates and enhancements)
3.) KOH Concentration (difficulty – easy but could take some real work to enhance)
4.) Pressure Sensor Processor (difficulty – medium, very mature program with lots of supporting information)
5.) Quadratic Equation Solver (difficulty – easy, has room for enhancement)
6.) 6 Gate Tester (difficulty – medium to easy, not much room for enhancements but good for study)
7.) Mini-Lou (difficulty – medium to easy, room for enhancements)

Other candidates
a.) Lab 9 – Purpose - to support the design of a 555 timer circuit for EECT 112 (difficult – easy)
b.) Data Acquisition Control and Display Panel (DAC-DP). This program contains two parts, one that interfaces to an Arduino, the SCME Pressure Sensor kit, and a custom Arduino Shield. The second program uses a strain gauge, the SCME Cantilever Model kit and a custom Arduino Shield.
(difficult – advanced and interfaces to Arduino)

LabView Programs



History - In the EECT 111 class we have an assignment to determine the wire resistance of 100 foot of wire for 4 wire gauges using Silver, Copper, Gold and Aluminum.

This program is based on information provided by Wiki on American Wire Gauge[1] and Resistivity[2].

Major features include the use of Case Structures, Exponential Functions, Comparison Functions and Numeric Functions ...

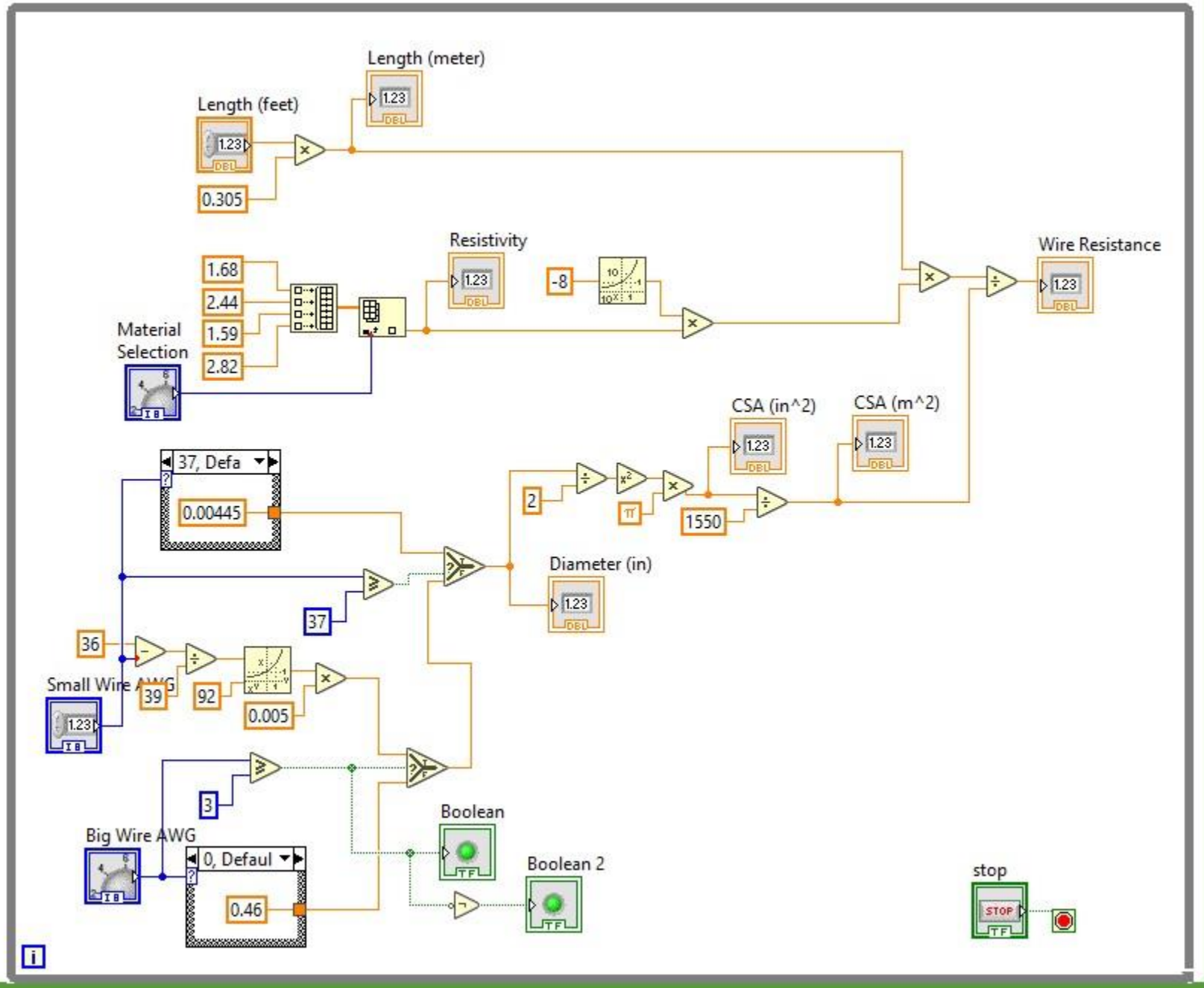
1 - https://en.wikipedia.org/wiki/American_wire_gauge
2 - https://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity

LabView Programs

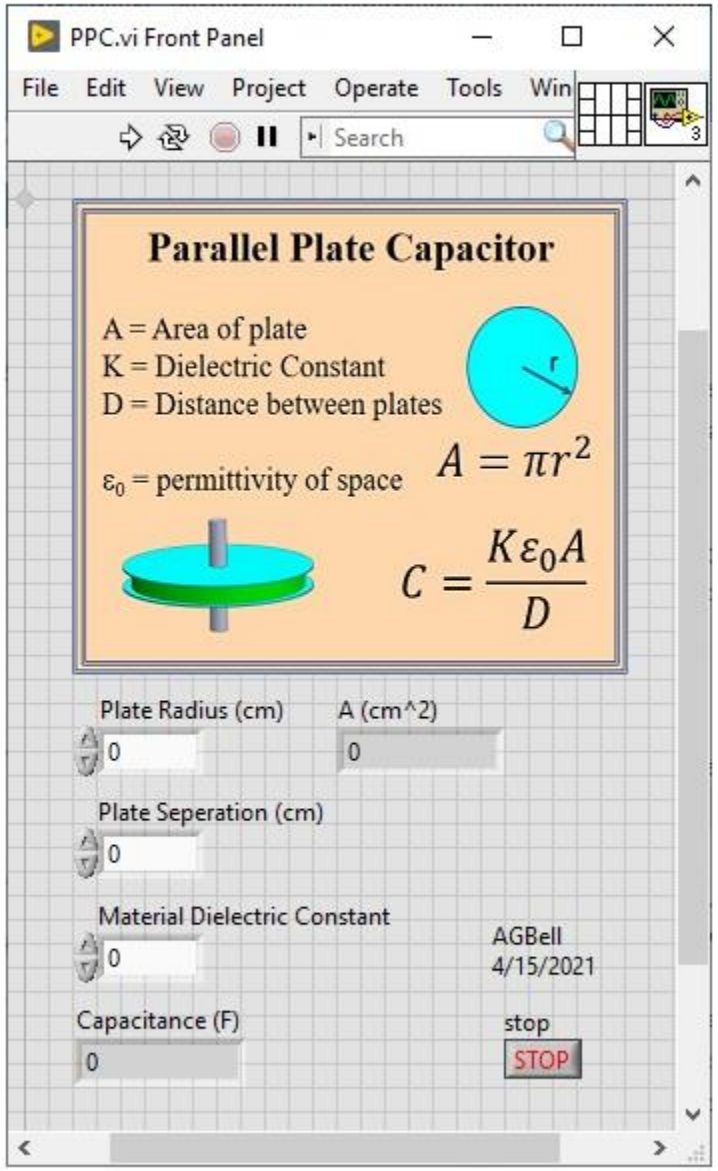
Status - This program has not been checked for accuracy.

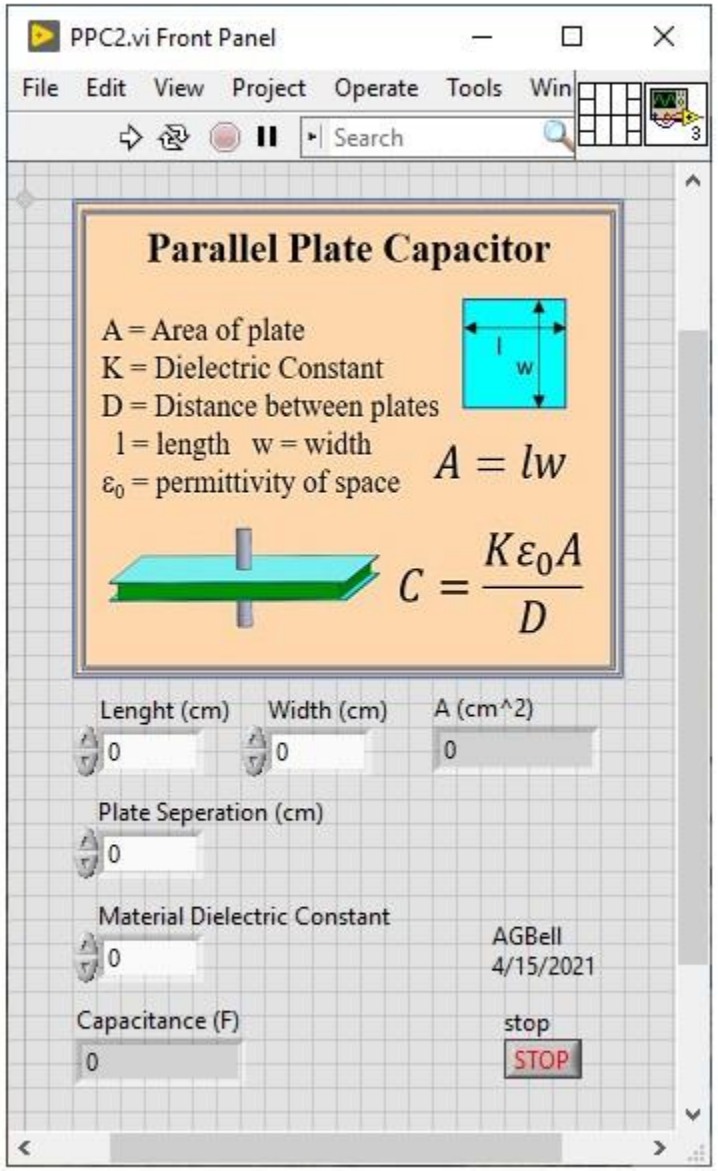
Updates:

1.) could add other metals that would be used in MEMS fabrication.
2.) create subvi for some of the code to make the software more modular.
3.) could add temperature coefficients for metals.
4.) Build executable



LabView Programs





History – This is a very old program that I have recently updated for the EECT 111 course.

It has some cool updates from the original Visual Basic program besides being translated into LabView. First, the graphics were actually created using SolidWorks and PowerPoint.

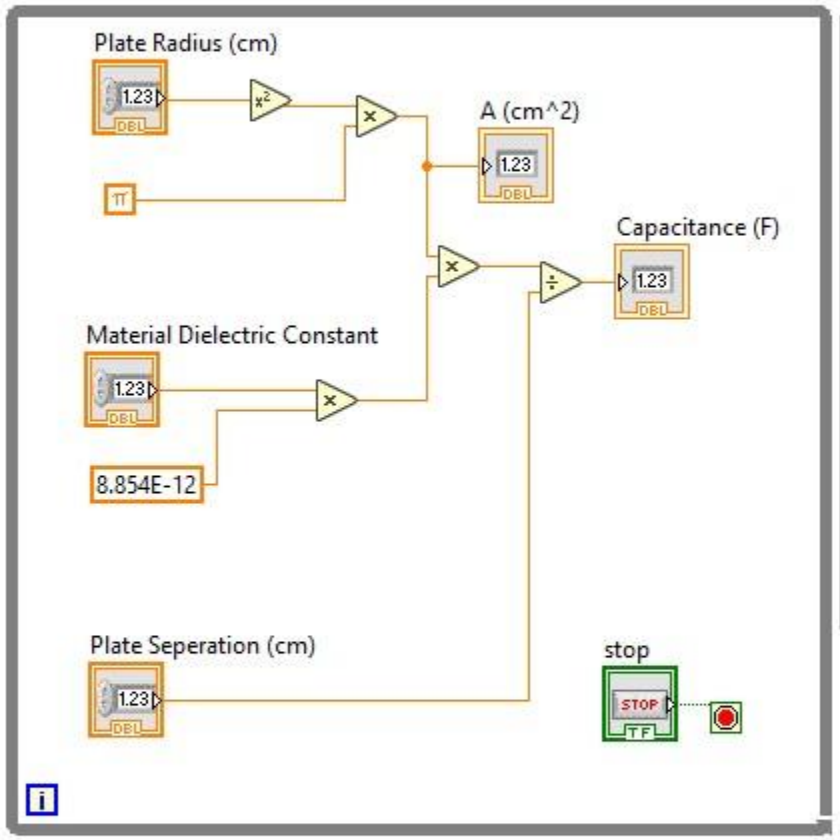
Major features Numeric Functions and use of graphics.

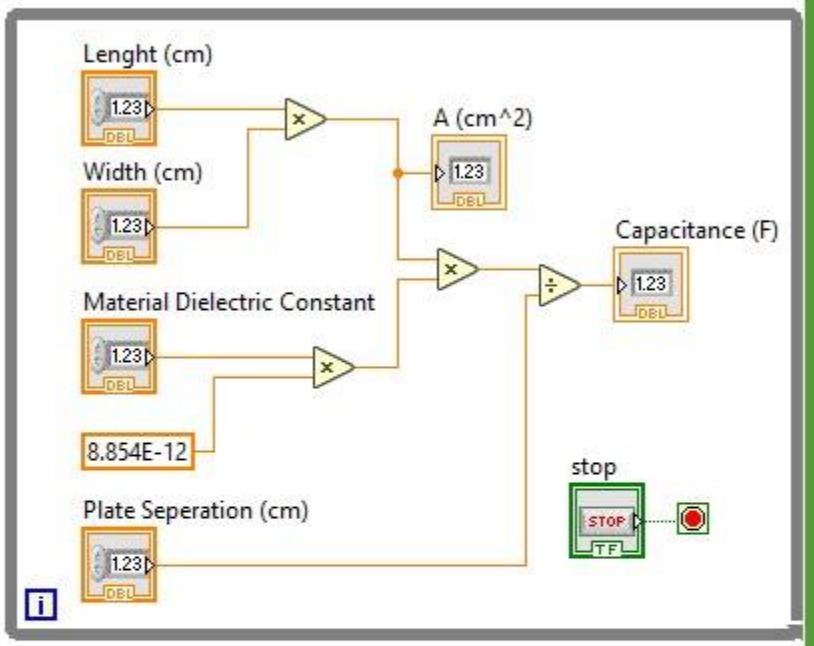
LabView Programs

Status – Program seems to work correctly, just noticed a typo in Lenght, lol

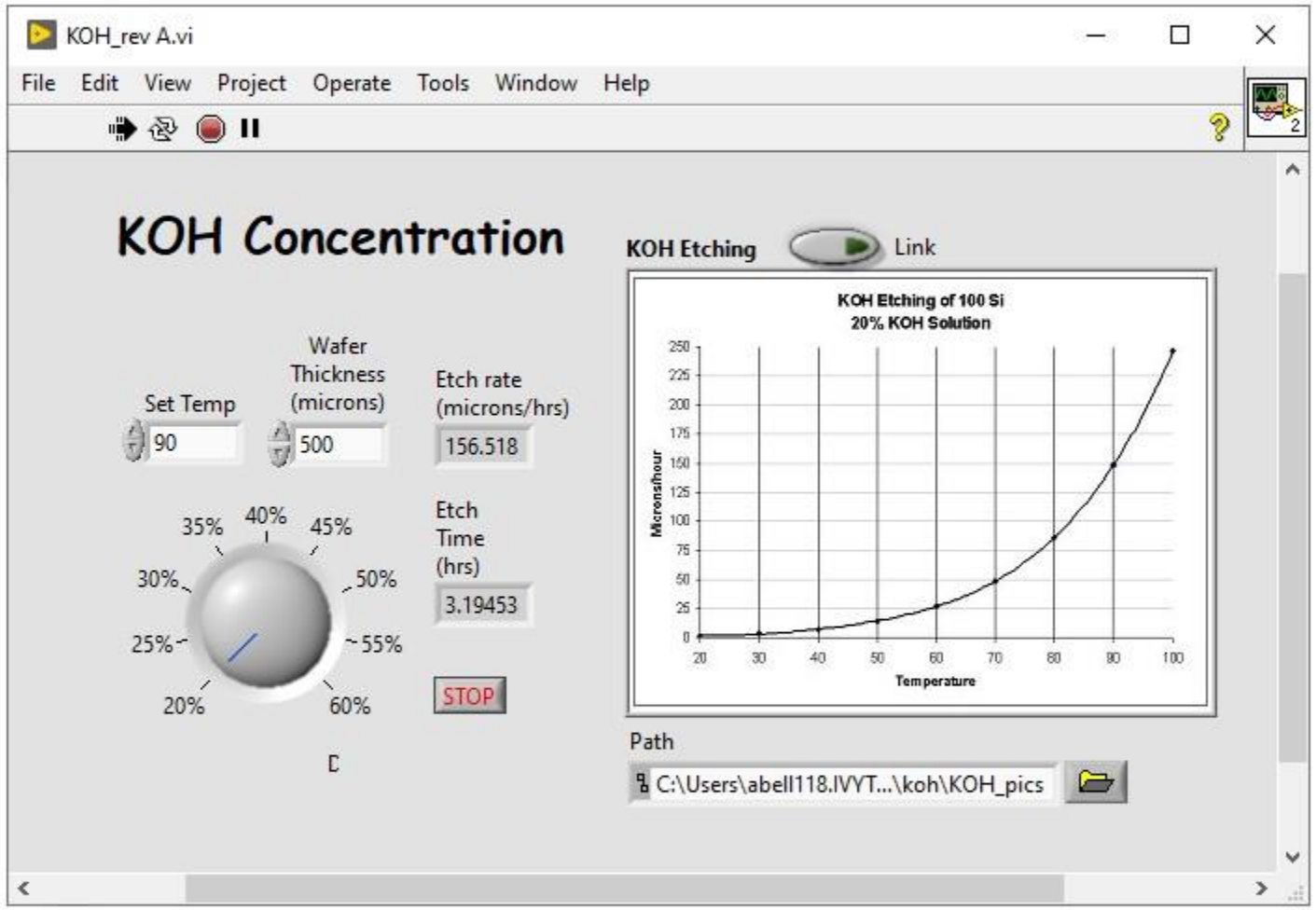
Updates:

1.) fix typo
2.) merge programs
3.) make dielectric constant a selectable value based on a good reference. Selectable dielectric constants should be based on material used for PCB for electronics and substrates used in MEMS devices.
4.) Could include range of capacitance based on range of dielectric constant.





LabView Programs



History – This a fun little program that I thought of when I was at UNM in 2019. It is based on the BYU KOH Etching website[3] for the 100 Si Miller Index. This program also used Engauge and Excel where the graphs for the BYU website were imported into Engauge and then the data was imported into Excel. In Excel curve fits were developed for each graph. This resulted in unique coefficients for third order polynomials for each concentration and temperature.

Major features include the changing of the images based on the % concentration knob, use of Polynomial VIs, use of subvi, uses Case Structures, link to external website.

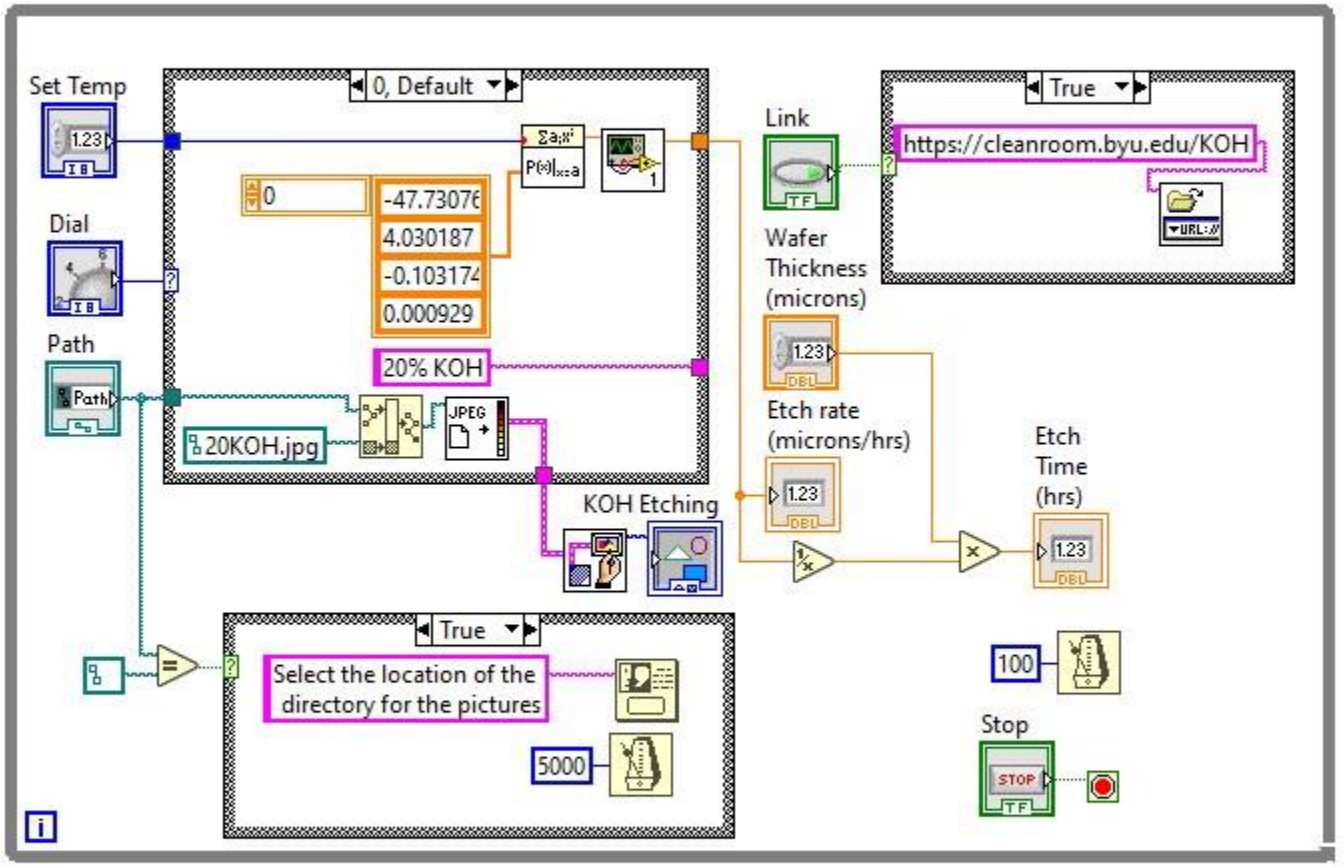
3 - https://cleanroom.byu.edu/koh

LabView Programs

Status – Program has not been validated for accuracy. Could plot curves and compare against the original curves.

Updates:

1.) Add the 110 Miller Index data
2.) Add Silicon Dioxide and Silicon Nitride
3.) make images a relative location vs an absolute to improve the functionality.
4.) add audio to the output.
5.) create executable

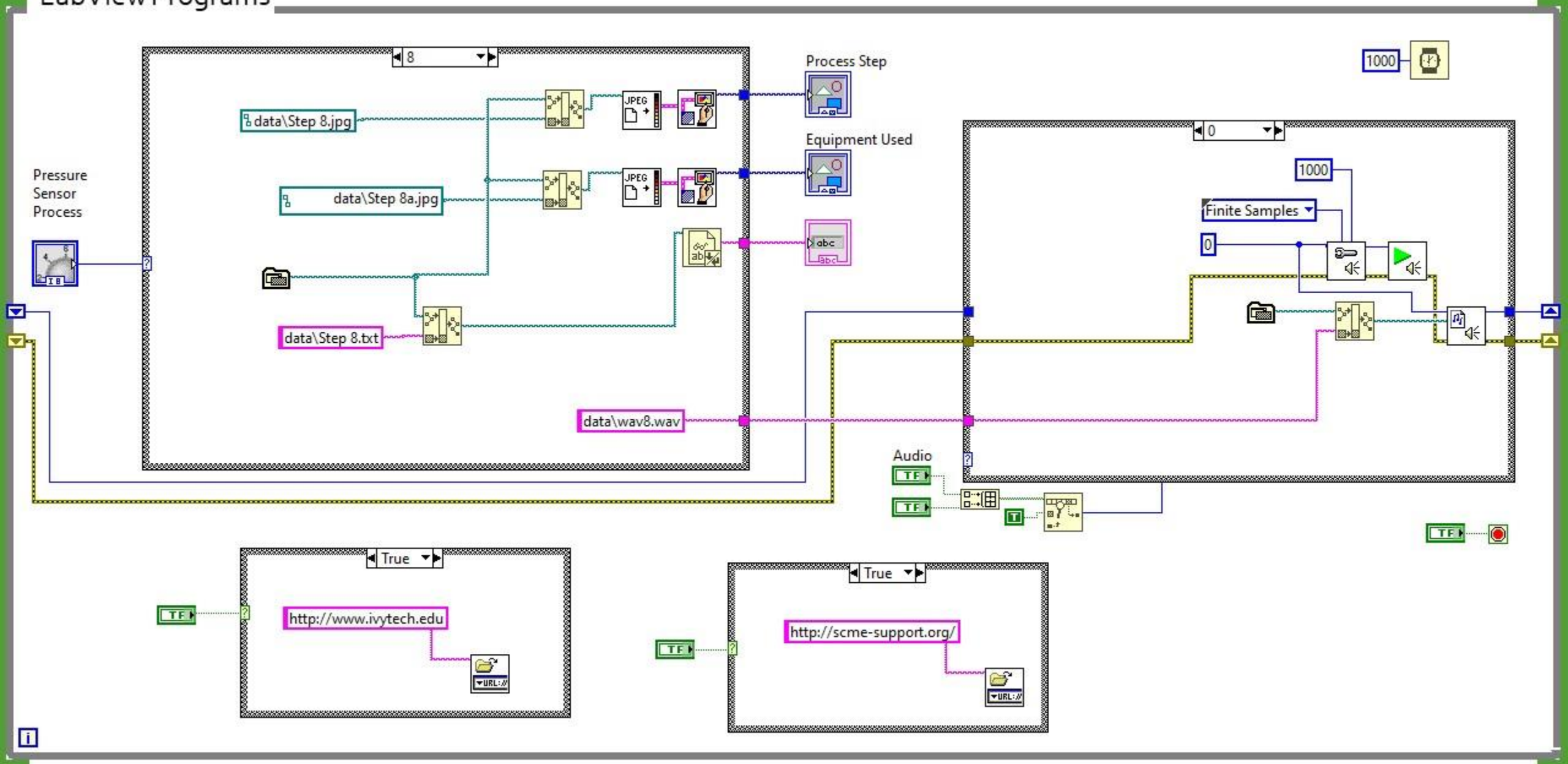


LabView Programs

History – This a great program that was started the first time we taught the MEMS 101 course back in 2017. The purpose of the program was to help students gain an understanding of the process steps used to create the SCME Pressure Sensor. Pictures of the process steps, text, audio and pictures of the equipment were used. The original idea was that this was a end of the semester project that the whole class would do to document the Pressure Sensor cleanroom experience at UNM.

Major features include external links, pictures, text and audio that changes as a function of switch selection, use of Case Structure, relative addressing out data, timer.

LabView Programs



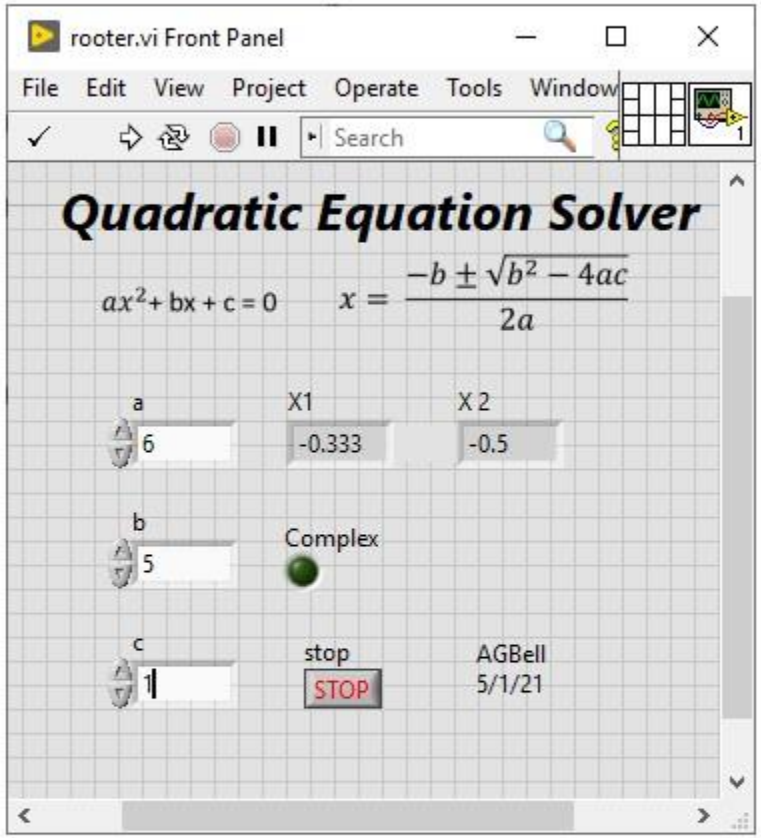
LabView Programs

Status – This program has be updated multiple times. The one that is shown here is PSP1.1 which is accessible from the https://www.ivytech-mems.org/ website.

Updates:

1.) Verify that the steps shown currently match the process steps used.
2.) Create executable
3.) create subvi for some of the code to make the software more modular and reduce block diagram size.

LabView Programs

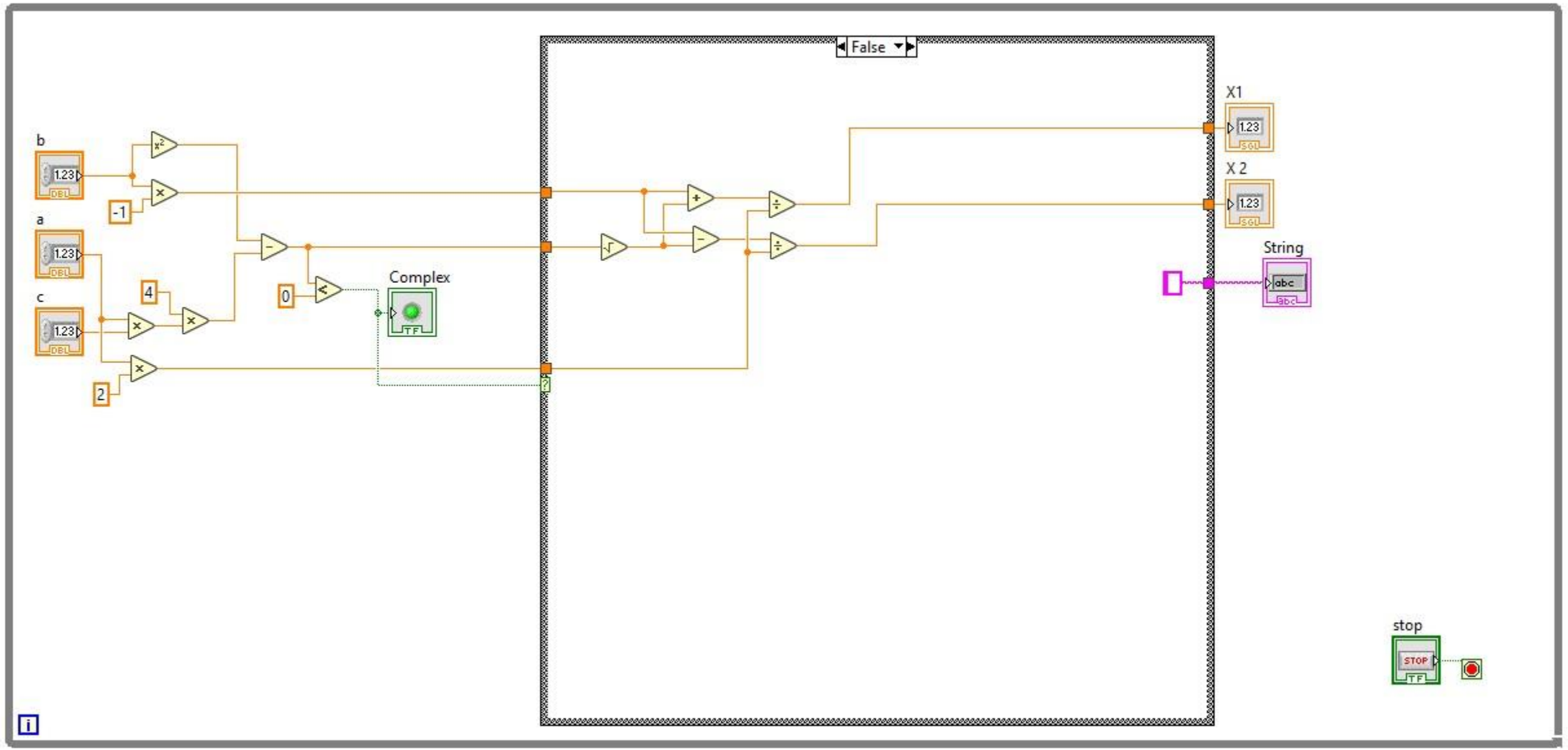


History – This program was recently created to support the METC 237 class when we were talking about the stability of a second order system.

Major features the use of Case Structures, Boolean Indicators, Comparison Functions and Numeric Functions. There is also a feature of adding the +/- i to the GUI if the roots are complex.

4 - https://www.mathsisfun.com/algebra/quadratic-equation.html

LabView Programs



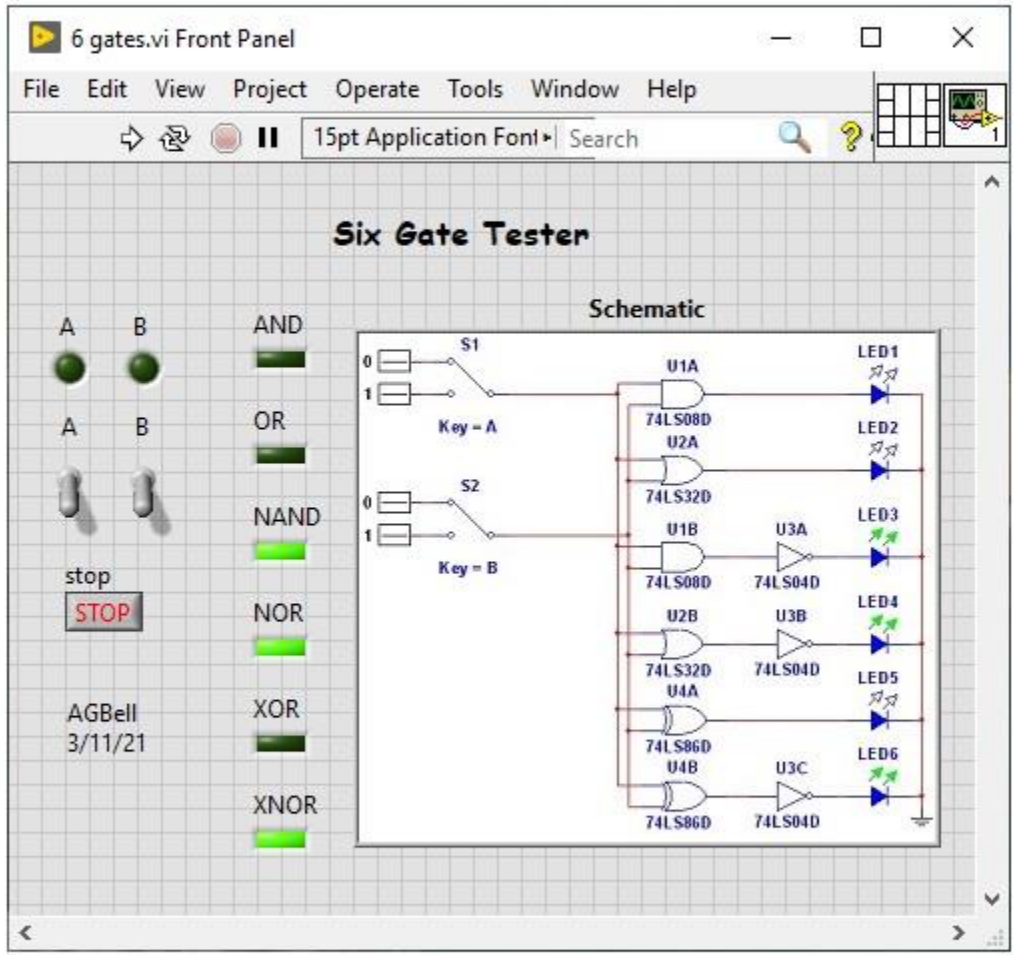
LabView Programs

Status – This program appears to work fine.

Updates:

1.) Create executable
2.) Compress Block Diagram using subvis or just shrinking the distance between elements.

LabView Programs



History – This is a newer program created for the EECT 112 class. It is straight forward and uses Boolean Toggle switches to change the logic value of two bits and LEDs to indicate the true or false results for the 6 basic gates: AND, OR, NAND, NOR, XOR and XNOR gates.

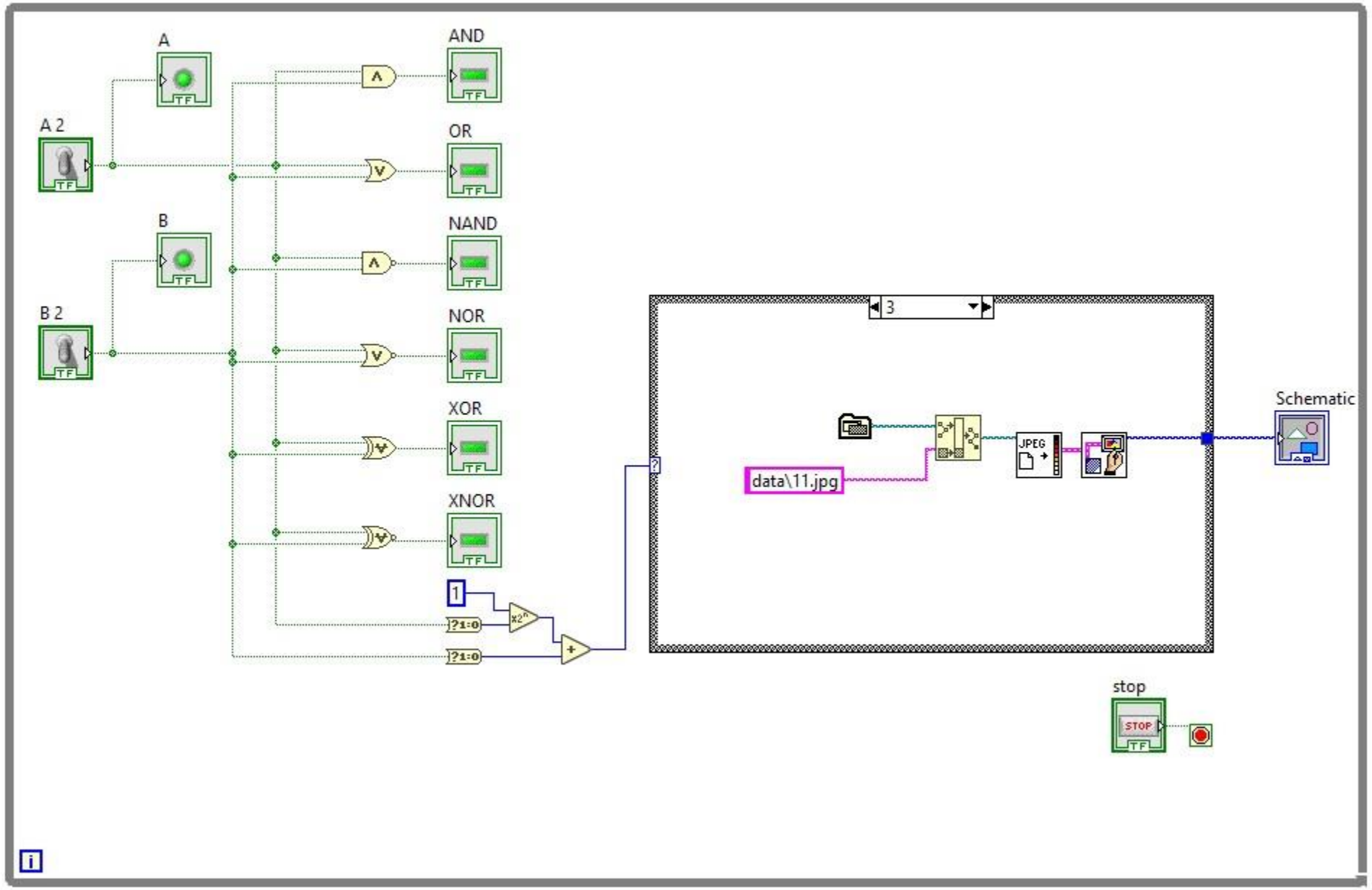
Major features the use of Case Structures, Boolean Toggle switches, Boolean Indicators, and File I/O Vis to build relative path to images that change based on the binary to decimal values. GUI includes black background for 7 segment displays.

LabView Programs

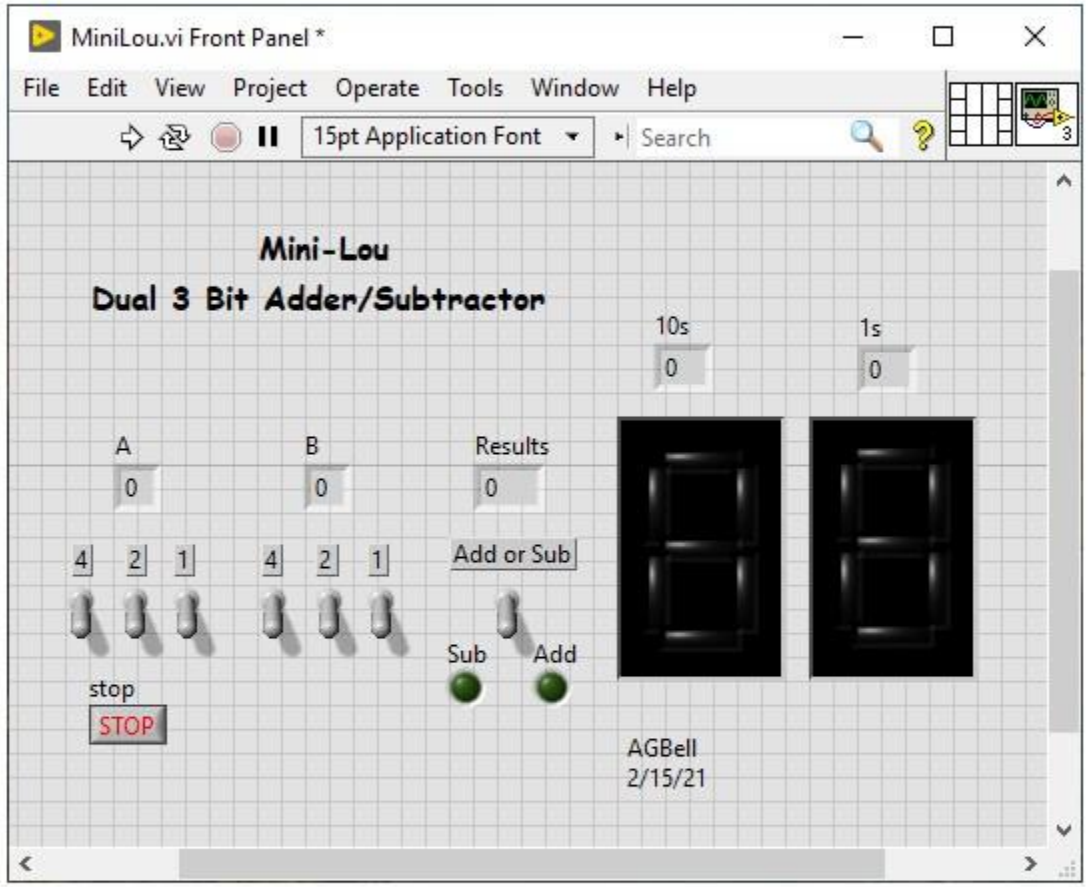
Status – This program appears to work fine.

Updates:

1.) Create executable
2.) Compress Block Diagram using subvis or just shrinking the distance between elements.



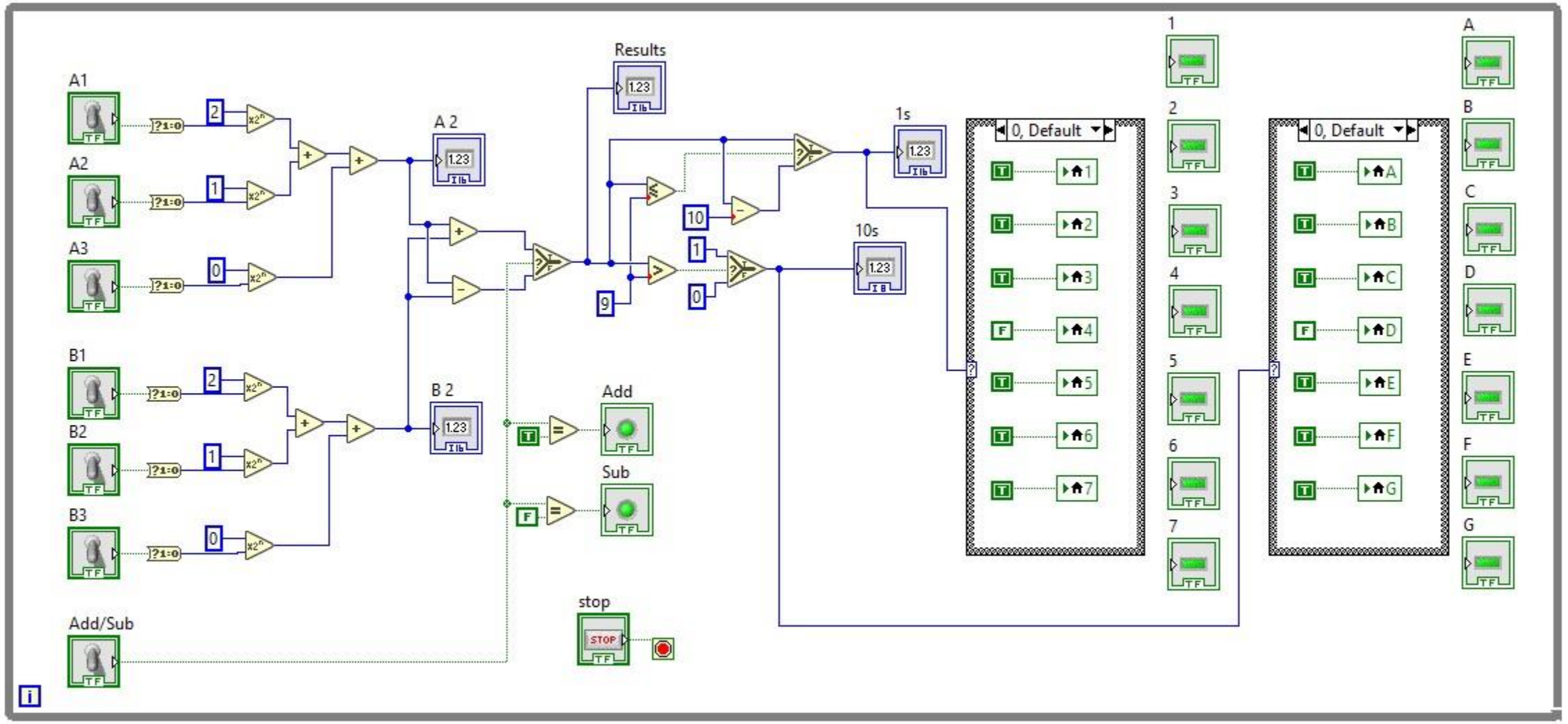
LabView Programs



History – We have been working on the Mini-Lou in EECT 122 for many years. This program represent the culmination of many years of work and it turns out to be a very simple program. This is a bruit force solution.

Major features the use of Case Structures, Comparison Functions, Numeric Functions, conversion from Binary to BCD, Local Variables with Boolean Controls.

LabView Programs



LabView Programs

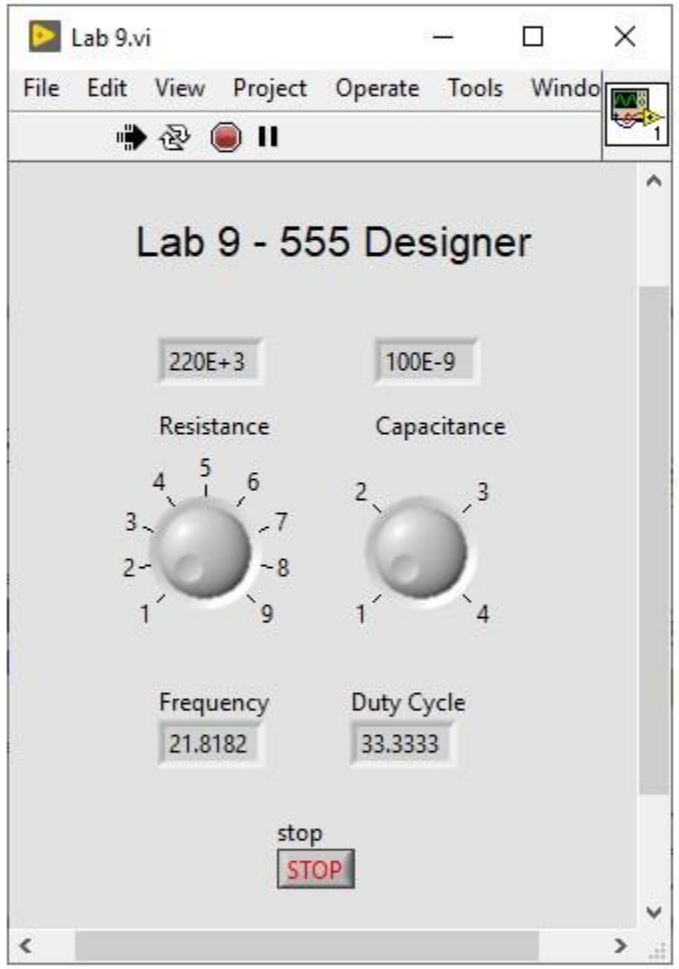
Status – This program appears to work fine.

Updates:

1.) Create executable
2.) Compress Block Diagram using subvis or just shrinking the distance between elements.
3.) Fix Toggle Switch locations so that they don't overlay the numbers.
4.) Fix A-B subtraction when number is negative using 2's complement approach or sign bit indicator.[5]
5.) Extend to 4 bits

5 - https://microcontrollerslab.com/seven-segment-display-labview/

LabView Programs



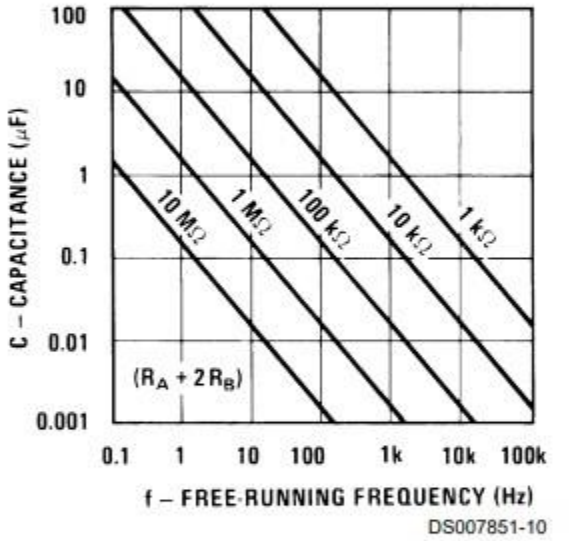


FIGURE 6. Free Running Frequency

History – This is a newer program created for the EECT 112 class. It is straight forward and uses variables for R and C to design a low frequency clock for Lab 9. Standard components are used for the resistor and capacitor. The program uses these two equation where $R_A = R_B$. In lab I ask for a 1Hz to 10Hz clock.

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)C} \qquad D = \frac{R_B}{R_A + 2R_B}$$

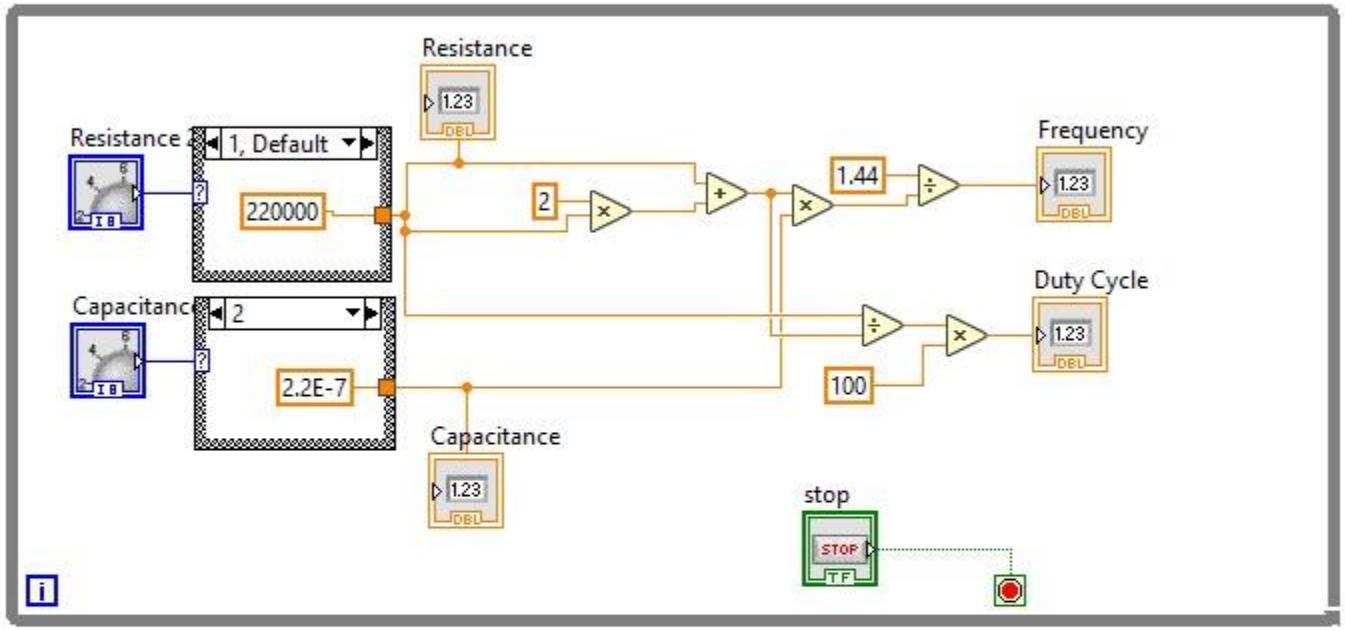
Major features the use of Case Structures, Numeric Functions and Knobs.

LabView Programs

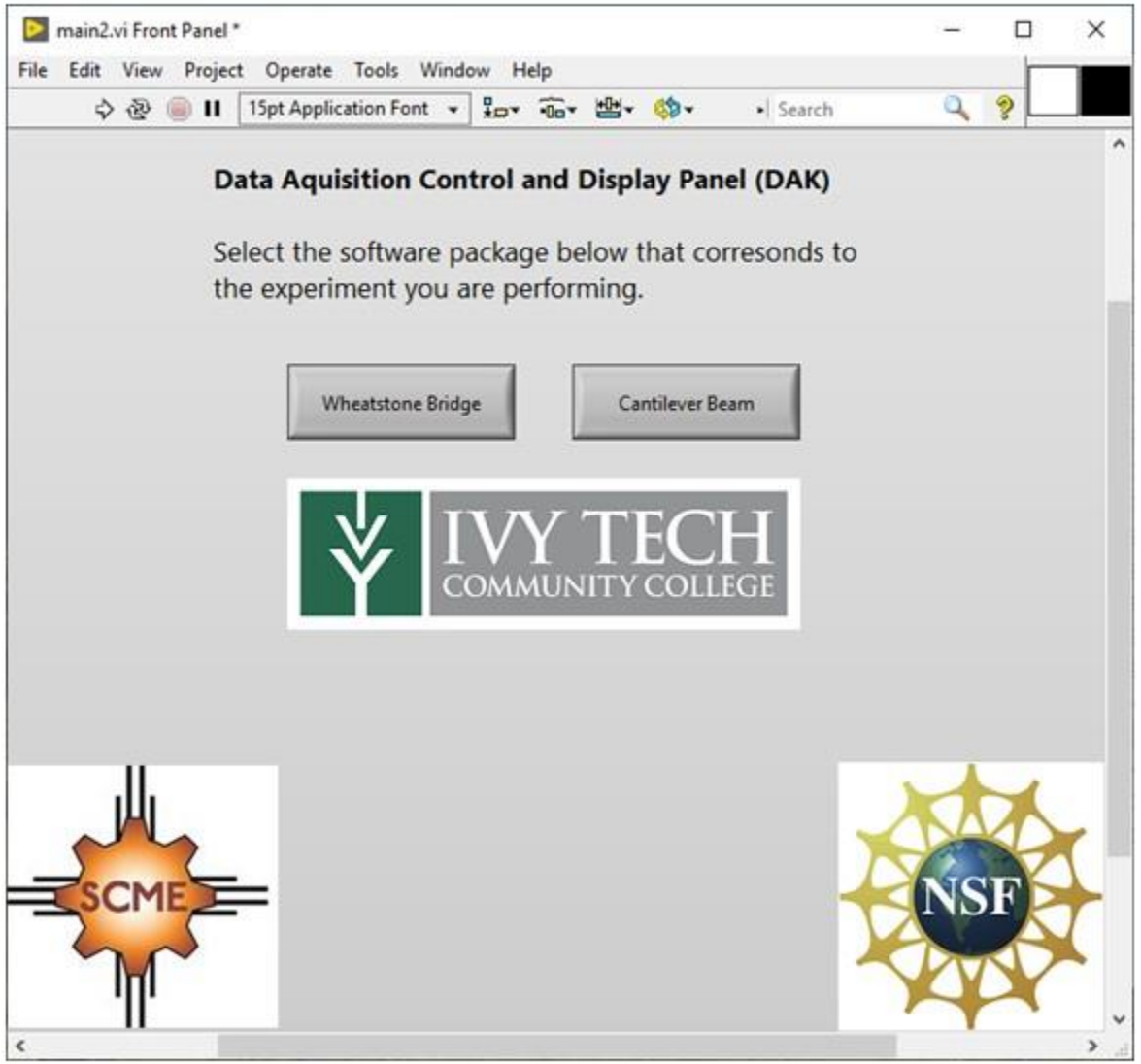
Status – This program appears to work fine.

Updates:

1.) Create executable
2.) Add more range to capacitor and resistor values.
3.) Compress Block Diagram using subvis
4.) Make R_A and R_B independent.



LabView Programs



History – This program is the main program that allows users to select either the Pressure Sensor (Wheatstone Bridge) or Cantilever (Cantilever Beam) program. The original program was created back in late 2015.

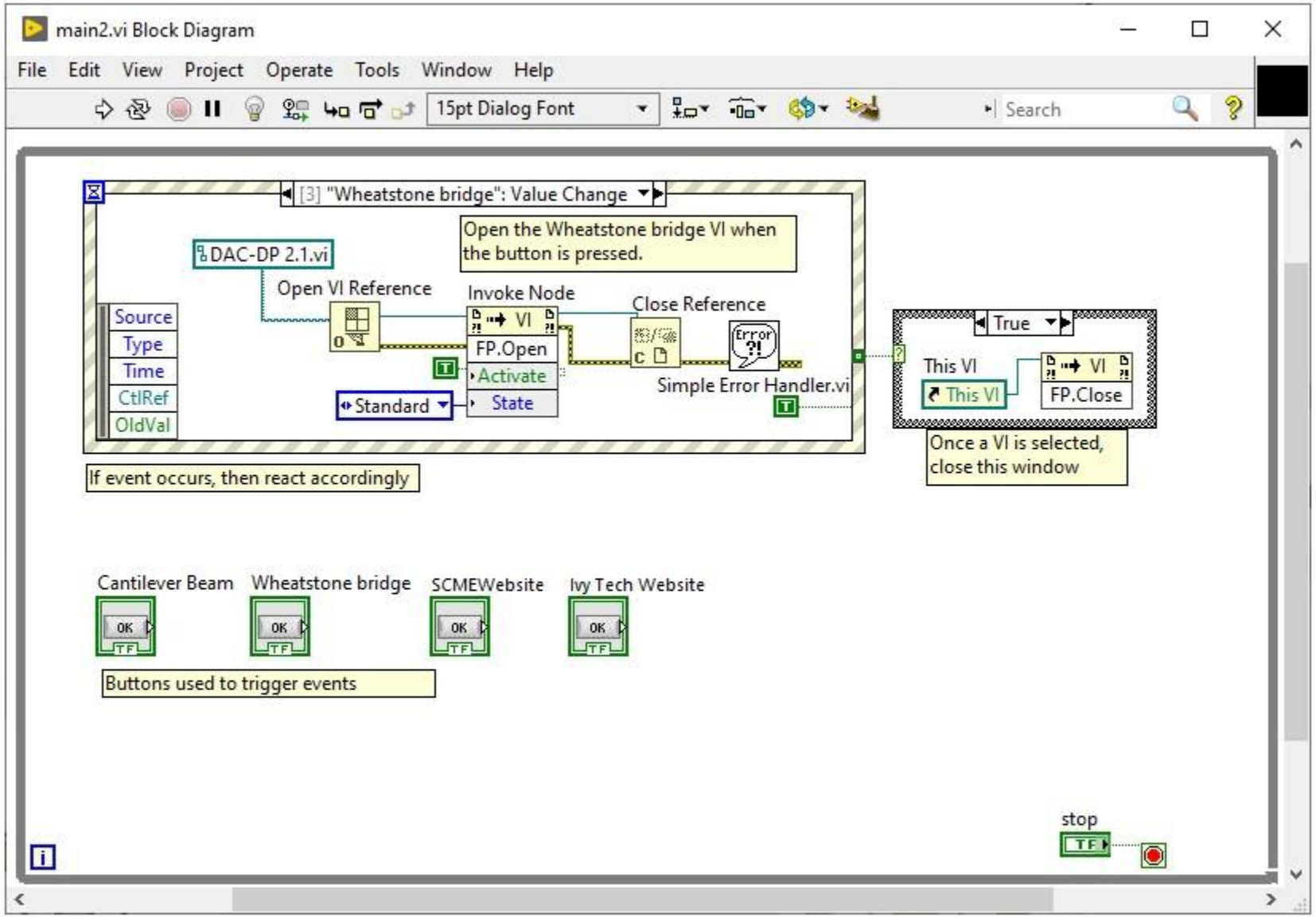
Major features the use of Event Structures, Case Structure, Boolean Buttons external links, Boolean Button (Latch when pressed).

LabView Programs

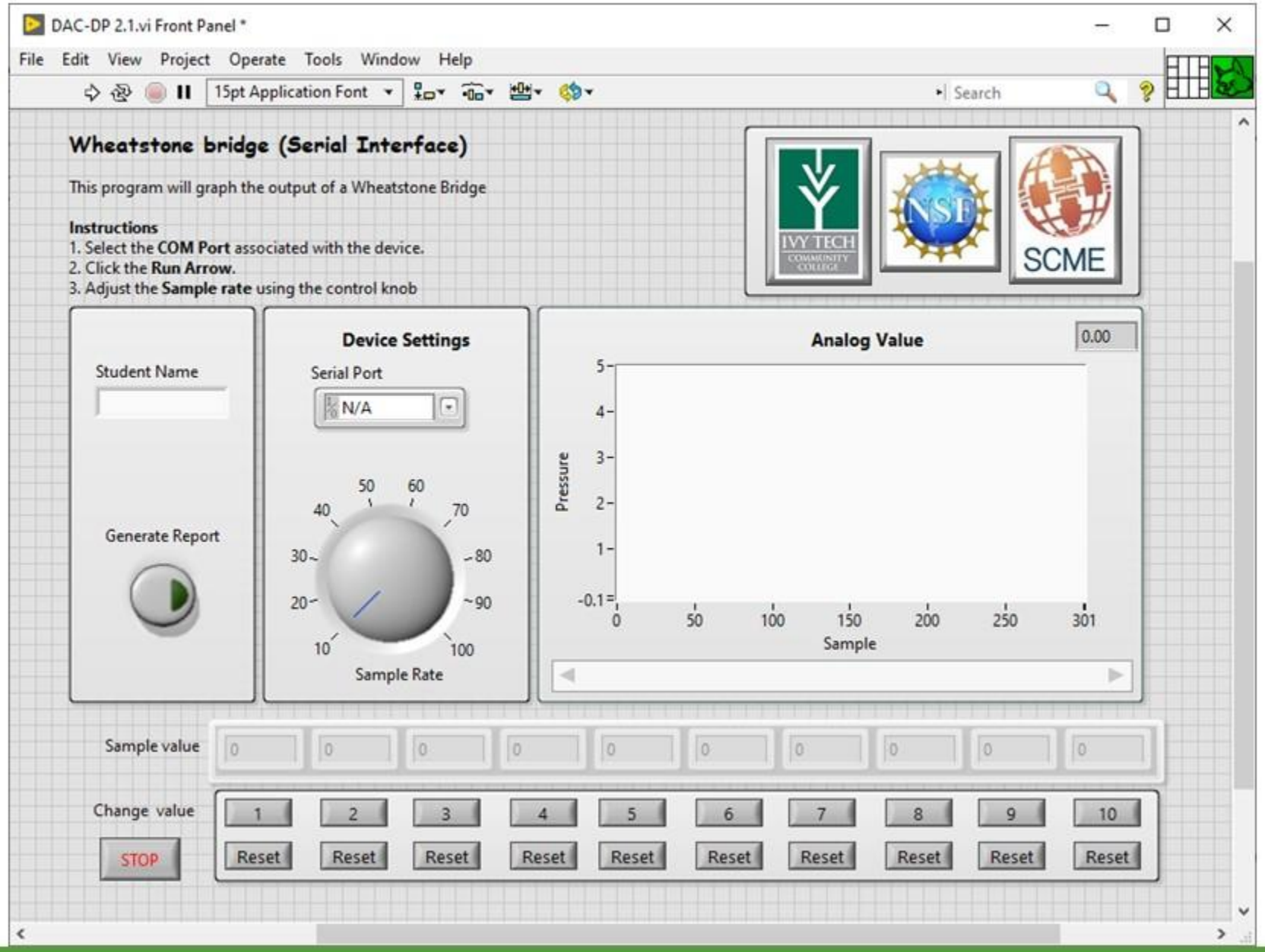
Status – This program appears to work fine and is mature.

Updates:

1.) Create executable
2.) Verify links
3.) Fix Front Panel icon for SCME.
4.) Possible change Wheatstone Bridge to Pressure Sensor Program



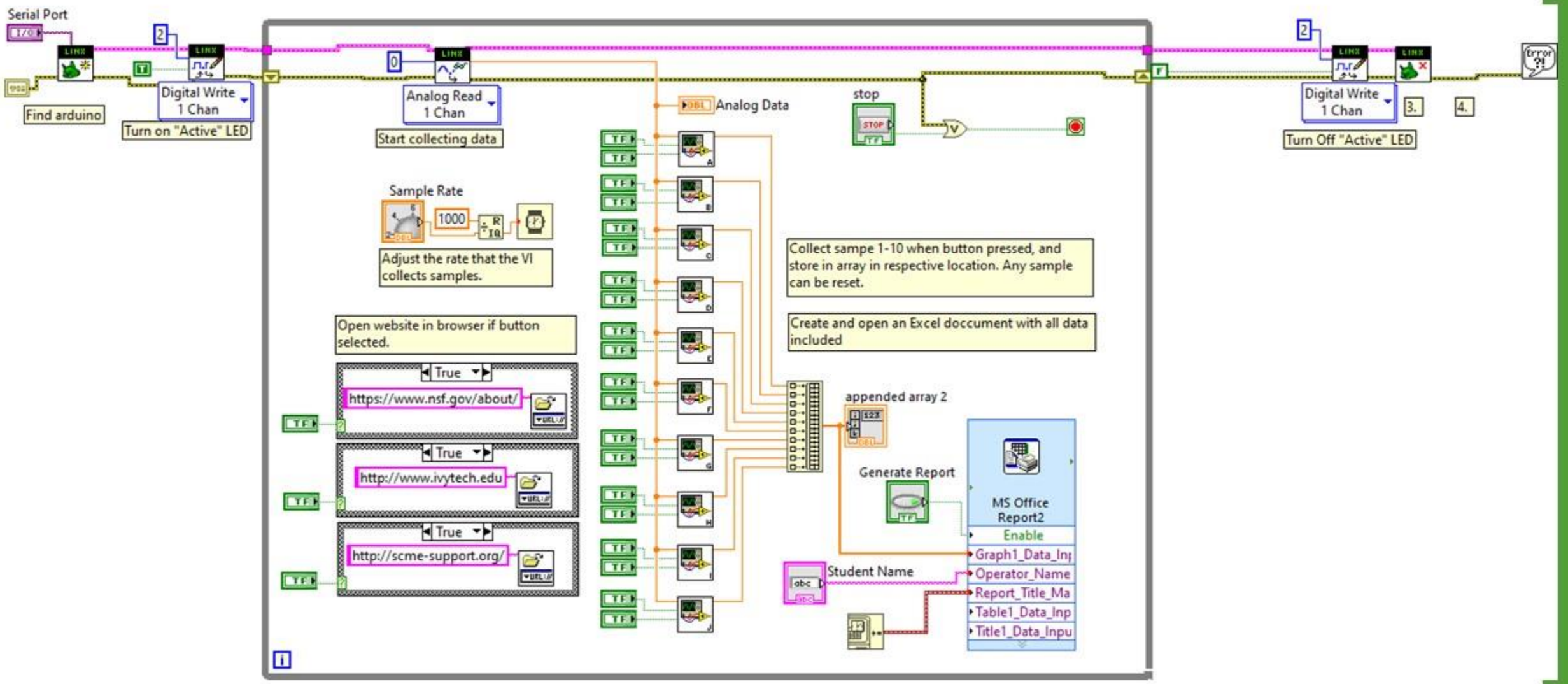
LabView Programs



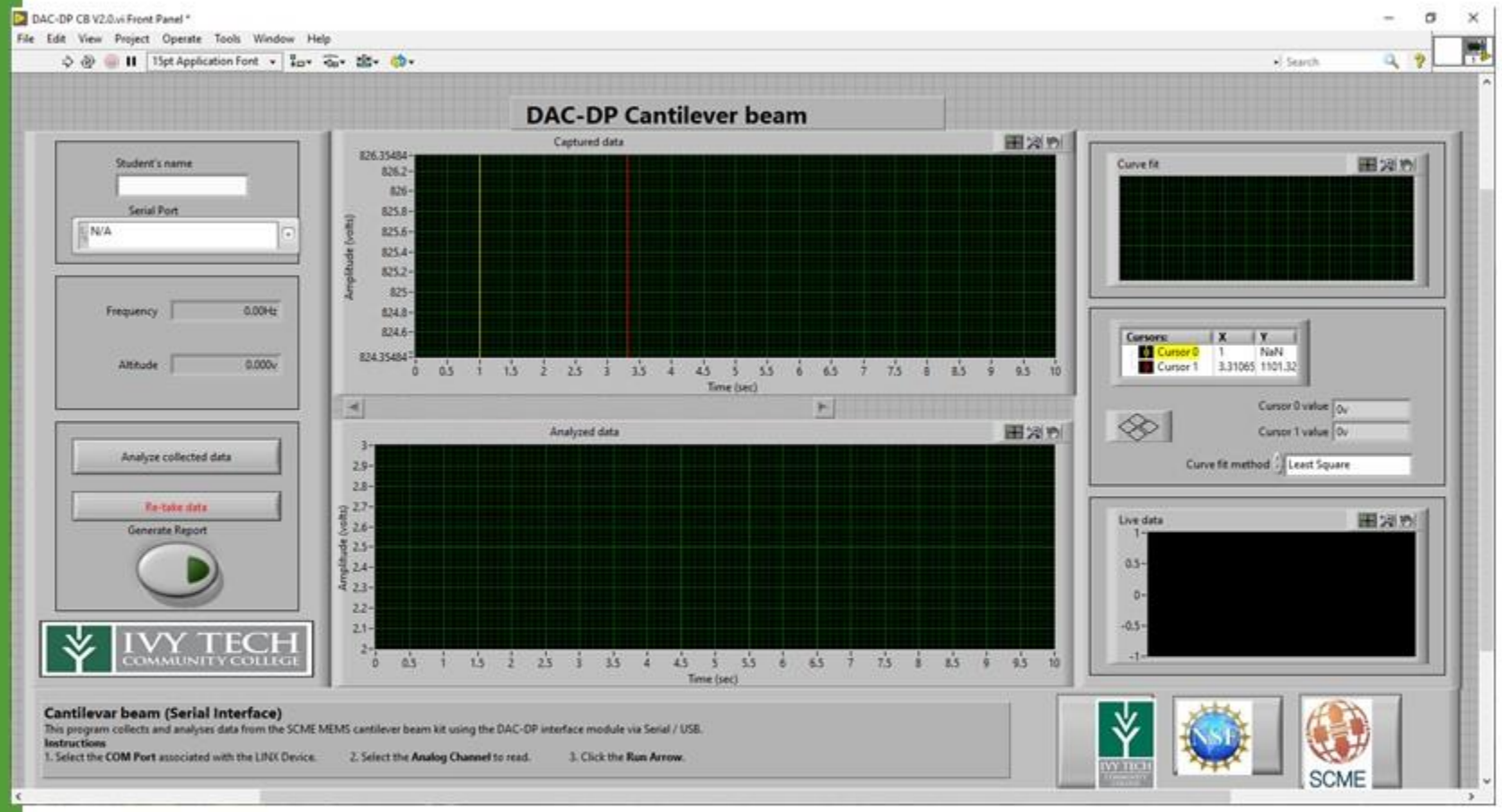
History – This is one of the oldest and most advanced programs that has been developed at Ivy Tech. It allows an Arduino UNO and Custom Shield to capture voltage readings from the SCME Pressure Sensor kit. Results are written to spreadsheet. To reduce this size of the upper block diagram, lower level subvi were created to act as a sample and hold.

Major features the use of Case Structures, Numeric Functions and Knob, external links, export data to file, arrays, Arduino control and capture of data.

LabView Programs



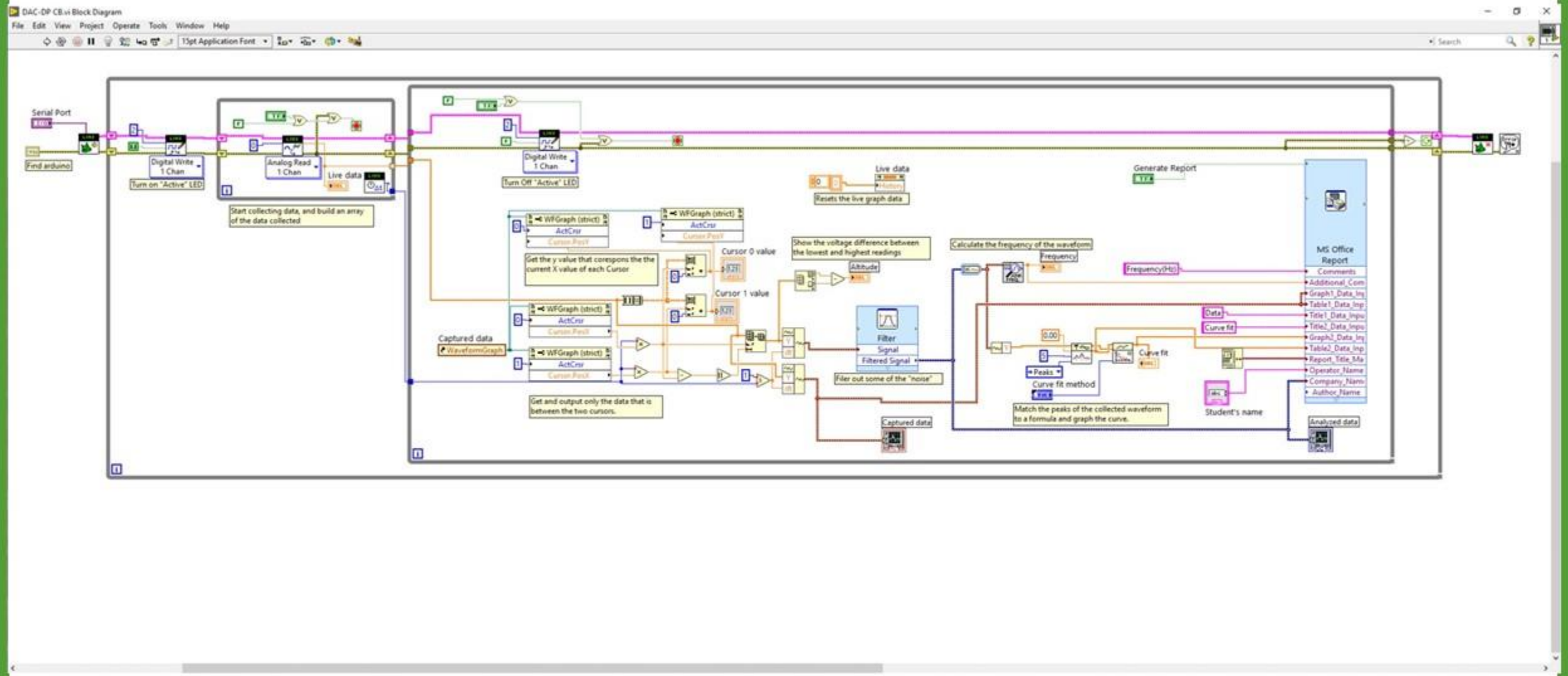
LabView Programs



History – This is one of the oldest and most advanced programs that has been developed at Ivy Tech. It allows an Arduino UNO and Custom Shield to capture voltage readings from a strain gauge connected to the SCME Cantilever kit. Results are written to spreadsheet. To reduce this size of the upper block diagram, lower level subvi were created to act as a sample and hold.

Major features the use of Case Structures, Numeric Functions and Knob, external links, export data to file, arrays and matrices, Arduino control and capture of data, waveform display and Waveform Measurement VI.

LabView Programs



LabView Programs

Status – This program appears to work fine and is mature but is too difficult to manage.

Updates:

1.) Create executable
2.) Verify links
3.) Maybe Split into a capture and analyze part.
4.) Some features could be removed such as the Curve Fit section.
5.) Not a big fan of the Excel template used, maybe just write data to text file

Questions

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https://www.ivytechengineering.com/LabView/