Assignment 2 – Testing

SOFTWARE DEVELOPMENT 3K04

GROUP 14: PIKA

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Part 1 – Pacemaker Design

Pacing Test

Table 1: VOO/AOO Testing

Inputs	Expected Output	Actual Output	Comments	Pass/Fail
Lower Rate Limit = 60ppm Ventricular Pulse Width = 10ms Ventricular Amplitude = 70% * 5V = 3.5V	Red LED to turn off every second	Red LED turned off every second	Proper functionality, 10ms pulse width verified with oscilloscope	Pass

Sensing Test

For the purposes of testing, a pushbutton was used as an abstraction for the sensing circuit due to limited time with the oscilloscope in the lab sections. In the Simulink model for the actual assignment, the sensing circuit was fully functional and was proven by the Labview testing system. In this case, however, VENT_SENSING_BOOLEAN represents the pushbutton on the K64F itself.

Table 2: VVI/AAI Testing

Inputs	Transitions	Expected Output	Actual Output	Comments	Pass/Fail
Lower Rate Limit = 60ppm	Charging state to Discharging state	Blue LED turns off every second	Blue LED turns off every second	Proper functionality	Pass
Ventricular Pulse Width = 10ms	Discharging state to Charging state	Blue LED turns on after 10ms	Blue LED turns on after 10ms		
Ventricular Amplitude = 70% * 5V = 3.5V	Charging state to Inhibit state	Blue LED -> Green LED when pushbutton==true	Blue LED -> Green LED when pushbutton==true		
VRP = 100ms Pushbutton	Inhibit state to Charging state	Green LED -> Blue LED when pushbutton==false	Green LED -> Blue LED when pushbutton==false		

Rate Adaptive Testing

Table 3: VOOR/AOOR Testing

Inputs	Expected Output	Actual Output	Comments	Pass/Fail
Lower Rate Limit = 60ppm	Red LED flashes every second	Red LED flashes every second	Proper functionality	Pass
Ventricular Pulse Width = 10ms	No LED's flashing while speeding up	No LED's flashing while speeding up		
Max Sensor Rate = 120	Red LED flashes every half a second when at max sensor rate	Red LED flashes every half a second when at max sensor rate		
Ventricular Amplitude = 70% * 5V = 3.5V	Green LED on when slowing down	Green LED on when slowing down		
Reaction Time = 5s	Red LED flashes every half a second after 5s	Red LED flashes every half a second after 5s		
Rate of Increase/Decrease = 2ppm/s				

Similarly to VVI/AAI testing, a pushbutton was used to demonstrate the natural heartbeat.

Table 4: VVIR/AAIR Testing

Inputs	Expected Output	Actual Output	Comments	Pass/Fail
Lower Rate Limit = 60ppm	Red LED flashes every second	Red LED flashes every second	Proper functionality	Pass
Ventricular Pulse Width = 10ms	No LED's flashing while speeding up	No LED's flashing while speeding up		
Max Sensor Rate = 120	Red LED flashes every half a second when at max sensor rate	Red LED flashes every half a second when at max sensor rate		
Ventricular Amplitude = 70% * 5V = 3.5V	Blue LED on when slowing down	Blue LED on when slowing down		
Reaction Time = 5s	Red LED flashes every half a second after 5s	Red LED flashes every half a second after 5s		
Rate of Increase/Decrease = 2ppm/s				
VRP = 100ms	Green LED on when pushbutton==true, off otherwise	Green LED on when pushbutton==true, off otherwise		
Pushbutton				

Lab Testing

Due to the limited lab time and the number of groups present at the lab, testing was performed for all Ventricular pacing modes except for VVIR. Testing for all Atrial modes except AAIR was also performed in the lab and the results were identical to the results of the corresponding Ventricular pacing modes but results were not photographed as the output was similar to that of the corresponding Ventricular modes and due to the limited time in the lab.

VOO/AOO

Figure 1: VOO Output

Above is the output of the oscilloscope when VOO functionality is in place with the parameters set to 60ppm, 10ms pulse-width, and 70% (3.5V). The output was expected as the difference between the peak of each pulse is 1 second and thus the functionality is corrected as the pacemaker will pulse every second as specified by the lower rate limit of 60ppm.

VOOR/AOOR

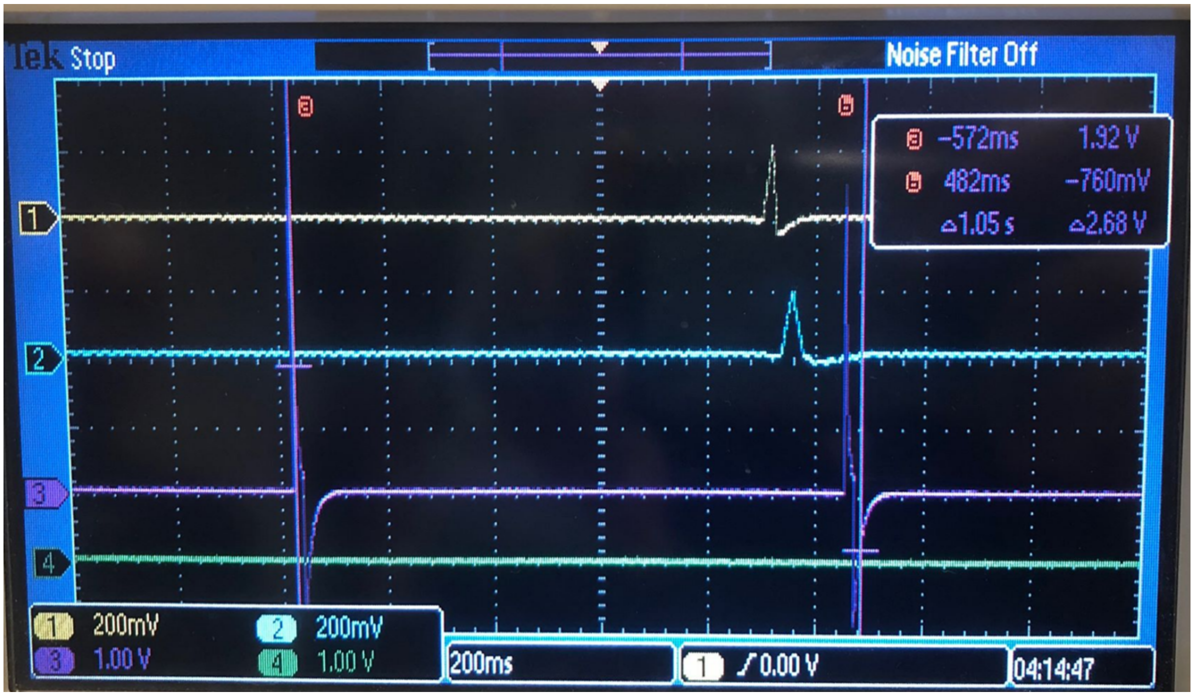

Figure 2: Original VOOR Output

Initially, the pacemaker is pacing once every 1 second (60ppm) as there is no movement, and thus the output of the accelerometer Boolean is false.

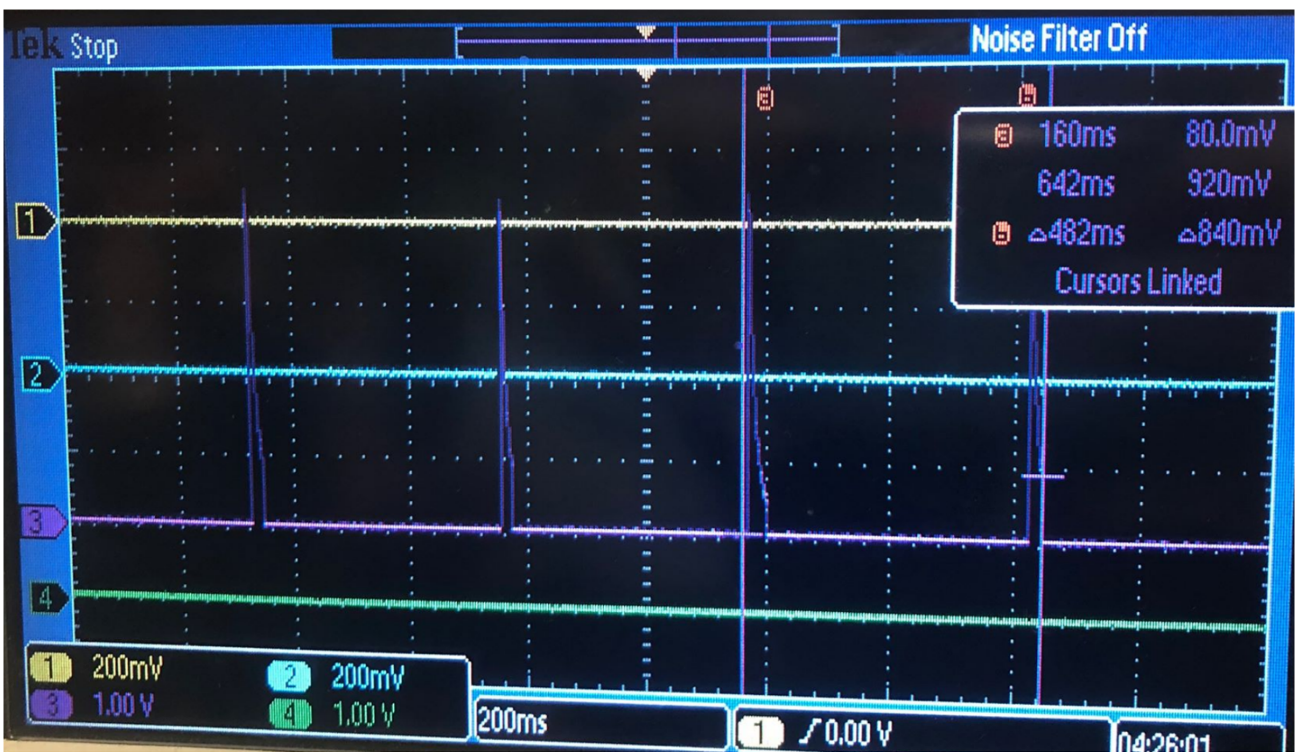

Figure 3: Increased Rate VOOR Output

Afterwards, when the pacemaker is moved the rate increases to up to 120ppm as the output of the accelerometer Boolean would be true and thus the rate increases until the upper rate limit of 120ppm.

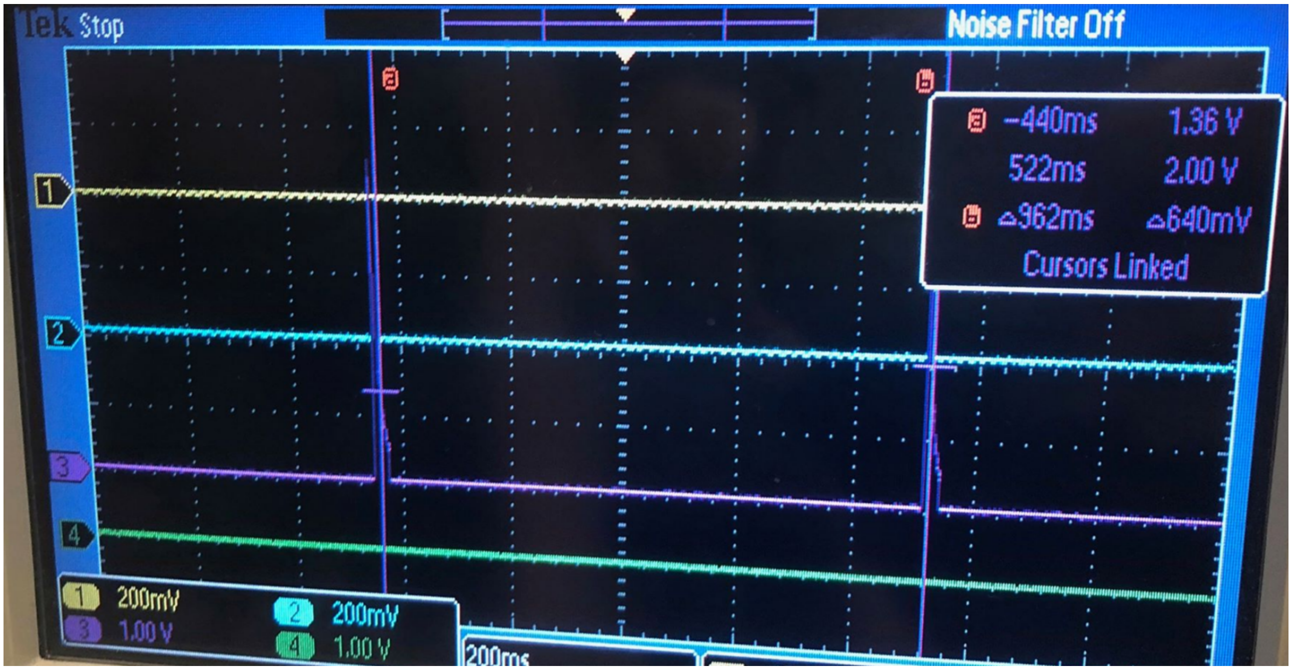

Figure 4: Resting Rate VOOR Output

After that, when the pacemaker is not moving the rate decreases again to 60ppm as the output of the accelerometer Boolean would be false and thus the rate will go to down to the lower rate limit of 60ppm.

VVI/AAI

Initially the test system is providing a pulse with a rate of 120 ppm, in this case the pace maker does not provide any pulse which is the expected behavior as the lower rate limit is set to 60 ppm.

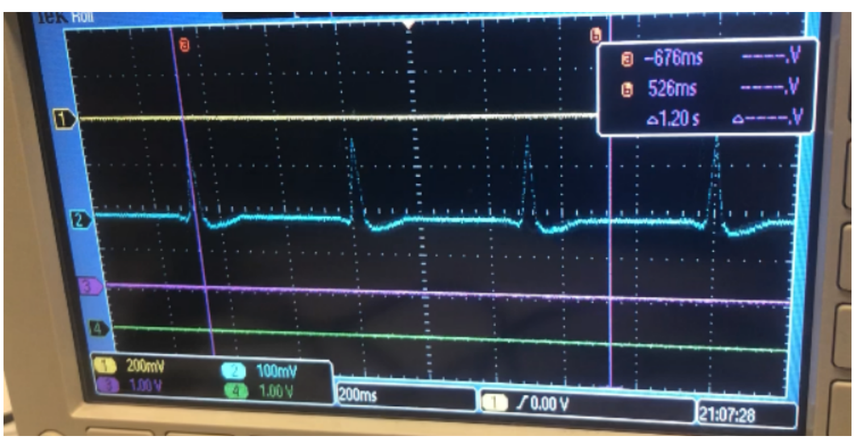

Figure 5: VVI at 120ppm

The rate from the test bed is the increased to 60ppm and the pacemaker does not provide any pulse which is the expected output.

Figure 6: VVI at 60ppm

The pulse from the testbed is then reduced further to 30ppm in which case the pacemaker starts pulsing every 2 seconds and thus, pulses between each 2 pulses that the testbed generates, which is the ideal output for when the test bed is set to 30ppm and the lower rate limit of the pacemaker is set to 60ppm.

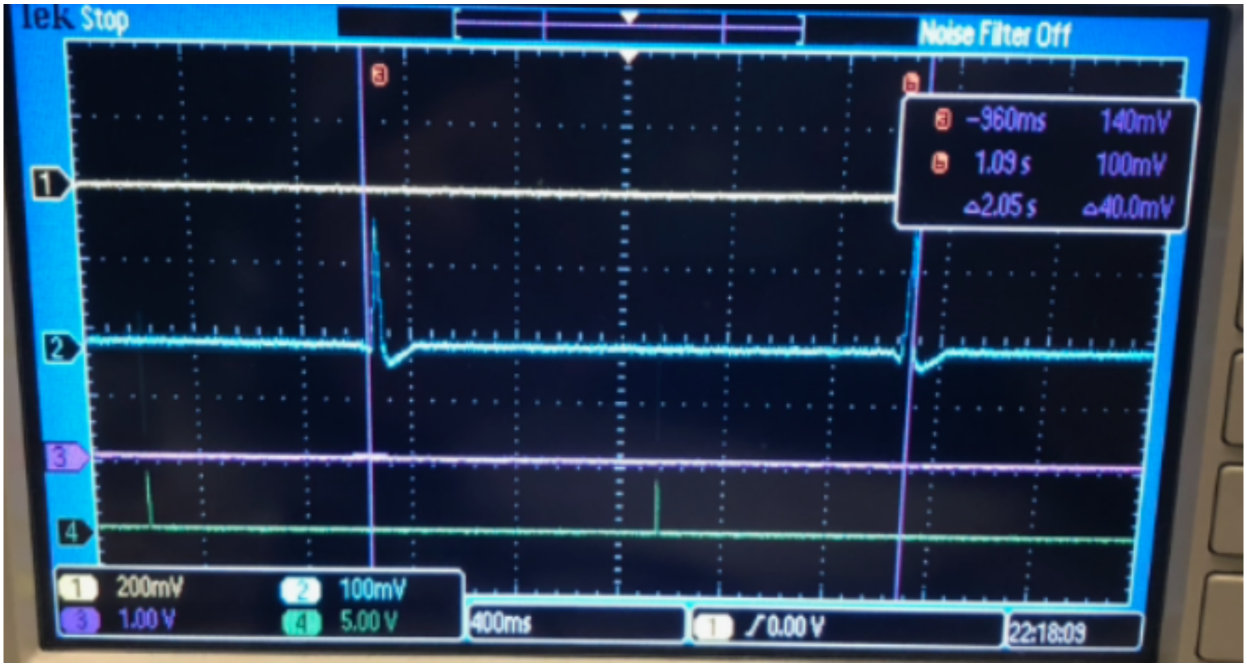

Figure 7: VVI at 30ppm

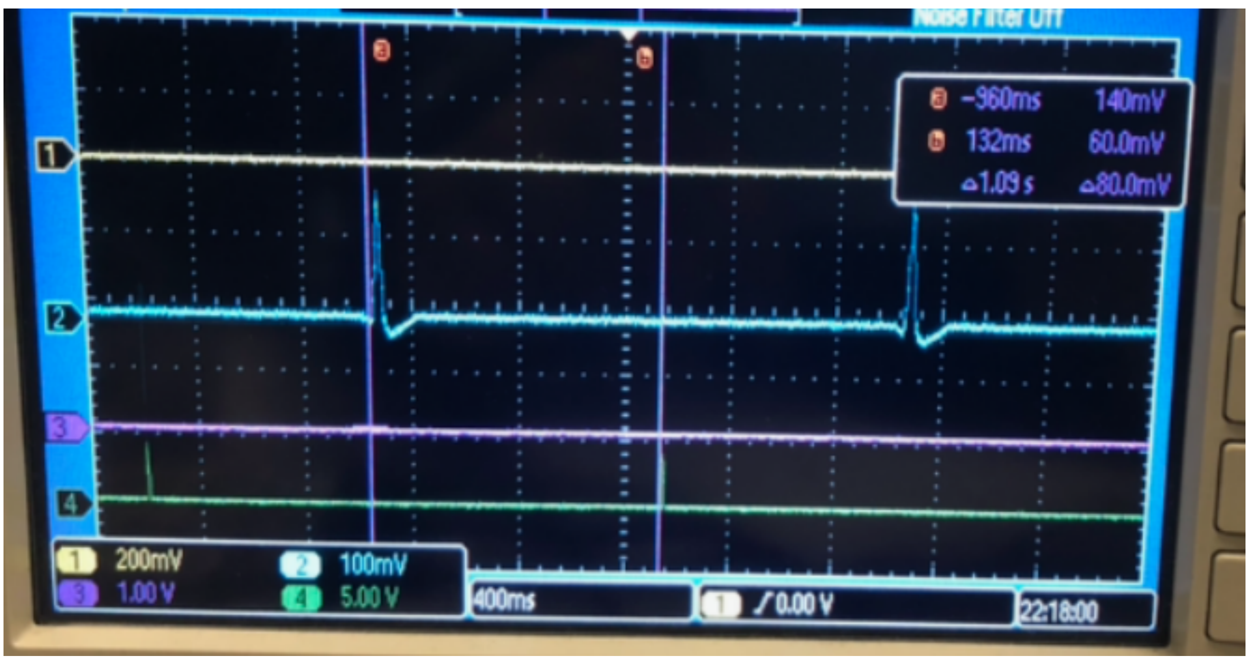

Figure 8: Time Between Natural and Artificial Pacing at 30ppm

Figure 9: Time Between Artificial Pulses

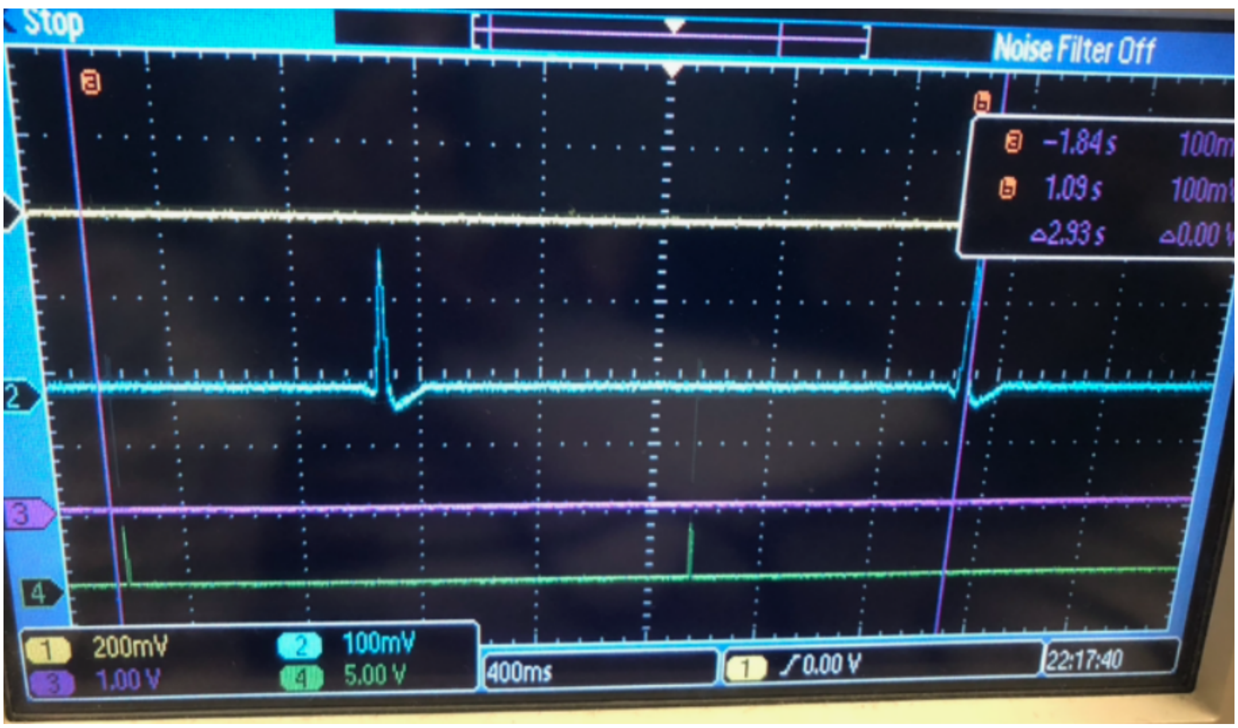

Figure 10: Proper VVI Functionality

Part 2 – DCM

All testing done for assignment 1 was redone for all modes and parameters in assignment 2 to ensure the same functionality. In this section, we will be testing the serial communication and the E-gram functions, as they are the two main additions to the DCM.

Serial Communication

Table 5: Serial Communication

TEST	INPUT	EXPECTED OUTPUT	ACTUAL OUTPUT	RESULT
Pressing Upload while Board is connected	Any mode while board is connected	Window saying, "Upload Successful!"	Window saying, "Upload Successful!"	Pass
Pressing Upload while Board is not connected	Any mode while board is not connected	Window saying, "Upload Failed, please connect device."	Window saying, "Upload Failed, please connect device."	Pass
Checking if parameters sent are correct	(10,1,60,120,70,19,0,0,0,0,0,0,0,0,0,0)	(10,1,60,120,70,19,0,0,0,0,0,0,0,0,0,0)	(10,1,60,120,70,19,0,0,0,0,0,0,0,0,0,0)	Pass

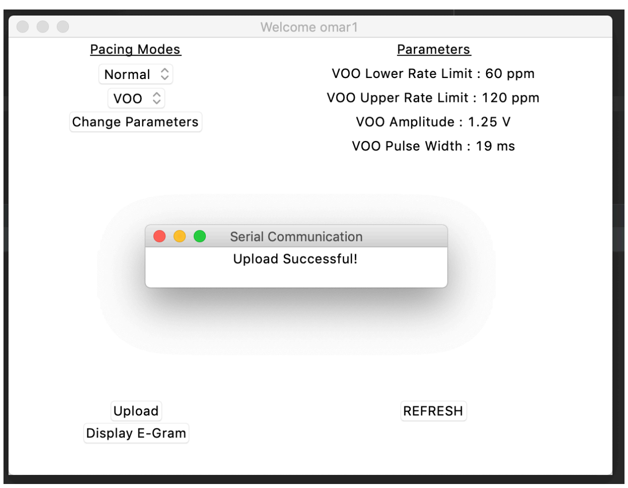

Figure 11: Uploading While Device is Connected

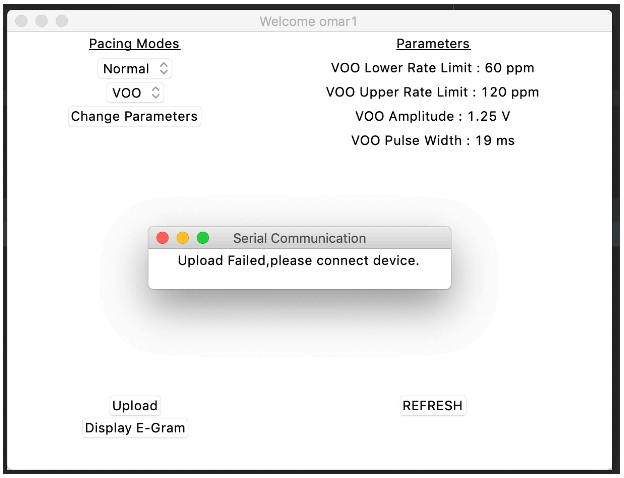

Figure 12: Uploading While Device is not Connected

All tests were repeated with all modes and all parameters to ensure correctness, and all tests were passed.

Egram Testing

Table 6: Egram Testing

TEST	INPUT	EXPECTED OUTPUT	ACTUAL OUTPUT	RESULT
E-gram output with no input	No input	Output voltage that looks like noise	Output voltage that looks like noise	Pass

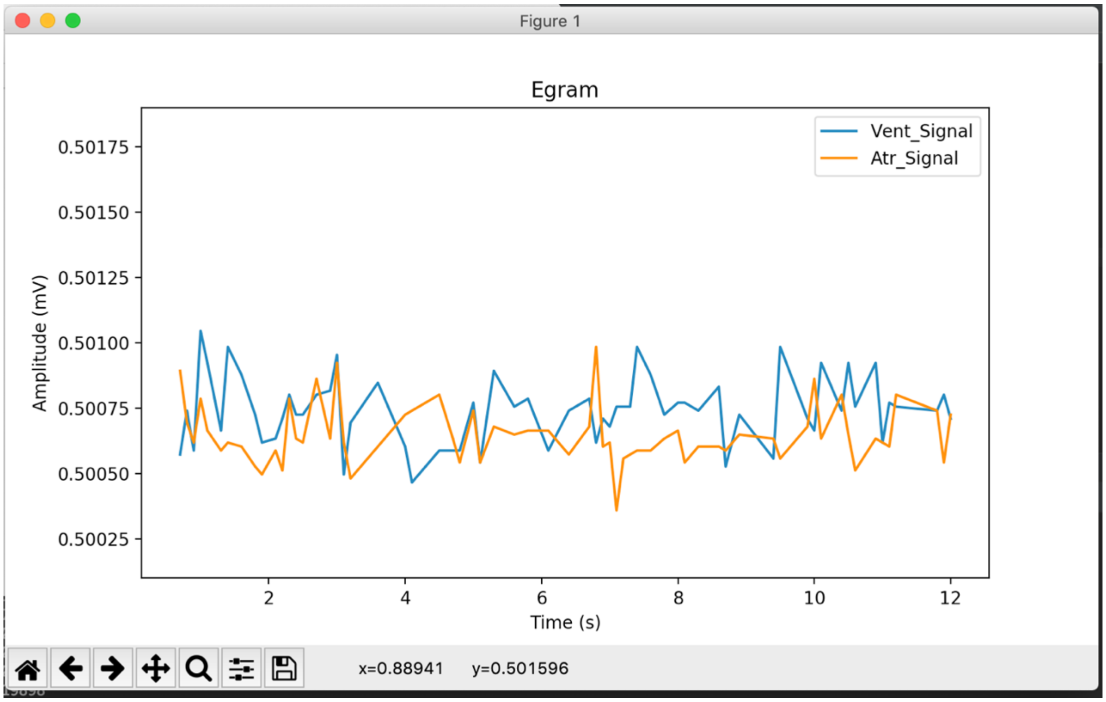

Figure 13: Egram Output with no Input