EE2026 Digital Design
Semester 2 2019/2020

FPGA Design Project Report:
Sound Display and Entertainment System

Lab Session: Thursday A.M.
Team Number: 8

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Student B	Liu YiFeng	A0206037N

Contents

1.Introduction

In this project, we designed a sound display and entertainment system, which captures audio signals through the mic and displays its volume on the LEDs, 7-segment displays and the OLED screen. We designed our device in a way such that there are various modes of volume display and features which relate both the input of the mic and the output on the OLED display.

In this project, Lee Hao Yuan is Student A who oversees real-time audio volume indicator and Liu Yifeng is Student B who oversees graphical visualisations and configurations.

2.User Guide

The following table is the user guide for our device. Note that all figures mentioned in the table are in the Appendix section.

Feature	Feature Marks For	Input Devices	Feature Description	Display
Real-time audio volume indicator	Lee Hao Yuan	SW0	**When SW0 is 0:** mic_in is shown on the first 12 LEDs. The LEDs will flicker with respect to the surrounding noise level. **When SW0 is 1:** mic_in is shown as max volume sampled at a frequency of 10Hz across all 16 LEDs. The number of LEDs that light up is in accordance to the predetermined volume levels written in the code. The respective volume level will also be shown on the 7-segment display. Eg.: When volume is at "level 3", LED0 to LED3 inclusive will all light up, and the 7- segment display will display a number 3.	Figure 1.1 Figure 1.2 Figure 1.3
Graphical visualisations and configurations	Liu YiFeng	SW0 SW15 SW14 SW13 SW12 SW11 SW10	**When SW0 is 0:** The OLED screen is black and with nothing displayed. **When SW0 is 1:** The OLED screen will display the default colour scheme for the volume bar which consists of a black background, green, yellow and red bars.	Figure 2.1 Figure 2.2

			When SW11 is 1: The colour scheme switches to black background, volume bar changes to yellow with increasing intensity.	Figure 2.3
			When SW10 is 1: The colour scheme switches to white background, volume bar changes to blue with increasing intensity.	Figure 2.4
			When SW15 OR SW14 is 0: There is no border.	
			When SW14 is 1: There is a border with a thickness of 1 pixel.	Figure 2.5
			When SW15 is 1: There is a border with a thickness of 3 pixels.	Figure 2.6
			When SW13 is 0: Volume bar reflects the change in volume.	
			When SW13 is 1: Volume bar will be frozen at the state when SW13 is switched to 1.	Figure 2.7
			When SW12 is 0: The volume bar is visible to the user.	
			When SW12 is 1: The volume bar is hidden.	Figure 2.8
			*Notes: all borders come with different thickness and with the option to turn it on or off. The colour of the border will change automatically according to the colour scheme.	Figure 2.9 Figure 2.10
Improvement 1: Tuneable mic sensitivity	Lee Hao Yuan	SW1 SW2	**When both SW1 and SW2 are 0:** this sets the default sampling frequency, which is 10Hz. **When SW1 is 1 and SW2 is 0:** this sets the sampling frequency to 20Hz, which is double the default sampling frequency of 10Hz. Hence this will make the mic extra sensitive to changes in the surrounding noise level.	

			When both SW1 and SW2 are 1: this sets the sampling frequency to 2Hz, which will make the mic not so responsive to changes in surrounding noise level. *Note that there is no related image to this section as this function is not demonstrable in the form of an image.	
Improvement 2: "Clap to unlock" lock screen	Lee Hao Yuan	mic	This is to display a lock screen on the 7-segment displays before a user gets into the main interface of the device. Initially, when the device is first switched on, the device will be in locked mode. The 7-segment displays will display "locked", looping from right to left infinitely. When the mic detects a clap from the user, the device will go into unlocked mode, in which the 7-segment displays will display "unlocked", looping only once from right to left, in which after that the device will goes into the initial stage where mic_in is shown on the first 12 LEDs.	Figure 3.1 Figure 3.2 Figure 3.3 Figure 3.4
Improvement 3: "Clap to unlock" OLED screen	Liu YiFeng	mic	The OLED displays a locked screen before a user gets into the main interface of the device. when the device is first switched on, the device will be in locked mode. The OLED locked screen consists of a lock and Mario. When the mic detects a clap from the user, the device will go into unlocked mode - the Mario jumps and unlocks the lock.	Figure 4.1 Figure 4.2
Improvement 4: Circular volume indicator	Liu YiFeng	SW9	**When SW9 is 1:** The volume bar display is changed to circle display instead.	Figure 5.1
Improvement 5: Mini Flappy Bird Game	Team	mic, centre pushbutton	**When the centre pushbutton is pressed:** The OLED enters the game mode in which the user can play a mini Flappy Bird game. The volume of the mic input will be used to control the bird to move up and down and to avoid the pipes. At high volume, the bird will move up and at lower volumes, the bird will move down.	Figure 6.1 Figure 6.2

3.Project Feedback

What we like most about the project?

We believe that this project teaches us the skill of combining multiple external modules to the Basys-3 board, in which we find very useful and interesting. The skeleton codes of the different external modules were also given to us, in which we find very helpful in a way such that we can focus solely on implementing the necessary codes for the different modules to work in harmony with the Basys-3 board.

What we dislike about the project?

The one main issue about the project is the fact that each group is only allocated one set of mic and OLED. This is very troublesome for us especially in a time like this, where school hours are cancelled due to government regulations regarding the COVID-19 outbreak. As much as possible, both of us wanted to try work from home due to the current pandemic situation, but the fact that we have to split up the equipment makes it very hard for us to integrate our system when we are not working together physically. Even though we may have finished writing and testing our own respective module's code, it is hard for us to integrate our code to work as one due to the fact that one is holding the mic while the other is holding the OLED. This integration issue would have been solved if each group was given 2 sets of mics and OLEDs.

Moreover, we also dislike the open-ended part of this project. This gives us stress as besides having to think of what improvement we can make in relation to both the mic and OLED, we also have to worry about competing with our peers who may have experiences in designing such systems.

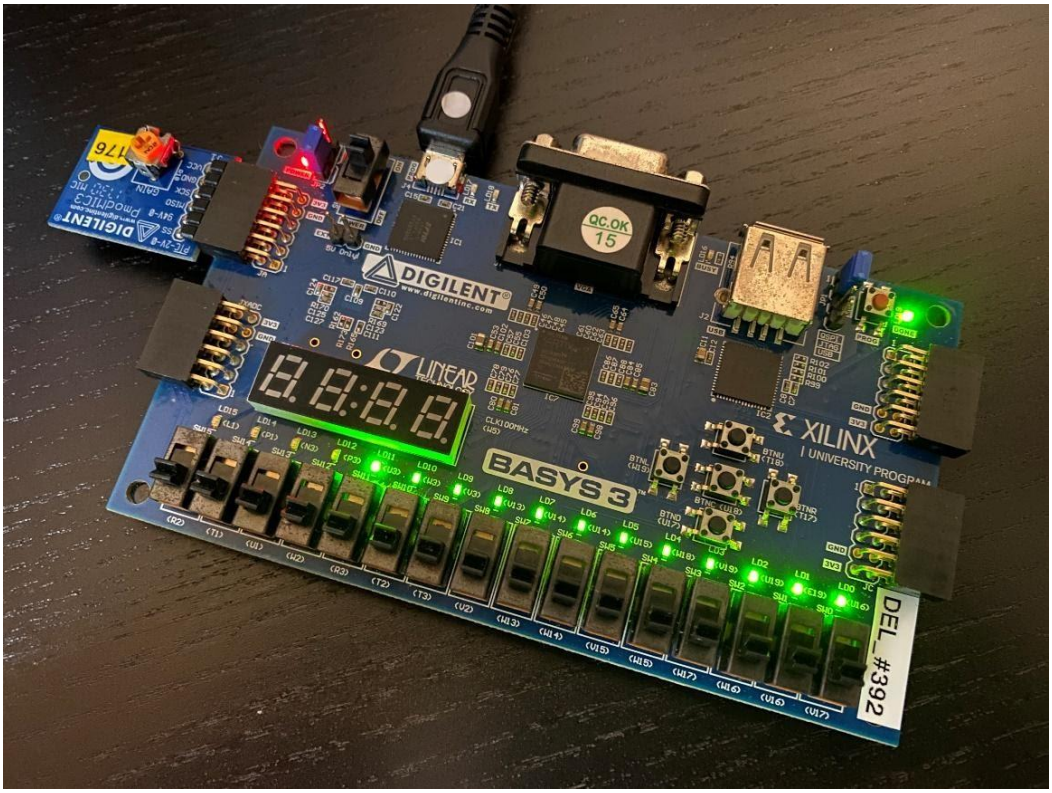
How can the project assignment be improved in the future?

We understand that the amount of equipment may be insufficient, but we do hope that every group will get two sets of mics and OLEDs as this will make system integration a lot easier. Moreover, with two sets of equipment, one group member can also help out the other member with his module much easily. That's the only thing that we hope will be improved for the subsequent batches of students.

4.Conclusion

Overall, both of us enjoyed the process of doing this project. Although there are difficult times especially in times of pandemic like this, we still managed to finish integrating our respective systems and follow the respective deadlines closely. We also feel that this project is quite fun due to the fact that we get to play around with modules such as the mic and OLED that we are never exposed to before. We also feel that the lab sessions leading up to this final project are useful and informative enough, which in a sense make this final project a fruitful ending to this module.

5.Appendix



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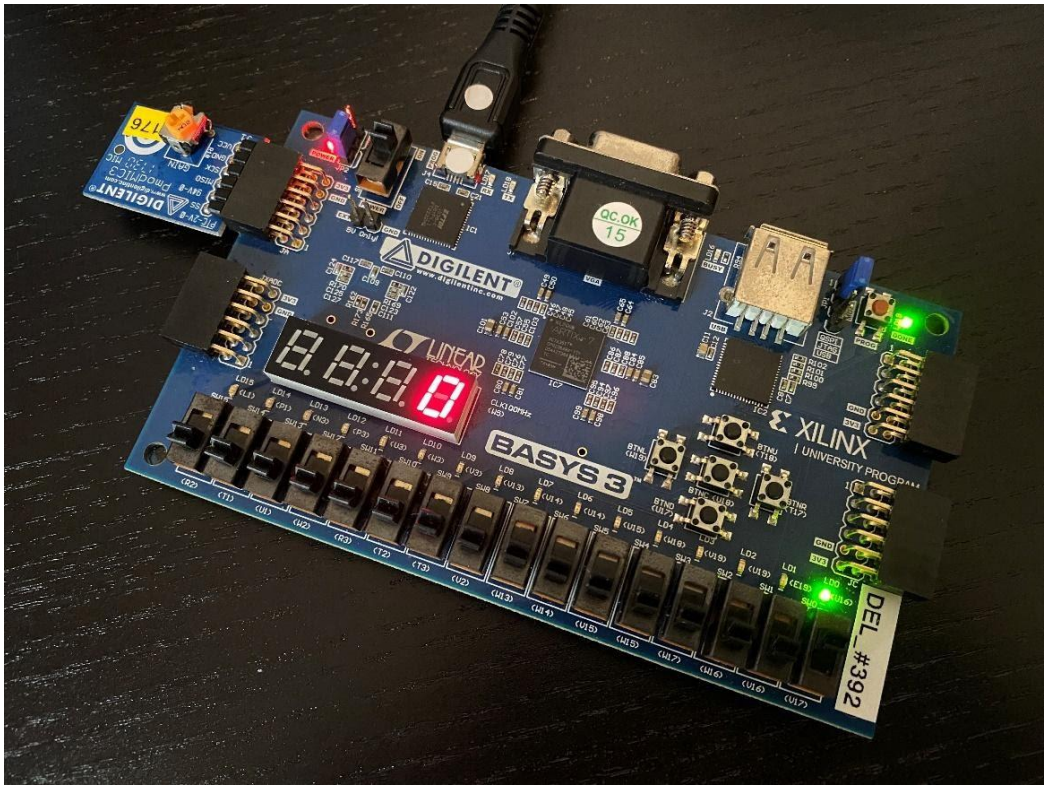

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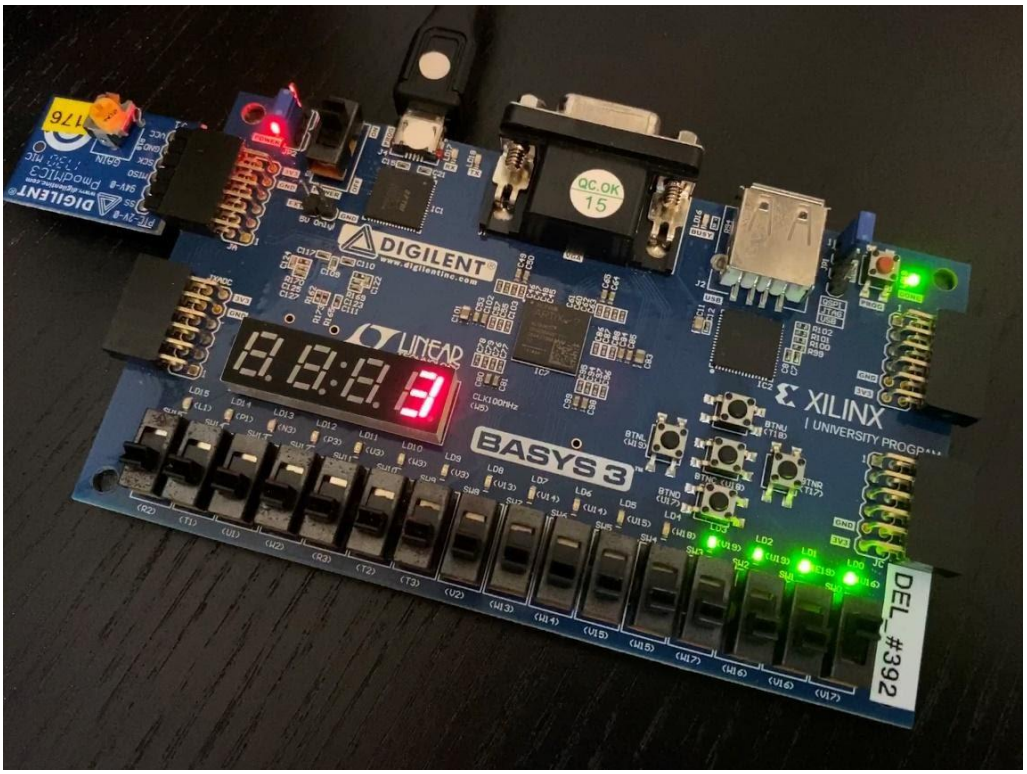

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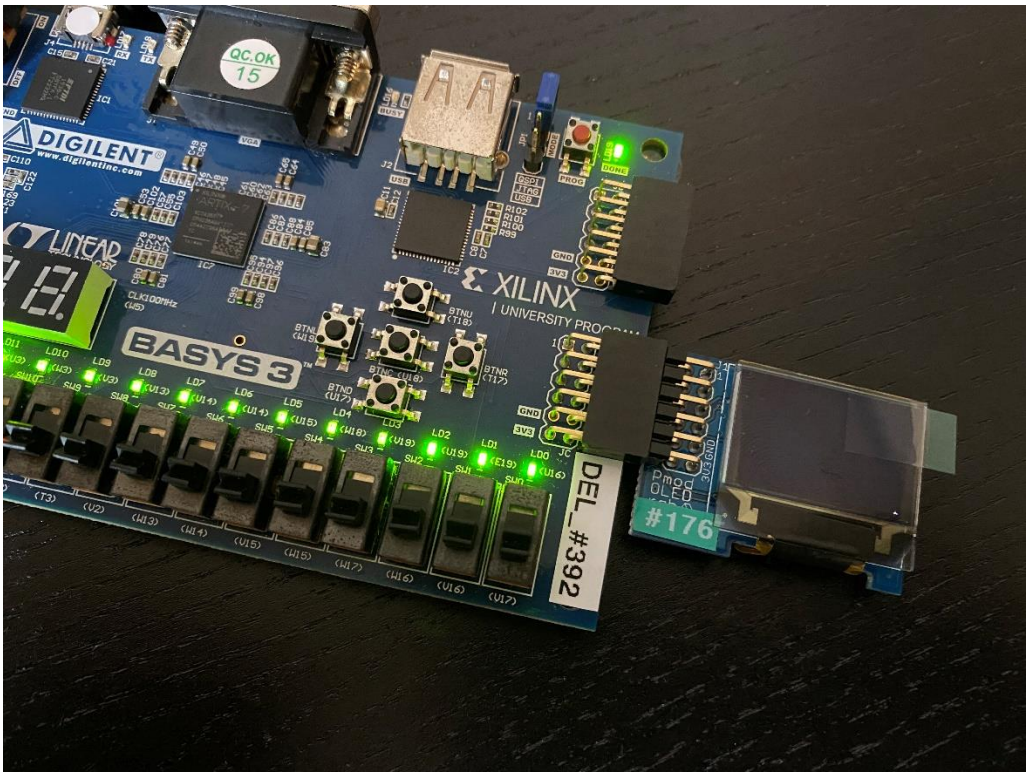

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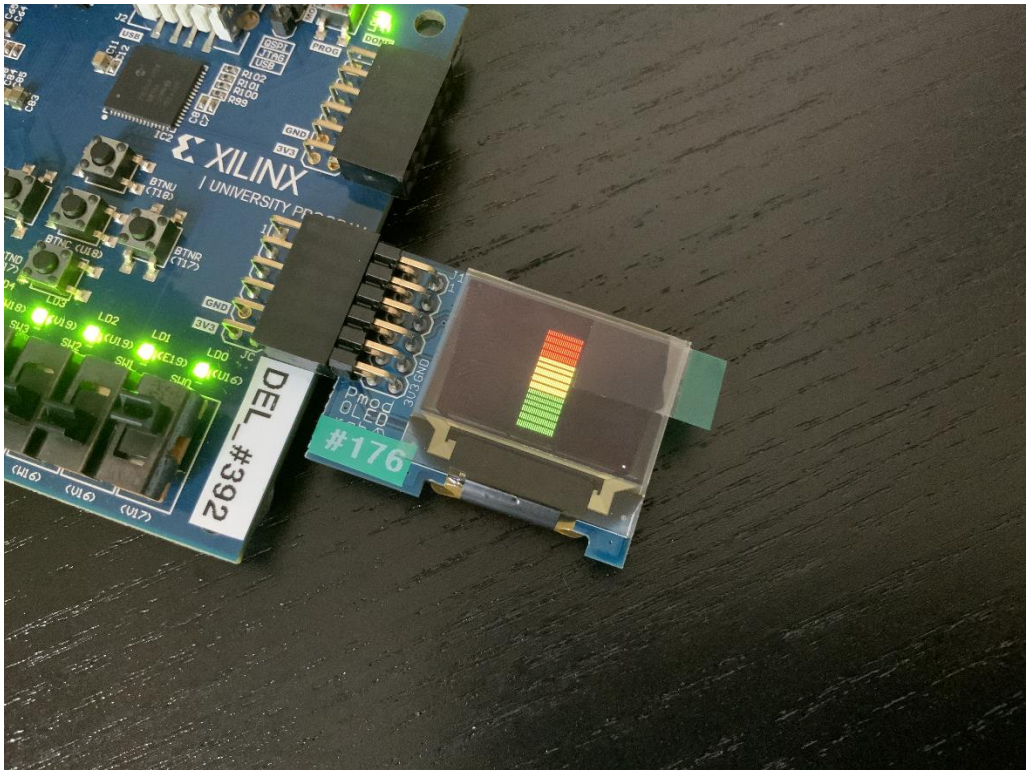

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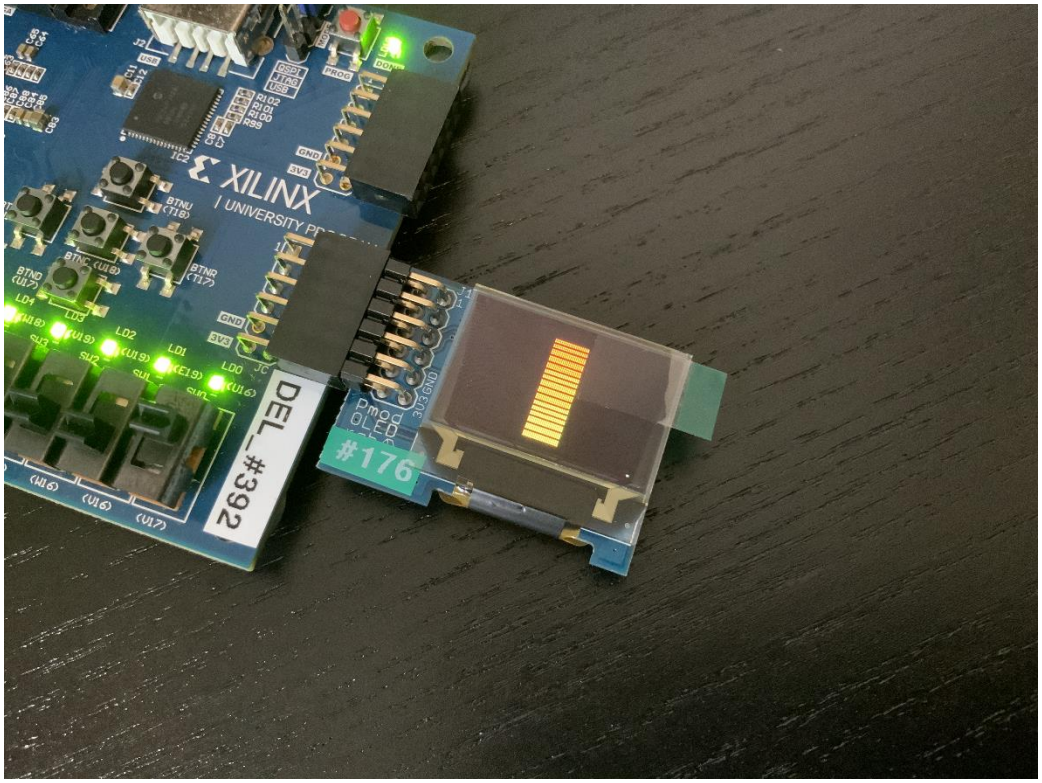

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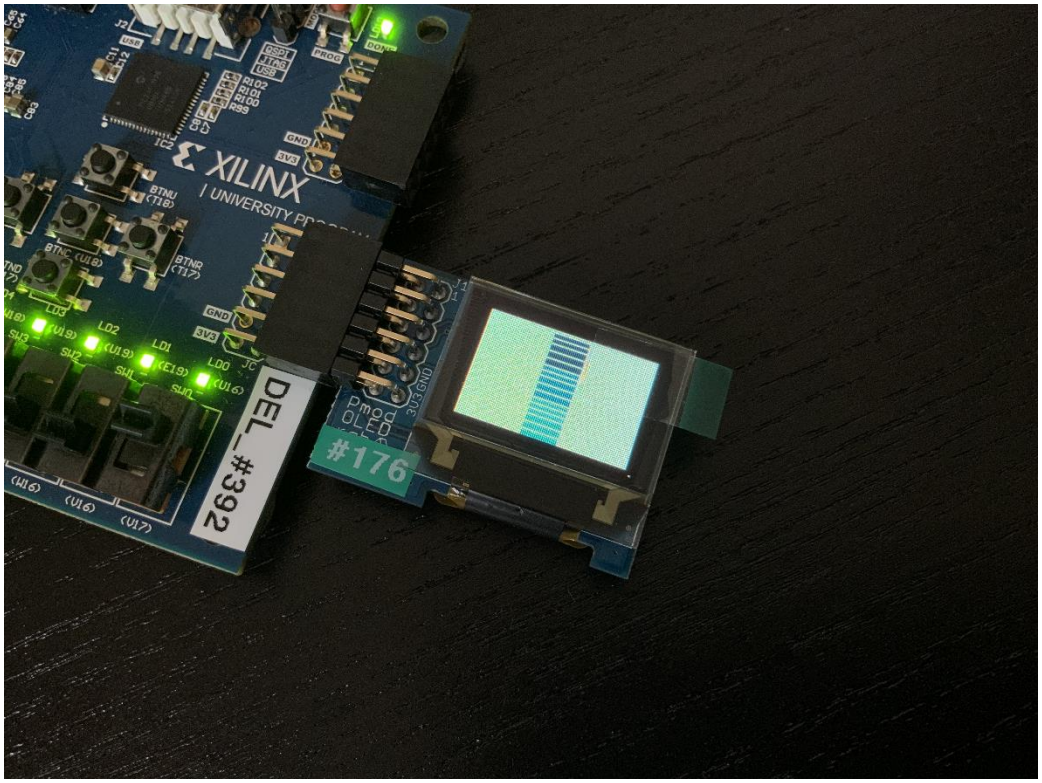

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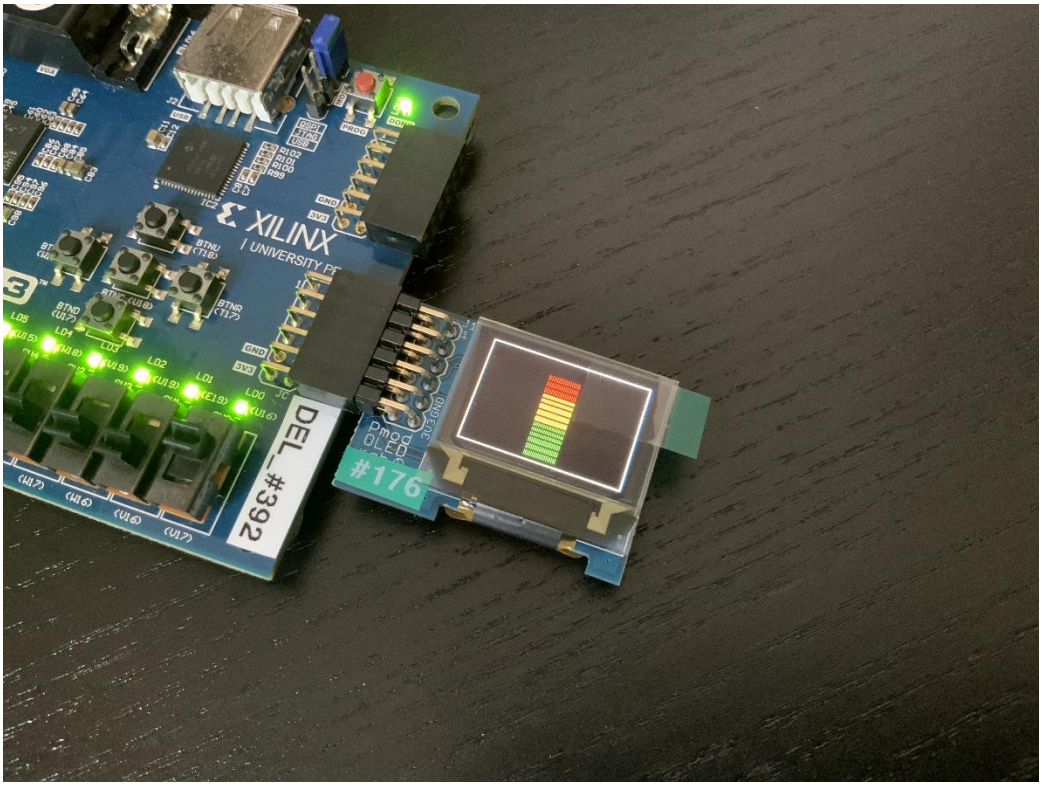

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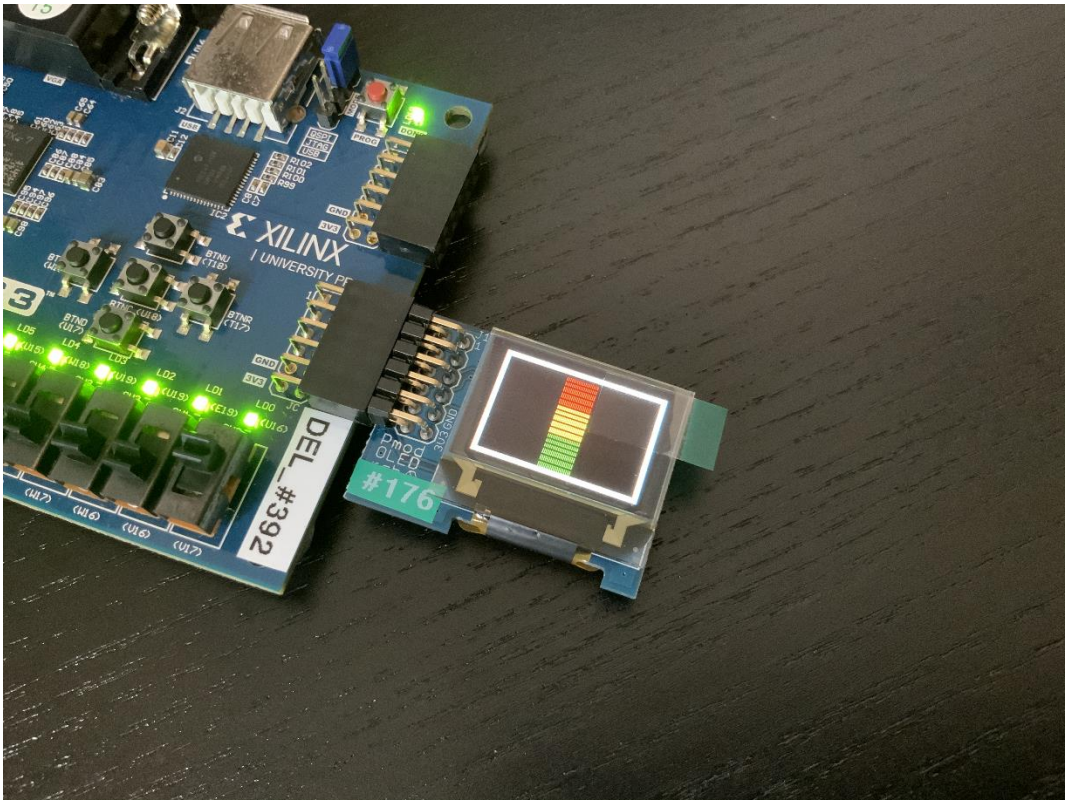

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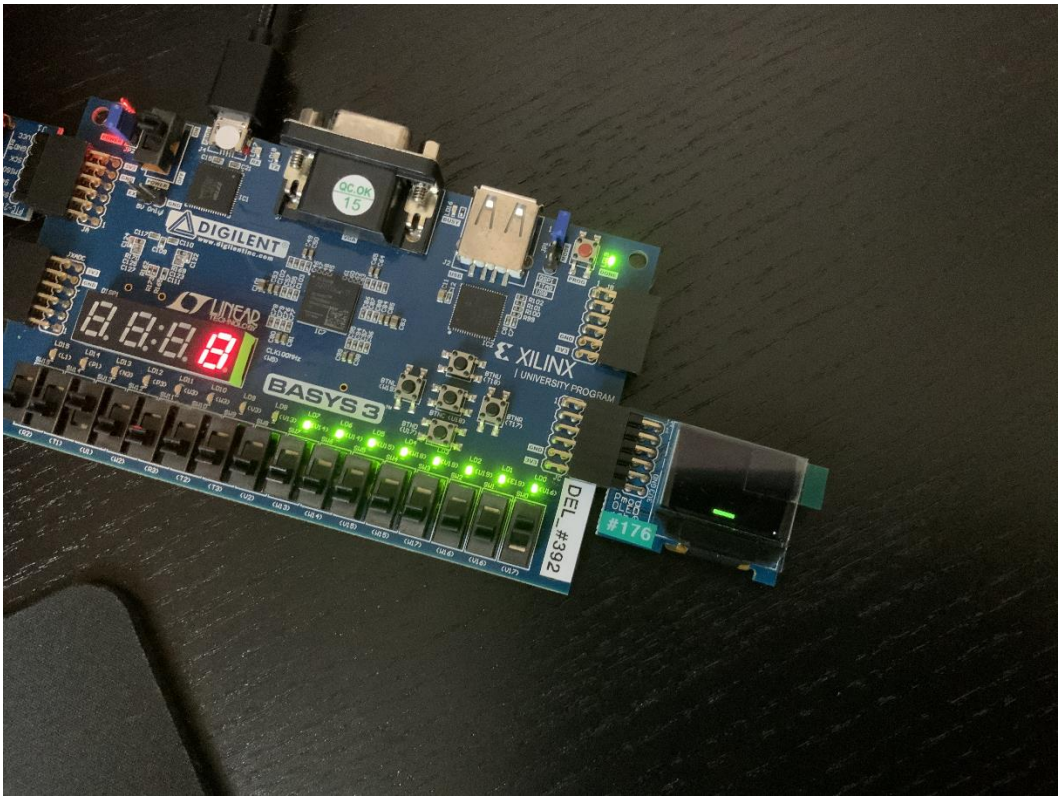

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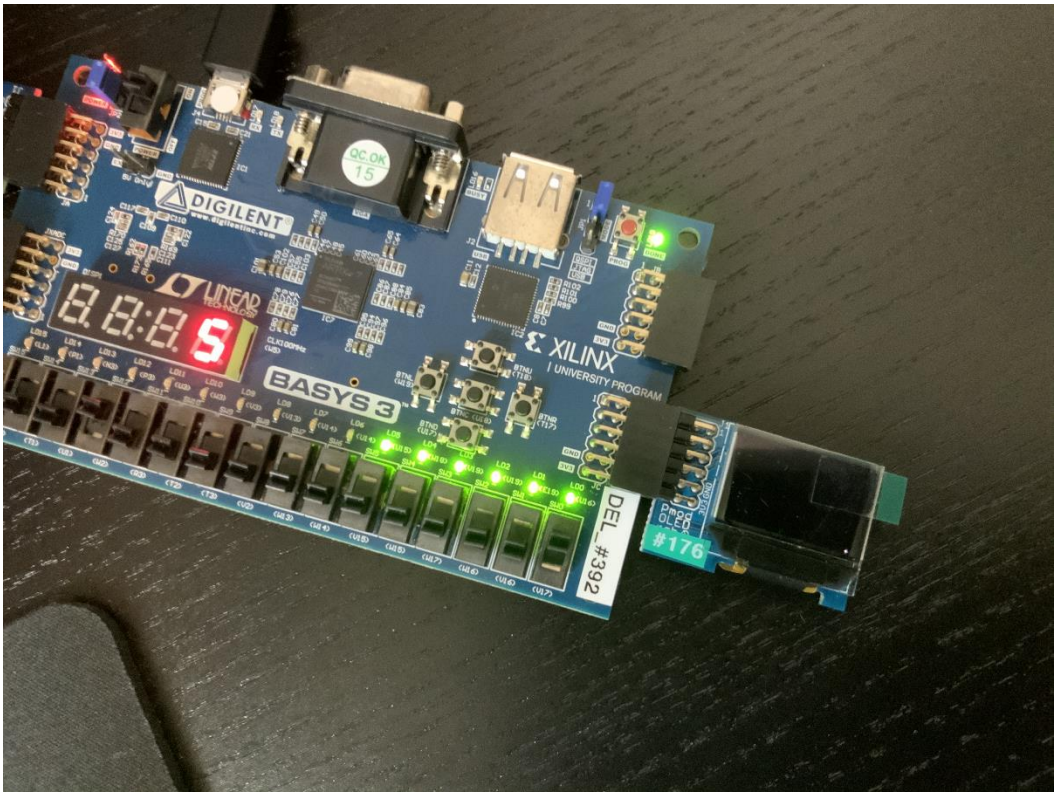

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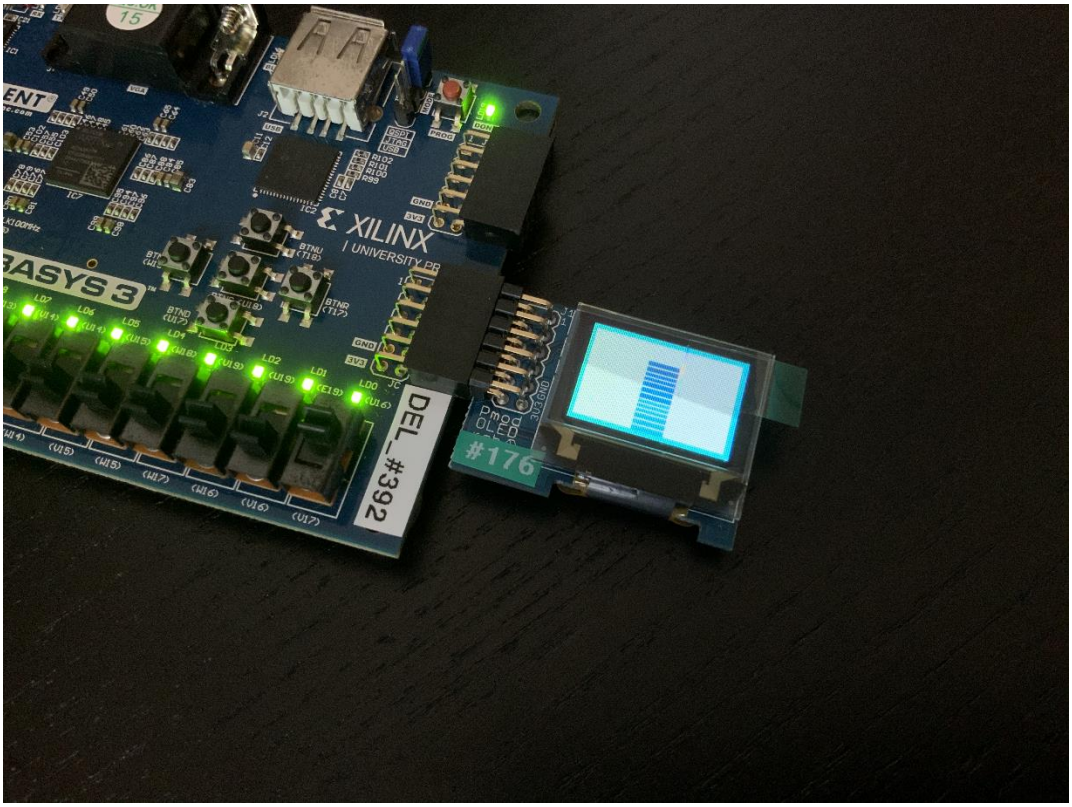

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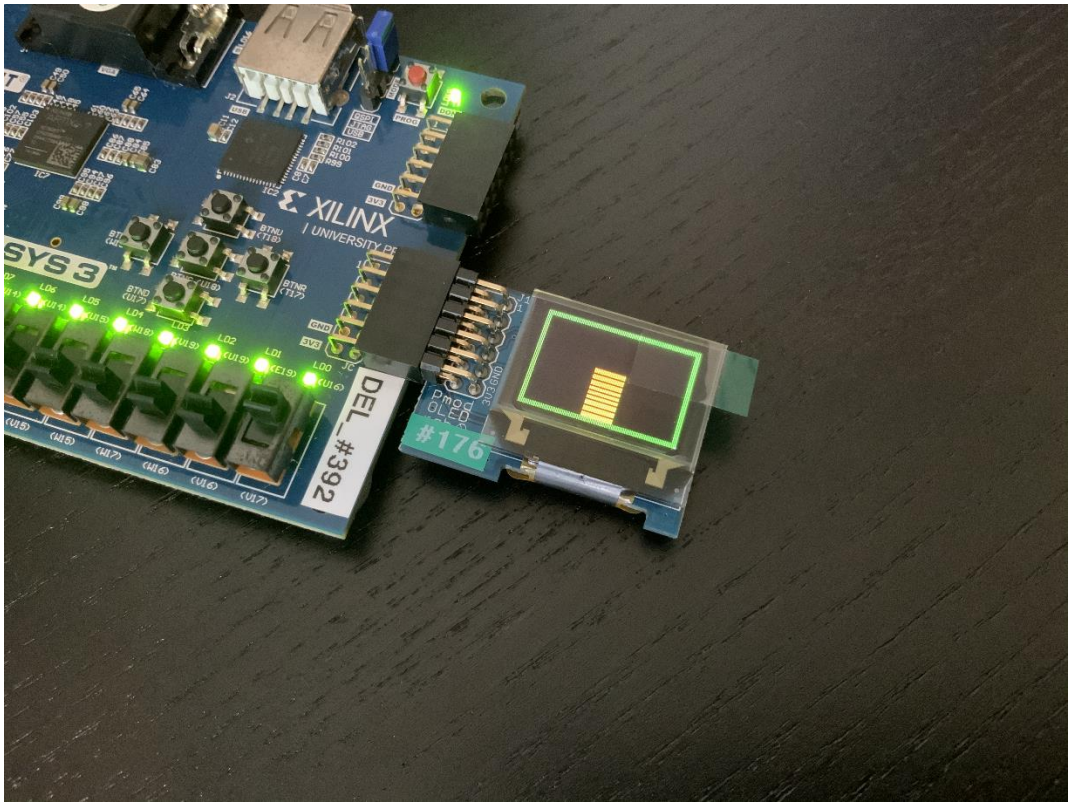

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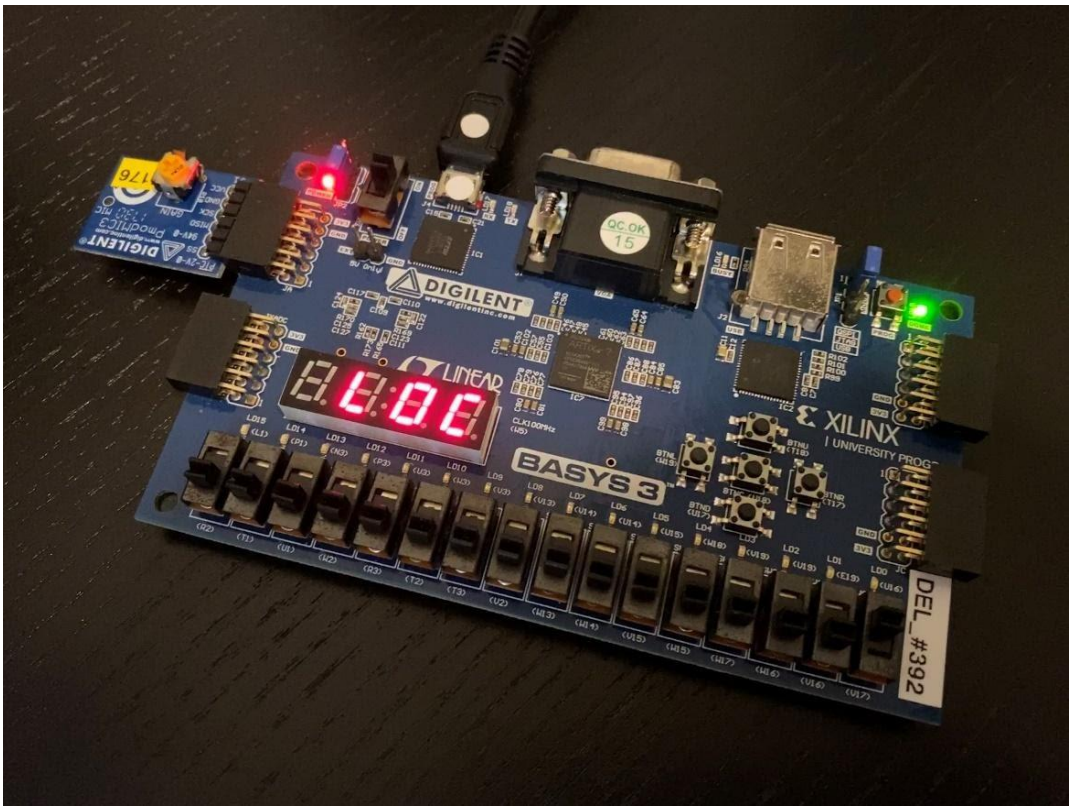

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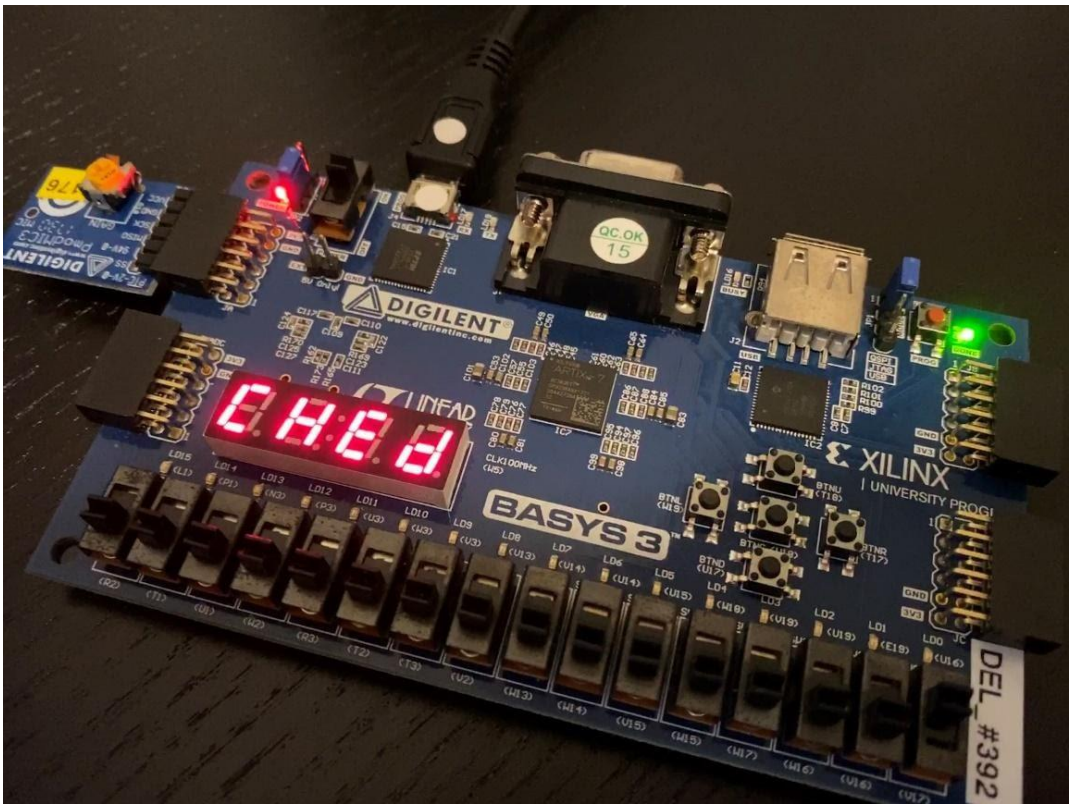

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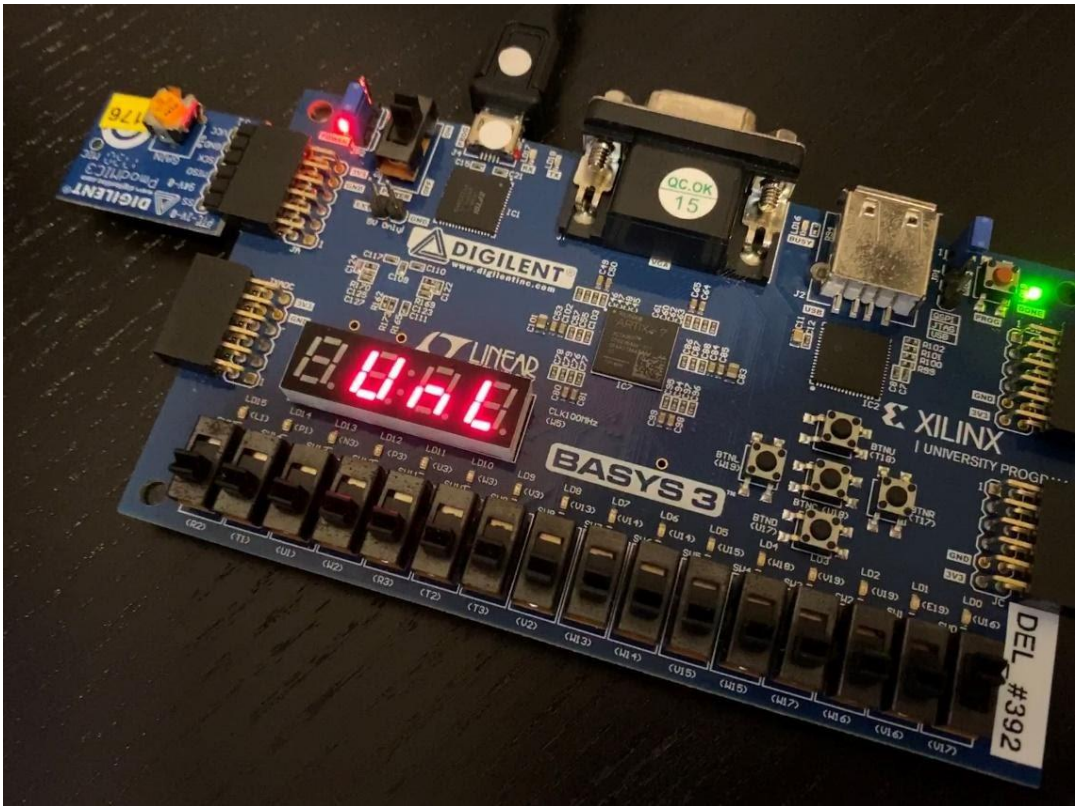

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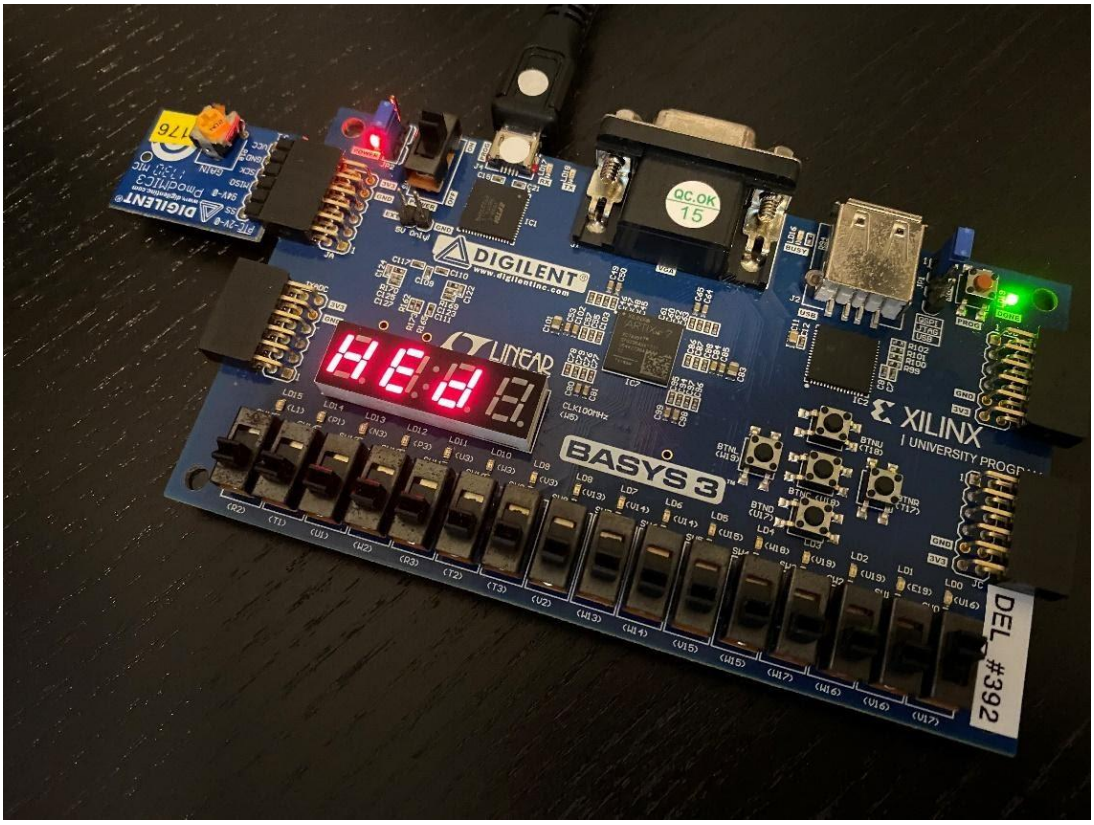

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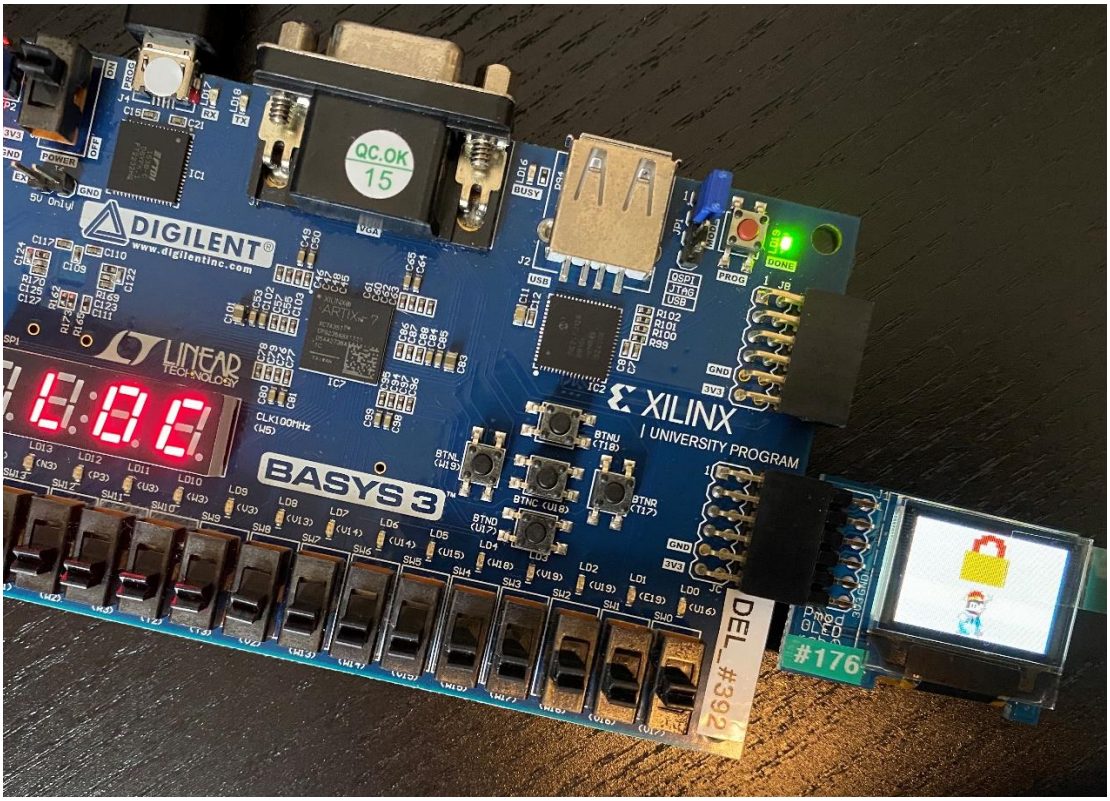
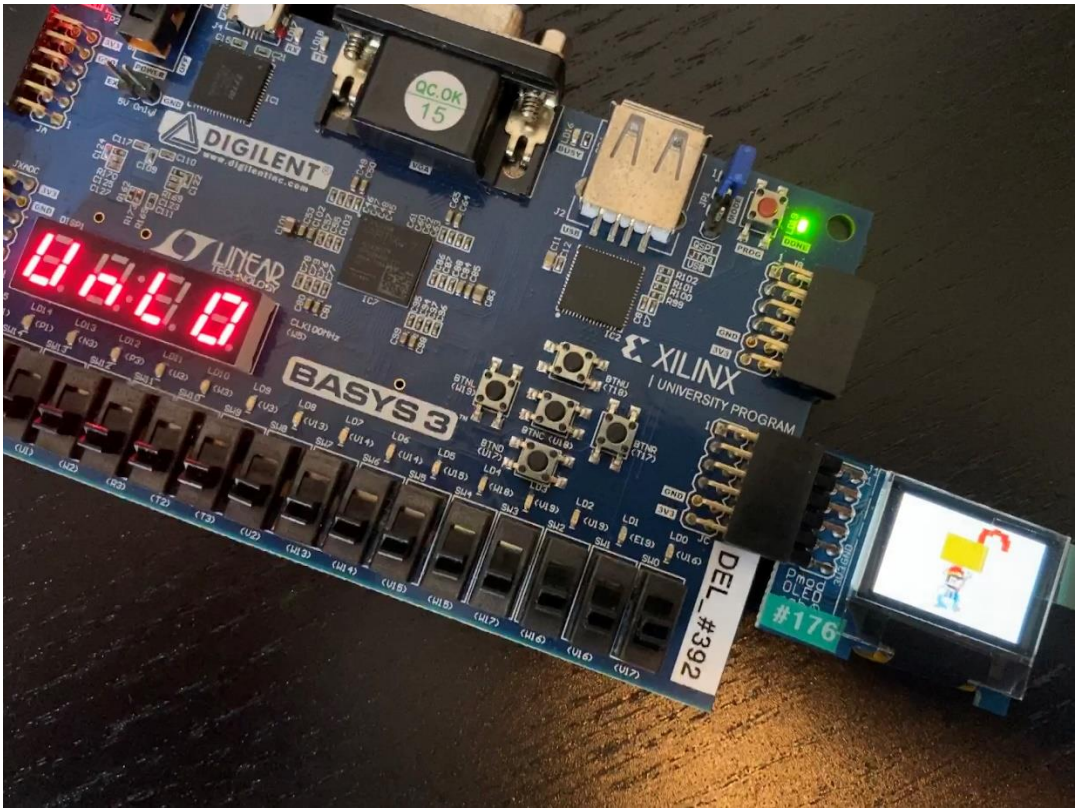


Figure 4.1



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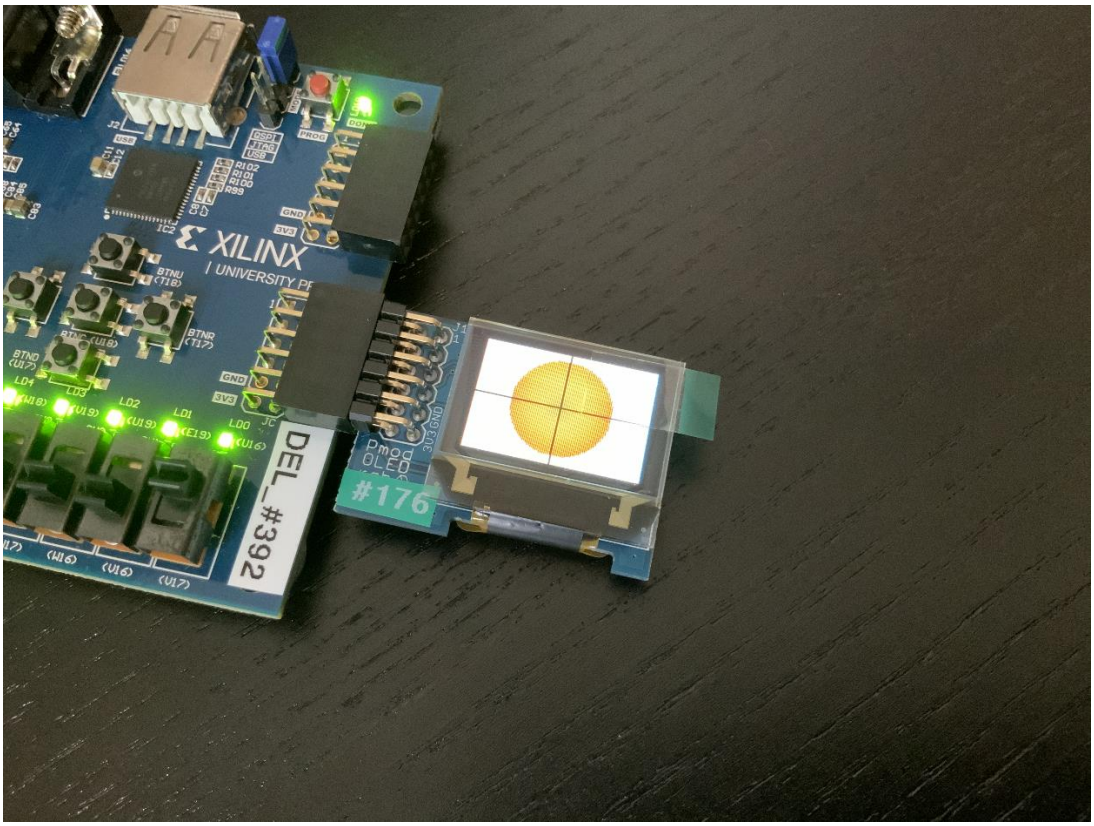

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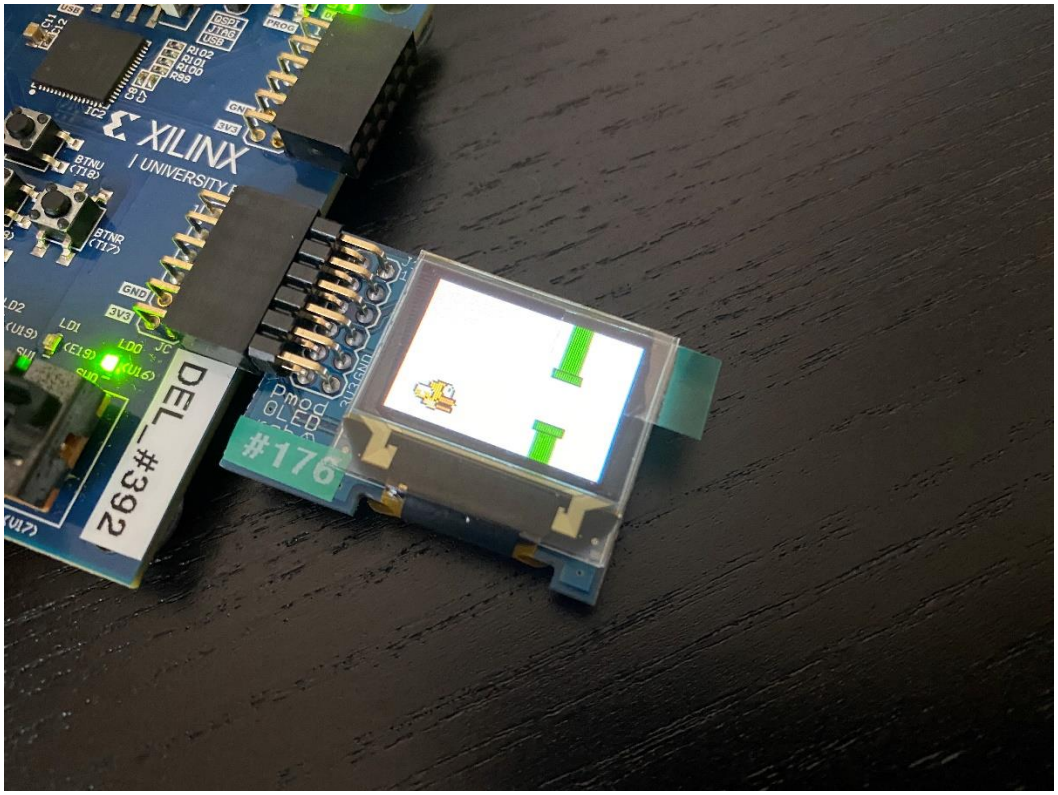

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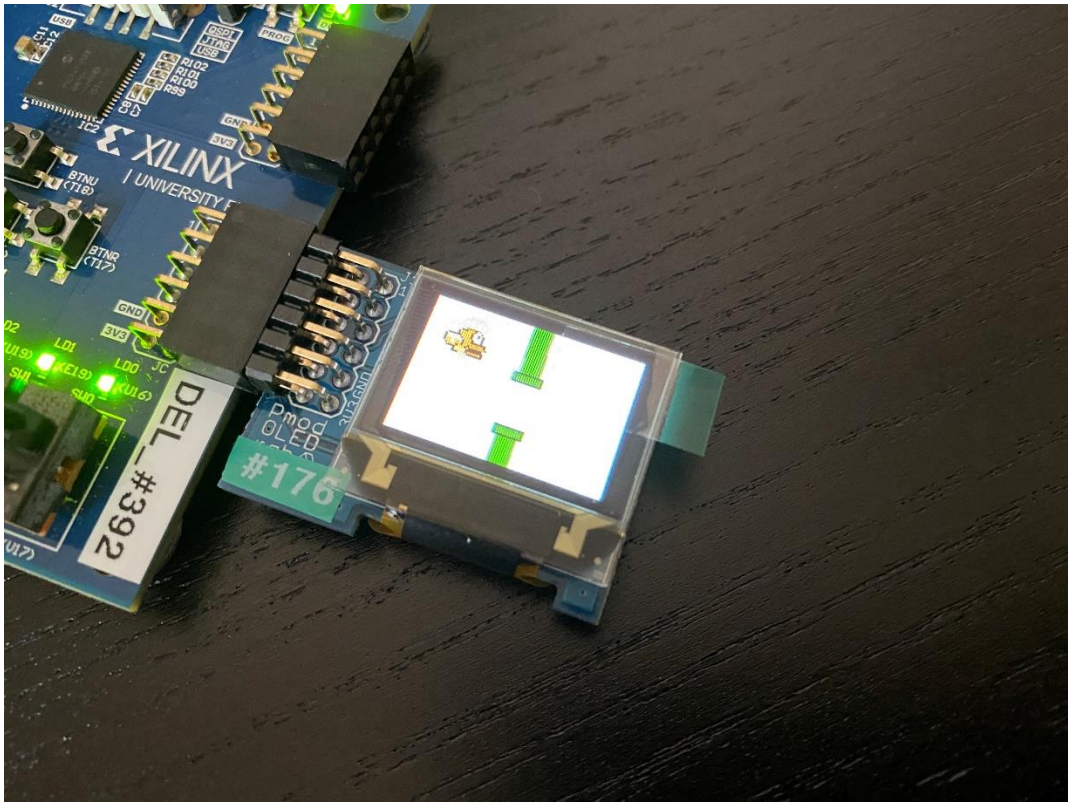

Figure 6.2