UCDAVIS COLLEGE OF ENGINEERING

Department of Electrical and Computer Engineering

EEC 172 Spring 2015

Lab verification due at the end of your lab session Wednesday April 22 or Thursday April 23, depending on you lab section.

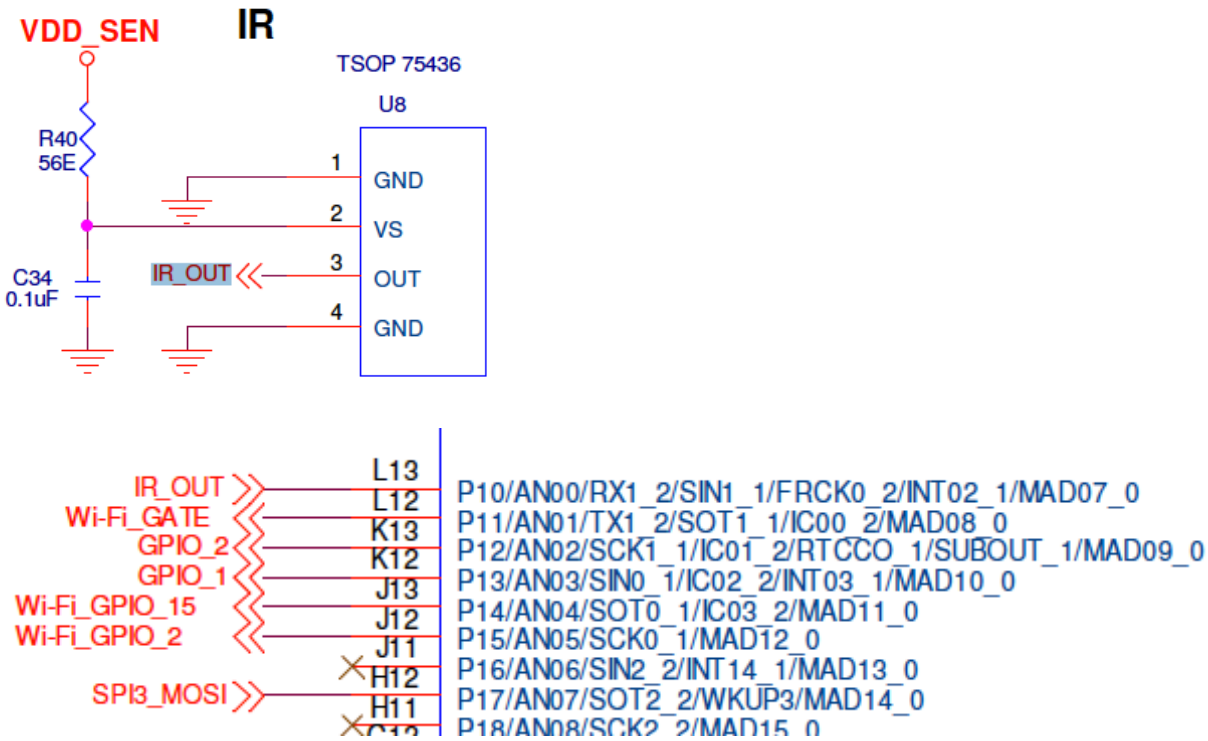
-5 points for verification on April 24. -10 point for verification during the week of April 27. Zero credit after May 1.

Lab report due during lab section May 6 or 7.

LAB 2: IR Remote control manipulation of an on screen image.

Objective:
In this lab, you will use the logic analyzer to characterize the transmissions from an infrared (IR) remote control and then use the IR remote control as an input device for the Wyzbee board. The main task in Part A is to determine how the IR transmission signals are encoded for a set of buttons on the IR remote, and from this analysis determine the IR remote data format and timing. In Part B, you will decode the transmissions for each button in the Wyzbee board. You will use key presses to manipulate an object you render on the OLED display.

Hardware:
The Wyzbee board includes an IR receiver from Vishay Semiconductor. Your software will use interrupts to detect the rising and falling edges of the IR remote input signal, and use one of the microcontroller's timers to determine the time span between edges, and in turn determine which key was pressed. You can find an example of interrupt use on the Wyzbee board on the company website: http://wyzbee.com/QuickStart/
For information on the IR sensor see: http://www.vishay.com/docs/82494/tsop752.pdf. The details of the onboard circuit can be found in the Board Schematic, found on Smartsite:



You should read through the TSOP75436 IR Receiver Module datasheet to understand how the module works. As shown in the Block Diagram of the datasheet, the IR receiver has a band-pass filter, which has a center frequency of 36 kHz. The TSOP75436 is able to suppress most of the interference from room lights. The room lights in our lab will probably not generate noise on the device, but if they do, you may need to shield your receiver from the lights. Also when in the lab around other groups you may need to shield your receiver from their IR remote.

You will use an AT&T RC1534801 or S10-S3 Remote Control to drive the on board IR. (User Guide in Technical Documents folder on SmartSite)

Remote Control Configuration

Your remote may have been previously configured so you should first reset the remote to factory defaults by following the instructions in of the *ATT IR Remote User Guide*, posted in the Technical Documents folder in the class SmartSite. We will use the IR remote in TV mode, which is entered by pressing the TV button. You will configure the IR remote to generate IR transmissions for a specific 4-digit set up code assigned by your TA. The IR transmission encoding varies by manufacturer and TV model so there are different setup codes for different TVs. The guide describes how to configure the remote TV set up code. We will be using the numeral keys to interact with the Wyzbee so you will need to follow the configuration procedure in section activate the numeral keys. In addition you should disable backlighting, as described in to extend battery life.

Part A: Capturing and Characterizing IR Transmissions

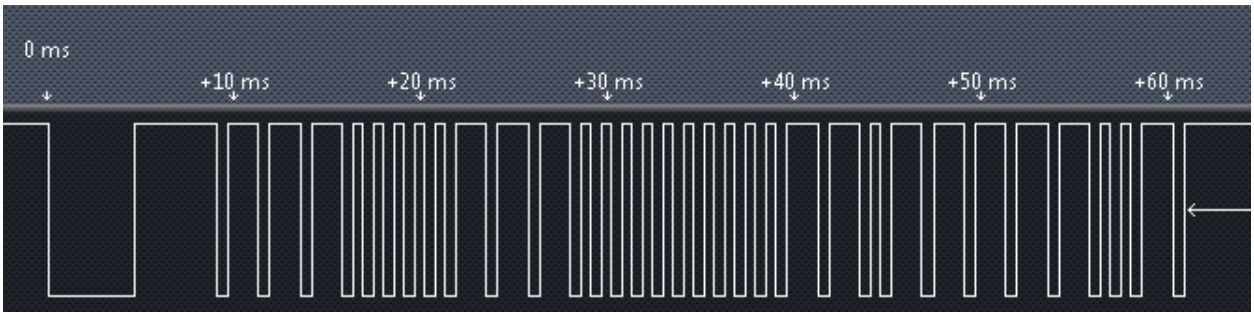
Each button on the remote is encoded with a different pattern of varying length pulses, similar to Morse code and various other communication coding systems. See the document *Data Formats for IR Remote Control* posted in the Reading Material/IR Remote folder in the class SmartSite for some background on IR remote control transmission data formats and timing. Also refer to the tutorial on IR Remote Control at http://www.sbprojects.com/knowledge/ir/index.php, and notice the links to some specific protocols in the left-hand column of the page.

In Part A you will use the Saleae USB Logic Analyzer to capture and characterize the IR transmission format and timing for five different buttons on the remote control. You can download the Saleae software for personal use from: http://www.saleae.com/downloads

Our IR remote has a modulation carrier frequency of 36KHz so a logic analyzer sampling frequency that is significantly above that (say 250KHz) will yield accurate timing measurements.

There is no direct access to the GPIO wired to IR_OUT. However, you can write a simple program to route the input of P10(IR_OUT) to an accessible GPIO pin. From there you can indirectly sample the IR_OUT signal with the logic analyzer.

Use the logic analyzer to capture a transmission for each of your chosen buttons in the target set and under 'Options' use 'Save Screenshot' to save a picture of the capture for each button. An example transmission capture for one button on one TV set up code is:



Use your set of captures to characterize the general format and general timing of your IR transmissions, and to determine the specific binary data that is sent for each button in the target set. Use the IR protocol documents described above and/or other web resources as a top down method to confirm the protocol for your TV set up code. Include this top-down analysis in your lab report.

Some IR remote transmissions have an address and a data field. The address directs the data to a specific device (e.g., TV, DVD, VCR, etc.) and the data is essentially a key code that specifies which key (button) has been pressed. These key codes are sometimes called 'commands' because the key code is mapped inside the receiving device to a specific operation, e.g., Fast Forward.

When you press a button on the remote control unit and hold it down, the data field is typically repeated as long as the button is held down. The receiving device ignores the repeated data, allowing a user to easily select Channel 3, for example, instead of accidentally getting Channel 33 (or 333, etc.) by pressing a button too long. For our application repeated data will be programmatically ignored by discarding the repeated data fields.

For this lab you will need to use a timer module. Spansion provides a peripheral driver for the dual timer module of the MCU. You can use the timer to analyze the IR pulse widths in your interrupt service routine. Documentation can be found on the timer Smartsite in the file FM4-AN709-0000-E.pdf.

Demonstrate a Logic Analyzer capture of one button press to your TA and have him sign off.

Demonstrate your software detecting at least five different button presses and print your decode to the screen and have him sign off.

Part B: Decoding IR Transmissions and Manipulating an Image

In Part B you will decode the signal coming into the Wyzbee to recognize when the user presses the buttons you have chosen. Your system must distinguish these buttons from any other buttons on the IR remote. Your system does not need to identify other buttons, but it must recognize that they are not in the target button set.

Using the data you acquired in Part A, write a program that (1) decodes and recognizes the IR transmissions for each button in the target button set, (2) Manipulate an onscreen object.

You should choose an object or set of objects to draw on the OLED. You should then change the image you have drawn depending on the button presses you detect. Here is a set of suggestions for what you might do when detecting key presses:

- Change the color of an object.
- Change the size of an object.
- Move a vertex\vertices of a shape.
- Manipulate some text.
- Move an object in screen space.
- Swap multiple objects in space.
- Change background colour.
- Perform some animation.
- Feeling ambitious? Write a simple game (Simon, Connect4…).
- Be creative. Do something different than your peers in lab.

Demonstrate to your TA how at least 5 different buttons change what is being displayed on the screen. Have him sign off on your work.

At a minimum your lab report should include:

- Your verification sheet.
- A hard copy of your well-written, well-commented code.
- A soft copy of you code uploaded to SmartSite
- An analysis and interpretation of the data format used for your assigned TV set up code.
- A timing diagram that illustrates the IR data format for your TV.
- Screen shots of the IR transmission for at least five different keys, labelled with the binary pattern that the transmission represents.
- A description of any noteworthy difficulties you encountered in constructioning your solution.
- A description of your manipulation program and how it works.
- A description of anything about your lab this is interesting, insightful, amazing or amusing that might be warrant bonus points.

Lab Completion Grading:

15%	Logic Analyzer Capture of Button presses
55%	Decoding of at least five button presses
30%	Image manipulation