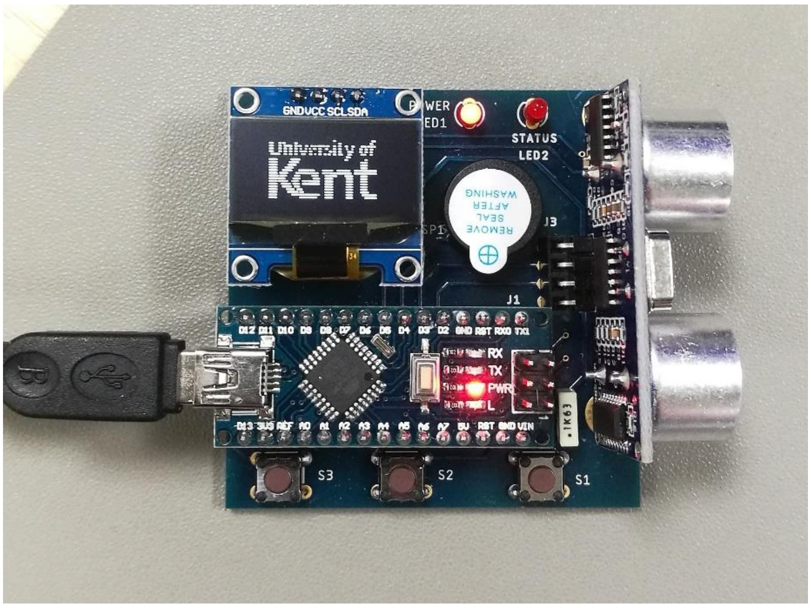
University of Kent | School of Engineering

Electronic and Computer Engineering

Applicants Day Laboratory Session: OLED Range Finder



Aim: To assemble an ultrasonic based range finder electronic circuit using the kit of components supplied and then to write/ modify firmware code for the micro-controller to be able to take distance measurements to objects and display the result on a display.

Learning outcomes:

- Practice and enhance component identification, PCB assembly and soldering skills
- Using basic electronic hand tools
- Familiarisation of basic electronic test equipment such as Oscilloscope and Digital Multi-Meter (DMM) and using them to make measurements
- Introduction to the Arduino Integrated Design Environment (IDE) for writing code, and to edit the code to make changes.
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Equipment Required

- Kit of components including PCB
- Soldering iron – available at lab work bench, Orange and Blue Zones
- Tool kit – Available to book from Technical Support Centre
- Oscilloscope probe kit - Available to book from Technical Support Centre
- Computer with Arduino IDE application software and range finder example code – Available in lab Orange and Green zones
- Tape measure or rule

Health and Safety

- **Caution !** – The soldering irons are hot and can cause burns
- Personal Protective Equipment (PPE) is provided
- Take care using the tools, especially the side cutters when cutting component wires, as the cut wire can fly and can hit your face/ eye
- Wash your hands after handling electronic components and solder wire
- No eating or drinking in the lab

Introduction

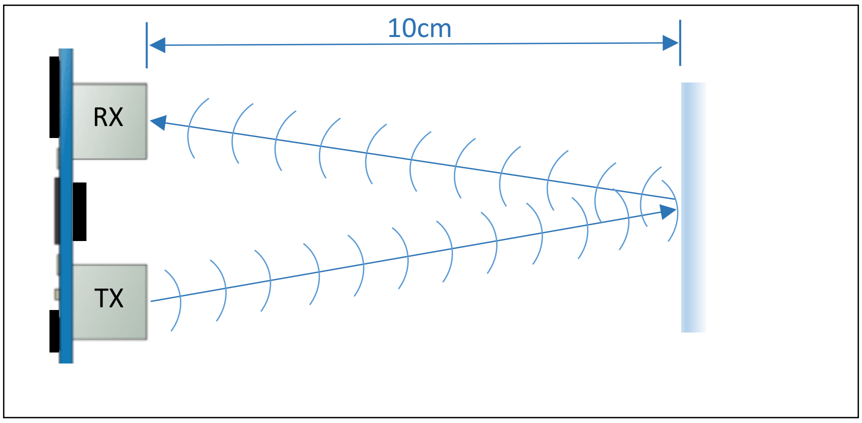
- It is recommended that you read this script in its entirety before attempting the exercises.
- The circuit schematics can be found at the back of this script.
- Ensure that you state the units when recording answers
- Work is to be undertaken individually
- If required, you will be asked to call a demonstrator to verify your work throughout the session. Work without the appropriate demonstrator signature will not be marked.
- Once you have finished, if required, submit this script to a demonstrator, making sure that you have filled your name and login on the front page.

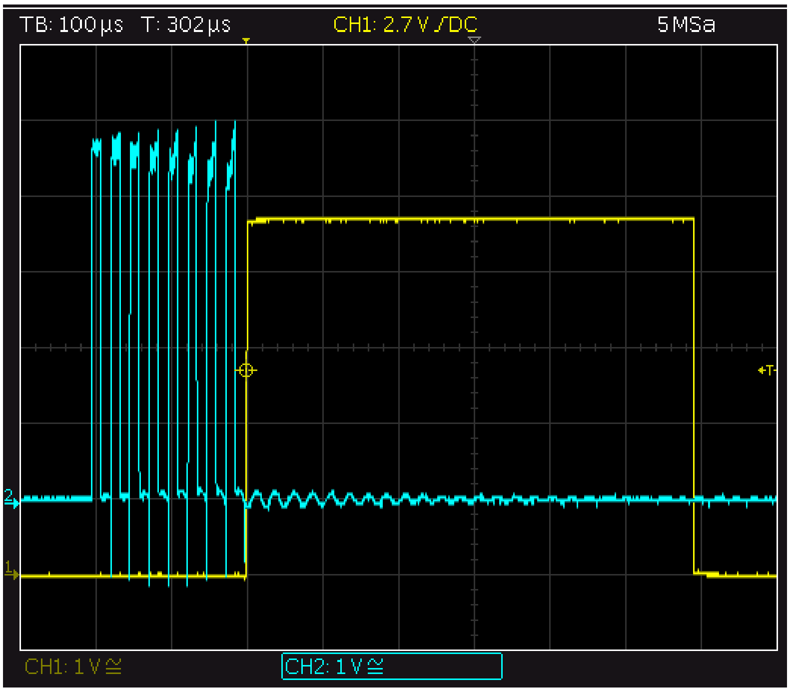
- This experiment uses the Arduino Nano microcontroller board. The Arduino environment is "Open-source electronic prototyping platform enabling users to create interactive electronic objects." The software is free to download. Visit www.arduino.cc

Theory – How an Ultrasonic Sensor Works

Ultrasound is high frequency sound waves. The ultrasonic sensor works by emitting the ultrasound signal at a frequency of 40KHz from the transmit (TX) transducer, and if there is an obstacle or object in the path, the ultrasound 'echo' gets reflected back and received by the receive (RX) transducer.

The time interval between sending the signal and receiving the echo determines the distance to the object.





Oscilloscope view of the TRIG and ECHO Signals

Blue trace = 8 fast pulses of the transmitter to create 40KHz ultrasound waves
Yellow trace = Received 'echo'. The width (time period) of the pulse relates to the distance

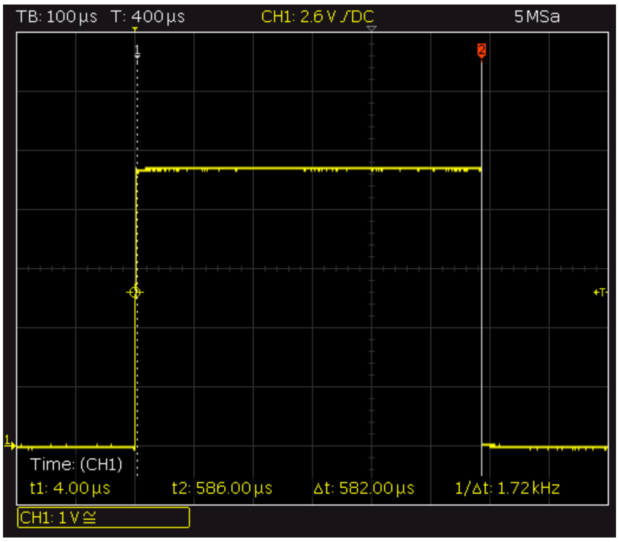
The distance to the object can be calculated using the following equation:

Distance = Time x Speed of sound

As time includes both transmit and receive times, the time period measured is twice the actual distance, therefore the answer should be divided by 2.

Where:
Speed of sound, v = 343m/s (or 0.0343cm/µs)
Time = the time period of the received pulse µs

Example



Time period measured on the echo pin = 585 µs

$$\text{Distance} = \frac{585\mu s \times 0.0343cm/\mu s}{2}$$

Distance = **10 cm**

Procedure

1) Build the circuit board using the kit of components supplied.
2) Before powering up the completed circuit board, measure the impedance between the 0v and +5v supply rails using the DMM to see if there is a short circuit.

Impedance, Ohms measured =

3) Power up the circuit by plugging in the USB cable into the microcontroller and check to see if the POWER LED is illuminated.
4) Compile and program the microcontroller with the test code. This test code will check that the LEDs, display and push button switch function correctly:

- Microcontroller programs correctly
- POWER LED is illuminated
- LCD displays “Hello World”
- When the switch is pushed, the LCD displays a different message.

5) If all parts function correctly compile and program the range finder code.
6) Check the range figure displayed on the LCD with a tape measure or rule:

- Do they agree?
- What is the error?

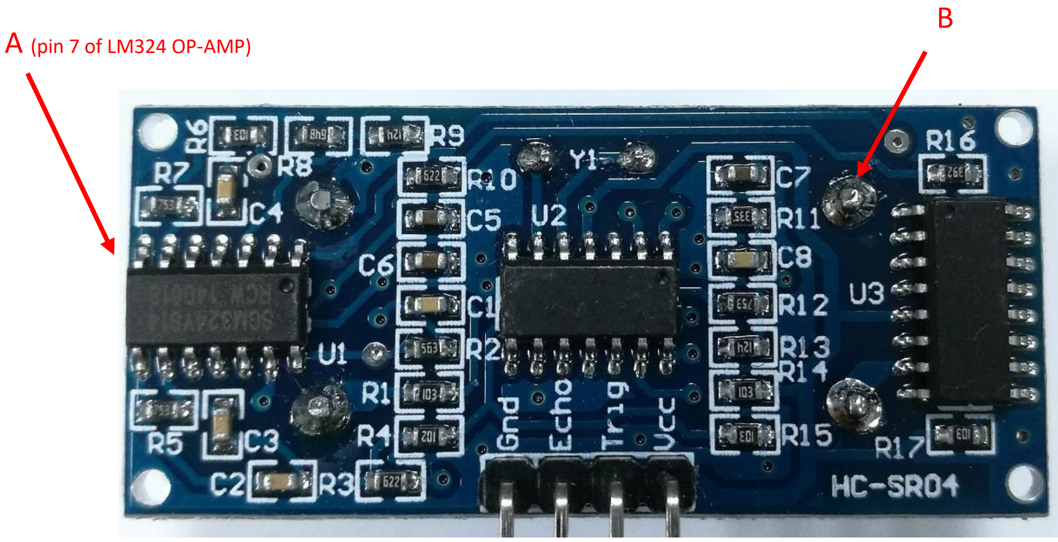
7) Averaging helps smooth and filter the range figure as it can jump around. Modify the code to change the amount of averaging and observe the effect this has on the displayed figure.

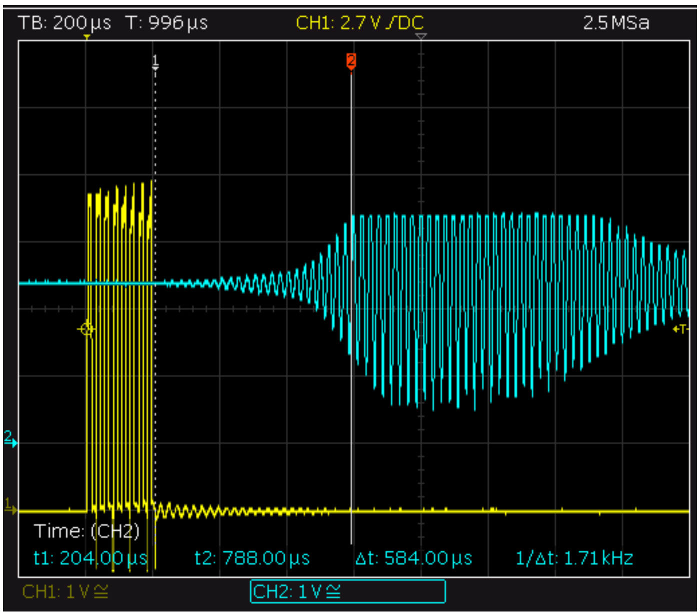
If time allows:

8) With reference to the circuit schematic of the HC-SR04 Ultrasonic module below, use the oscilloscope to measure the 2 points indicated. These points are the raw transmit pulses and the raw received echo. The received echo signal at this point is analogue and includes a lot of noise:

- Point A = received analogue echo signal
- Point B = 40KHz ultrasound

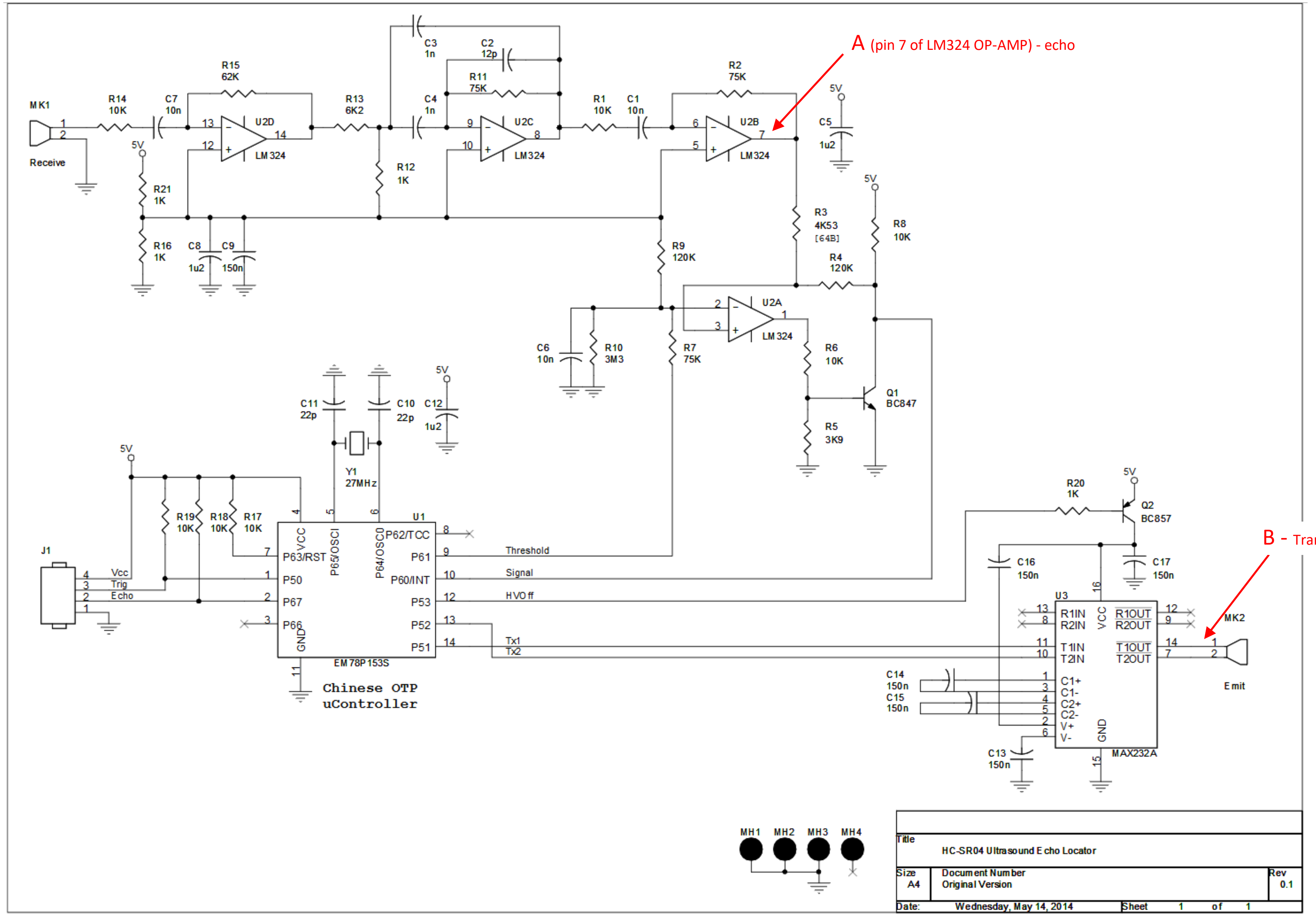
Observe how the received echo changes with distance.



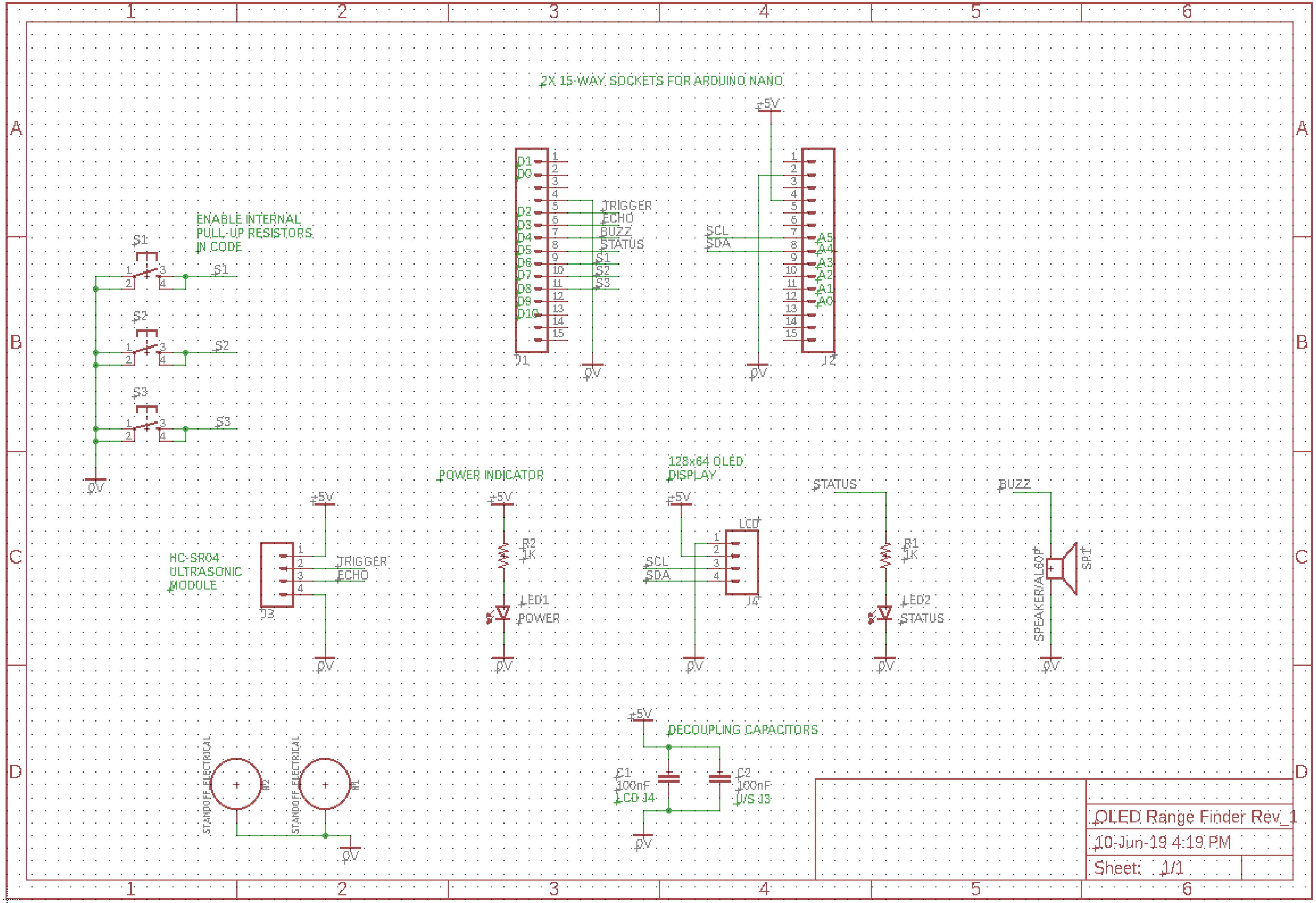


Yellow trace = 8 fast pulses of the transmitter to create 40KHz ultrasound
Blue trace = Received analogue ‘echo’ with multiple reflections and noise

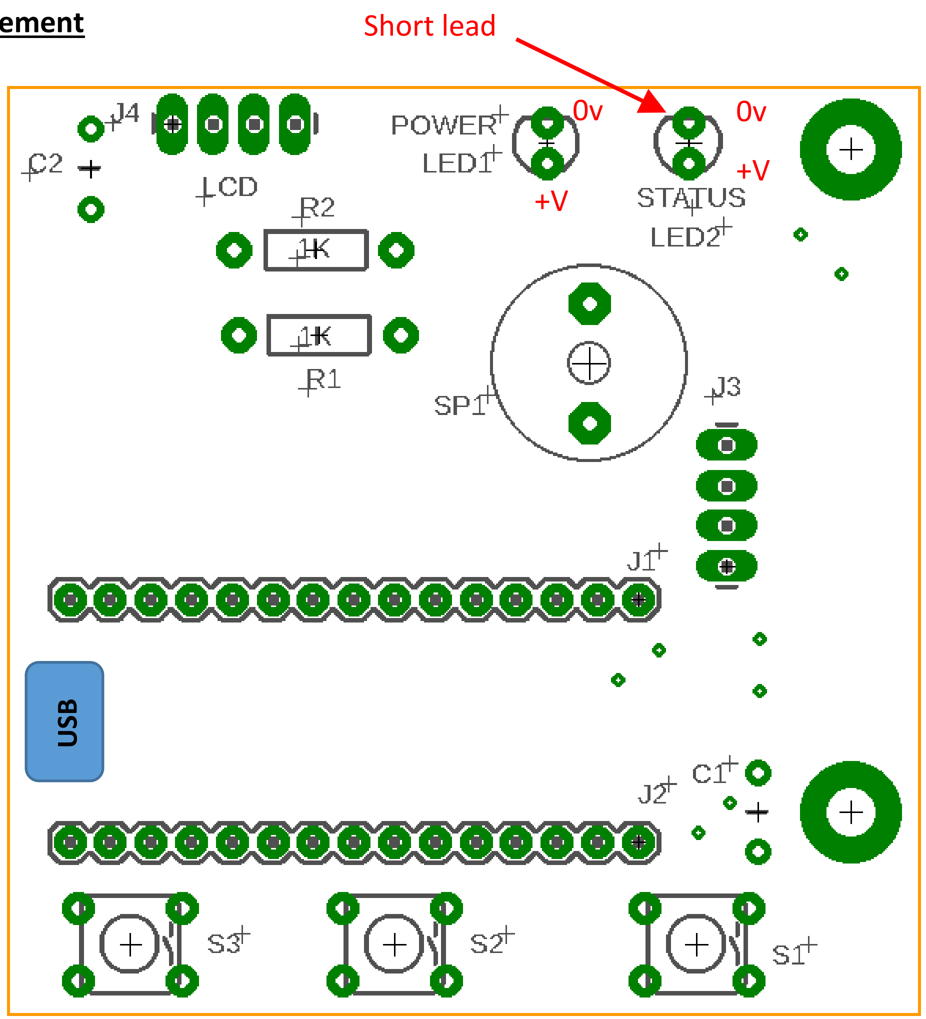
Circuit Schematic - Ultrasonic Module HC-SR04

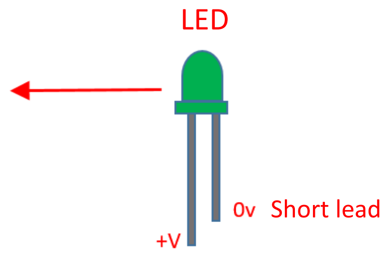


Range Finder PCB - Circuit Schematic



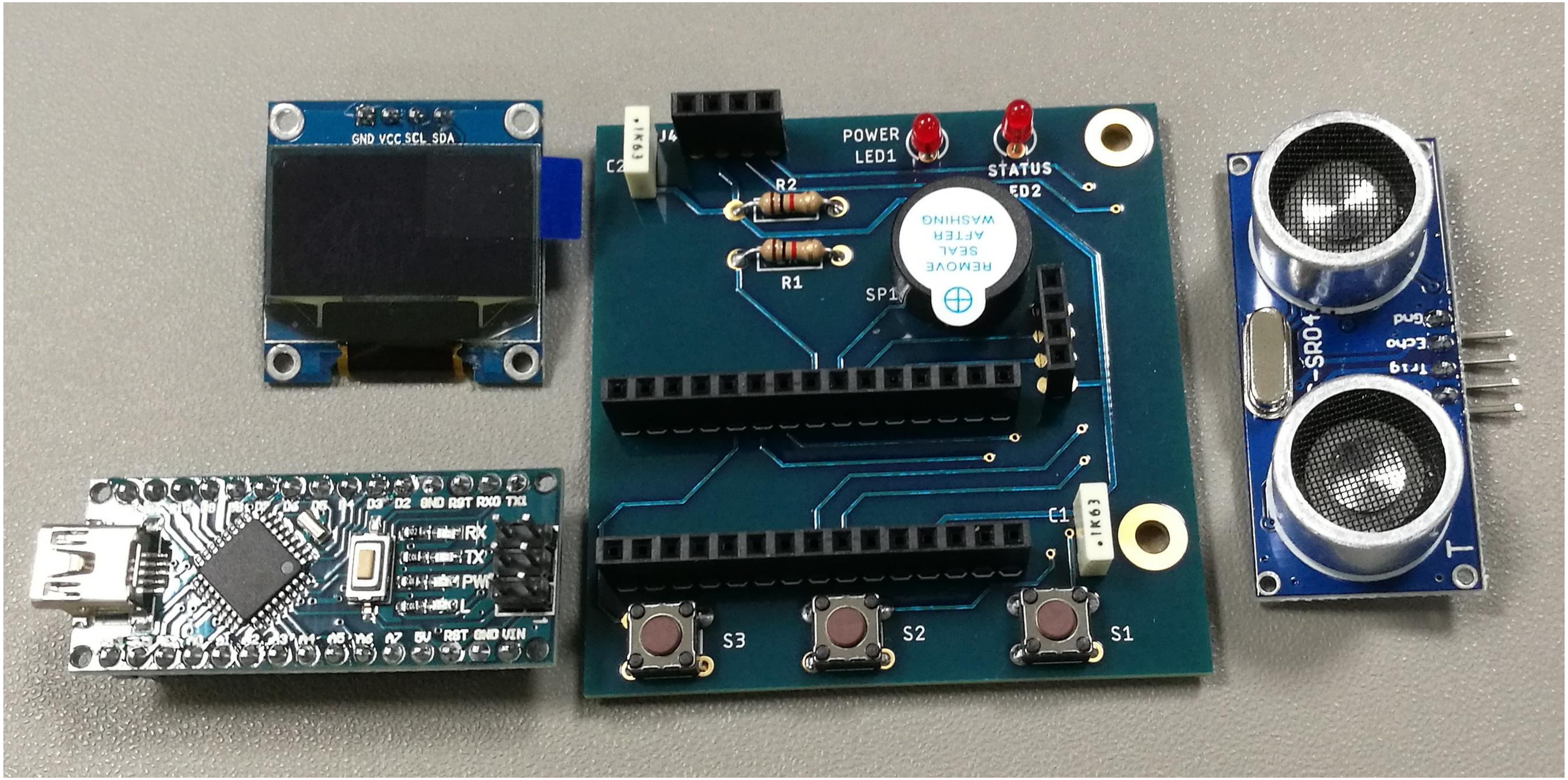
OLED Range Finder PCB Component Placement





Build Sequence:

1 – Resistors R1 & R2.
2 – Capacitors C1 & C2.
3 – 4-way Connectors, J3 & J4
4 – Buzzer SP1
5 – Power and Status LEDs – Note: make sure they are Placed the correct way around !!
6 – 15-way connectors J1 and J2. Use the Arduino Nano as a guide.
7 – Buttons S1, S2 & S3 – if provided in the kit
8 - Plug in the ultrasonic module, Arduino Nano and the LCD display.


GND VCC SCL SDA
POWER
LED1
STATUS
R2
R1
SP1
C2
J4
C1
REMOVE
SEAL
AFTER
WASHING
S3
S2
S1
RX
TX
D2 GND RST RX0 TX1
A7 5V RST GND VIN
Gnd
Echo
Trig