

Building an Ultrasonic Distance Meter: Marking Guidelines

Part 1: Demonstration (10 marks)

Submit a maximum 7-minute video of your project demonstrating the following:

1. (1 marks) The system goes through the **startup routine** specified below
2. (4 marks) Measurements
 - a. Measurement 1: 3-6 cm
 - b. Measurement 2: 6-15 cm
 - c. Measurement 3: 15-23 cm
 - d. Measurement 4: 23-30 cm
3. (0.5 marks) Display does not flicker when a switch is held down
4. (0.5 marks) Button should emit one short beep when held down
5. (3 marks) **Program mode test**

Dear demonstrators, please state a distance to be measured to the student and allow them to position the aluminium reflector. They then can push the button TWICE to get the reading.

System startup

- 1) The USB cord is unplugged, so all LEDS and displays should be off.
- 2) USB cable is plugged in.
- 3) The Display will then do the following:
 - a) 7 segment display one operates with all LED's on for 1 second then off.
 - b) 7 segment display two operates with all LED's on for 1 second then off.
 - c) 7 segment display three operates with all LED's on for 1 second then off.
 - d) 7 segment display four operates with all LED's on for 1 second then off.
 - e) Unit shows group number on display for 1 second then off.
 - f) Unit shows "C" for centimetres on the display for 1 second then off.
 - g) Unit enters sleep mode with just one of the decimal points flashing at a rate of one (1) hertz).

Measurements

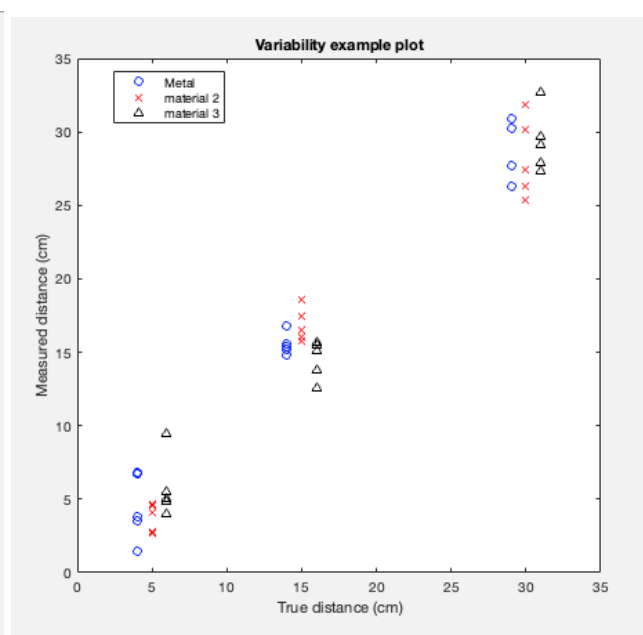
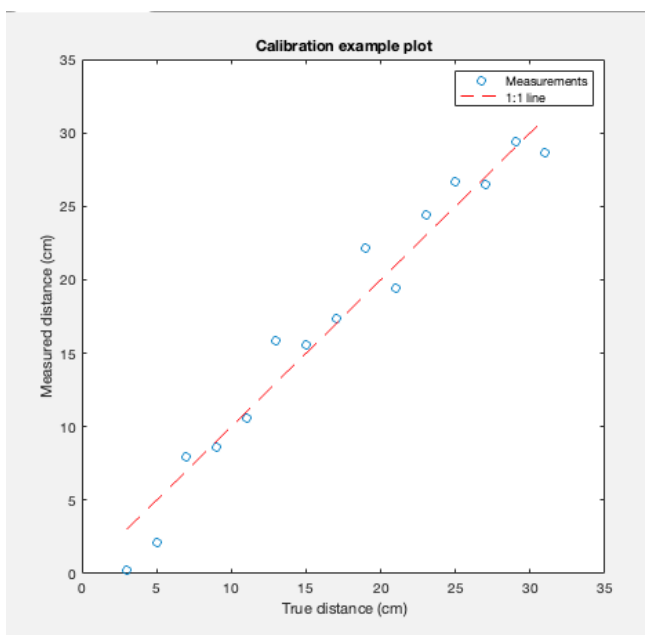
- 1) Show yourself generating a random integer in the specified range (random.org)
- 2) Place your surface at this distance and show it with a ruler or measuring tape
- 3) Press a button to begin the measurement
- 4) Show the reading with one floating point of precision (23.4cm/10.9in)
- 5) Accuracy must be within +- 3mm

Program mode test

- 1) Switch one and switch two are held down for 1 second, and then the unit enters program mode and displays the student's group number on displays. E.g. 058.
- 2) The display should continually flash at a rate of 1 second on and 500 ms off.
- 3) Release the switches
- 4) Now use the two switches to increment or decrement the student group number
- 5) Pushing increment or decrement causes the group number to increment or decrement by one.
- 6) When switch three is pushed and released, the unit comes up with a "C" or "I" on the display to indicate centimetres or inches output.
- 7) Switches one and two can now be used to change from "C" to "I" or vice versa. This sets the default start-up mode of either centimetres or inches
- 8) Switch three is pushed, and when released, the unit saves all new data and exits program mode.
- 9) Unit is unplugged and then plugged in again to show that new data has been saved.

Part 2: Report (5 marks)

- 1) **[2] Calibration.** Using the metal surface, test your ultrasonic distance meter every two centimetres between 3 and 31 cm inclusive. Plot the measured distance against the true distance. Is the device well-calibrated? Is its performance linear? Ensure all data series on the graph and axes are fully labelled (see example).



- 2) **[2] Variability.** Test your ultrasonic distance meter at 3, 15, and 30 cm for your metal surface and two different surfaces of your choosing. Make each measurement at least 5 times. Plot your results. Ensure all data series on the graph and axes are fully labelled. Describe how the material affects the performance of your device in terms of accuracy (difference between each measurement and true distance) and precision (variance of measurements).
- 3) **[1] Recommendations for use.** Write a short (100 words max) description of best use cases for your device based on your above findings. Give at least 2 scenarios where it would be expected to perform well and 2 where it would be expected to perform poorly.

Part 3: Use of Generative AI Statement (unmarked, mandatory)