Department of Electronic and Telecommunication Engineering
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Morse Code Practice Kit

Individual Project

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Contents

Abstract

This report presents a project wherein the undergraduates were tasked with selecting a product from the global market priced below $50, with the objective of enhancing it by incorporating additional features and improvements. The chosen approach involved analyzing various market options, considering their limitations, strengths, and potential for enhancement. Subsequently, a new and improved version was developed, showcasing advancements that elevate its performance and usability, offering greater value to the end-users.

1. Introduction

The Morse Code, which was initially introduced by Samuel F.B. Morse and became known as the "American" version, has undergone significant changes over time. Today, the usage of the original American Morse Code is scarce. However, the International Morse Code remains in use among various groups such as U.S. Navy intelligence specialists, aviation professionals who rely on Morse Code to communicate succinct identifiers, and enthusiasts who constitute the International Morse Code Preservation Society. Following are some specific applications of the Morse code in recent times.

Morse code was used extensively by the military in the past and is still used today in some contexts, such as for emergency signalling or low-bandwidth communication. It's low bandwidth compared to voice or even text and can be discerned against background noise even at extremely low signal strengths.

Morse code is used in some aviation communication systems, especially in situations where radio contact is lost or unreliable. The Federal Aviation Administration in the USA requires pilots to understand Morse code and to identify aircraft call signs since NDBs (Non-Directional Beacons) and VORs (VHF Omni-Directional Range) still send their identifying letters via Morse code.

Morse code is still used by some mariners, particularly in emergency situations or when other forms of communication are not available.

Morse code proves to be highly advantageous in circumstances that demand survival skills. In addition, it also serves as an effective tool to overcome censorship barriers. Overall, while Morse code is no longer a primary means of communication in most contexts, but still used in some specialized applications.

2. Functionality Description

The product functions as a proficient tool for Morse code generation from a provided text, while simultaneously possessing the capability to decode Morse code inputs and convert them back into readable text.

Upon inputting a designated text into the product, it performs the process of Morse code generation with remarkable accuracy and efficiency. As a result, users can effortlessly convert textual information into its corresponding Morse code representation.

Furthermore, the product showcases its versatility by offering inverse functionality, enabling the translation of incoming Morse code sequences into their original text format. By receiving Morse code input, the device interprets the series of dots and dashes and accurately deciphers them, providing users with the intended textual message.

3. Specifications and Extra features

3.1. Existing Product

- Morse Code sending process: ASCII code input is received by the module, converted into Morse code, and then converted into audio signal.
- Morse Code receiving process: It converts the received audio signal into Morse code, and then convert it into ASCII code and sends it.
- Operating voltage is 5V.
- There are 4 header pins
  - 5V : Power supply positive interface.
  - GND : Power supply ground interface.
  - RXD : receiving end of the module.
  - TXD : sending end of the module.
- Signal input interface : 3.5mm audio input interface.
- Signal output interface : 3.5mm audio output interface.
- There is a potentiometer to adjust the input.
- There are LEDs to indicate different operations/processes handled by the module.
  - Power (PWR)
  - Receive (RX)
  - Transmit (TX)
- Channel impairments are **not handled** by the module.

3.2. Variations from Existing Product on the Market

The current product is marketed in a module format, lacking an enclosure. Conversely, the envisioned iteration will be presented as a fully integrated, standalone product.

3.3. Extra Features

- LCD screen with Button inputs.
  - The user will be able to input text and output Morse codes.
- The integration of an enclosure. (Considering the absence of an enclosure in the available product within the market.)
  - Additionally the enclosure will contain a concise guide to the Morse code, intended for easy reference.
- A Buzzer to produce Morse code outputs.
- May include several Morse code protocols that the user can select. Such as,
  - American Morse code (Railroad Morse)
  - International/Continental Morse code
  - Japanese Morse code/Wabun code
  - Russian Morse code

  Implementation of these protocols will depend on the storage availability of the micro controller.

4. System model

4.1. Block Diagram

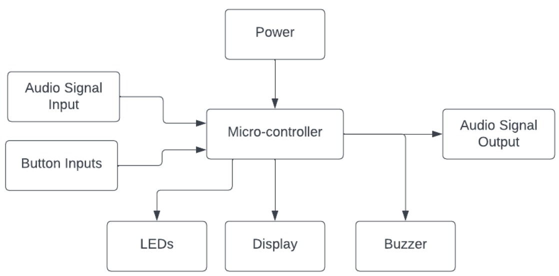

Figure 1: Block Diagram of the System Model

4.2. Design Parameters

- Operating Voltage - 5 V
- Microcontroller - ATMEGA328P-PU
- Display - ”0.96 OLED
- Power port - USB Type B
- Audio port - 3.5 MM AUDIO JACK
- PCB - 2 Layer, Manufactured and imported from JLC PCB (China)
- Enclosure Material - Plastic

5. Components

- Microcontroller - ATMEGA328P-PU
- Display - Adafruit SSD1306 ”0.96 OLED I2C
- USB Type B port - 61729-1011BLF
- 3.5 MM AUDIO JACK - SJ1-352XN
- Resistors (SMD-0805) - 330 Ω, 10 kΩ
- Capacitors (SMD-0805) - 22 pF, 100 nF, 10 μF
- Ferrite Beads(SMD-0805) - 100 mΩ MPZ2012S601AT000

6. Simulation

6.1. Platform

The simulation was conducted utilizing the online platform available at, www.wokwi.com.

Herein lies the reference to access the simulation pertaining to this project for further examination and analysis.

https://wokwi.com/projects/361934817357446145

6.2. Programming

The programming was done using the C++ language, and during execution, the available SRAM memory became insufficient. Consequently, certain variables were preserved in the flash memory on a permanent basis to address this limitation.

The code is available at the link for the simulation provided above.

7. Schematics

Following are the schematics used for the PCB design.

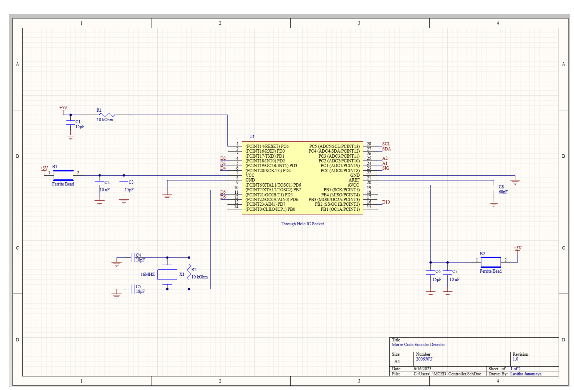

Figure 2: Schematic - Microcontroller

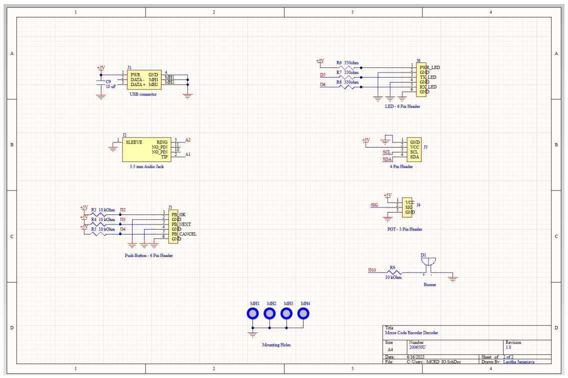

Figure 3: Schematic - I/O

8. PCB Design

The Printed Circuit Board (PCB) was designed using **Altium Designer** and it consists of a total of two layers, encompassing both the Top and Bottom layers, each featuring Power and Ground polygon pours. Careful consideration has been given to the component placement to ensure minimal distances and simple routing wherever feasible.

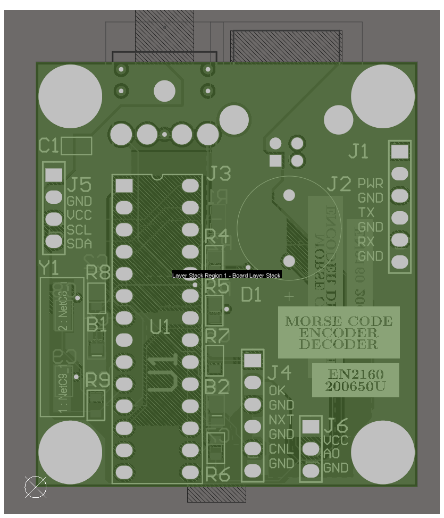

Figure 4: Board Layout Design

Surface-mount device (SMD) components were employed to minimize the size of the PCB.

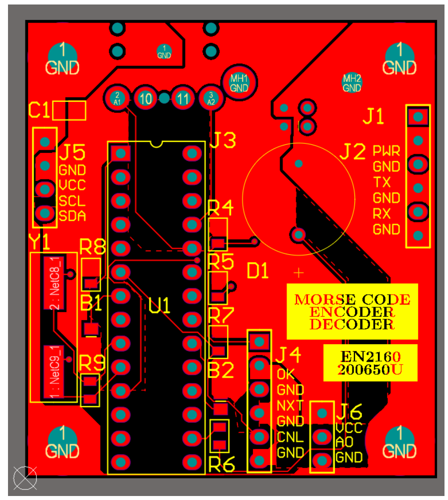

Figure 5: Top Layer

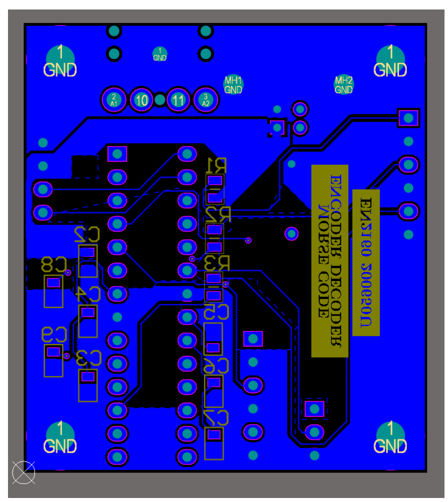

Figure 6: Bottom Layer

Presented below are the three-dimensional perspectives of the printed circuit board (PCB).

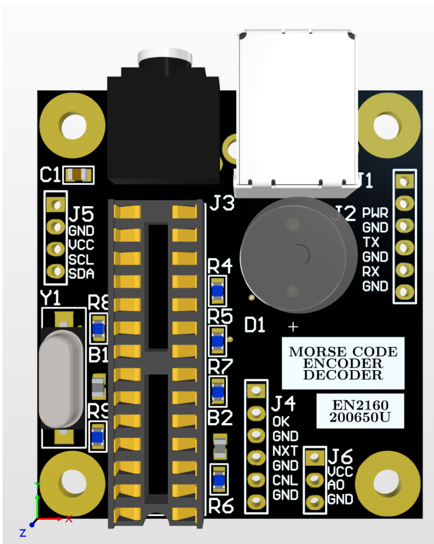

Figure 7: Top

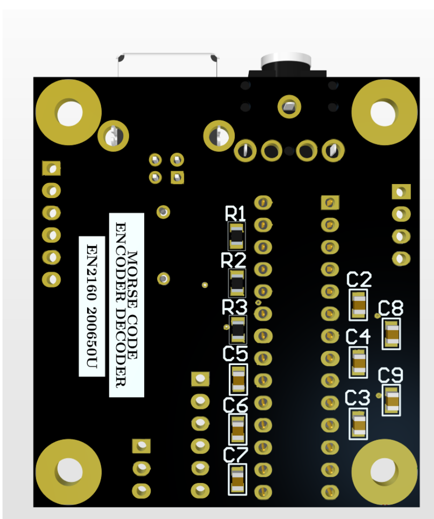

Figure 8: Bottom

9. Enclosure Design

Enclosure was designed using **Solidworks** and it contains 2 parts as Top and Bottom.

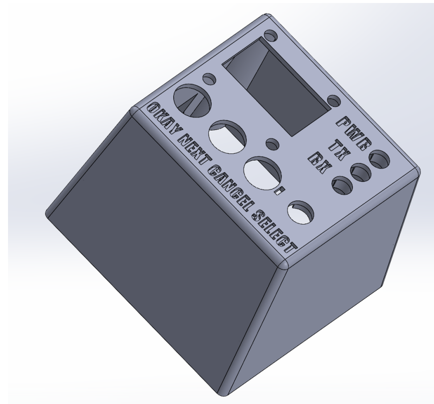

Figure 9: Top - Outside

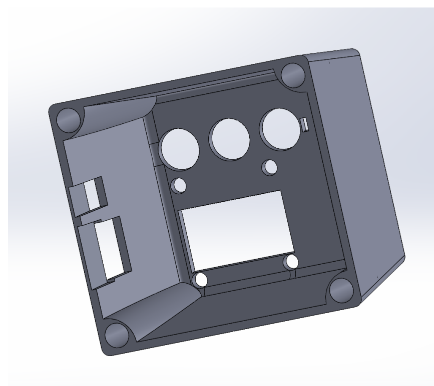

Figure 10: Top - Inside

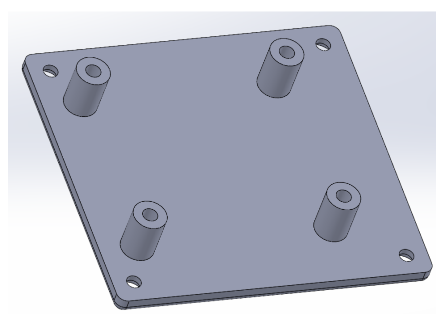

Figure 11: Bottom - Mounts for the PCB

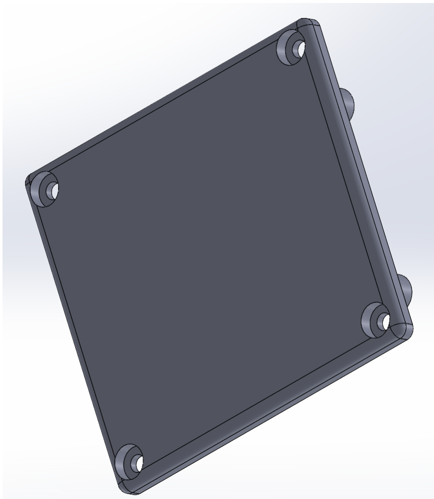

Figure 12: Bottom - Holes which the 3 mm screws will go in

10. Production

10.1. PCB

The printed circuit board (PCB) was fabricated by **JLCPCB**, a company based in China, with the following specifications: **2 layer - 1 oz**.

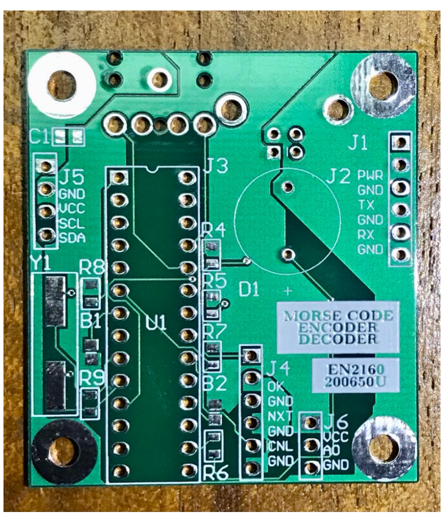

Figure 13: Top

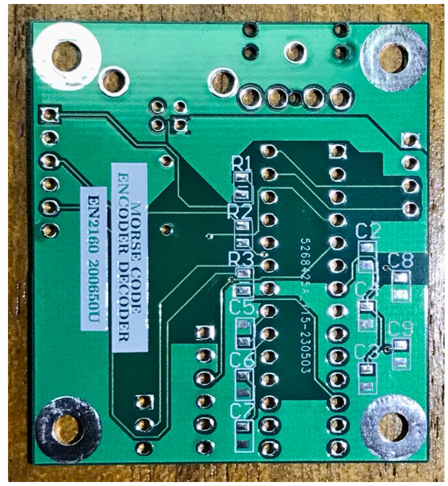

Figure 14: Bottom

10.2. Soldered PCB

Each component on the PCB was meticulously hand-soldered with care and precision.

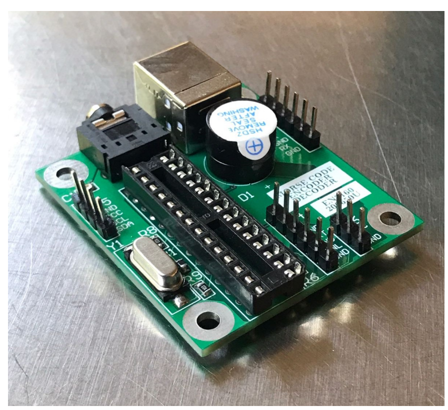

Figure 15: Top

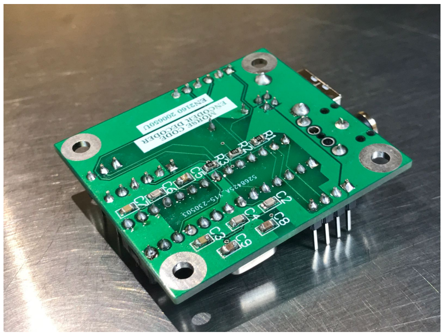

Figure 16: Bottom

*Please note that all the headers connected to the PCB were later replaced by **JST connectors**. See figure 18 and figure 19.

10.3. Enclosure

The enclosure was fabricated using 3D printing technology in a black color, while careful consideration was given to selecting components that complemented the enclosure's color.

Figure 17: Enclosure Fixed

10.4. Assembly

The assembly process was executed with ease by carefully placing all the nuts in their designated positions and seamlessly connecting all the JST connectors. Additionally, determining the PCB orientation proved to be straightforward and effortless.

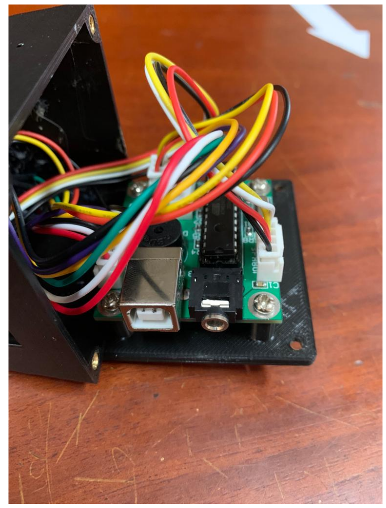

Figure 18: Assembled Product 1

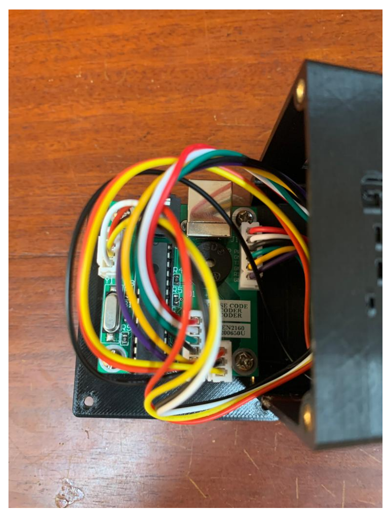

Figure 19: Assembled Product 1

To begin the assembly process, securely attach the OLED display to the upper section of the enclosure using 2mm nuts and bolts. Next, fasten the buttons and potentiometer in their designated positions using their respective nuts. Install the potentiometer knob to its designated location. Proceed by affixing the LEDs in place with 5mm rubber rings.

Subsequently, position the PCB on the lower part of the enclosure in the correct orientation and secure it using 3mm bolts. Exercise caution while connecting the JST Connectors, as they are easily distinguishable.

Finally, unite the two parts of the enclosure and firmly fasten them together using 3mm nuts.

11. Testing for functionality

11.1. Power-On Test

Initiate the process by establishing power connection using a USB type A to USB type B cable. Observe the OLED display for successful initialization and verify the illumination of the PWR LED to ensure proper functionality.

11.2. Visual Inspection

Perform a comprehensive visual examination of the product, meticulously assessing for any physical damages, loose connections, or abnormalities on both the circuit board and individual components.

11.3. Functional Components

Verify the functionality of the buttons and the potentiometer. Ensure that the buttons exhibit their designated momentary push functionality, while also confirming the smooth and unhindered rotation of the potentiometer.

11.4. Functional Modes

Subsequently, assess the operation of the Encode and Decode modes upon selection. The successful loading of these modes indicates their satisfactory performance.

12. Bill of Materials

In this context, it is assumed that 1 USD is equivalent to 330 LKR (Sri Lankan Rupees).

Item	Quantity	Unit Cost ($)	Amount ($)
Overseas			
Resistor 10kΩ SMD 0805 MCU0805MD1002DP500	6	0.1862	1.1172
Resistor 330Ω SMD 0805 CRCW0805330RFKEA	3	0.0168	0.0504
Capacitor 10μF SMD 0805 CL21A106KBYQNNE	3	0.0994	0.2982
Capacitors 22pF SMD 0805 VJ0805A220GXACW1BC	5	0.0733	0.3665
Ferrite Beads SMD 0805 MPZ2012S601AT000	2	0.0314	0.0628
16MHz 18pF SMD Crystal ABLS-16.000MHZ-B4-T	1	0.3153	0.3153
USB Type-B Female Connector 61729-1011BLF	1	0.8735	0.8735
3.5 mm Female Audio Connector SJ1-3523NG	1	0.5378	0.5378
Adafruit OLED display 0.96 in I2C	1	12.48	12.48
ATMEGA328P-PU	1	2.89	2.89
32 pin dip socket 110-44-632-41-001000	1	2.18	2.18
PCB fabrication - JLC PCB	1	8.19	8.19
		Cost ($)	29.3617
Local			
Item	**Quantity**	**Unit Cost (Rs)**	**Amount (Rs)**
3 way JST connector	1	30	30
4 way JST connector	1	40	40
6 way JST connector	2	50	100
Buzzer	1	50	50
LED 5mm	3	5	15
M3 bolts	8	5	40
M2 bolts and nuts	4	5	20
Potentiometer knob	1	110	110
Momentary Push Button	3	80	240
Enclosure 3D Print	1	3200	3200
		Cost (Rs)	3845
	Total Cost	Rs 13,536	41.02 $

Table 1: Bill Of Materials

13. References

[1] "Arduino memory guide." https://docs.arduino.cc/learn/programming/memory-guide.

[2] "Reading and writing flash memory with portenta h7." https://docs.arduino.cc/tutorials/portenta-h7/reading-writing-flash-memory.

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[4] "Atmel atmega comparison." https://www.futurlec.com/ICAtmel_ATMega_Comparison.shtml.

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