Prison Access Card System

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Design Laboratory

1. Introduction

The main objective of the project was to create a scanning card system for prisons. Destined location would be in front of the visiting room, to give access to visitors, and prison staff. This is a security system, which is to prevent unwanted users from accessing the room. Users who scanned their card are monitored in the live database. They are divided into three groups: Admin, Entitled, and Unknown.

To ensure the highest class safety, several solutions have been used:

- the amount of tries/attempts limited to 3
- protection against opening the reader case by unauthorized users by using a reed switch and neodymium magnet
- solution preventing the power supply shortage by using a Linear Li-Pol Battery Charger

The electrical scheme and PCB layout was made in EasyEDA.com. In order to achieve the desired effect, the following components were used:

- ESP8266
- MF RC522 RFID Module
- OLED Display
- Voltage regulator 6206A
- TP-4056 Battery Charger
- other necessary: switch buttons, LED diodes, USB-C connector, a reed switch, neodymium magnets, Li-Pol battery, resistors, capacitors, wires, fuse

2. Scope of the project

1. Research stage
2. Arrangement of the work schedule
3. Creating an operation algorithm
4. Creating a schematic using EasyEDA platform - division into specific sections
    - designing the power supply section
    - planning the distribution of the pins
    - working with datasheets
5. Cost estimation
6. Layout design
7. Etching the PCB circuit
8. Software implementation
9. Testing the code
10. Ordering the PCB
11. Final assembly

3. Technical data

Component	Purpose	Specification
ESP8266	The heart of the project, interfacing with all of the components, responsible for the WiFi connection	band: 2,4GHz Wi-Fi 5, 802.11b/g/n voltage supply: 3.3V
MF RC522 RFID Module	Identification of the RFID cards	contactless communication at 13.56 MHz SPI bus speed up to 10Mbit/s operating voltage: 2.5V~3.3V
OLED Display	Displaying the messages live on the screen	resolution: 128x32 I2C bus
Voltage regulator	Adjusting power supply for the logical part	6206A LDO 3.3V
TP-4056 Battery Charger	Charg Li-Pol battery	Input Voltage: -0.3V ~ 8V BAT Pin Current: 1200mA
switch buttons	Admin button, Reset button, Enable button	NO contact
LED diodes	Informing about battery charging	3 mm diffused LED voltage drop of 2,1 V 20mA output current
reed switch	Prevents the device from being opened unsupervised	NO
Li-Pol battery	Emergency power supply	3.7V, 1580mAh
resistors, capacitors, wires, fuse	Parts to ensure proper operation of the circuit	values adapted to component requirements

4. Electric diagram

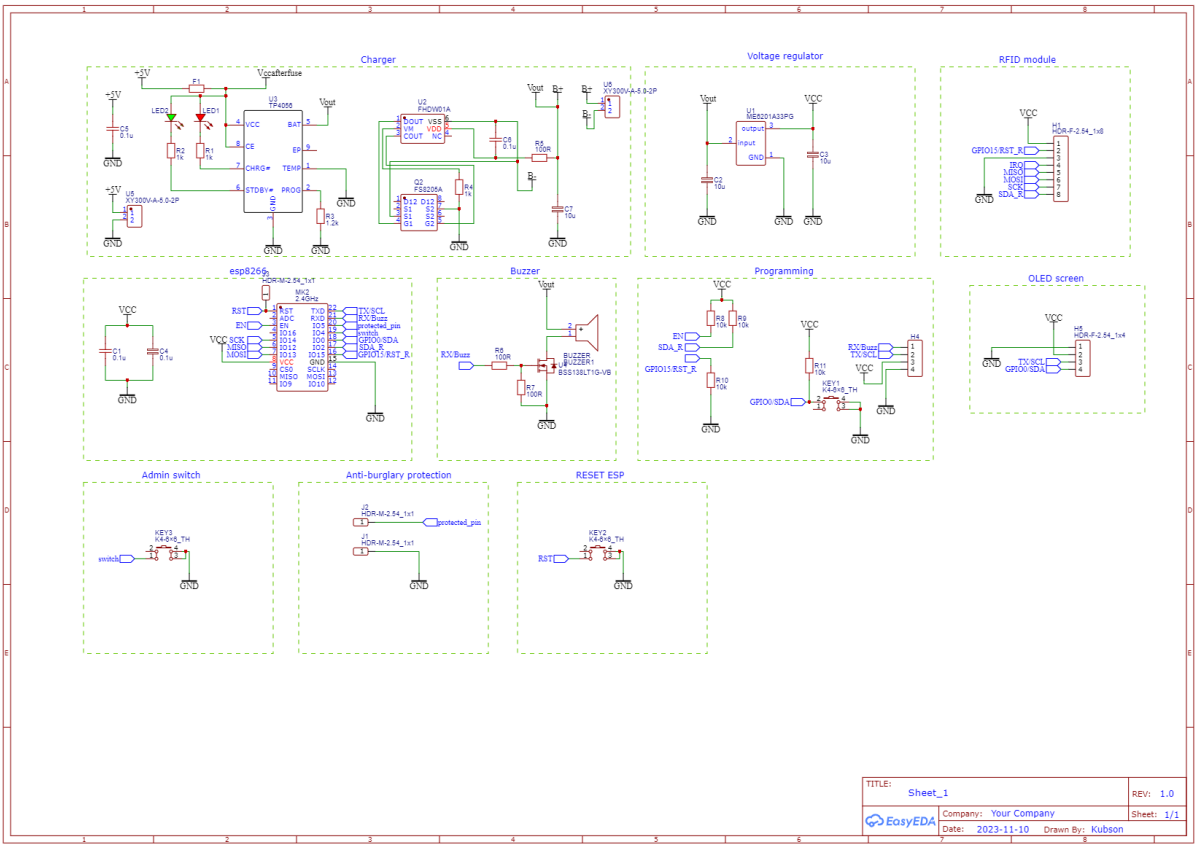
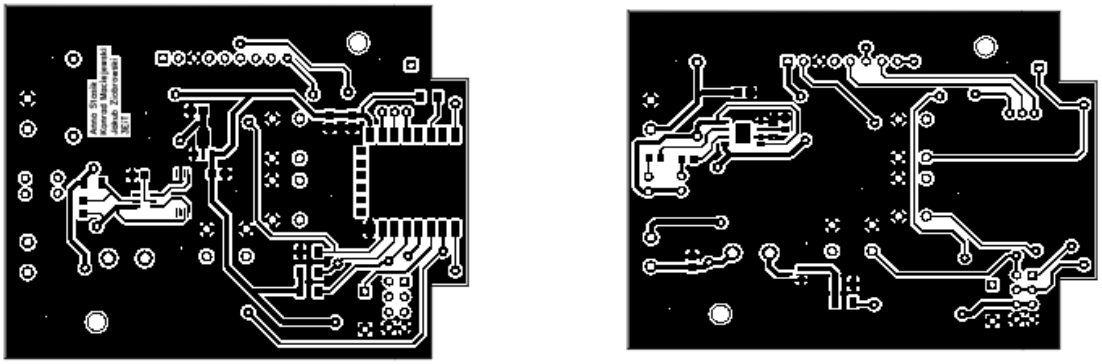


Figure 1. Electronic circuit block diagram using easyEDA.com

5. PCB Layout



TOP LAYER **BOTTOM LAYER**

Figure 2. Double-sided PCB project made with easyEDA.com

6. Software implementation

The code was created in C/C++ using the VisualStudioCode environment with PlatformIO extension. Libraries applied in the making are as follows:

- Arduino.h
- Wire.h
- Adafruit_SSD1306.h
- Adafruit_GFX.h
- MFRC522.h
- Ticker.h
- ESP8266WiFi.h
- HTTPSRedirect.h

Crucial functions used in the code covered the basic logic of the scanning process as well as processing the data and storing it in google sheets. There is a quick overview of the code's main components and functionalities below:

Constants and Variables:
The code defines constants for screen dimensions, addresses, and pins.
It declares variables for RFID card information, flags for system states, and timing-related variables.

Google Sheets Integration:
It communicates with a Google Sheets script via HTTPS to log RFID card scans.
The script ID and sheet name are specified. The HTTPS communication is handled using the HTTPSRedirect library.

Wi-Fi Setup:
It sets up Wi-Fi credentials for connecting to the network.

RFID Setup:
Initializes the RFID module and defines a structure for storing key-value pairs (card ID to user).

Function Definitions:
Functions are defined for adding key-value pairs, retrieving values, drawing different pages on the OLED display, handling RFID card checks, and creating payload for Google Sheets.

Setup Function:
Configures pin modes, initializes components, establishes Wi-Fi connection, and sets up communication with the Google Sheets script. It draws the start page on the OLED display.

Loop Function:
Continuously loops through RFID card scanning.
Checks for new RFID card presence and reads the card's unique identifier.

Performs various actions based on the card information, such as displaying welcome messages, handling wrong attempts, triggering alarms, or entering service mode. Sends data to the Google Sheets script using HTTPS.

Interrupts:
Utilizes interrupts for handling an admin button press (admin_button) and triggering an alarm (isr).

Timers:
Uses Ticker library to handle periodic tasks, such as blinking an LED during an alarm.

Display Functions:
Functions are provided for drawing different pages on the OLED display, such as the start page, main page, welcome page, wrong attempt page, alarm page, and service page.

7. Literature and other resources

- Płytki drukowane (PCB) : nauka i projekty od podstaw / Shawn Wallace; tłumaczenie Konrad Matuk
- https://www.espressif.com/sites/default/files/documentation/esp8266_hardware_design_guidelines_en.pdf
- https://randomnerdtutorials.com/esp8266-pinout-reference-gpios/
- https://www.udemy.com/course/internet-of-things-using-esp8266/
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