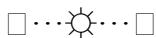


**VIETNAM NATIONAL UNIVERSITY OF HO CHI MINH CITY**

**HO CHI MINH UNIVERSITY OF TECHNOLOGY**



**ASSIGNMENT REPORT**

**SUBJECT: ELECTRICAL ELECTRONICS CIRCUITS (CO2038)**

**MODULE: COMPUTER HARDWARE DESIGN**

**GROUP: 06 - CLASS: L02 - SEMESTER:231**

**ACADEMIC YEAR:2023-2024**

**LECTURER: HUỲNH HOÀNG KHA**

**01/01/2024**

## **TEAM MEMBER**

NO	NAME	ID	Contribution
1	Vũ Đức Lâm	2211824	100%
2	Nguyễn Nhật Nam	2212147	100%
3	Lưu Văn Huy	2211199	100%

## I. REQUIREMENT ENGINEERING

### 1. GENERAL DESCRIPTION

This assignment is inspired by the concept of hardware design of game consoles that play games such as Nintendo, Gameboy. Additionally, this console can also be an MP3 player or some compatible stimulators which can be generated on our project.

This product is compact, easy to use for ages of 4 or above, and especially safe for users.

### 2. REQUIREMENTS SPECIFICATIONS

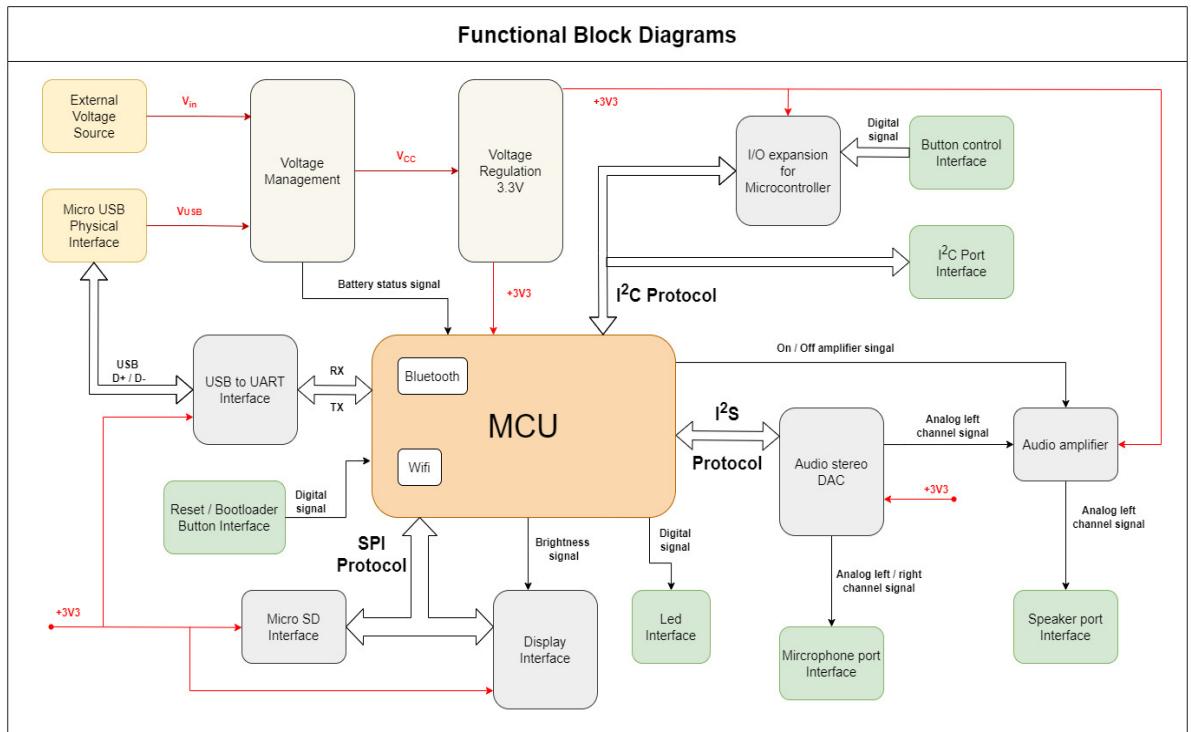
MECHANICAL	Size	Weight	Height		
	100x50mm	150g	16mm		
ENVIRONMENT	Operating temperature	Storage temperature			
	-20°C to 85°C	-40°C to 105°C			
POWER	USB Power supply	PIN Power supply			
	5V-500mA	<20V-500mA (Recommend Pin Lipo 3.7V)			
STORAGE	Depend on the external SD card				
CPU	<ul style="list-style-type: none"><li>• Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS</li><li>• Ultra low power (ULP) co-processor</li></ul>				
MEMORY	520 KiB RAM, 448 KiB ROM				
WIRELESS CONNECTIVITY	WIFI	BLUETOOTH			
	802.11/b/g/n	v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)			
DISPLAY SCREEN	RESOLUTION				
	240x320 pixels				

## AUDIO

- Sampling frequency: 44.1kHz
- Ultra low out-of-band noise
- Direct line level 2.1-Vrms output
- Automatic power-save mode
- Speaker: 0.6W-8Ω

## II. CONCEPTUAL DESIGN

### 1. IDEA:



### 2. DETAIL EXPLANATION OF EACH COMPONENT:

- **MCU:** Processing data and displaying the operation, wifi and bluetooth are integrated.
- **Micro SD Interface:** Read and write data from SD card with SPI communication protocol.
- **USB to UART interface:** Realize signal to send and receive serial data from USB port into serial data that can be sent or received by UART interface.
- **Display Interface:** Display graphics from data taken from MCU through SPI communication protocol.
- **LED interface:** notify the status of the board.
- **I/O expansion for microcontroller:** Expand GPIO gate for the MCU through I<sup>2</sup>C communication protocol.
  - + **Button control interface:** controlled physical buttons by users.

- **RESET/Bootloader button interface:** reset the entire board and turn on the bootloader status for compiling code.
- **I<sup>2</sup>C port interface:** connect external devices through I<sup>2</sup>C communication protocol.
- **Audio Stereo DAC:** Decoder that converts digital signal to analog signal from MCU by I<sup>2</sup>S communication protocol.
  - + **Microphone port interface:** Deliver analog audio signal to microphone.
- **Audio amplifier:** amplitude the audio to speaker and receive signals from Audio Stereo DAC.
  - + **Speaker port interface:** connect the external physical left channel speaker.
- **External Voltage source:** pin supplier (<20V)
- **Micro USB physical interface:** 2-way transmission of data to **USB to UART interface**
- **Voltage management:** managing and processing input suppliers. can be charged.
- **Voltage Regulation:** provide the main voltage source for the board at the default of 3.3V.

### **3. MCU PIN CONFIGURATION FOR DEVELOPER:**

NAME	GPIO	DESCRIPTION
<b>DISPLAY SPI</b>	5	CS
	12	DC
	18	SCK
	23	MOSI
	27	BACKLIGHT
<b>SD CARD SPI</b>	2	DAT0
	14	CLK
	15	CMD
<b>I<sup>2</sup>C</b>	21	SDA
	22	SCL

<b>I<sup>2</sup>S audio</b>	19	DIN
	25	LCK
	26	BCK
<b>AMPLIFIER</b>	4	ON/OFF
<b>LED</b>	13	ON/OFF
<b>POWER SUPPLY</b>	39	BATTERY STATUS
	32	DETECT USB
	33	CHARGE STATUS
<b>L-BUTTON</b>	36	NONE
<b>R-BUTTON</b>	34	NONE
<b>MENU BUTTON</b>	35	NONE

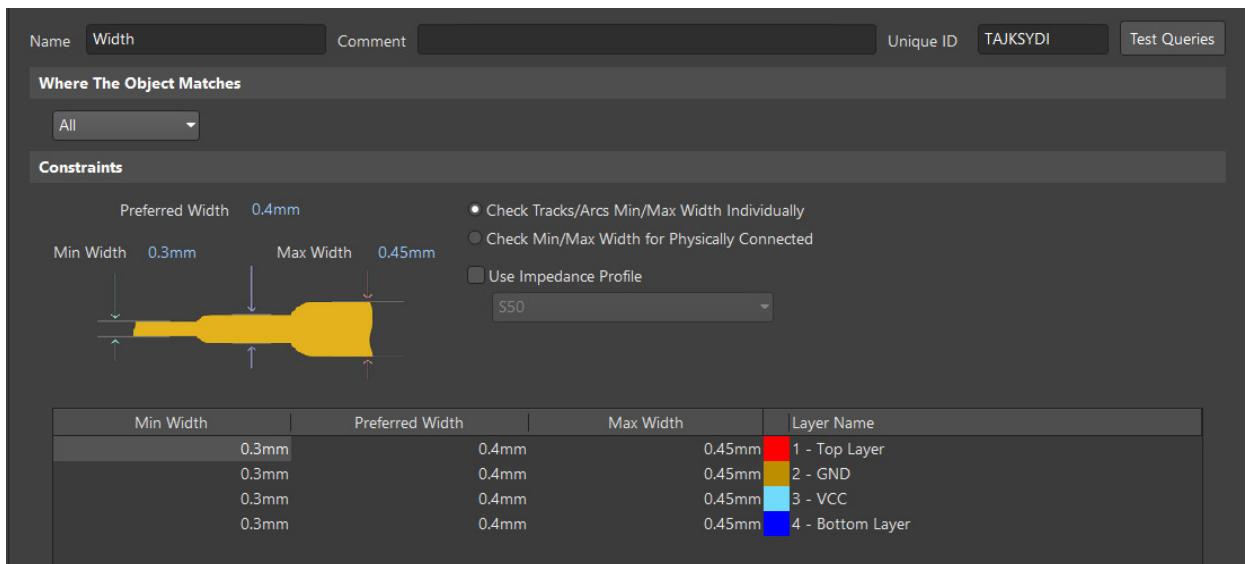
### **Hardware used:**

- ESP32 WROVER, Dual core processor with Integrated 4MB Flash + 4MB PSRAM.
- Integrated WIFI and Bluetooth 4 BLE
- 2.4" ILI9341 TFT Panel
- More button (expanded via PCF8574 I2C GPIO)
- Micro SD slot connected to SDMMC Host in 1 Line Mode for save GPIO pin
- Integrated I<sup>2</sup>S DAC via PCM5102A
- Integrated amplifier PAM8403
- Integrated USB to Serial for programming and debugging using CH340C
- Built-in TP4056 Li-Po charger
- I<sup>2</sup>C port for expandable function
- 3.5mm Headphone jack
- XH 2.54mm speaker jack
- Smaller Size, PCB only 100 x 50 mm.

## **4. CALCULATION OF THE DESIGN**

We use the website: <https://www.4pcb.com/trace-width-calculator.html> to compare things we have done in the project.

**Our project parameter:**



### Web calculator:

#### Inputs:

Current	0.5	Amps
Thickness	1.6	oz/ft <sup>2</sup>

#### Optional Inputs:

Temperature Rise	10	Deg C
Ambient Temperature	40	Deg C
Trace Length	1	mm

#### Results for Internal Layers:

Required Trace Width	0.188	mm
Resistance	0.00177	Ohms
Voltage Drop	0.000887	Volts
Power Loss	0.000444	Watts

#### Results for External Layers in Air:

Required Trace Width	0.0722	mm
Resistance	0.00462	Ohms
Voltage Drop	0.00231	Volts
Power Loss	0.00115	Watts

We estimated that the maximum of the current is 0.5A and thickness = 1.6oz/ft<sup>2</sup>

The comparison we include below:

Criteria	PCB calculator website	Our Project
Internal Layers (Trace Width)	Minimum = 0.188mm	0.3-0.45mm
External Layers (Trace Width)	Minimum = 0.0722mm	0.3-0.45mm

## 5. WAYS OF CHOOSING COMPONENTS

Because these components are available on the Vietnamese market and the datasheet of them are fully public when we searched. Moreover, these components we have chosen can be bought in a short period of time in order to make and fix the design conveniently. In addition, the SMD encapsulation is suitable for machining precisely and compactly.

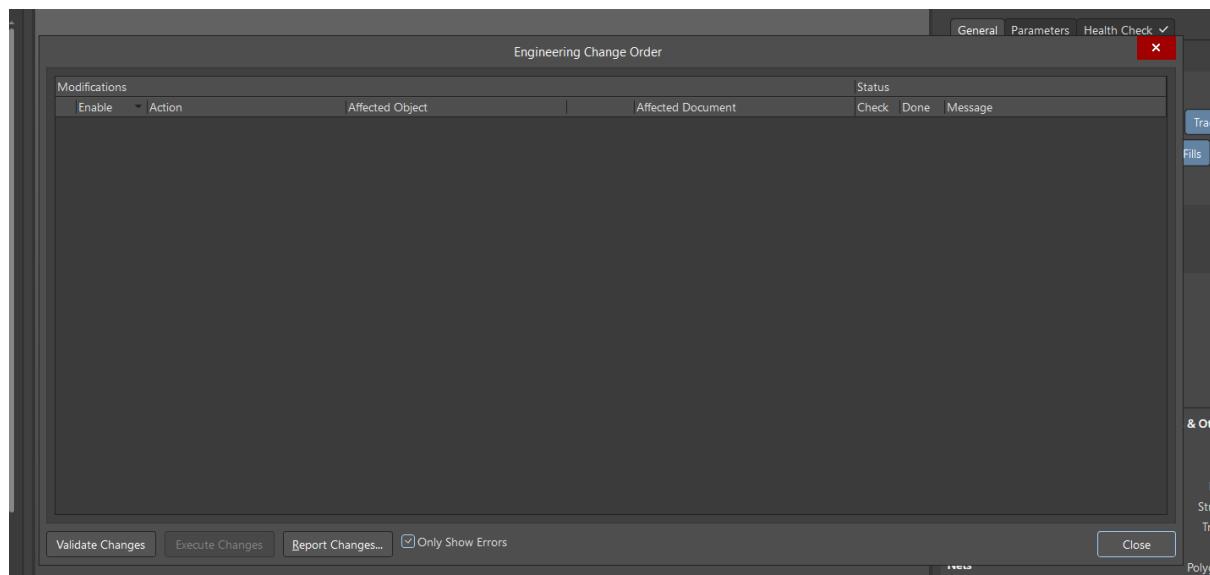
One of the most attractive shops on the market place is “IC dây ròi!”, “Thế giới IC”,... Thus, they are our preferable places to buy components for this assignment.

### III. SCHEMATIC VALIDATION AND UPDATE PCB, DESIGN RULES AND RESULT OF THE DESIGN RULES CHECK

At first, when running the schematic validation, there were some warnings that were not to be crucially considered.

Class	Document	Source	Message	Time	Date	No.
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_5	contains IO Pin and Input Port objects (Pin MD1-5, Port VBAT_S).	11:31:44 PM	1/3/2024	8
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_6	contains IO Pin and Input Port objects (Pin MD1-6, Port R_BTN).	11:31:44 PM	1/3/2024	9
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_7	contains IO Pin and Input Port objects (Pin MD1-7, Port MENU).	11:31:44 PM	1/3/2024	10
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_8	contains IO Pin and Input Port objects (Pin MD1-8, Port USB_DET).	11:31:44 PM	1/3/2024	11
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_9	contains IO Pin and Input Port objects (Pin MD1-9, Port CHRG_STAT).	11:31:44 PM	1/3/2024	12
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_10	contains IO Pin and Output Port objects (Pin MD1-10, Port I2S_LCK).	11:31:44 PM	1/3/2024	13
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_11	contains IO Pin and Output Port objects (Pin MD1-11, Port I2S_BCK).	11:31:44 PM	1/3/2024	14
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_12	contains IO Pin and Output Port objects (Pin MD1-12, Port LCD_BCKL).	11:31:44 PM	1/3/2024	15
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_13	contains IO Pin and Output Port objects (Pin MD1-13, Port SD_CLK).	11:31:44 PM	1/3/2024	16
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_14	contains IO Pin and Output Port objects (Pin MD1-14, Port LCD_DC).	11:31:44 PM	1/3/2024	17
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_23	contains IO Pin and Output Port objects (Pin MD1-23, Port SD_CMD).	11:31:44 PM	1/3/2024	18
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_24	contains IO Pin and Input Port objects (Pin MD1-24, Port SD_DAT0).	11:31:44 PM	1/3/2024	19
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_25	contains IO Pin and Input Port objects (Pin MD1-25, Port IO0).	11:31:44 PM	1/3/2024	20
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_26	contains IO Pin and Output Port objects (Pin MD1-26, Port AUDIO_SHD).	11:31:44 PM	1/3/2024	21
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_29	contains IO Pin and Output Port objects (Pin MD1-29, Port LCD_CS).	11:31:44 PM	1/3/2024	22
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_30	contains IO Pin and Output Port objects (Pin MD1-30, Port LCD_SCK).	11:31:44 PM	1/3/2024	23
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_31	contains IO Pin and Output Port objects (Pin MD1-31, Port I2S_DIN).	11:31:44 PM	1/3/2024	24
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_36	contains IO Pin and Output Port objects (Pin MD1-36, Port I2C_SCL).	11:31:44 PM	1/3/2024	25
■ [Warning]	MICROCONTROLLF Compiler	NetMD1_37	contains IO Pin and Output Port objects (Pin MD1-37, Port LCD_MOSI).	11:31:44 PM	1/3/2024	26
■ [Warning]	MINI CONSOLE.Sch Compiler	Nets Wire CSX	has multiple names (Net Label CSX, Sheet Entry U_MICROCONTROLLE	11:31:44 PM	1/3/2024	27
■ [Warning]	MINI CONSOLE.Sch Compiler	Nets Wire D/CX	has multiple names (Net Label D/CX, Sheet Entry U_MICROCONTROL	11:31:44 PM	1/3/2024	28
■ [Warning]	MINI CONSOLE.Sch Compiler	Nets Wire D_N	has multiple names (Net Label D_N, Sheet Entry U_POWER SUPPLY AN	11:31:44 PM	1/3/2024	29
■ [Warning]	MINI CONSOLE.Sch Compiler	Nets Wire D_P	has multiple names (Net Label D_P, Sheet Entry U_POWER SUPPLY AN	11:31:44 PM	1/3/2024	30
■ [Warning]	UART AND DISPLAY Compiler	Nets Wire LED_K1	has multiple names (Net Label LED_K1, Net Label LED_K2, Net Label LED_K3)	11:31:44 PM	1/3/2024	31
■ [Warning]	MINI CONSOLE.Sch Compiler	Nets Wire SCL	has multiple names (Net Label SCL, Sheet Entry U_MICROCONTROLLEI	11:31:44 PM	1/3/2024	32
■ [Warning]	MINI CONSOLE.Sch Compiler	Nets Wire SDI	has multiple names (Net Label SDI, Sheet Entry U_MICROCONTROLLER	11:31:44 PM	1/3/2024	33
■ [Warning]	INPUT_BUTTON.Sch Compiler	Off grid Net Label BTN_DOWN	at 2394.665mil,3000mil	11:31:44 PM	1/3/2024	34
■ [Warning]	INPUT_BUTTON.Sch Compiler	Off grid Net Label BTN_START	at 6290.52mil,3000mil	11:31:44 PM	1/3/2024	35
■ [Warning]	INPUT_BUTTON.Sch Compiler	Off grid Port I2C_SCL	at 2055.732mil,6500mil	11:31:44 PM	1/3/2024	36
■ [Warning]	INPUT_BUTTON.Sch Compiler	Off grid Port I2C_SDA	at 2039.771mil,6400mil	11:31:44 PM	1/3/2024	37
■ [Warning]	UART AND DISPLAY Compiler	Off grid Port LCD_SCK	at 3097.84mil,3100mil	11:31:44 PM	1/3/2024	38
■ [Warning]	INPUT_BUTTON.Sch Compiler	Off grid Port MENU	at 7272.399mil,4800mil	11:31:44 PM	1/3/2024	39
■ [Warning]	MICROCONTROLLF Compiler	Off grid Port R_BTN	at 105.98mm,6.58mm	11:31:44 PM	1/3/2024	40
■ [Warning]	INPUT_BUTTON.Sch Compiler	Off grid Port R_BTN	at 7272.399mil,5700mil	11:31:44 PM	1/3/2024	41
■ [Warning]	UART AND DISPLAY Compiler	Unconnected line (200mil,4000mil)	To (7000mil,4000mil)	11:31:44 PM	1/3/2024	42
■ [Warning]	AUDIO.SchDoc Compiler	Unconnected line (200mil,5200mil)	To (11300mil,3700mil)	11:31:44 PM	1/3/2024	43

After updating the schematic to PCB, there was no warnings at all:



We had observed and analyzed the way that the manufacturer can generate a board as our assignment's criteria. Thus, we came into this website as our priority before ordering: <https://jlcpcb.com/capabilities/pcb-capabilities>

We create a table to compare our project's rules and the manufacturer's capability as below:

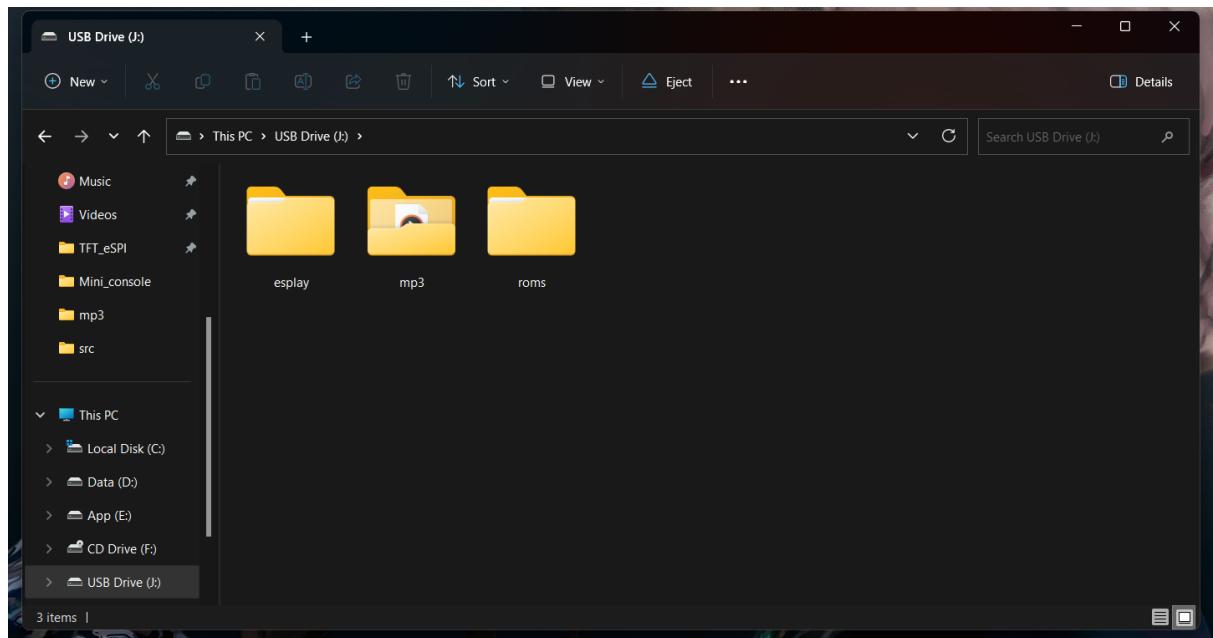
<b>Criteria</b>	<b>Manufacturer</b>	<b>Our Project</b>
Drill Hole Size Constraint	0.15-6.3mm	0.25-6.2mm
Blind/buried Vias	Only make through holes	Through holes
Via hole size/Diameter	$\geq 0.15\text{mm}/0.25\text{mm}$	$\geq 0.35\text{mm}/0.5\text{mm}$
PTH Hole Size	0.2-6.35mm	0.25-6.2mm
Hole To Hold Clearance	$\geq 0.5\text{mm}$	0.6mm
Via to Via Clearance	$\geq 0.254\text{mm}$	0.3mm
Via to Track	$\geq 0.254\text{mm}$	0.3mm
Pad to Track	$\geq 0.2\text{mm}$	0.25mm
Track width	$\geq 0.09\text{mm}$	0.3-0.45mm
Min Spacing	$\geq 0.09\text{mm}$	0.254mm
Silk To Solder Mask (Clearance)	$\geq 0.08\text{mm}$	0.17mm
Line width	$\geq 0.153\text{mm}$	0.254mm
Text height	$\geq 1.0\text{mm}$	1.3mm
Pad to silkscreen	$\geq 0.15\text{mm}$	0.17mm
Trace to outline	$\geq 0.3\text{mm}$	0.35mm

## The Design Rule Check when run:

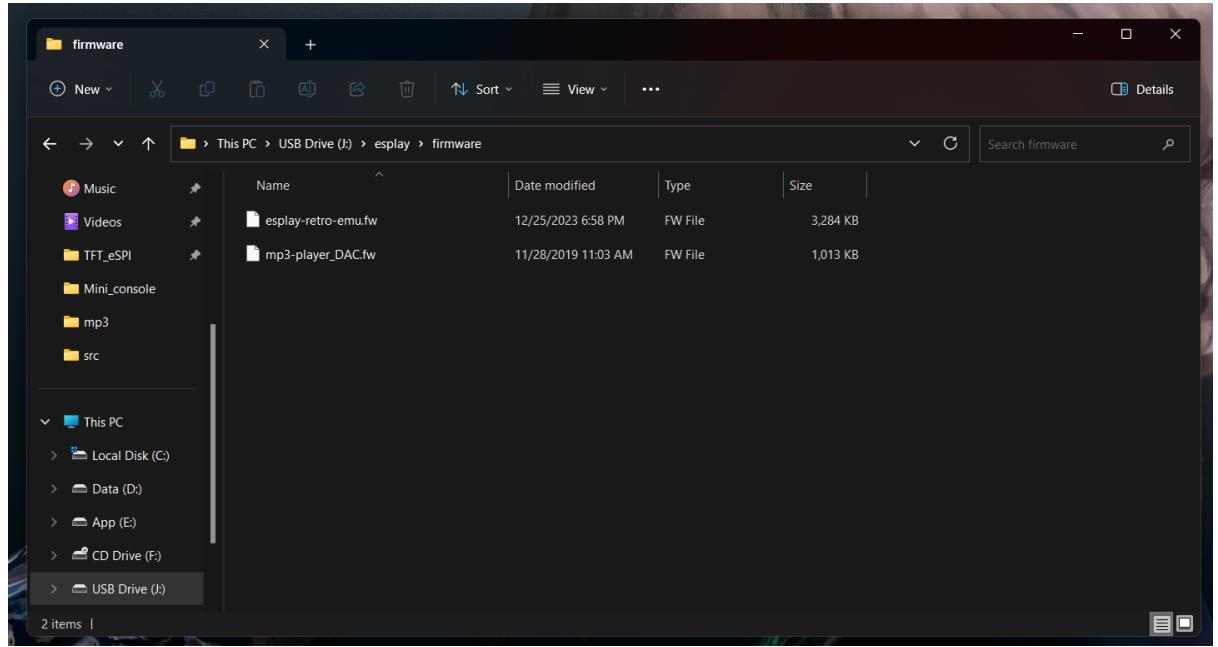
Warnings	Count
Total	0
Rule Violations	Count
Clearance Constraint (Gap=0.3mm).(All).(All)	0
Short-Circuit Constraint (Allowed=Yes).(All).(All)	0
Un-Routed Net Constraint .(All).	0
Modified Polygon (Allow modified: No).(Allow shelved: No)	0
Width Constraint (Min=0.3mm) (Max=0.45mm) (Preferred=0.4mm).(All)	0
Power Plane Connect Rule(Direct Connect )(Expansion=0.508mm) (Conductor Width=0.254mm) (Air Gap=0.254mm) (Entries=2).(All)	0
Hole Size Constraint (Min=0.25mm) (Max=6.2mm).(All)	0
Hole To Hole Clearance (Gap=0.6mm).(All).(All)	0
Minimum Solder Mask Sliver (Gap=0.1mm).(All).(All)	0
Silk To Solder Mask (Clearance=0.17mm).(IsPad).(All)	0
Silk to Silk (Clearance=0.2mm).(All).(All)	0
Net Antennae (Tolerance=0mm).(All)	0
Board Clearance Constraint (Gap=0mm).(All)	0
Height Constraint (Min=0mm) (Max=25.4mm) (Preferred=12.7mm).(All)	0
Total	0

## IV. USER'S MANUAL

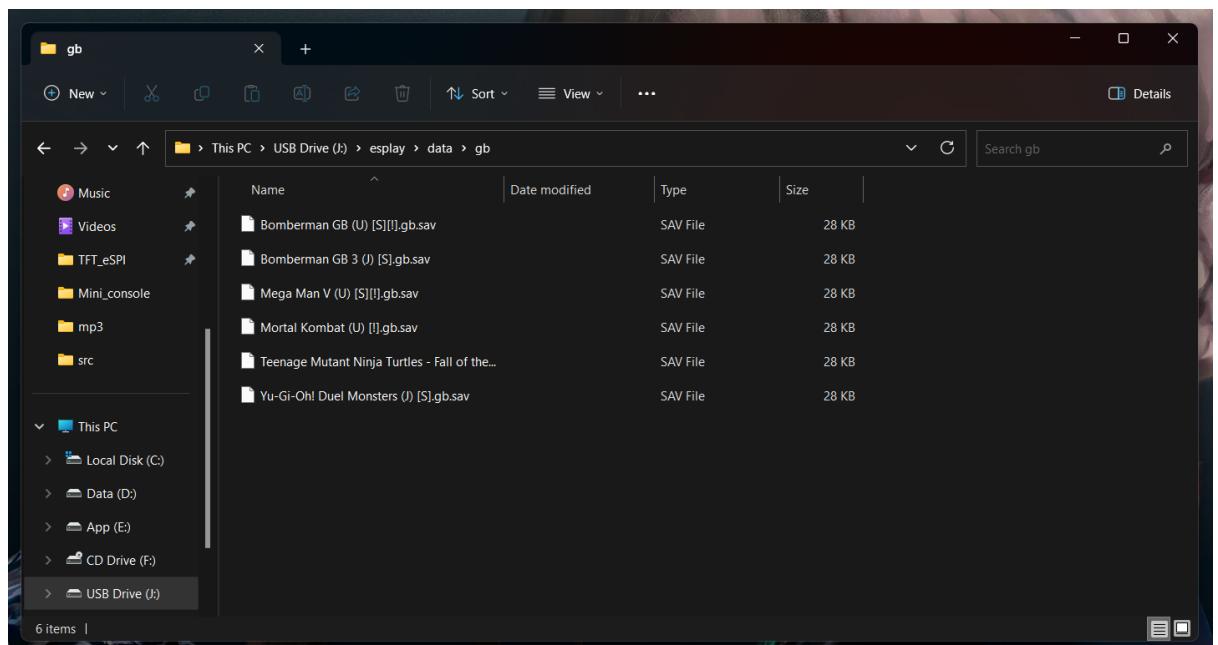
### 1. Folder in SD card



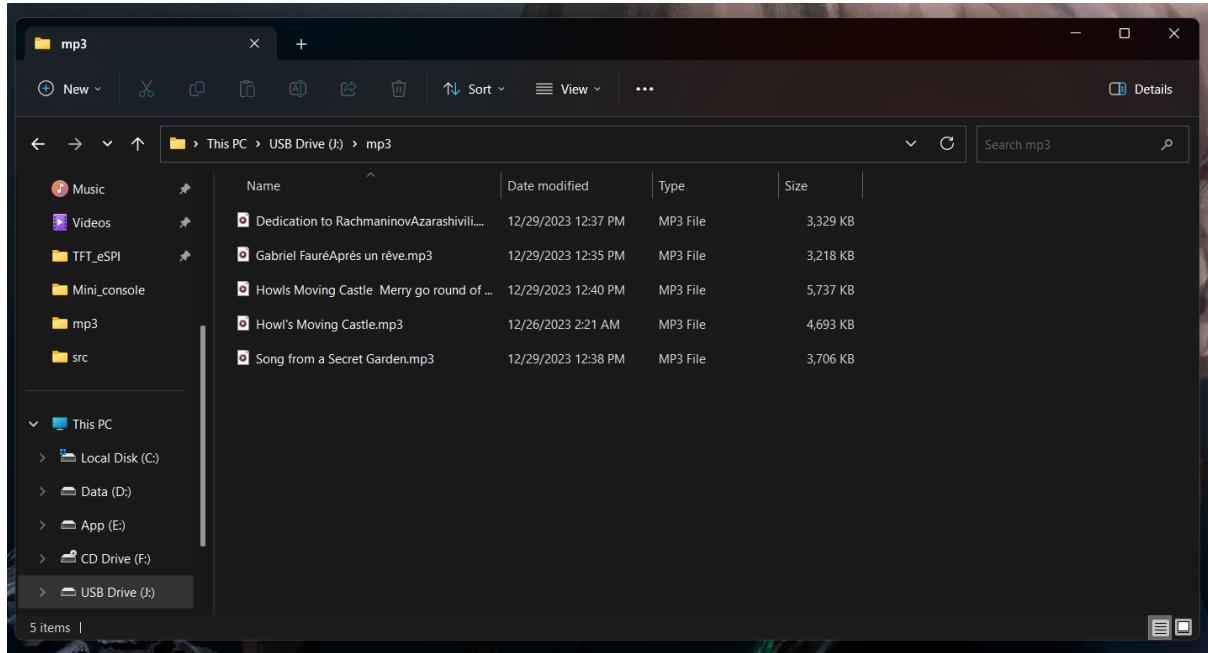
- **Folder esplay: includes data game save and firmware**
- **Folder mp3: includes MP3 file as audio**
- **Folder roms: includes game file**



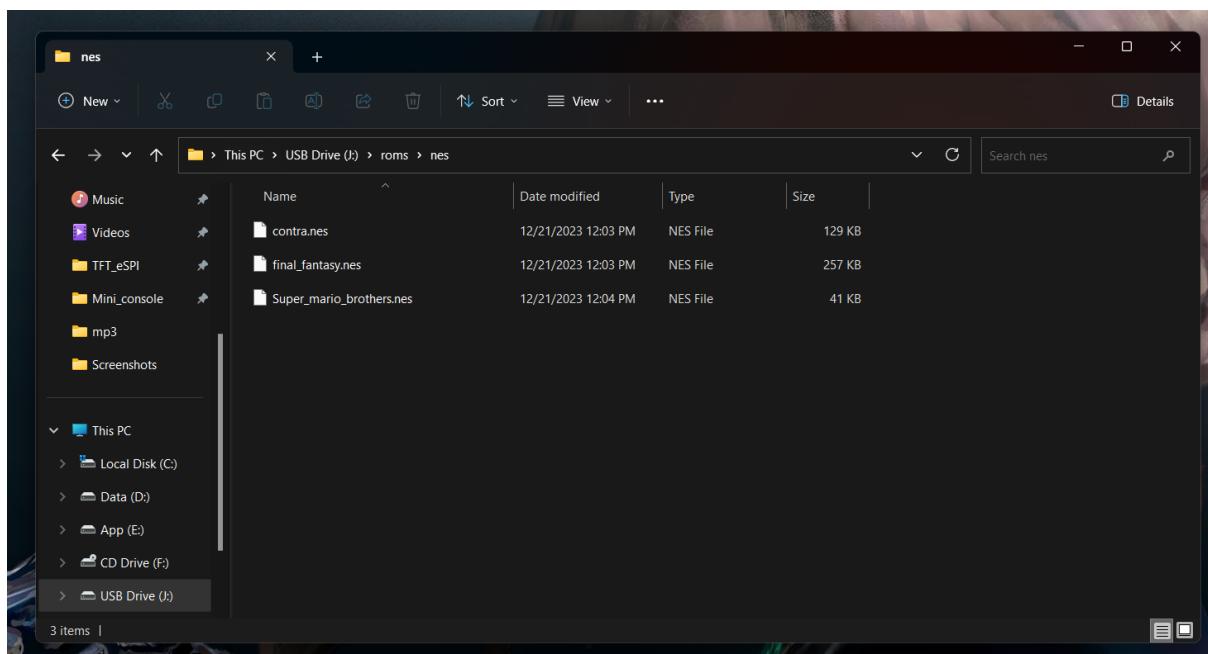
- Inside the firmware folder, there are 2 firmware files



- Game saved we had taken from some sources

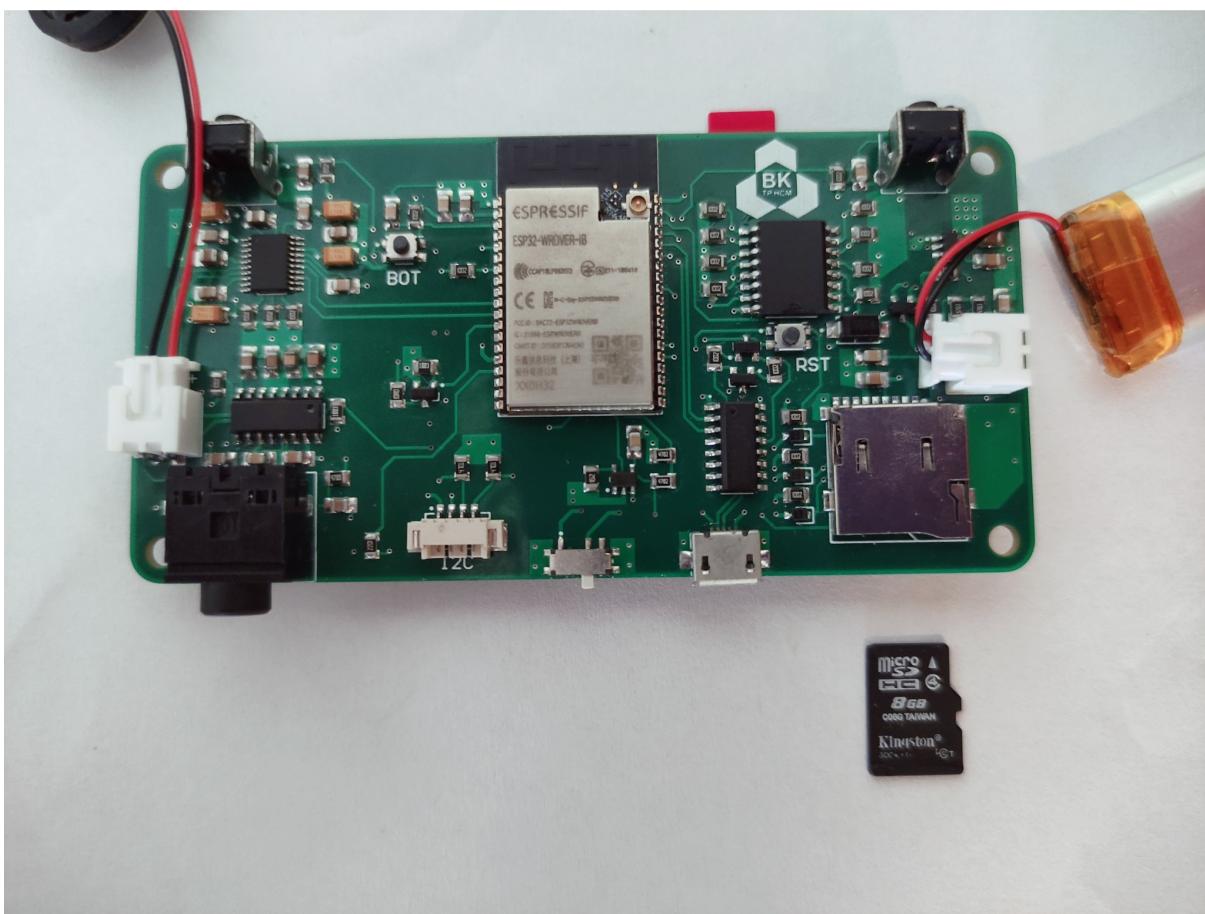


- MP3 file



- Some games as file.nes from Nintendo

## 2. Demo

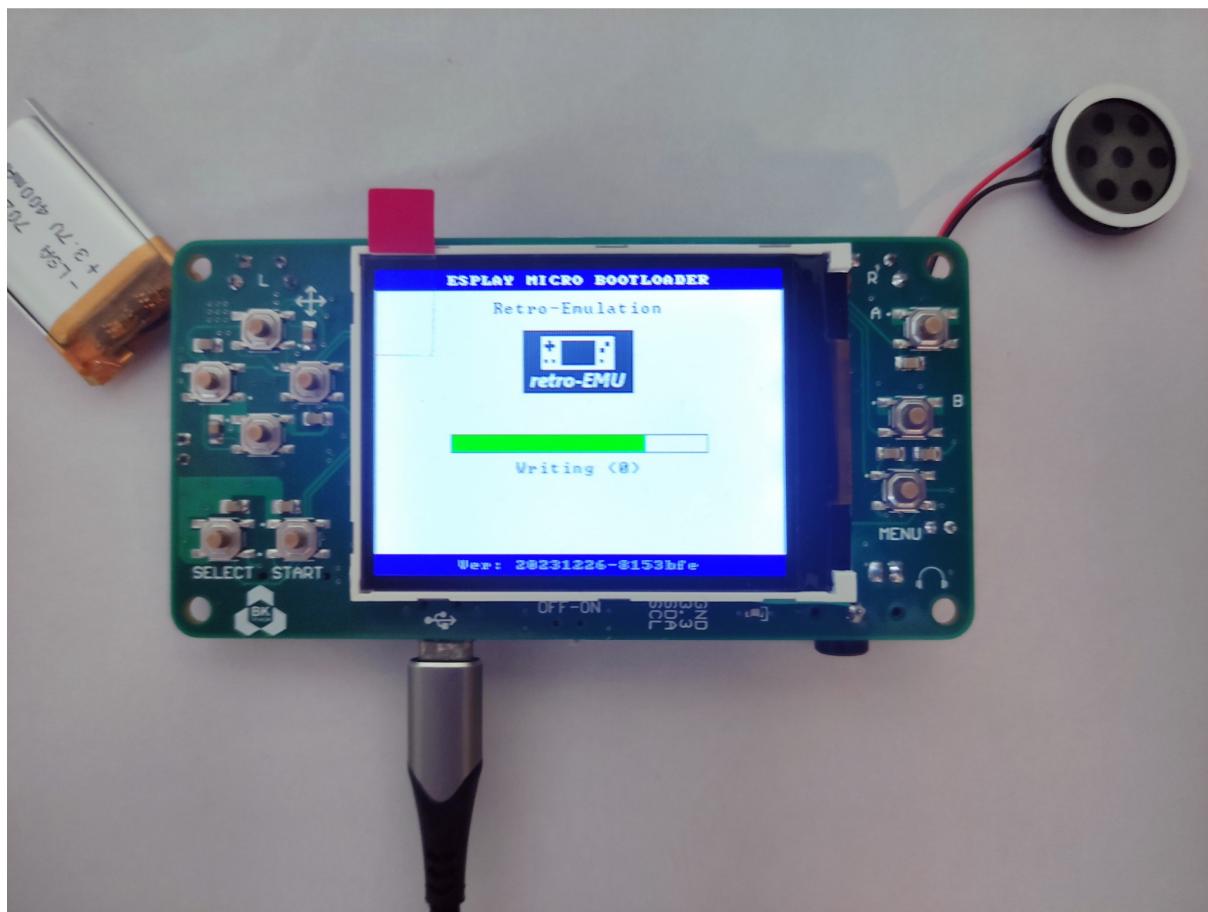


**Plug SD card**

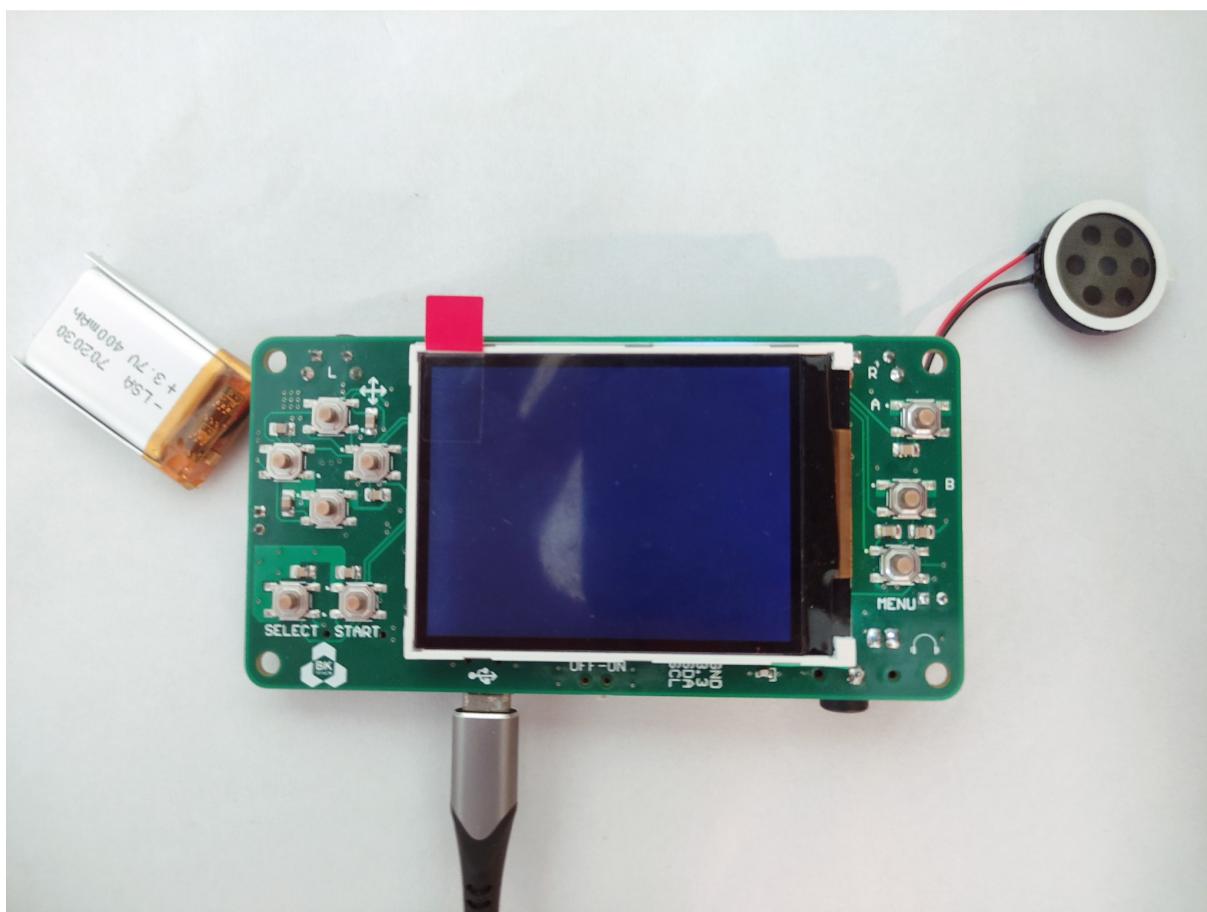
**Notice:** BOT is reset and RST is Bootloader



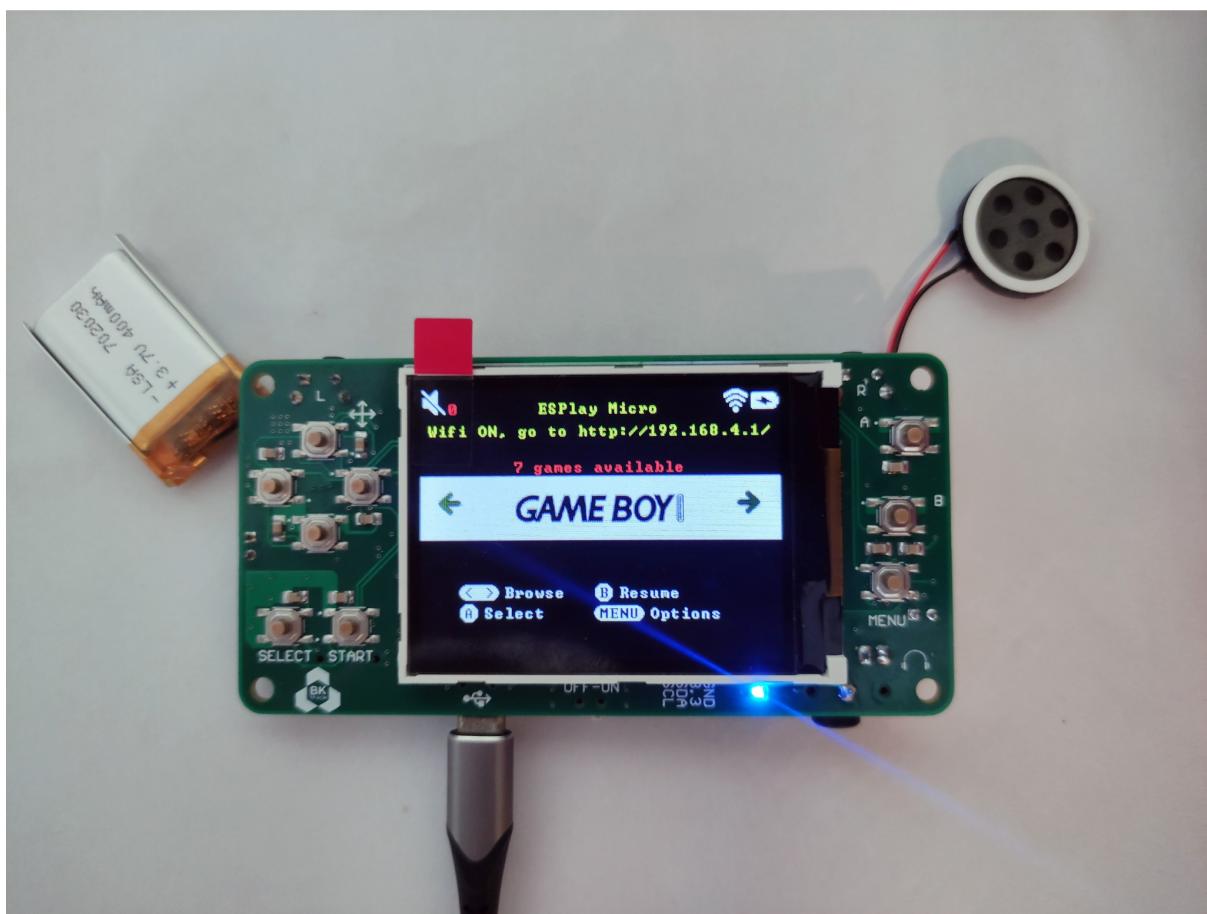
- After reset, please hold Menu button to turn on bootloader status
- Press A and Start to choose file firmware in SD card for bootloader
- Firmware MP3 player only supports for microphone



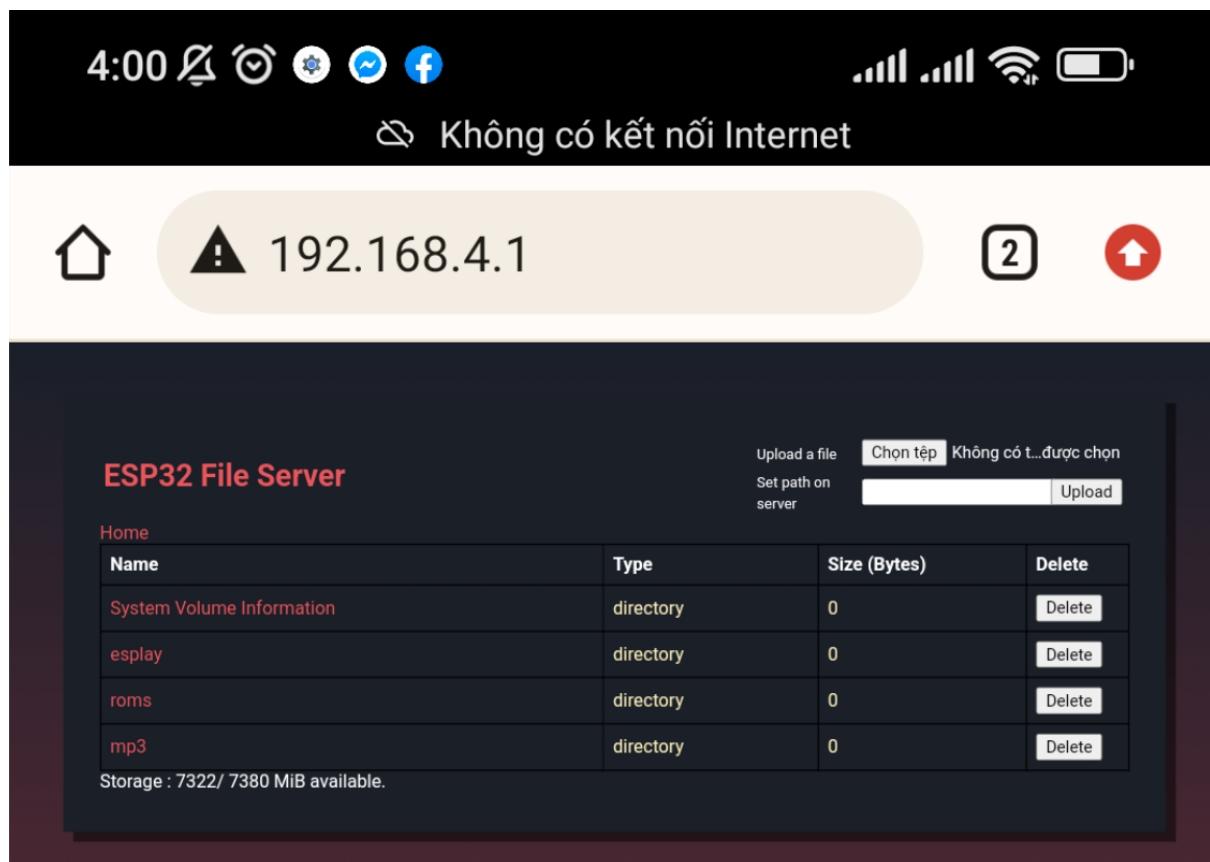
**Flash firmware**



**After flashing, please press the reset button**

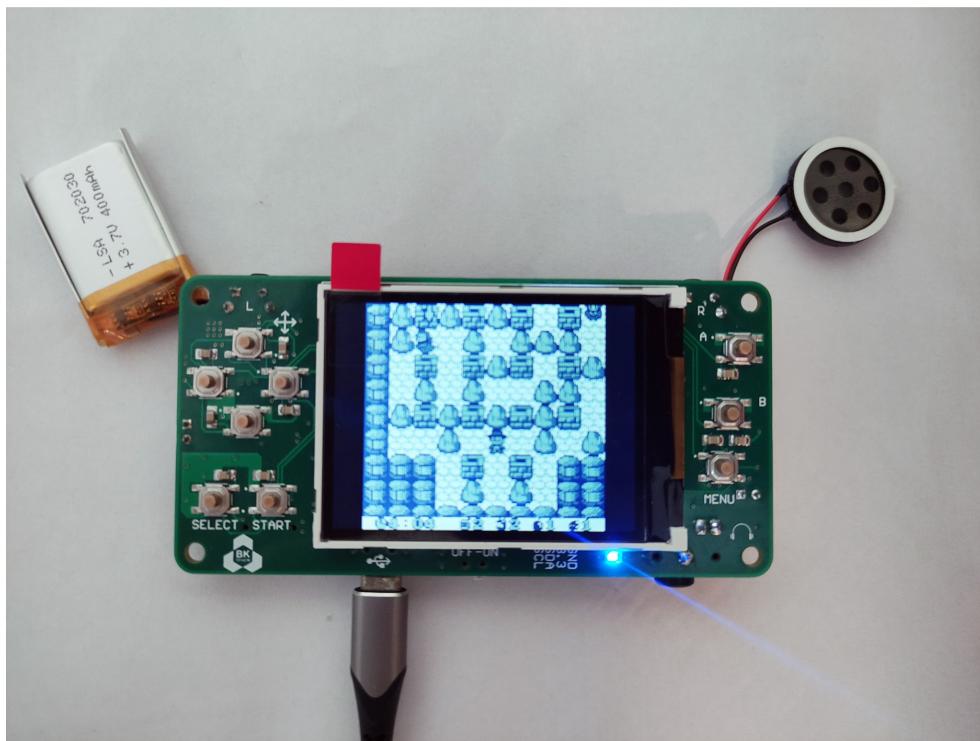


**Successfully loading the software**



**WIFI status to upload file wirelessly**

## V. RESULT IN PRACTICE



Full HD detailed video:

[https://drive.google.com/file/d/16fUWJGmK2uQfiekzWe\\_pELFI6ilC\\_O1l/view?usp=sharing](https://drive.google.com/file/d/16fUWJGmK2uQfiekzWe_pELFI6ilC_O1l/view?usp=sharing)